Enquiry for appointment of Design Consultant during tendering stage itself in regards to “Tender for Construction of civil, mechanical, and electrical works for pressurised pipe distribution network at Lower Pedhi Project including survey, planning and design of system, HSCADA, formation and capacity building of WUAS, and operation and maintenance for five years after completion”

We, Engineering Projects (India) Limited intend to participate in following Lump sum Basis tenders invited by Executive Engineer, Amravati Project Construction Division No. 1, Amravati Water Resources Department, Government of Maharashtra. (Estimated Cost: Rs. 24157.23 /- Lacs)

During the tendering stage, a Design Consultant, having experience in similar work for association with EPIL, is required who are having similar experience in Designing of Irrigation Projects which includes detailed estimate, complete survey of whole command area, fixing alignment of all pipelines network, design of RCC pump houses, all main and branch pipelines, road / railway crossings, All pumping machineries & required electrical equipment’s, HSCADA system along with preparation of BOQ, detailed estimate, drawings vetting of above with Amravati Water Resources Department etc. complete as per tender requirement of the department.

The design criteria is enclosed in Annexure A. Bidders are requested to quote their competitive price on lump sum basis including all Taxes/GST for providing the services during tendering stage as per the scope of work, detailed specification. Other terms and conditions is enclosed in Annexure-B

The sealed offer in two envelope (Envelope - 1 Technical Part, Envelope - 2 Price Part) which will be super scribed with the subject mentioned above and submit to the official address mentioned below to reach the office by 27.09.2018.

General Manager (Contract)
Engineering Projects (India) Ltd.,
(A Govt. of India Enterprise)
6A, 6th Floor, BAKHTAWAR,
Nariman Point, Mumbai – 400021
Tel No : (022) 22885900
E-mail : wromktg@engineeringprojects.com
Annexure B

Qualification Requirement

a) The Design Consultant firm should have experience of successfully Designed at least one completed similar works during the last 7 (seven) years

“Similar work” Shall mean “Design of Irrigation Project/Lift Irrigation/Pressurized Pipe Network & P.H.”

b) Should have GST Registration No. (Copy of GST Registration certificate to be enclosed).

c) Copies of valid PAN of income tax

d) Registration Certificate/Memorandum and Articles of Association/ Partnership Deed /Affidavit

Other Terms & Conditions

1. Selection of the Consultant shall be subject to thorough verification of their credential and inspection of similar works (if required) carried out / in progress by them, through a Technical Committee of experts.

2. The quoted rates shall be inclusive of all taxes, GST, duties, levies etc. applicable as on date of publication of NIT.

3. The consultant is required to submit invoice indicating details of applicable taxes separately.

4. Any variation in taxes after date of submission will be adjusted/reimbursed by EPI.

5. The rates quoted by the tenderer shall be firm.

6. EPI reserves the right to accept any tender or reject any or all tenders or annul this tendering process without assigning any reason and liability whatsoever and to re-invite the tender at its sole discretion.

7. Conditional Tenders is liable for rejections.

8. Validity of offer is 60 days from issue of LOI/WO.

9. Envelope - 2 Price Part will opened on same date if possible. EPI may not intimate to Bidders for the same.

10. The successful bidder shall have to submit base cost estimate of the work for consideration by EPI as EPI tender shall be submitted based on the details provided by the Consultant.
## Payment Terms

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<td>60% of Contract value on stage – 1</td>
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<td>After Verification &amp; necessary amendments of documents submitted from EPI Officials</td>
<td>As per Mutual Agreed time of EPI &amp; Consultant</td>
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CHAPTER - XIII

GENERAL

SPECIFICATIONS
CHAPTER XIII
GENERAL SPECIFICATIONS

1.00 SCOPE

The general specification shall apply to all the items covered under the scope of work mentioned in volume I and II of this Tender. Details are as given below

SCOPE OF WORK

Scope of work under this contract Envisages the following works.

SURVEY WORK-

1. Survey, planning and Investigation of whole Command Area, Alignment of all pipelines network up to 3 Ha area. Catchment area surveys, all River / nallas crossing, Survey for all inline structure using advanced equipment like Total Station, carry over of GTS bench mark from nearest GTS bench mark to command area including pump house location and construction of Permanent Bench Marks as directed by Engineer-in-Charge. Study and review of surveys available with department, if any. Various types of Investigation, Sub-soil exploration (Trial Pits and bore holes) for strata classification and foundation design purpose of various components of project. Study and review of core log data available for pump house location). All works to be executed as per relevant IS codes, Departmental codes / Circulars / GR received time to time. Preparation of Topographical map with grid survey with size 15 m or less and contour interval of 0.20m.

2. Collection and study of all village maps included in command of Lower Pedhi Project, relevant revenue / concerned VIDC land related documents for preparation of combined command map showing all features including Village boundaries, Roads, Railway lines, natural features like water bodies, Rivers, nallas, Forest area markings, etc., collection of Latest Land Record of each land holder etc. Preparation of Digitized command map WUA wise including all details as per MMISF Act, 2005.

All other surveys required for Building portion including soil investigation.

3. Drawing and Drafting of Survey data with latest and advanced software including incorporation of revenue data on drawings and printing as per
scale on good quality papers / tracings all as directed by Engineer-in-Charge. Also in soft copy with various formats in pen drive.

4. Getting survey work sanctioned from authorities concerned. All trial pit strata, bore hole data to be tested from Geologist and from laboratories and finally bought sanctioned from authorities concerned.

5. After sanctioning of all survey and investigation work, related document to be submitted to department in required number of Hard Copies and in soft copies as mentioned earlier.

6. The contractor shall tie up the survey grid of areas to be surveyed, all type of bench marks etc. with Latitude and Longitude. (GIS Based)

**PLANNING & DESIGNING**

1. Planning of entire scheme as per scope given and based on survey, carried out, & with available data, cropping pattern decided for scheme, water requirement of each crop based on local weather station data, studying of future change in cropping pattern due to adaptation of Micro irrigation and advanced agriculture practices, Minimum consumption of electricity, optimum utilization of water available and as per relevant IS codes, Government Circulars, etc.

2. Planning of each component of entire scheme should be such that the future maintenance cost shall be minimum, system shall be easy and hassle free to use, shall be easily adopted by WUA bodies and farmers / stake holders. Minimum utilization of resources like water, electricity, man power, and expenditure in whole life cycle of scheme, farmers should have maximum benefits in the form of increased quality and quantity of produce.

3. Planning of automation system shall be such that, it will collect daily weather data from established field weather stations and calculate daily water requirement. Based on daily weather data, weather history, type of crop and its water requirement and WUA requirements / inputs, pumping shall be optimised and entire pumps and entire system should run accordingly. It also includes crop field data collection farmer wise, chakwise in every season and plan irrigation system accordingly. Automation system shall be planned in such a way that data transfer or
exchange between user / farmer and system shall be easy, fast and error free. System shall be able to give alerts, bills, and messages to every stake holder. Also store data and prepare reports accordingly and as required. Automation shall be able to control or manage optimum utilisation of electricity and water available and avoid wastages. User friendly and highly encrypted software with easy accessibility from web through internet connection, long life and maintenance free hardware shall be used for automation. System shall be able to supply daily, weekly, fortnightly, monthly, seasonally and yearly complied data to department and specific user through email.

4 Integrated planning of 33 kV / 11 kV / 433 V OR 33 kV / 6.6 kV substation / switch yard as per system requirement suspension type transmission line and sub-station, components and accessories including complete HSCADA automation.

DESIGN & EXECUTION / CONSTRUCTION / SUPPLY

1. Design & Construction of various civil and structural, hydraulic components like approach channel, fore bay, RCC Pump house and its various components, compound wall, entrance gate & security cabin etc., all main and branch pipelines in distribution network, distribution network up to 3 Ha, all inline structures, all railway / road / River / nallas / pipeline crossings, farmers training centre and WUA main building, Roads all strictly as per relevant Indian standards, IRC standards, as per government circular / guidelines / GR etc., and all as per detailed scope, specifications, CDO code of practice, design guidelines and as directed by Engineer-in-Charge.

The system designed and constructed should be compatible to irrigate different types of crops, as government can’t enforce any cropping pattern on beneficiaries in the command and also compatible to use ground water available within the command as conjunctive use.

(Note: - The Pump house building shall be architecturally aesthetic, energy efficient, with minimum maintenance cost. Aluminium partition, inbuilt furniture, Air conditioning for panel & automation room, proper air ventilation and lighting shall be provided. Arboriculture and area
beautification including lawn preparation, tree plantation and water arrangements shall be provided. Separate lavatory blocks for ladies & gents, security cabin with rest room, external & internal electric supply, area lighting and drainage arrangements, firefighting arrangements, diesel generators of 10 KV A, security system with CCTV cameras, firefighting & safety arrangements including lightning arresters shall be provided. Parking facilities for visitors & working personnel shall be provided. Painting for pump house shall be 3 coats of plastic emulsion paint over a coat of primer and putty for internal surfaces and 2 coats of apex paint over primer for external surfaces. For steel / wooden surfaces, 2 coat of oil paint over coat of primer. Scope of farmer training centre and WUA main building as per detailed scope given. (All other Building component as per PWD Red Book)).

2. Design & construction, supply, installation, commissioning, testing of various energy efficient mechanical components like pumping machinery and allied electrical equipment’s, various valves, manifolds, surge protection system, anti-breaking system of pipe distribution network, all required for minimum discharge of 0.47lps / Hectare to irrigate 12230 Ha CCA with micro irrigation and as per relevant Indian standard code of practices & standard specifications.

3. Design & construction, installation, supply, commissioning and testing of various electrical components like 33 kV suspension type transmission line from Lalkhadi 132 KV substation to proposed pump house location at 33 kV / 11 kV / 433 kV OR 33 kV / 6.6 kV substation / switchyard and complete HSCADA automation at pump house location, all related components required to carry 3.90 MW load as per related electrical Indian standard codes, as per government circular / guidelines / GR etc., and all as per detailed scope, specifications and as directed by Engineer-in-Charge.

4. Design, supply, installation, commissioning of Various automation components of HSCADA system including centralised control units, all field units and their communication with centralised control unit, local weather station etc. and all as per detailed scope and specifications. Establishment of required number of local weather station in Command area of Lower Pedhi Project. Complete Automation of pumping components.
machinery for minimum electricity consumption using VFD panels etc. (License free band frequency of 865 to 867 MHz is permitted for wireless communication. If any permission from concerned department in this regard, shall be the responsibility of bidder).

5. Design, supply, installation, commissioning, testing of Micro Irrigation system for 0.47LPS / Hectare flow over 12230 hectare area (by drip irrigation system & by permanent Sprinkler system) as per Indian Standard and PMKSY guidelines and based on crop water requirement calculated by Modified Penmen Method as per detailed scope and specification.

**VARIOUS PROPOSALS & APPROVALS**

1. Contractor shall prepare necessary proposals seeking permission for all proposals like railway, roadways and pipeline crossings, etc. required during Lower Pedhi Project construction and getting it sanctioned from concerned authorities in stipulated time. Pursuing with these authorities for their approval etc., implementing condition if any imposed by them, etc. shall be the responsibility of contractor / bidder. There shall be no separate time or any extension regarding the same shall be given to contractor. Bidder shall quote his offer including all cost required towards fees to concerned department, if any and cost of structures required for crossing.

2. All statutory clearances from statutory authorities for commissioning of scheme within stipulated time.

**VETTING**

1. Vetting of all components designed for scheme from competent authority as directed by engineer in charge and final approval by Chief Engineer, special project, WRD Amravati.

2. Vetting period shall not be more than 1 month.

3. Bidder shall quote his offer including design and vetting charges.

- **THIRD PARTY INSPECTION OF ENTIRE SCHEME**

Third party inspection for mechanical, electrical, hydraulic, automation components are mandatory. Third party inspection agencies will be decided by the Chief Engineer, Special Project Water Resources
Department. Amravati, after the work is awarded (Contractor may suggest three names of reputed third party inspection agencies).

**ESTIMATION & APPROVAL**

Bidder shall prepare detailed estimate of each component of scheme based on approved design and drawing, approved alignments and based on latest DSR and get it approved before execution of work. Measurement of work shall be done according to approved estimate.

- **REPAIRS / OPERATION & MAINTENANCE, TRAINING**

1. Operation & maintenance period for entire scheme shall be 60 months (5 Years) including all types of repairs, replacements of electrical, mechanical, civil, automation equipment or components required for successful commissioning of scheme for all season i.e. for complete 12 months of year. (Even though in cropping pattern no provision is made for hot weather crops and also area under crops reduced for other seasons like kharif and rabi, contractor shall be ready for 12 months (365 days) irrigation facility on total 12230 hectare CCA as directed by Engineer-in-Charge time to time during O & M period).

2. O & M also consist of training of every stake holder for implementation of micro irrigation and adaptation of new farming methodologies and techniques for success of the scheme with contractors own cost. Bid amount shall be inclusive of the same. Detailed schedule of training along the bid document shall be submitted to Engineer-in-Charge. Detailed schedule of training shall be got approved from competent authority. Training regarding entire scheme operation including automation shall be given to WUA members and employees appointed by them during the O & M period so that after completion of O & M period, trained persons can easily operate and maintain the scheme successfully.

3. Defect liability period for entire scheme will be 5 years after completion of project all testing and successful trial run.

*(Defect liability period will start after successful testing, trial run)*
and commissioning of the scheme and operation and maintenance period will be simultaneous with defect liability period).

4. During last Two years out of Five years of maintenance period, handing over of distribution scheme with WUA’s and federations at canal / branch level & project level shall be done.

5. License free band frequency of 865 to 867 MHz is permitted for wireless communication. If any permission from concerned department in this regard, shall be the responsibility of bidder.

- COMMISSIONING / TRIAL RUN

After completion of scheme, trial run for 24 hours x 13 days entire scheme shall be done as per relevant Indian standards and code of practice.

- POWER CONSUMPTION

Power Consumption shall not exceed 3.9 MW in 15 years lifetime. For remote field units, solar panels with batteries (with minimum 3 days power backup facilities) shall be used.

- OTHER REQUIREMENTS

1. Fixing K.M. Stone at every 0.20 km, painting the same as per specifications of Water Resources Department, relevant I.S. code, I.R.C. Publications and circulars issued by the Department time to time, necessary structures required to meet-out effective and efficient regulation of discharge.

2. The bidder shall quote his price inclusive of crop compensation and rent for temporary land acquisition required, if any. Crop compensation and rent for temporary land acquisition will not be reimbursed to the contractor, in any case.

3. Execution of all other miscellaneous components or items required for successful commissioning and running of entire scheme throughout the life time of the scheme. Provision of infromatory sign Boards (Retro reflective type).

- FARMER TRAINING CENTRE BUILDINGS

Survey, planning, Investigation, design (Architectural & Structural),
vetting & Approval, Estimation, Construction of architecturally aesthetic, eco-friendly, energy efficient, two numbers RCC buildings at suitable location as per standard specification & as per national building code for Farmer Training Centre of **standard size** including all services like Internal & External Electrification, Internal & External Water supply, sanitary system, Furniture, arboriculture & area beautification, area lighting, water proofing treatment and anti-termite treatment, compound wall, gate & security cabin structure, parking facility for vehicles, area drainage and sewage disposal system, heat insulation of building, fire fighting arrangements, Rain water harvesting, Underground water tank, Internal Roads or paver blocks, Sound proofing and insulation for auditorium and lecture hall, miscellaneous items required for training centre like projectors and screens, sound systems, power backup generators, proper ventilation etc., on government land all as directed by Engineer-in-Charge.

**Components of the one building**

1. Auditorium cum conference hall of minimum capacity **250 persons**
2. Class Rooms - 02 Nos (Capacity 60 Persons Each)
3. Administrative office building (5 Rooms including toilets)
4. Soil testing laboratory - 1 Nos
5. Library cum information centre-01 Nos
6. Kitchen and Dining area (For serving of 250 People at a time)
7. Store room – 1 Nos
8. Separate Ladies and Gents Lavatory Areas
9. Rest suits - 02 Nos with attached bath & toilets including all furniture
10. Entrance lobby and porch including waiting area.

**ARCHITECTURAL PLANNING & RCC DESIGN OF BUILDING**

Bidder shall appoint architect consultant and structural consultant for planning and design purpose and get all Architectural & RCC, services etc., design & drawings approved from Superintending Engineer before execution of work. Auditorium shall be plan as per latest Indian architectural standards and Specifications including sound insulation and sound proofing arrangements. RCC design shall be based on standard code of practice and specifications. Execution of building shall be as per standard PWD specifications and practices.
Notes:

1. Area of parking, internal roads, compound, gate, security cabin, Bidder offer shall be inclusive of all these items.

2. Furniture shall include-
   i. Auditorium - 250 Nos of auditorium chairs with cushions, sofas, tables and chairs on stage, dais and boards, projector screen and inbuilt furniture required for auditorium.
   ii. Classrooms - Tables and chairs, Boards, projector screen etc. and inbuilt furniture required for all classrooms.
   iii. Administrative Building - Inbuilt office furniture with plywood, laminates and fixtures, glass, including tables, chairs, cupboards etc., aluminium partitions, as required for all rooms.
   iv. Kitchen and Dining - Seating arrangements including 250 plastic chairs of good quality and dining table.
   v. Soil testing laboratory - Granite & Kota stone plat forms, inbuilt office furniture with ply-wood, laminates and fixtures, glass including tables, chairs, cupboards etc. all required.
   vi. Library cum information centre - computer tables and chairs, aluminium partition, library cupboards and office furniture with plywood, laminates and fixtures, glass including tables, chairs, cupboards etc.
   vii. Store room - inbuilt cupboards with plywood, laminates and fixtures and locks etc.
   viii. Lavatory blocks - big size mirrors and other necessary furniture.
   ix. All windows, required doors and openings shall provide with curtains or venetian blinds.
   x. Wall panelling, false ceiling or POP shall be provided in administrative block, auditorium, rest suits and other required area.

3. All services and arrangements provided in farmer training centre shall be based on minimum 250 person capacity at a time basis.

4. All internal Electrification shall be concealed type and all materials and fittings shall be as per standard specifications and approved makes. External electrification including area lighting shall be as per Indian code of practice and standard specification. Material used for internal & external electrification shall consume minimum electricity and shall have good life (e.g. LED tube lights and bulbs).

5. Internal water supply shall be with concealed plumbing and fittings shall
be of approved make with longer life. Overhead water tank shall be sintex or equivalent make. HDPE pipes shall be used for concealed fitting.

6. Minimum 3 computers with LED screen and Projector and sound system with good quality speaker shall be provided for all classroom and auditorium. (Computer and LED projectors with latest configurations with i5 Intel processor and approved by Engineer-in-Charge).

7. Separate Parking for 4 wheelers and two wheeler with hard floor shall be provided.

8. Area beautification and arboriculture consists of tree plantation, Lawn preparation for area not less than 100 Sqm and architectural symbols and monuments in open area with minimum 1 fountain in front of auditorium porch portion and other miscellaneous components like watering arrangements, etc.

9. Flooring - shall be of vitrified tiles of min size 2'x2', entrance portion and stairs shall be of marble / granite. Lavatory portion - Glazed / ceramic / vitrified tiles. For all doors and windows granite / marble shall be used all around.

10. Doors & Windows, Ventilators
Main entrance Door - Wooden with grills, internal- Laminated Doors, Lavatory Blocks - PVC
Windows - 3 track aluminium sliding windows with steel grills
Ventilators - aluminium with MS grills
Security Gates / Entrance Gate - MS
Stair and other railings - Stainless-steel

11. Painting & Finishing
Internal - 3 Coats of Plastic emulsion paint with white primer and wall care putty
External - 2 coats of apex paints with white primer.
Structural steel items- red oxide primer with 3 coats of oil paints
Wooden items - Primer with two coats of oil paints.
(Note that all paints shall be of approved make and as directed by Engineer-in-Charge.)

12. Water Proofing Treatment – Brick bat coba with plaster or APP membrane.

13. Air & Light ventilation and sound proofing shall be done as per provisions

14. Diesel generator power backup of 25 KV A capacity, solar water heater for rest suits, inverters with battery backup, 02 no’s water bore wells, water purification and cooling system for 250 persons, security system with CCTV cameras, decorative items in veranda / lobby etc. shall be provided.

15. All material and methodology, treatment shall be modern and latest. Above mentioned requirements are minimum, bidder shall plan and construct best and international standards farmer training centre which fulfils present and future needs of farmers training.

16. Green Building materials shall be used.

17. Defect liability period of the building shall be 5 years after completion of building portion.

18. Operation & Maintenance of training centre building for 5 years after completion of actual work of Lower Pedhi Project. Security services are included in O & M.

19. After successful completion of 5 years of O & M period, building with all infrastructure & amenities shall be handover to department in good condition.

20. Obtaining necessary all permission, services or connections from local municipal bodies, MSEDCL, fire safety department shall be the responsibility of contractor including all required fees, deposits etc. Contractor shall include amount of all items in the bid itself.

**WUA MAIN BUILDING**

Survey, Planning, Investigation, Design (Architectural & Structural), Vetting & Approval, Estimation, Construction of architecturally aesthetic, Eco-friendly, energy efficient RCC Building as per standard specifications as per National Building Code for Water User Association Main Building of standard size including all services like Internal & External Electrification, Internal & External Water supply, sanitary system, Furniture, arboriculture & area beautification, area lighting, water proofing treatment and anti-termite treatment, compound wall, gate, parking facility for vehicles, drainage and sewage disposal system, heat insulation of building, firefighting arrangements, Rain water harvesting,
Underground Water Tank, paver blocks around building, on government land as directed by Engineer-in-Charge.

**Components of building**

1. Administrative area
2. Conference cum meeting room of standard size as directed by Engineer in charge.
3. Store room.
4. Separate Ladies and Gents Lavatory blocks
5. Entrance lobby and porch including waiting area.

**Architectural Planning & RCC Design of Building**

Bidder shall appoint architect consultant and structural consultant for planning and design purpose and have all Architectural & RCC, services etc., design & drawings approved from Superintending Engineer before execution of work.

RCC design based on standard code of practice and specifications.

Execution of building as per standard PWD specification and practices.

**Notes:**

1. Furniture includes tables & chairs for office, inbuilt cupboards in all rooms with plywood, laminates and fixtures, glass tops, etc. Wall panelling and POP ceiling, aluminium partitions in all rooms except store, lobby, porch and lavatory area. Lavatory blocks - big size mirrors and other necessary furniture's.
2. All windows, required doors and opening shall provide shall be with curtains or venetian blinds.
3. All internal Electrification shall be concealed type and all materials and fittings shall be as per standard specifications and approved makes. External electrification including area lighting shall be as per Indian code of practice and standard specification. Material used for internal & external electrification shall consume minimum electricity and shall have good life (e.g. LED tube lights and bulbs).
4. Internal water supply shall be with concealed plumbing and fittings shall be of approved make with longer life. Overhead water tank shall be of sintex or equivalent make. HDPE Pipes shall be used for concealed fitting.
5. Separate Parking for 4 wheeler and two wheeler hard floors shall be
6. Area beautification and arboriculture consist of tree plantation, Lawn preparation for area not less than 50 Sqm and architectural symbols and monuments in open area with and other miscellaneous components like watering arrangements etc.

7. Flooring - shall be of vitrified tiles of min size 2’x2’, entrance portion and stairs shall be of marble / granite. Lavatory portion – Glazed / ceramic / vitrified tiles. For all doors and windows granite / marble shall be used all around.

8. Doors & Windows, Ventilators
   Main entrance Door - Wooden with grills, internal- Laminated Doors, Lavatory Blocks- PVC
   Windows - 3 track aluminium sliding windows with steel grills
   Ventilators - aluminium with MS grills
   Security Gates / Entrance Gate- MS
   Stair and other railings - Stainless-steel

9. Painting & Finishing
   Internal - 3 Coats of Plastic emulsion paint with white primer and wall care putty
   External - 2 coats of apex paints with white primer.
   Structural steel items - red oxide primer with 3 coats of oil paints
   Wooden items - Primer with two coats of oil paints.
   (Note that all paints shall be of approved make and as directed by Engineer-in- Charge.)

10. Water Proofing Treatment – Brick bat coba with plaster or APP membrane.

11. Air & Light ventilation and sound proofing shall be done as per provisions in National Building Code 2005.

12. Investors with battery backup, water bore wells etc. shall be provided.

13. All materials and methodology, treatment shall be modern and latest. Above mentioned requirements are minimum, bidder shall plan and construct best and international standards building which fulfils present and future needs of water user association.

14. Green Building materials shall be used.

15. Defect liability period of the building shall be 5 years after completion of
building portion

16. After completion of construction, building with all infrastructure & amenities shall be handed over to department or WUA in good condition as directed by Engineer-in-Charge.

Farmers training centre at both flanks & WUA main building are to be constructed.

- **COLLECTION OF WATER CHARGES INCLUDING ELECTRICITY CHARGES FROM WUA / FARMERS.**

  Contactor shall recover water charges including electricity charges from farmers / WUA and deposit the same to the office of Executive Engineer, Amravati Project Construction Division during the maintenance period of 5 years. (Engineer’s / Staff from the department will assist for collection of charges from WUA / farmers).

- Bids not covering the entire scope will be treated as **non-responsive** and will be liable for rejection

  - **SCOPE OF QUALITY CONTROL FOR ENTIRE WORK.**

    Quality control of work will be done by Superintendent Engineer, Quality Control Circle, Nagpur and his authorised persons.

    Quality control of work shall be done as per relevant BIS Codes, specifications, Quality control manuals, water supply manuals and all as directed by Engineer - In-Charge.

**Criteria for Design of the scheme**

This is a 'C' contract. Bidders are required to Design and Implement the complete project with detailed survey, investigation and design. Bidders shall therefore submit details of Technical design proposal with drawing and work method, construction schedule backed with their planning and deployment of construction equipment etc. in sufficient detail to demonstrate the adequacy of bidder’s capacity to design and complete the works in accordance with the specifications and time limit. He should submit his best techno-economic design proposal. This shall be evaluated as to Technical feasibility and feasibility for completion in the given time period. Only Technically feasible proposal which can be completed within the time period specified in the tender and which meets the
Technical standards and specified conditions mentioned in this tender shall be considered as responsive.

It may be noted that certain design criteria are fixed in this tender and the bidder has to design within the ambit of this criteria only. However the design submitted by the bidder at the POST-QUALIFICATION stage shall not be binding on the VIDC, Nagpur / Government and the Final design shall be approved by Chief Engineer, Special Project Water Resources Department, Amravati with such modifications and alterations as may be deemed fit in the interest of the project and interest of the state and to bring the design as per with the required IS or other standards and requirements of this tender and project. Successful bidder shall have no right of any claim whatsoever for any such changes as may be directed by Chief Engineer, Special Project Water Resources Department, Amravati.

1 Work includes Review of available survey and investigation data, identification of additional survey and investigation requirement considered necessary for design, execution and commissioning and operation of the pressurized pipe distribution network. Preparing combined village map on tracing cloth for pressurized pipe distribution network separately. Survey of whole command area, plotting the same on combined village map, contouring the village map, marking ridges by red dotted lines and valleys by blue arrow lines, survey for fixing alignment, taking trial pits, drilling bore holes along the alignments wherever necessary. Marking the approved alignments, chak boundaries and other structures on the village maps, preparing chak statements, outlet register, cut-off / design statement, design-drawing of the pressurized pipe distribution network as per design criteria of Water Resources Department, relevant Indian standard codes and IRC publications, circulars issued by the department time to time, preparing detailed estimate as per CSR of the department on the basis of approved design and drawing. Clubbing of items for record measurement and basis of payment, getting approval from competent authorities.

The work components requiring permanent land acquisition should preferably be constructed on Government land available

Catchment area survey, grid survey, levelling along the nallas / river to determine the bed slope of the nallas / river, cross section of nallas / river for cross drainage works, grid survey for other structures such as railway crossings, road
crossing and taking trial pits / drilling bore holes for foundation investigation of structures, design-drawing of structures as per design criteria of Water Resources Department, relevant Indian standard codes and IRC publications, pressurized pipe distribution network parameters and circulars issued by the department time to time, preparing detail estimate as per DSR of the department on the basis of approved design-drawing, getting approval from competent authorities.

Wherever pipe line system is crossing railway line or Highways or Roads or other restricted area, the contractor has to prepare, necessary proposal for seeking permission of concerned authority. The Engineer-in-Charge will process such proposal to railway or highway or Road or other departmental authority concerned for taking up the work under ‘C’ Contract if the work is executed as a deposit work by the concerned department, the amount demanded by the railway authorities or concerned authorities will be paid by the department and shall be recovered from the next running bill of the contractor. The contractor shall include such cost in the bid price.

For establishing water users associations and federations on canal / branch level & project level as per MMISF Act, 2005 for CCA 12230 ha. of command area under this contract, all works up including preparation of voter list of cultivators based on revenue records with due marking for the area of water users association and territorial constituencies is to be prepared on village map by ‘C’ Agency. The contractor shall include such cost in the bid price.

The monitoring up to outlet from Head regulator shall be done by Supervisory Control and Data Acquisition (HSCADA) through well-equipped single control room at suitable location shall be established by contractor for this scheme. The power supply arrangement for operation of SCADA and valves, flow meter shall be made by providing suitable solar panels with battery backups along with the rising main / underground pipe line. Alternative power supply system shall be established by providing automatic operative generators. The contractor will obtain necessary permissions from Government of India for use of required frequency for operation of HSCADA and the cost on this account shall be borne by the contractor.

The bidders are advised to study all the details of existing power supply to be brought from Lalkhadi 132 KV substation and provide any additions /
modifications in the switch yard at his own cost for getting power directly from Lalkhadi 132 KV substation to pumping stations for the running of the scheme. Any additions / modifications and providing of transformers, cables, HT / LT line and related components shall be within the scope of the work. The power to proposed pumping stations are to be provided by this dedicated line and cost of providing HT / LT power line, transformers, sub-stations for pumping station shall be borne by the contractor. The necessary permission for laying / erection of suitable power lines as the case may be, shall have to be obtained by the contractor from statutory safety & regulatory bodies governing on electrical erection and transmission. The illumination of working area is to be provided by this dedicated line and alternately diesel generating sets shall be provided at all suitable locations for illuminations during non-running hours of HT power line. However, the cost of security deposit, supply affording charges and new transformer at HT supply start point if required by M.S.E.D.C.L / M.S.E.T.C.L. Transmission Company shall be borne by VIDC, Nagpur.

Disposal of surplus excavated material after refilling of pipe trenches shall be done as per direction of Engineer-in-Charge with all leads and lifts.

Bidders shall submit with the post-qualification documents and financial bid, the proposal for conceptual Technical design, Pressurised pipe distribution network and disnet up to chak 3 Ha irrigate 12230 ha CCA, but the scope of work requires that the pressure head at each 3 ha outlet shall not be less than 15 m to run drip and sprinkler system both. In any case the total power required should not exceed 3.9 MW. The system designed and constructed should be compatible to irrigate different types of crops, as government can’t enforce any cropping pattern on beneficiaries in the command and also compatible to use ground water available within the command as conjunctive use. The detail design should include the parameters specified in the volume-I and also as above. Details of pipe, length and diameter of pipeline, power required for pumping station, efficiency of pumps, type of pumps, static and dynamic head calculations in detail used for design of entire system, HT substation specifications, work methodology, construction schedule backed with details of planning and deployment of construction equipment with sufficient details to demonstrate the adequacy of bidder’s capacity to design and complete the project work in accordance with the specifications and within the stipulated time period.
Note: Design and Vetting Charges of entire Scheme shall be borne by the contractor. The contractor shall include such cost in the bid price.

The ultimate aim of the scheme is to irrigate 12230 ha. CCA (by drip & sprinkler system) as per the index map attached in the tender document volume-III.

Necessary safety measures and fire fighting arrangements shall be established in the pump house.

Necessary safety sign boards / Informatory Sign Board will be displayed at work site on suitable location as per directions of the Engineer in-charge.

c. Guidelines for Design

Bidders should submit proposals regarding proposed work method, construction schedule backed with their construction equipment planning and deployment in sufficient detail to demonstrate the adequacy of bidder’s capacity to complete the works in accordance with the specification and time of completion. The bidders are required to submit conceptual Technical Proposal with post-qualification proposal. However the design submitted at the bidding stage shall not be binding on VIDC Nagpur / Government of Maharashtra and would subject to such modifications as may be deemed fit in the interest of the state and VIDC and/or such modifications as may be necessary to bring the design at par with the requirements of this tender or such national standards prevalent for such materials and construction (IS, BS, CPHEEO) and the bidder's final design will be subject to the approval of the Chief Engineer, Special Project Water Resources Department. Amravati,

Wherever standards do not exist for a particular item of material or construction or specific requirements for them have not been given in this tender, then the same shall be adopted as per the nearest standard in the same code or in absence of such standard in that code from equivalent international codes as the Chief Engineer, Special Project Water Resources Department. Amravati, may deem fit. Wherever specific standards or requirements in specification are given in this tender they shall prevail over the prevalent standards specifically.

1.1 GENERAL DESCRIPTION OF THE PROJECT

a. All types of survey, planning of entire system, designs, drawings, vetting from concerned authorities.
b. Construction of pump houses, and its components, control rooms, internal roads in pump house area, compound wall & mild steel gate.

c. Execution of underground pressurized pipe network up to chak 3 Ha.sub chak including main lines, branch lines, manifolds, primary & secondary filtration units, suitable anti-surge devices, all inline structures like thrust / anchor blocks & encasings, railway, highway and pipe line crossings, all types of valves, water measuring devices and all accessories.

d. Supply, installation, commissioning and testing of electric 33 kV suspension type transmission line using RSJ Pole (152 mm x 152 mm) from M.S.E.T.C.L / M.S.E.D.C.L, Lalkhadi 132 kV substation to proposed switch yard near pumping station. Design, supply, installation, commissioning and testing of 33 kV / 11 kV / 433 V OR 33 kV / 6.6 kV substation / switch yard as per system requirement etc. with all accessories & with complete HSCADA automation and getting all clearances from statutory authorities.

e. Supply, installation, commissioning and testing of suitable pumps and motors with all related electrical & mechanical components of pumps, pump house and accessories.

f. Supply, installation, commissioning and testing of web based SCADA automation system to control entire system including pumps, filters, surge devices, valves & wireless field control units.

g. Distribution Network up to chak 3 Ha. Sub Chak with minimum 15 m residual head for Micro Irrigation.

h. Construction of Two numbers Architecturally aesthetic RCC Farmers Training center of standard size as directed by Engineer-in-Charge each at suitable locations and WUA main building as per relevant standards and specifications.

i. Formation of Water User Associations and federations as per MMISF Act, 2005 for total command considered under this scheme.

j. To conduct farmers awareness training programme for effective functioning of the scheme and capacity building of farmers.

k. Preparation of demo plots for on farm demonstration of farmer at the start of work, with contractor's own cost. (minimum 10 ha area per WUA within command)

l. All other miscellaneous works required for commissioning of entire scheme
as directed by Engineer-in-Charge during execution.

m. Power consumption should not exceed 3.9 MW in 15 years lifetime.

n. Commissioning, flushing of entire pipe network & testing of entire system after execution.

o. Operation & maintenance of complete commissioned system for 5 years after completion of the project. During last Two years out of Five years of maintenance period, handing over of distribution scheme with WUA’s shall be done.

p. Preparation of railway, highway or road proposal and getting sanctioned from concerned authorities.

q. Preparation of proposals for all required statutory clearances from authority concerned and getting it sanctioned.

The Salient features of the Lower Pedhi Project are given

1.1.1 WORK AND SITE CONDITION

It shall be presumed that the Contractor has acquainted fully himself as to the nature and locations of work, general and local conditions and particularly those having bearing on approaches to the site, locations of stone and sand quarries, availability and transport of material, tools and plants, machinery, disposal areas, availability of labour, weather conditions and river stages, etc. and has estimated his cost accordingly. Corporation shall bear no responsibility for any lack of such acquaintance with site conditions on the part of the Contractor and the consequences thereof to the Contractor. The information and data about site conditions shown in the drawings and mentioned herein is furnished as a rough guideline only but Corporation shall not be responsible for the accuracy thereof or for any deductions, interpretations and conclusions drawn there from by the Contractor.

1.1.2 CLIMATIC CONDITIONS

The information is given in Section I in volume-I of work specific information.

1.1.3 AVAILABILITY OF LABOURS

Some local unskilled labour may be available during non-agricultural season but skilled labour may not be available Contractor must however make his own enquiries.

1.1.4 LOCATION

The information is given in Section I in volume-I of work specific information.
1.1.5 RAIL ROUTE
The information is given in Section I in volume-I of work specific information.

1.1.6 ROADS
The information is given in Section I in volume-I of work specific information.

1.1.7 WATER SUPPLY
The Contractor shall have to make his own arrangements for the water supply required for his work, staff and labour. He shall have to provide all arrangement for making water potable and safe for drinking by his staff, labourers and other dependents on Contractor’s services. Disinfections of all drinking water by chlorination shall be obligatory, on the part of the Contractor.
Fresh and potable drinking water shall be made available by the Contractor to all persons working at work spots in clean and hygienic earthen or other pots at all working places and in sufficient quantity.

1.2.0 ELECTRIC POWER
Electric power, if required for construction of work and at the camp office & labour colonies shall be arranged by the Contractor at his own efforts and cost and he shall have to make his own arrangements for laying, installation, maintaining the power lines, etc. he should observe all requirements of the Indian Electricity Act, 1910, 1948. Indian Electricity Rules 1956, and rules in existence and framed from time to time, failure to which Corporation accepts no responsibility for any damage, injury or compensation.

1.3.0 TELEPHONE AND TELEGRAMS
The information is given in Section I in volume-I of work specific information.

1.4.0 COLONY
ESTABLISHMENT OF COLONY
The Contractor shall be allowed to construct his own colony for his workers and supervisory staff within the limits of VIDC land, if available.
The land used by the Contractor for his staff and labour colony shall be handed over back to the VIDC within three months after the physical completion of work
or termination of the contract whichever is earlier duly cleared and fairly brought to the original condition. No structures or constructions shall be left on the land at the time of vacating it without the specific approval of the Engineer-in-charge. The Contractor shall prepare and submit his proposed plan of colony layout and get it approved from the Engineer-in-charge before establishing any colony for the Labours or for the supervisory staff. The Contractor shall have to construct and maintain all access and approach roads etc. in his colony areas at his own cost. Any modifications, changes and alterations suggested by the Engineer-in-charge in respect of area of colony, layout of roads etc. shall be binding on the Contractor and shall have to be done at his cost.

1.4.1 SANITATION AND UP-KEEP OF COLONY

The Contractor shall be responsible for maintaining satisfactory water supply and sanitary facilities in his labour camp and for his other staff. He shall take precautions not to allow any unhealthy and unsanitary conditions in his camp. The Engineer-in-charge shall have the right to inspect the Contractor’s colonies at any time and to suggest improvement, modification etc. with special regards to cleanliness and sanitation, sullage water and garbage disposal, any other nuisance, and proper layout, which shall be binding on the Contractor. The Contractor shall provide adequate number of portable chemical closets for use, and urinals and water closets, and make proper lighting and scavenging arrangements to the satisfaction of Engineer-in-charge. Separate arrangements should be made for female labour.

1.4.2 CAMP REGULATIONS

The Contractor shall be responsible for maintaining law and order in his camp and on his work and to that end shall employ such officers, watchmen labour etc. as required. Unauthorized and undesirable persons shall be expelled from the camp and from the works. If in the opinion of Engineer-in-charge any employee or agent of the Contractor misbehaves or causes obstruction in proper execution of work or otherwise makes him undesirable, the Contractor shall on receipt of instructions from the Engineer-in-charge remove him from premises.

1.4.3 MEDICAL AID:
The Contractor shall arrange all the necessary medical facilities for his staff and labour at his own cost and to the satisfaction of the Engineer-in-charge.

1.4.4 GENERAL

The cost for sanitation and supply of drinking water is deemed to have been included in the unit rates of items of work. All other details given in Volume-II.

1.5.0 MATERIALS

1.5.1 PETROL OIL AND LUBRICANT

The Contractor shall have to install his own supply for petrol and diesel at the site the location of pumps shall have to be got approved from the Engineer-in-charge and usual precautions which are necessary, for such installation shall have to be taken by the contractor.

1.5.2 STONE FOR RUBBLE MASONRY AND FOR METAL

The Contractor shall make his own investigation regarding location of quarries, quality of stone and adequacy of the various sources of stone in quarry areas known to him. It is for Contractor to investigate the quarries which shall yield stones in sufficient quantities and of required quality. Over burden on quarry shall have to be removed by the Contractor at his own cost. The locations of quarries have to be such that they do not affect permanent structures and should not be near the existing or proposed habitations. The locations and size of the quarries shall be subject to the approval of the Engineer-in-charge. If quantities on its opening does not yield adequate or suitable stone, no claims can be raised against the Corporation. In that case other quarries shall have to be established by the Contractor at his own cost and risk and the stone got approved from the VIDC for its quality before using it in the work.

If the quarries located are in private properties, the Contractor shall negotiate with the respective owners and shall attend to legal rights and attend to payments etc. to the concerned parties for operations of these quarries at his own cost. Similarly, he shall make arrangements for roads leading to and from the stone quarries to the work site at his own cost.

1.5.3 SAND
The Contractor is advised to make his own enquiries regarding adequacy, proper quality and cost of sand and approaches to quarries, etc. The Contractor shall, however obtain permission from revenue and other authorities before removing the material and shall pay royalty and other taxes. Octroi duty, escort fee, if any for sand which shall not be reimbursed.

The Contractor shall have to make his own enquiries regarding legal rights and attend to the aspect of payments due, etc. for the operation of the quarries. The extent of annual replenishment of the sand sources is unknown. The Contractor may therefore choose to collect the sand in advance of its use for the work. The Contractor shall make his own arrangements for quarrying and transport of sand from the quarries to the work site. Approach roads to the quarries shall also be constructed and maintained by the Contractor at his own cost. All the cost of transport of sand shall be borne by the Contractor and no claims on this account shall be entertained. Use of crushed sand conforming to the required gradation and specifications can be permitted with specific approval of the Engineer-in-charge.

1.6.0 PRECAUTIONS DURING THE FLOODS

It shall be responsibility of the Contractor to preserve and maintain in safe condition all materials, machinery and tools from floods and rain and no compensation whatsoever shall be payable to him on account of loss due to floods, rain and any other causes.

1.7.0 CONTRACT DRAWINGS AND SPECIFICATIONS

On acceptance of the tender, sets of copies of contract conditions and drawings (if any) to a maximum of one, shall be supplied to the Contractor free of charge. Being "C" contract, all approved drawings after final vetting shall be the part of contract document. Actual work done / execution shall be based on these approved drawings only.

The drawing which form part of this contract, show the work to be done in such details as is possible to do for the present. They shall be supplemented or superseded by such additional detailed working drawings as may be necessary as the work progresses. The Contractor shall carry out the work in accordance with these additional or revised working drawings, as the case may be and at the applicable rates as per the contract.
The Contractor shall check all drawings carefully and advise the Engineer-in-charge immediately of any errors or omissions discovered. The Contractor shall not take advantage of any kind of errors or omissions in the approved drawings supplied to him.

1.8.0 EMBEDDED ITEMS

Before placing concrete and of masonry, care shall take to see that all embedded items are firmly and securely fastened in place as indicated on the drawings or as directed. All embedded items shall be cleaned free from all foreign matter such as scale, rust, oil paint etc. The Contractor shall be responsible for correctly embedding the part as directed without any charge, the cost of such embedding being deemed to have been included in the items of contract and or masonry as the case may be; no extra payment shall be made for the installations of this embedded work for delays, or for interruptions arising there from.

1.9.0 SIGNING THE FIELD BOOKS, LONGITUDINAL SECTIONS, CROSS SECTIONS AND MEASUREMENT BOOKS.

Before starting the work for intermediate payments and at the end before the work is covered, level for plotting the longitudinal section (along the axis as decided by the Engineer-in-charge or his authorized representative) and cross sections of the portion of the work shall be taken by the authorized Engineer of the Contractor in the presence of Engineer-in-charge or his duly authorized representative. The Contractor or his authorized engineer shall have to sign the field books and plants showing longitudinal sections and cross sections of the portion of the work in token of acceptance. If the Contractor fails to sign them, the levels recorded by the Engineer-in-charge or his representative in the authorized books shall be final and binding on the Contractor. If the Contractor or his duly authorized agent fails to attend, the levels shall be taken in his absence and such levels and longitudinal sections and cross sections based thereon shall be final and binding on the Contractors. The levels shall be taken on such alignments and cross sections as shall be useful for reference permanently and shall be in harmony with the mode of the measurements for payments as described under specifications. The point locations for the levels
shall depend upon the raggedness of the area and shall also be at least in conformity with the requirements of specifications.

1.10.0 CEMENT AND STEEL
No material will be issued by the VIDC on schedule “A”. The Contractor is responsible for all materials including cement, steel, explosives, pipes, etc.

1.10.1 CEMENT
(A) Only 43 grade OPC / PPC Cement shall be used for this work unless otherwise specified by Engineer-in-Charge. The cement shall confirm to I.S.-8112-1989.
(B) The use of admixtures and agents shall be made as per instructions of the Engineer-in-charge. The cost of cartage / storing / handling / batching / mixing shall be borne by the Contractor and shall be included by them in prices tendered for concrete.

1.11.0 STEEL
The T.M.T. shall confirm to I.S. 1786-1985 and M.S. steel shall confirm to I.S. 432 (Part-I) 1982 both I.S. as amended from time to time.

1.12.0 ROYALTIES
The Contractor shall arrange for the materials from approved quarries. It is necessary for the Contractor to obtain permission from Revenue authorities or other relevant authorities before removing the materials, pay royalties etc.

1.13.0 ADVANCE ON CONSTRUCTION MATERIALS.
Advance payment against material brought to site will be made to contractor at the rate of not more than 75% of value assessed by the Engineer-in-charge, on production of indenture bond. At no point of time the amount of outstanding advance against material shall exceed Rs. 8 Crore.

1.14.0 PAYMENT
The payment under contract shall be regulated in terms of the stipulations of payment schedule. (Chapter XII) of Volume – II and based on measurement of work done based on approved Estimate of Work.

1.15.0 NO INTEREST ON MONEY DUE TO THE CONTRACTOR

No omission, by the Engineer-in-charge, to pay the amount due upon measurements or otherwise shall vitiate or make void, the contract, nor shall Contractor be entitled to get interest on any guarantee bond or payment in arrears nor on any balance which may, on the final settlement of his account be found due to him.

1.16.0 It is expected for laying pipes contractor should use the land acquired for construction of canal if other alternative alignment suggested by contractor then temporary Land acquisition required for distribution network and for other work if any shall be the responsibility of Contractor / Contractor. Contractor shall make necessary liaison with Revenue and other Department for completion of the work within work chart given for physical completion of the work. Contractor shall quote his price inclusive of all costs required for the same.

1.17.0 MEASUREMENT OF WORK

The measurements for the work shall be taken by Contractor's authorized Engineer in the presence of Engineer-in-charge or his authorized representative and recorded in the authorized books. The Contractor shall obtain the signature of Engineer-in-charge or his authorized representative on such recorded measurements in token of acceptance. If the Contractor fails to take such measurements then the Engineer-in-charge shall cause to record the measurements which shall be final and bindings on the Contractor. This Para is applicable to all items. Contractor shall submit Measurement of work along with Drawings as constructed immediately upon completing each component of work.

CONDITIONS RELATING TO INSURANCE OF CONTRACT WORK :

1.18.0 Contractor shall take out necessary insurance policy / policies viz. Contractor's All Risk Insurance Policy, Erection All risk Insurance Policy etc. as decided by the Directorate of Insurance) so as to provide adequate insurance cover for execution of the awarded contract work for total contract value and complete
contract period COMPULSORY from the 'Director of Insurance, Maharashtra State, Mumbai 400051' only. Its postal address for correspondence is "264, MHADA, Opp. Kalanagar, Bandra (E), and Mumbai 400051. (Tel. No. 022-26590403 / 26590690) & Fax 022-26592461 / 26590403)". Similarly all workmen appointed to complete the contract work are required to insure under Workmen's Compensation Insurance Policy. Insurance policy / policies taken out from any other company shall not be accepted. If the contractor has Not taken out the insurance policy from the 'Director of Insurance, Maharashtra State, Mumbai' or has effected insurance with any Insurance Company, the same shall Not be accepted and 1% of the tender amount or such amount of premium calculated by the Govt. Insurance Fund shall be recovered directly from the amount payable to the contractor for the executed contract work and paid to the Directorate of Insurance Fund, Maharashtra State, Mumbai. The Director of Insurance reserves the right to distribute the risks of insurance among the other insurers.

The contractor has to make insurance of work as per Govt. Marathi letter dated 1 / 7 / 06. The payment of instalment made by the contractor towards this insurance shall be reimbursed separately to the contractor by the Engineer-in-charge after verification of original receipt produced by the contractors as per special condition of contract.

1.19.0 INSURANCE CHARGES:
Additional Conditions regarding payment of insurance Charges as:
1) The Insurance Charges are to be paid by the Contractor to the Director of Insurance Maharashtra State, Mumbai.
2) The insurance amount shall be released to Contractor as per conditions mentioned below.
   a) The Contractor shall submit the original proof of Insurance policies to the Engineer-in-charge.
   b) After the verification of record submitted by the contractor the total amount that can be released shall be limited to the actual payment made as mentioned in the condition (a).
   c) If the actual insurance charges claimed are less than the provision made in the tender the amount shall be paid as per actual.

LABOUR WELFARE FUND
1.20.0 SCOPE OF ITEM:
The item deals with the payment of labour Welfare cess as per the relevant provision of prevailing law of central Govt. and guide lines laid by the Govt. of Maharashtra towards labour engaged in the construction of several of work.
1.20.1 A sum at the rate of 1% or at the prevailing rate as decided by the Govt. shall be deducted from the bills of the contractor till the completion of the contract work.

ROYALTY CHARGES FOR MATERIAL:

1.21.0 The contractor shall arrange for the materials from approved quarry. It is necessary for the contractor to obtain permission from Revenue authority before removing the material.

As per the provisions in relevant clause, quarry fees, Royalties and ground rents for stocking material, if any, should be paid by contractor, Royalties paid by the contractor to the Revenue authorities shall be entitled to the contractor after submitting receipts of the same.

The amount shall be released to the contractor subject to following condition.

a) Contractor shall submit proof of the payment of the Royalty charges to the concerned revenue authority acceptable to the engineer-in-charge.

b) The total amount that can be released shall be limited to the actual payment made as mentioned in condition (a).

c) The contractor shall intimate to Dept. towards payment of Royalty.

d) The contractor shall indemnify Corporation / Govt. towards payment of royalty charges.

e) The payment of the Royalty charges based on the executed quantity only shall be made to the contractor after producing payment receipt from revenue authority. No price escalation shall be paid on this item.

MODERN TECHNOLOGY
The Contractor should adopt the latest / modern methodologies and State of Art Techniques in the investigation, design of Pressurized piped Distribution Networks, structures, etc. and also construction, measuring devices, operation and maintenance, monitoring mechanism using computers.

**SPECIFICATION FOR ITEMS WHICH ARE NOT COVERED UNDER VOLUME-III**

This is a ‘C’ contract. Specifications for item which are not covered under Volume –III, relevant Indian / International standard specification shall be applicable.
CHAPTER XIV
SURVEY WORK
CHAPTER IV
TECHNICAL SPECIFICATIONS FOR SURVEY WORK

1.0 Scope of Work and Specifications
The detailed scope of survey work is given in Volume I & II. In addition, survey work shall be done with advanced equipment and all survey work shall be GIS based (Geo reference).

The entire survey work shall be done as per relevant Indian standard codes, IRC publications and various guidelines, norms, specifications, manuals and standard handbooks & practices of WRD Maharashtra, CWC, PWD Maharashtra, etc.

1.1 Topographical Surveys
The Contractor shall carry out the Topographical Survey in the command area for preparation of contour plan, locating all topographical features like river / streams, villages, road, railway line, important monuments, forest boundary, contours and administrative boundaries, if any, etc.

The Contractor shall carry out the Bench Mark (Preferably GTS bench mark approved by Engineer-in-charge) from nearest permanent bench mark to the specified location (At proposed pump house location and various locations in command) of the survey area by double tertiary (D.T.) levelling using two auto levels / Total station, establishing and construction of Permanent bench mark / TBMs and reference pillars in the field.

Clearing Site & Disposal of stuff Removed
The item pertains to the provision of site clearing including cutting small shrubs, vegetation, bushes and clearing stumps and molehills during the survey work.

The land width required for component of pump house & its sub component, all pipeline distribution network, various crossings and other components of entire scheme, etc., shall be cleared for all trees having a girth of 30 cm. and less brushwood. Vegetation, bushes, stumps and other objectionable material. The roots of trees shall be removed to a depth of 30 cm. Below the surface of the foundation land and side slopes and the excavation filled up with excavated material in 15 cm to 20 layers and the compacted. Brushwood, vegetation, bushes, stumps, etc. shall be cut flush with the ground. All the material cleared shall be the property of VIDC. Useful material shall be arranged
in convenient stacks as directed at convenient place of disposal and handed over to the VIDC for disposal. Unsuitable material shall be burned or otherwise disposed off by the contractor at his own cost as directed by the Engineer-in-charge without causing any nuisance, inconvenience or damage to the property of the people in neighbourhood in all cases, the material shall be disposed off in a neat manner. All necessary labour, materials and use of tools for carrying out the item shall be arranged by the contractor.

**Command area survey:**

Grid survey by using total station to cover an area as shown on index map (about 12230 ha Culturable command area). The size of grid shall be 15 m or less. The base line shall be by double tertiary levelling using two auto levels. This is including transfer of entire data to computer system in different geo referential layer / themes using features of standard plotting software compatible with irrigation system design software packages including contour plotting at 0.20m interval. The command area contour plan shall be in the scale of 1:1000 (H) with contour interval of 0.20 m. The sets of map should have sufficient overlap to enable simultaneous study of area covered in two or more maps. An additional map to take scale of 1:5000 or as informed by the Executive Engineer would also be supplied indicating all the area and also the contours at suitable intervals, as informed by the Executive Engineer, herein after called the survey map for work. This map should also be prepared with a contour interval of 0.20 m.

**Preparation Of Digital Map**

Preparation of digitized command map of various WUA’S and federations in the command showing its jurisdiction as per instructions of Engineer-in-Charge and as required as per MMISF Act, 2005 and rules there of provided. All Details such as Alignment of pipe distribution network, chak wise / sub chak wise details, detail location of irrigation & drainage structure and flow measuring devices details of acquired land demarcation of Head Middle and tail parts of WUA’S, Minor Irrigation structures and all others relevant details are provided by department. (Assuming 250 ha CCA on an average for each WUA).

**Construction Of Permanent Bench Mark (PBM):**

The required number of PBM of size as per drawing given by the department with following details of construction-
Details of Construction of PBM

1) Carry out excavation in any type of strata / soil for PCC Bench Mark & Reference pillar.

2) PCC Bench Mark
   - Use C.C 1:4:8 & 1:2:4 as shown in drawing available with Engineer-in-Charge.
   - M.S. Plate of size 200 X 200 & 6 mm thickness of approved quality shall be used.
   - Marking of P.B.M. value on steel plate as per instruction of Eng-in-charge.
   - 4 Nos of 16 mm dia Anchor Bolt welded to MS Plate shall be used (As shown in Drawing)
   - Good quality dressed stone of size 300 X 300 X 600 mm approved by Eng-in-charge shall be used.
   - Fencing around PBM.

This should be located preferably at one corner of the field, which shall not hamper the agriculture operations or as instructed by the Engineer-in-Charge. The level of PBM shall be established on top of pillar. Adequate care shall be taken by the Contractor for curing the concrete laid for the PBMs. Payment shall be made as per approved estimate.

**Note:** - Latitude and longitude values of each PBM & TBM shall be submitted to department in register after or during survey work for future references.

Construction of Temporary Bench Mark (TBM):
RCC precast block of size 900 x 175 x 100 mm shall be used as TBM. The required number of TBM shall be establish in entire command area of 100 Ha. from established PBM required for execution of work. The numbers of TBM shall be decide by Engineer-In-Charge.

Details of RCC Precast Block
- Excavation & necessary refilling as per specification given & instruction by Eng-in-charge.
- Use of PCC 1:4:8 for fixing of RCC Precast Pillor (size-600 x 450 x 450 mm)
- RCC Precast stone of size 900 x 175 x 100 mm in CC 1:2:4 with reinforcement 0.75 kg / each Block and as per instruction of by Eng-in-charge shall be used.
- Rates inclusive of necessary paintings of B.M value and other Details.

**Excavation for Trial Pits**

This includes Excavation in any type of soil, sand, murum for taking Trial Pits on final alignment or in command area and canal / pipe network at specified interval and in Nalla bed of size 2.00 X 2.00 X 2.50 mtr. In length, breadth and depth respectively or size as may be directed by Engineer-in-Charge including backfilling of trial pits etc., complete.

i) The item include furnishing of all tools, plant, labour and material required for carrying out excavation in all strata including conveyance and disposal in a manner here in after specified and all operations within the intent and purpose of the time.

ii) The item of excavation for other purpose shall include furnishing of all tools, plant and material required for carrying our excavation in different strata for the various parts as noted in the drawings, and removing and disposal in manner hereafter specified with leads and lifts, maintaining the excavated slopes and trenches and all operations covered within the intent and purpose of the item. The excavation in dry and moist conditions is also covered.

iii) **Classification of Strata**

The classification of the strata shall be made by the Engineer-in-charge on the basis of average of the strata exposed on the sides of cutting.

Providing necessary surveying instruments and all other tools and materials, labour and qualified surveyors, scaffoldings, necessary transport, supervision by competent Engineer / surveyors, full insurance and all other incidental items as may be necessary for successful completion of the surveying and mapping work shall be the responsibility of the Contractor.

**Survey Work for Building Portion**
Necessary survey work shall be done for building work with help of Total station as per standard practice of PWD Maharashtra. Necessary drawings and Cross sections, levelling maps shall be submitted to the department in required number.

**Agricultural / Soil Survey**

Agricultural survey & soil survey for entire command shall be done as per relevant WRD Maharashtra / WALMI norms and report of the same shall be submitted to concerned Superintending Engineer for approval.

**Investigation & Foundation Exploration**

Taking required number of trial bore as per relevant code of practice for detailed investigation with NX diamond drill double tube in all sorts of soil like soft murum, hard murum and boulders including all materials such as casing pipes, accessories, grease, steel balsams and other such materials and or as required including conveying such materials and machinery to site of works, preserving the loose samples in glass / plastic jar and core samples serially numbered at site of work and conveying the same to the head quarter of concerned office as directed and submission of detailed bore log sheets. (As directed by the Engineer in charge) and Providing core boxes of Plastic core boxes / Galvanised steel boxes / Corrugated plastic core boxes (normal) of size 1.50 x 0.35 x 0.10m for preserving core samples with all fixtures and fastening, painting, handles, locking arrangement including material and labourel etc. complete.In addition to above, Carrying out water intake test / permeability test at any stage or depth as may be directed by Engineer in charge by filling the bore hole with water or air at specific pressure of specified limit as and where directed etc. complete. Necessary soil investigation shall be getting done from consultant based on exploration data, and getting it approved from Superintending Engineer,

The Contractor shall furnish all field data & drawings in soft copy (on CDs) in **ASCII and Auto CAD format** apart from hard copies.

The enclosed index map indicates the tentative locations of the proposed pump house location, water lifting point & Reservoir, power houses and command area to be surveyed. These locations / areas indicated in the index map are subject to change as may be necessary during-actual execution of the work. The work shall be carried out as per the instructions of the Engineer-in-charge.

The Contractor must visit the area prior to submitting his tender, to acquaint
himself fully with the nature, type and scope of work involved therein. The rates quoted shall remain firm during entire period of execution and till completion of the work and any additional claim for lack of knowledge shall not be entertained.

The work shall be executed according to the specifications and good standard of practice necessary to fulfil the objective of the survey work, strictly in accordance with the instructions and satisfaction of the Engineer-in-Charge.

The specifications shall be read in conjunction with the scope of work given in volume 1 & 2, 3. For any discrepancy, which may exist, decision of the Engineer-in-charge to clarify the point shall be final and binding on the Contractor.

1.1.1 Setting up of Temporary Bench Marks

1. The Engineer-in-Chargeshall furnish the details of GTS / Permanent bench marks to the Contractor at the initial point and also at important road / river crossings. With this as datum, additional network of temporary bench marks (TBMs) shall have to be established by the Contractor as per the instruction of Engineer-in-Charge. The temporary bench marks shall be fixed with reference to the standard Bench Mark (PBM) established. The representative of the corporation not below the rank of Junior Engineer shall remain present while establishing the temporary bench marks.

2. Engineer-in-Charge may check the levels independently along with Contractor's representative. Labour, equipment etc., if so required for checking the levels by Engineer-in-Charge shall be provided by the Contractor at his cost. Closing error in levelling should be limited to $12 \sqrt{L} \text{ in mm, where } L \text{ is the length of the route in km. If the variation in level exceeds the limit, the entire survey needs to be redone.}$

3. Engineer-in-Charge may check independently along with Contractor’s representative, the establishment of TBM / RCC centre line pillar in respect to its value, location entered in field book and specification as per drawing. If the same is not found as per record & drawing, the entire exercise is required to be redone by the Contractor. Labour, equipments, if so required for checking by Engineer-in-Charge shall be provided by the Contractor at his cost.

1.1.2 Topographical survey and mapping

1. Positions, both in plan and elevation, of all natural and artificial features of the
area like waterways, railway tracks, cultivation, villages, fences, pucca and kaccha roads including culverts and crossings, foot tracks, other permanent objects like telephone posts and transmission towers etc. are to be established and subsequently shown on survey maps by means of conventional symbols (preferably, symbols of Survey of India Maps). All the hills and valleys within the area / areas are to be surveyed and plotted on maps by contours. Necessary levelling work of the entire area / areas, to be surveyed and plotted on maps by establishing horizontal location so that location and plotting of contours for the area / areas can be done at 0.20 m interval and in the scale of 1:1000 H on maps. Method of survey, contour intervals, etc. shall be decided by Engineer-in-Charge on site in case of steep slopes, dense jungle, etc. where grid formation may not be possible. Any unusual condition or formations on the ground, locations of rock outcrops (if visible on the surface) and spring / falls, possible aggregate deposits etc. shall also be noted and plotted on the maps.

2. The survey work shall be done with “Total Station Equipment” in the following steps:
   a. Establishing horizontal and vertical controls and locating reference grids and bench mark in the area.
   b. Surveying for establishing spot levels and plotting contours at 0.20 m in Contour interval.
   c. Surveying for locating the natural and manmade details as described earlier.
   d. Transfer of GTS bench marks and double tertiary levelling shall be done through two auto levels / Total stations and surveyors.

The grids for the survey work shall be established in N-S & E-W direction (Corresponding to magnetic north) or as directed by the Engineer-in-charge.

1.1.2 Traversing
1. Triangulation or traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal control and in order to determine the exact relationship between various existing points on ground so that surveys required under the present scope of work and in future may be co-related and tied together.
2. Total station instruments should be deployed to achieve the specified
accuracy of the work. Proper precautions for avoiding graduation errors and other instrumental and personal errors should be scrupulously observed.

3. From main traverse / triangulation station, subsidiary station shall be established at suitable intervals to cover the entire area. Levels of these stations shall be based on the Bench Mark established in the survey area. Occupying the main & subsidiary stations, all major details shall be surveyed by Total Station instrument.

4. The closing error in traverse shall not exceed one in twenty five thousand (1: 25000) in terms of length or \( L\sqrt{N} \) seconds total in angular measurement, whichever is less (where \( L \) is the least count of the instrument and \( N \) is the number of stations). If the variation exceeds the limits, the entire traversing needs to be redone. Engineer-in-Charge may check the traversing independently along with Contractor’s representative. Labour, equipment etc., if so required for verification in traverse by Engineer-in-Charge shall be provided by the Contractor at his cost.

**1.1.4 Contour Plotting**

1. Contractor shall carry out spot level surveying at an interval of 15 metres or less grid interval for plotting contour of the area. Levels shall also be taken on all traverse stations and on salient points located at random over the area (ground points). Contours are to be plotted at 0.20 m interval for command area after the above points are depicted on maps. The contours shall not be just interpolated but properly surveyed on the ground so that features falling between the two successive levels are also picked up. Sufficient points properly distributed over the entire area shall be located and levels taken so that accurate plotting of contour can be done at places of sharp curvature or abrupt change in direction and elevation. Points selected shall be close to each other.

2. Transfer of levels shall always start from Main / Subsidiary stations whose levels are based on GTS bench mark available in the nearby area to be surveyed.

3. Any other levels of existing bench marks, which are supplied to the Contractor by the VIDC shall be checked by the Contractor with reference to the GTS BMs and if any discrepancy is observed, the same shall be immediately brought to the notice of Engineer-in-Charge. His decision in this regard should be obtained inwriting.

**1.1.5 Latitude and Longitude**

The Contractor shall tie up the survey grid of areas surveyed with latitudes and
longitudes.

1.1.6 Preparation & submission of survey maps

1. The Contractor shall submit contour plan for command area in the scale of 1:1000 H scale with 0.20 m contour interval; demarcating all permanent features like roads, railways, waterways, buildings, power lines, natural streams, villages, monuments, Culturable area, forest boundary, administrative boundaries etc. Each area should have three original plotting's: one showing spot levels and contours; one showing only contour lines; and one showing contour lines and permanent features. All the three drawings/maps must have the latitudes and longitudes and legend in similar manner as per S.O.I top sheets.

2. The Contractor shall also submit one set each of maps/drawings for the entire area covering: (i) details as indicated in Para – I above; and map indicating land classification as mentioned in Para-III of Clause 1.1.7.

3. The Mauza and Khasra map of the command area shall be collected by the Contractor from the local revenue authorities after ascertaining the availability of the same with corporation and survey grids need to be superimposed on the maps. The scale of this map should be the same as that for the Mauza / Khasra map or as directed by Engineer-in-Charge.

4. Water User Association wised command map as described above 1.1 shall be prepared.

5. All the maps and drawings should be prepared in digitized forms having adequate separate layers for features using standard computer software like AutoCAD (latest version) on standard A-0 and A-3 size. The title block/legend of all the drawings/maps should be as per standard format and as per the instructions of Engineer-in-Charge.

6. The Contractor shall submit two copies of all the maps for review and approval of the Superintending Engineer. After approval, 10 (ten) prints of all the final maps along with a set of the originals on good quality paper shall be submitted along with soft copy in pen drives & in DVDs. Copies of the maps shall be submitted in proper flappers and original polyester base drawings should be handed over in proper card board covers indicating index of drawings.

1.1.7 Submission of field data and report

1. Contractor shall submit all data pertaining to the survey having financial value in original in soft (in pen drives & in DVDs) and hard copy to the Engineer-in-charge,
which is supposed to be entered in measurement book or level field book.

2. All field data shall be submitted to Engineer-in-Charge from time to time as per progress of the work.

3. The agricultural survey shall give details about the various types of land e.g. cultivated, private land, Abadi land, Govt. reclassified land, forest land, Grampanchayat land etc. falling within the area surveyed. Ten copies of the map in 1:1000 scale indicating land classifications shall be submitted.

4. Required number of copies of the draft report shall be submitted on completion of the field work to the Engineer-in-charge for review and approval of the Superintending Engineer and above. The report should contain the introduction of the site, methodology adopted for surveying the areas, calculation of errors, transfer of Bench Mark, calculation for connecting the areas with latitudes and longitudes, the agriculture survey details, Trial pit exploration & strata classifications and any other calculation required for surveying and preparation of the survey maps and data required for design purpose of entire scheme components.

5. Ten copies of the final report on the survey of the above works along with soft copy in DVD / CD should be submitted after incorporating all the suggestions / observations given by the Engineer-in-Charge on draft report. The final report should be printed on good quality paper & bound properly in the presentable form.

1.1.8 Inspection

The Contractor shall make all arrangements of men, material and transport at the work site for checking of the work to the satisfaction of Engineer-in-charge during the progress and on successful completion of the work. The Contractor shall intimate the completion of work within ten days, before final decamping from work site, so that final work can be inspected by the Superintending Engineer / Higher Authorities. This shall form a part of acceptance of the work for release of final payments.

1.2 Deployment of Resources

1.2.1 For the scope of work under the contract, as detailed in the specifications above the Contractor shall mobilize adequate instruments so as to complete the work as per schedule. The Contractor should submit the details of the instruments
to be deployed which shall be subject to the approval of the Engineer-in-Charge.

**NOTE:** Matching to the instruments to be deployed, accessories like stands, staffs, ranging rods, umbrella, crow bar, steel tapes, stationery etc. should also be made available at site by the Contractor.

Additional instruments, if required, shall be mobilized to adhere to the work schedule and as per the direction of Engineer-in-charge at no extra cost.

1.2.2 The work at site shall be carried out under the full time supervision of a qualified Engineer / Surveyor. The Engineer shall be responsible for and capable of coordinating the work of the surveying teams, setting out the work accurately and identifying immediately and positively the type of instruments to be deployed and change in the methodology of surveying to achieve speed and accuracy in the work, and shall be fully conversant with the theory and techniques of the traversing, triangulation, spot levelling survey work covered by this contract.

1.2.3 For proper and continuous supervision of the work under the agreement, the Contractor shall engage and mobilize the necessary contingent of qualified and experienced manpower at site. The Contractor before start of work should submit the details regarding qualification, experience etc. of the manpower to be deployed which shall be subject to the approval of the Engineer-in-Charge.

1.2.4 The details of the actual staff shall be as per the requirement of the work.

1.3 **Progress report**

1.3.1 The Contractor shall prepare and submit without fail to the Engineer-in-charge progress report in three copies every fortnight indicating status of setting out of the grids, total area surveyed, TBM / BM pillars constructed, Trial Pits Taken, methodology adopted for surveying and instruments deployed including staff working on the site, reasons for lag, planning to make it up and difficulties encountered during execution of the work, if any, etc.

1.3.2 The submission of such reports and review thereof by Engineer-in-Charge shall not be deemed to absolve the Contractor of his responsibility of timely completion of the assignment as per the time schedule indicated.

1.4 **Additions & Modifications**

If circumstances arise for additions / modifications in the topographical survey work, the Engineer-in-Charge shall intimate the additions / modifications to the Contractor. These additions / modifications shall have to be taken into account in all works undertaken under the contract after they are intimated.

**Being ‘C’ Contract, any other survey required for execution &**
commissioning of PDN for Lower Pedhi Project successfully shall be the contractor’s responsibility without any extra cost.

1.5 Work Ownership

The ownership / copyright of all maps / drawings / field data and computations, report, any other documents concerning the study shall rest with the corporation. The Contractor may keep a copy of the report of the study but shall not use the contents thereof for any purpose without the prior written consent of Engineer-in-Charge.

Note:-

1. Being ‘C’ contract, all other survey required for successful completion of scheme shall be done by contractor as per instruction of Engineer-in-Charge / VIDC authority. No extra payment shall be done to the contractor for the same.
2. Details of survey Instruments including their makes & Nos, software packages used for surveying, drafting etc. shall be submitted to Engineer-in-Charge before starting of Survey work.
3. In addition to above field survey data, contractor has to use necessary approved satellite data / images, modern survey analysis and design software packages for scheme shall be used. No extra payment shall be done to the contractor for the same.
CHAPTER XV

DESIGN & VETTING
CHAPTER XV

DESIGN & VETTING

1. SPECIFICATIONS FOR DESIGN

Scope-

Detailed scope of work and design requirements, finalised parameters for scheme are given in detailed scope of work. Criteria of design and general guidelines for design are given in General specification. Project Design criteria and conditions related to design of project given in Volume-II shall be strictly followed during design.

Design and drawings of various Civil, Mechanical, Electrical, Architectural, structural components of irrigation schemes from reputed design consultancy consist of Approach channel, fore bay, pump house components, surge tanks, entire pressurized pipe distribution network required for micro irrigation of 12230 ha CCA, automation components, all inline structure required, all connected components required for commissioning of entire scheme, all building structures as per Indian / International standards and various Indian codes and as per standard practices and all as directed by Engineer-in-Charge complete.

The Contractor’s Scope of Services shall include the following activities other than activities mentioned in detailed scope of design work-

1. Review and Assessment of Data Requirement
   1.1 Identification of survey and investigation requirement considered necessary for design, execution, commissioning and operation of the project.
   1.2 Review of technical and design Parameters for piped Distribution network, Electro-mechanical and other underground pipe line works.
   1.3 Preparation and submission of Reports on the above for the information to the Engineer-in-Charge.
   1.4 Preparation of work programmers for carrying out additional investigations and studies for the information of the Engineer-in-Charge.
   1.5 The contractor shall submit a review report after carrying out the above activities for acceptance of the Engineer-in-Charge.

2. Additional / fresh investigations, Observations and Studies
   2.1 Carrying out additional surveys, geo-technical investigations and
laboratory tests, analysis and studies including collection of other relevant data as necessary.

2.2 Evaluation of results of additional investigations, carrying out studies and analysis for the design of the Project components.

2.3 Finalizations of conceptual plan based upon the Preliminary design / planning of the Corporation, the works to be executed for pipe line Distribution System of the scheme. The conceptual plan shall be on whole to the part principle.

2.4 Preparation and submission of Reports on point 2.1, 2.2 and 2.3 above for reference, acceptance and record of the Engineer-in-Charge

3. Detailed Design
1. Detailed design of each Civil, Mechanical, Electrical, Instrumentation, Automation components and sub components by using latest software packages and by manual checking based on relevant Indian / International code of practice.

2. Pumping station and allied components shall be design as per CDO code of practice including layout preparations.

3. Hydraulic design of underground pressurized pipe distribution network shall be design with software Pipe 2000 / BENTLEY WATER GEMS with latest revision or any other similar software (Internationally Accepted) for all factors such as possible surge, materials of pipes, maximum & Minimum velocity, pressure head, etc. Design shall be in confirmation with the guidelines provided in Govt. of Maharashtra G.R. (in Marathi) no.2015/प्र.क्र.24 / (भाग-2) / 2015 / जसं(धोरण), दि. 02 / 02 / 2017.

4. Maximum design period for all component shall not be more than 1 month including preparation of drawings.

5. Proper care shall be taken for earthquake and other forces while design of RCC components such as pump house, buildings, thrust block, etc.

6. Contractor shall made available all design data, software model & Analysis output results, drawings, etc., to department in soft copy at the time of submission of drawings.

7. Proper Co-ordination of Engineer-in-Charge or his representative with design consultant shall be the responsibility of Contractor.

4. Project Completion Report
4.1 Preparation of as-built drawings for pipe line Distribution System, its structures, pumps, Gates / valves & EM Parts of structures and a Detailed Project Completion Report.

5. **Supply of Drawings, Reports etc.**

5.1 The Contractor shall furnish to the Engineer-in-Charge the following number of copies of drawings, reports and other technical documents.

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>PARTICULARS</th>
<th>HARD COPIES</th>
<th>SOFT COPIES (CD)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Drawings for information</td>
<td>6 (six) sets</td>
<td>1 (One)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Drawings for approval</td>
<td>6 (six) sets</td>
<td>1 (One)</td>
<td>One hard copy shall be returned to the Contractor with approval or comments.</td>
</tr>
<tr>
<td>3.</td>
<td>Approved drawings</td>
<td>1+ 10 sets</td>
<td>1 (One) copy in CD</td>
<td>Shall be submitted in accordance with Clause 143 of Conditions of Contract.</td>
</tr>
<tr>
<td>4.</td>
<td>As-built document</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Review Report / Design Briefs / Design Memo / Design Reports (Draft)</td>
<td>3 (Three) sets</td>
<td></td>
<td>One hard copy shall be returned to the Contractor with approval or comments.</td>
</tr>
<tr>
<td>6.</td>
<td>Review Report / Design Briefs / Design Memo / Design Reports (Final)</td>
<td>1 + 10 sets</td>
<td>1 (One) copy in CD</td>
<td>`</td>
</tr>
<tr>
<td>7.</td>
<td>Progress Reports (monthly)</td>
<td>6 (Six) sets</td>
<td>Hard Copy</td>
<td>Also through e-mail to respective authority</td>
</tr>
<tr>
<td>8.</td>
<td>Final design computations</td>
<td>6 (six) sets</td>
<td>1 (One) copy in CD</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Detailed Project Completion Report</td>
<td>10 (Ten) sets</td>
<td>1 (One) copy in CD</td>
<td></td>
</tr>
</tbody>
</table>
2. SPECIFICATIONS FOR VETTING

Scope-

Complete Vetting of Design and drawings of Various Civil, Mechanical, Electrical, Architectural, structural components of irrigation schemes received from design consultant consist of Approach channel, fore bay, pump house components, surge tanks, entire pressurized pipe distribution network required for drip irrigation of 12230 ha CCA, all inline structure required, all connected components required for commissioning of entire scheme as per Indian / International standards and various Indian codes and as per standard practices.

1. Vetting of all components designed for scheme from competent authority as directed by engineer in charge and final approval by Chief Engineer, Special Project Water Resources Department. Amravati.
2. Vetting period shall not be more than 1 month.
3. Contractor shall quote his offer including Design and vetting charges.
CHAPTER XVI
BUILDING WORK & PUMP HOUSE
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BUILDING WORK & PUMP HOUSE

SCOPE:
The item shall include clearing site. Excavation to the designed section, removal of the material, their sorting out as specified and their depositing either in spoil banks or on canal banks in layers or other locations as specified includes all leads and lifts. In addition to above, PWD Maharashtra Standard Specification - Volume II: Buildings-2012 Bd. A Excavation (Appropriate Item Specification) for Building portion is applicable as per direction of Engineer-in-Charge.

1.1 CLEARING SITE
The site of construction shall be cleared of all grass vegetation, fencing, bushes, and trees as directed by Engineer-in-charge. The material obtained from such clearance shall be the property of the Corporation and shall be stacked as directed by the Engineer-in-charge, so as not to cause obstruction to the work.

1.2 LINED OUT
1.2.1 All materials such as pegs, bamboo's and strings and templates for marking out slopes, and labour required for line out should be provided by the Contractor at his own cost. The centreline of excavation shall be clearly marked by pegs or by stones at each chain or change of direction or at shorter intervals on curves, in the beginning. The final line out shall be done by fixing reference stone at suitable distances on either side of the centreline, beyond the canal edges so that they are not disturbed the construction period. The position of these stones shall be marked on the cross section.
1.2.2 For building line out, standard methodology shall be used.
1.2.3 No change in the sanctioned plan and designs is permissible without the written permission of Engineer-in-charge.
1.2.4 Before starting the work, the Contractor shall have prepare & submit the signed field books and plans showing the working longitudinal section and cross sections of the portions of the alignment, that he has to tackle. If the Contractor fails to sign them within three days of being called upon to do so, the levels and sections as recorded by Engineer-in-charge or his Assistant shall be final and binding on the Contractor.
1.2.5 Contractor shall construct and maintained the quarry roads and temporary roads required for conveying and transport of material at his cost.

1.2.6 For the points, which are not covered under these specifications, the instructions given by the Engineer-in-charge shall be final and binding on the Contractor.

1.2.7 The material available from all excavation and remaining surplus after use on the work from adjacent reaches, etc. can be used by the Contractor free of cost provided these materials are used solely or the specific contract work and prior approval of the Engineer-in-charge is taken.

1.3 EXCAVATION

1.3.1 SCOPE OF WORK

Along the excavation and removal of excavated material and its disposal in a manner herein after specified, the item of excavation shall also include.

i) Cleaning of site.

ii) Setting out work, profiles etc. according to sanctioned plan, or as directed by the Engineer-in-charge and setting up benchmarks and other reference marks.

iii) Providing and subsequently removing shoring and strutting if and when necessary.

iv) Bailing and pumping out water including continuous pumping till completion of excavation.

v) Necessary protection including labour, material and equipment’s to ensure safety and protection against risk or accident.

vi) Provide necessary facilities for inspection and measurements of work at any time to the concerned Corporation officials.

vii) Compensation for injury to life and damage to property if any, during work, O&M shall be the responsibility of contractor.

1.3.2 Suitable arrangements for drainage shall be provided to take surface water clear of excavation during the progress of work.

1.3.3 Excavation may be carried out by manual labour or by excavating machine.

1.4 CLASSIFICATION

1.4.1 The classification of strata shall be as under.

i) SOFT STRATA
This shall include all kinds of rock of shale, indurate clay, soil, silt sand and gravel soft average and hard murum and any other materials which can best be removed with a shovel after loosening with a pick and/or bar. It shall also include isolated boulders up to 0.1 cubic meter each, which does not need blasting and could be removed with a pick/bar and shovel.

1.4.2. EXTRA EXCAVATION FOR BLACK COTTON SOIL
Wherever the canal bed and sides up to T.B.L. are in B.C. soil, extra excavation to 100 cm. Depth is to be done for having murum back filling and this shall be measured under respective items. Murum filling shall be paid under item of casing.
While excavating in hard strata, if soft seams are struck, they shall be considered as part of hard strata if the depth of individual seams is up to 15 cm. When depth of soft seams is more than 15 cm. It shall be paid under item of casing.

1.5 MAINTENANCE OF SLOPES IN EXCAVATION
1.5.1 SLIPS-CORPORATION NOT RESPONSIBLE
Slips shall be avoided, but if any slips occur on account of any reason, the excavation shall be promptly restored to stability. No extra claims shall be entertained for such slips.
The Contractor shall have to make good the work at his cost.

1.6 SORTING AND STACKING OF MATERIALS.
Excavated materials shall be sorted out and stacked as under.

a) SOFT STRATA
All the excavated materials from the soft strata shall be sorted out. The material not useful for bank work shall be deposited as directed by the Engineer-in-charge. Material useful in bank work shall be sorted out to be used in hearting or casing. Each stockpile of unrequired material shall be of regular size and not less than 5 cm. In height.

1.7 SURPLUS MATERIAL
The excavated materials, if not required for embankment, should be stacked in spoil banks with neatly made stable slopes at top and a suitable berms being left between the toe of bank, and edge of excavation, as directed. In partial banks,
where a side embankments is required to retain water, its limit should be lined out before starting the excavation so that the soil may be disposed off properly.

1.7.1 STACKING IN STOCK AND WASTE PILES
After sorting is done, useful material of various types shall be stacked in stock piles and rest may be disposed of as directed by the Engineer-in-charge. Useful material shall be stacked in separate areas as directed with reference to the nature of the material. Stockpiles shall be of regular shapes allowing for easy measurement. No stockpile shall measure less than 60 m. length and 5 m. height unless specially permitted by the Engineer-in-charge.

1.7.2 The excavated material shall be stacked within the area approved by the Engineer-in-charge. If the excavated material is deposited in unauthorized land, such work shall not be measured for payment unless suitable action as may be directed by the Engineer-in-charge is taken by the Contractor. In addition to non-payment of such work suitable amounts as deposited towards any extra cost which Corporation may have to bear on account of the Contractor’s unauthorized action.

1.8 All the material available from excavation shall be the property of Corporation and shall be deposited as directed by the Engineer-in-charge. The material of approved quality may be used by the Contractor. Prior approval of the Engineer-in-charge for such free use shall however be taken.

1.9 Classification of the excavation shall be made from the cross sections visible at the side of excavation and from measurements of ridges which shall be left at 20 m. or less as directed by the Engineer-in-charge which must be removed immediately after the final measurements have been taken except when orders are specially given to retain these ridges. No dead man would be allowed. The areas shall be worked out generally by trapezoidal formula.

1.10 SILTING OF EXCAVATION
SILTING OF EXCAVATED PITS
If excavated pits get silted due to intervening floods, slips or any other cause, till completion of the work, the Contractor shall excavate and restore the pits and section to the required shape and dimensions without any extra cost.

Initially box excavation shall be carried out up to top of hard stratum. Thereafter stable slopes may be cut in strata as stated hereafter.
On striking hard rock in foundation trench the surface of this rock should be exposed on all area of the trench and it should be brought to the notice of the Engineer-in-charge by the Contractor and Contractor's authorized engineer shall immediately take levels of the top of hard stratum along predetermined sections in the presence of Engineer-in-charge or his authorized representative. If the Contractor fails to take levels as above, then such levels shall be recorded by the Engineer-in-charge or his authorized representative and the same shall be binding on the Contractor. Thereafter further excavation in hard strata can be continued up to foundation level to be fixed by the Engineer-in-charge. Failure to do so by the Contractor shall not entitle him to get payment for the work that may have been done under item of hard stratum.

1.11 EXCAVATION IN WET CONDITION AND DEWATERING.

Unless otherwise specified, no distinction shall be made as to whether the material being excavated is dry, moist or in wet conditions. Dealing with the ground water or rainwater collected and its disposal is covered under relevant items of excavations and shall not be paid for separately.

CONTRACTOR TO DEWATER WHENEVER REQUIRED.

The area under all the works pertaining to this tender and adjoining area as necessary shall be maintained free of water. The area shall also be maintained free of water after any part of the work is completed for inspection. Safety and installation by Corporation, or for any other reasons determined as necessary by the Engineer-in-charge. The sumps shall be lighted and shall be readily accessible for inspection. The Contractor shall pump out all water from the site and appurtenant works and shall keep the foundations free of water, while excavation, concreting and placing masonry and continue to keep the works free of water for a period as may be required for proper setting of mortar or concrete or otherwise required for the completion of works.

1.12 PREPARING AND TESTING OF FOUNDATION.

1.12.1 SCALLING AND TRIMMING OF FOUNDATION.

operations for the removal of all pieces loosened during excavation or partly separated from main rock mass by seams or cracks shall be carried out to the satisfaction of the Engineer-in-charge.
1.12.2 TREATMENT OF WEAK LOCAL SPOTS.
All weathered or partly or decomposed pieces of rock shall be removed so as not leave on the foundation any rock other than that which is an integral part of the rock mass. Areas of low bearing capacity, steep inclined seams, faults, and crushed zone in otherwise good foundation, if permitted to be kept shall be cleared out to a sufficient depth and refilled and plugged with masonry or concrete as directed by the Engineer-in-charge.

1.12.3 FINAL FINISHED SURFACE OF FOUNDATION.
The finally prepared foundation shall present a rough surface in cross section to give added resistance to sliding. All smooth surfaces shall be roughened artificially to give a good bond. The surface shall be free from steep angles and the edges of beaches shall be chamfered approximately to 450 Pinnacles of sharp projection shall be knocked off and prominent knobs flattened.

1.12.4 TESTING FOR SOUNDNESS.
The finally finished foundation rock shall be tested by striking with a heavy hammer and if loose portion of foundation rock is revealed by a hollow sound, it shall be excavated further (without blasting) till a clear ringing sound is obtained.

1.12.5 EXCAVATION OUTLINES AND PAYLINES.
All excavation shall be performed in accordance with the lines, grades, levels and dimensions shown in the drawing or established by the Engineer-in-charge. The dimensions shown in the drawing are tentative. During the progress of work it may be necessary or desirable to vary the slopes or the dimensions of excavation from those specified in the drawing. The side slopes of the excavation shall be as steep as would stand with safety as decided by the Engineer-in-charge. If the slopes established are found to be steeper and likely to slip, they shall be made flatter by removing the additional material and introducing suitable berms if possible and stable faces established. The additional shall be paid at the rate accepted for excavation for particular class of material.

EXCESS EXCAVATION
No payment shall be made for the work done beyond specified pay lines. Normally pay lines for different strata for excavation are defined as the lines starting from the outer dimension of the masonry or concrete at foundation level and sloping up as specified below.

a) Soft strata 1.5:1
b) Hard strata 1/4 :1
c) Berms with prior approval.

If in the opinion of Engineer-in-charge the sides are unstable and prone to slip, modified pay lines shall be laid down with flatter slopes and berms etc. as decided by him. Any or all excess excavation carried out by the Contractor beyond approved pay lines for any purpose or reason, shall unless ordered in writing be at the expense of the Contractor, and if the unauthorized excavation has to be filled with concrete or masonry or with materials approved as filling so needed shall be carried by the Contractor as per specifications of the respective items of work at his own expense. Tolerances over cut beyond pay lines arising out of peculiar nature of rock at the site and other site conditions shall be decided by the Engineer-in-charge of the work. No tolerance shall however be permitted in any strata.

1.13 EXCAVATION FOR BUILDINGS& OTHER COMPONENTS


CEMENT CONCRETE

1.14 CEMENT CONCRETE

Reinforced Cement concrete work for Building portion shall be done As per PWD standard specification Volume-II Bd.F. (Appropriate Item Specification is applicable as directed by Engineer-in-Charge)

For RCC work if grade of concrete as per design requirement is more than M20 then Design mixes shall only be used. Minimum grade of concrete shall be based on Design Requirement, Exposure conditions and as per IS 456:2000 and other appropriate code provisions. (Latest Revisions)

All work related to Reinforced Cement Concrete shall be done according to PWD standard specification Volume-II-2012 including all type of testing.
Concrete work for Thrust Block and anchorages, encasings, railway crossings, road crossings, nallas crossings, roads, concrete below floors and other miscellaneous works shall be done as per relevant code of practice as directed by Engineer-in-Charge.

1.14.1 SCOPE OF WORK
The work covered by this item consist of
i) Furnishing all materials, equipment and labour for the manufacture, transport, placing and curing of concrete and performing all the functions necessary and ancillary thereto including the concrete to the required shape as per drawing.
ii) Installation of all embedded parts stands included in the rates. No extra payment shall be made for the installation of this embedded metal work or for delays or for interruptions arising there from.
iii) Providing and removal of all form work comprising of furnishing all materials equipment and labour for the manufacture, transport, erection, keeping in place with necessary fixtures and supports oiling etc. complete.
iv) Necessary sampling and tests for materials and concrete.
v) Compensation for injury to persons and damages to work or property.

1.14.2 The following specifications shall apply in general of all types of concrete work including R.C.C. work.

1.14.3 CEMENT
Cement shall be obtained by the contractor and confirm to the bureau of Indian Standard of Portland cement.(OPC / PPC).

1.15 SAND
1.15.1 SOURCE AND SIZE
The Contractors own sand as per specification shall be used. The sand used for mortar shall be Natural River sand. The maximum size shall be limited to 4.5 mm.

1.15.2 QUALITY
The sand shall consist of hard, dense, durable, un-coated, gritty material obtained from rock fragment, it shall be free from injurious amounts of dust lumps,
soft and flaky particles, shale, alkali organic matter, loam, mica and other deleterious substance. The maximum percentage of deleterious matter in sand as delivered for use in mortar shall not exceed the following values.

**PERCENTAGE BY WEIGHT**

Material passing 75 micron I.S. Sieve

- Shale - 1 Percent
- Cole - 1 Percent
- Clay lumps - 1 Percent

Total of other deleterious substances such as Alkali, mica-coated grains soft and flaky 2 percent particles.

The sum of percentage of all deleterious substances shall not exceed 5% by weight. The sand shall be free from injurious amounts of organic impurities. Sand production a calorimetric than the standard in the calorimetric tests for organic impurities shall be rejected. If the impurities are beyond the acceptable limits stated above, the sand shall be washed with power or diesel driven sand washing machine to the entire satisfaction of the Engineer-in-charge at the cost of the Contractor.

**1.15.3 MECHANICAL ANALYSIS**

The natural sand shall be well graded and the sieve analysis of the sand shall conform to the following limits of gradations.

<table>
<thead>
<tr>
<th>I.S.S. No.</th>
<th>Cumulative percentage by weight retained on Sieve.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>Nil</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>1 to 8</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>10 to 25</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>25 to 45</td>
</tr>
<tr>
<td>600 micron</td>
<td>50 to 70</td>
</tr>
<tr>
<td>300 micron</td>
<td>75 to 90</td>
</tr>
<tr>
<td>150 micron</td>
<td>90 to 97</td>
</tr>
</tbody>
</table>

The gradation curve of the natural sand shall lie within the enveloping curve of gradation specified as above.

**1.15.4 a) FINENESS MODULES**

The fineness modules shall be computed by adding cumulative percentages of sand retained on the 6 standard screens from No. 4.75 to 150
micron inclusive ISS and dividing the sum by 100. Any deviation from the specified range of gradation and fineness modulus shall not be permitted without the written permission of the Engineer-in-charge. Corrective measures if any required for improving the fineness modulus shall be arranged by the Contractor at his own as directed by Engineer-in-charge.

b) **NATURAL SAND**

Natural sand shall have fineness modulus ranging from 2.60 to 3.85 without any admixture.

c) **ALLOWANCE FOR BULKAGE**

If the Contractor’s own sand required to be washed or obtained after its washing is found to be moist, bulkage shall be measured and allowed provided sand is stacked at site at least for 48 hours before use. Bulkage of such a stack shall be measured regularly as directed by the Engineer-in-charge and allowed according to these observations. Observation for bulkage shall be made as per Indian Standard Procedure and allowance shall be made as under.

<table>
<thead>
<tr>
<th>BULKAGE OBSERVED</th>
<th>ALLOWANCE TO BE MADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 5%</td>
<td>Nil</td>
</tr>
<tr>
<td>5 to 10</td>
<td>5 percent</td>
</tr>
<tr>
<td>10 to 15</td>
<td>10 percent</td>
</tr>
<tr>
<td>15 to 20</td>
<td>15 percent</td>
</tr>
<tr>
<td>20 to 25</td>
<td>20 percent</td>
</tr>
<tr>
<td>25 to 30</td>
<td>25 percent</td>
</tr>
<tr>
<td>31 to 35</td>
<td>30 percent</td>
</tr>
</tbody>
</table>

1.16.0 **COARSE AGGREGATE**

1.16.1 Coarse aggregate for concrete shall consist of hard, durable uncoated crushed rock and shall be free injurious amount of soft, feeble thin, elongated or laminated pieces, alkali, organic matter or other deleterious substances. Flaky and weathered stones shall not be used.

1.16.2 **IMPURITIES**

The broken stones shall be free from dust and dirt and shall be washed if necessary to ensure that all faces of the stones are perfectly clean. The maximum
individual percentage by weight or deleterious substances of any size of coarse shall not exceed the following values.

**Material passing through No. 150 microns I.S. sieve one percent by weight.**

- Shale: 1 percent by weight
- Coat: 1 percent by weight
- Soft lumps: 1 percent by weight
- Clay lumps: ¾ percent by weight
- Other deleterious: 1 percent by weight

The sum of the percentage by weight of all the deleterious substances in any size shall not exceed five percent by weight.

The aggregate containing impurities above the specified permissible limits shall be screened / washed / or treated as directed before use in producing concrete.

### 1.16.3 GRADING

The approximate range in grading of coarse aggregate shall be as under. Coarse aggregate shall be of such size as shall be retained on a mesh 5 mm. Sq.

<table>
<thead>
<tr>
<th>Maximum size of aggregate mm.</th>
<th>Normal range mm.</th>
<th>Percentage if coarse aggregate fraction (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 to 80</td>
<td>20 to 40</td>
</tr>
<tr>
<td>20 mm.</td>
<td>10 to 20</td>
<td>100</td>
</tr>
<tr>
<td>40 mm.</td>
<td>20 to 40</td>
<td>100</td>
</tr>
<tr>
<td>80 mm.</td>
<td>40 to 80</td>
<td>100</td>
</tr>
</tbody>
</table>

The grading between the limits specified above shall be such as shall produce a dense concrete of the specified proportion and consistency that shall work readily into position without segregation and without the use of excessive water content.

The use of gravel fraction left behind after sieving river sand for winning fine aggregates shall be permitted in the blending of coarse aggregate if asked for after suitable experiments and without rate variations.

### 1.16.3 SIZE

The maximum size of coarse aggregate for a particular grade of concrete shall be as large as possible but normally not greater than 1 / 4th of minimum thickness of
the concrete member provided that in the case of R.C.C. this size presents no
difficulty to surround the reinforcement thoroughly and fill up the corners of the
form work fully and is less than the minimum cover by 6 mm.
For heavily reinforced concrete members such as ribs of beams, etc. the maximum
size of aggregate shall be restricted to 6 mm less than the minimum clear lateral
distance between the reinforcement bars of 6 mm. Less than the cover whichever
is smaller.
Generally a maximum size of 20 mm. should be found satisfactory for reinforced
cement work.
The grading between the maximum size and minimum size of 5 mm shall be such
as to produce a dense concrete of the specified proportion and consistency that
shall work readily into position without segregation and without the use of
excessive water content.
1.16.4 The Contractor shall at all times maintain a minimum storage of all grades
of the aggregate for the day's requirements, at work site failing which the work
may not be commenced. The Contractor shall furnish representative samples of
aggregates proposed for use in the work at least two months before aggregates
are required for use.

1.17.0 CONCRETE ADMIXTURES
Concrete admixtures shall be used for concrete / RCC work / in Mortars, for
industrial flooring etc. as per PWD Standard specification Volume-II-2012.

1.18.0 WATER
Water used in concrete shall be clean and free from objectionable quantities of
silt, organic matter, alkali, salt and other impurities, which are likely to be injurious.
The turbidity of water for mixing shall not be more than 200 parts per million and
shall preferably be lower.

1.19.0 GRADING AND RELATIVE PROPORTION.
Grading of the aggregates (fine and coarse) brought on the site shall be done by
the Contractor and shall be got approved from the Engineer-in-charge.
The grading of sand and coarse aggregate is liable to be modified beyond the
limits specified above to suit local condition order to obtain required strength and
workability. The grading as well as relative proportion of sand and coarse
aggregate are liable to be changed at the discretion of the Engineer-in-charge. In
order to produce dense concrete of required strength, which can be worked
readily into position without segregation in a given ratio of cement and total aggregate (sum of Volume of sand and coarse aggregate). No compensation is payable for adjustment in relative proportion and grading of aggregates.

1.20.0 DESIGN MIX
The ratio of the volumes of the fine and coarse aggregate may be varied within limits of 1:1.5 to 1:2.5 as directed by the Engineer-in-charge to suit the maximum size of coarse aggregates, the grading density, workability and strength without extra cost. The quantity of water shall be just sufficient, but not more than sufficient to produce a dense concrete of required workability for its purpose. An accurate control shall be kept on the quantity of mixing water. An allowance shall be made for surface moisture present in the aggregates when computing water content is indicated in I.S 456-1978.

Nominal mix proportions of concrete are given in para 4.8.0. However, the exact proportions in which the materials are to be used for different parts of the work shall be determined by carrying out mix design to obtain the specified strength of the concrete. The design of mix, shall be submitted by the Contractor and got approved from the Engineer-in-charge at least one month before the commencement of the work. The design may be changed at any given time at the discretion of the Engineer-in-charge during progress of work. The samples of aggregates and cement and the resulting concrete as well as the concrete mix design shall be tested as per relevant I.S. by the Engineer-in-charge. So as to secure the required workability, density, impermeability, strength and economy.

All the materials going in each batch of concrete shall be weighed before use. The amount of each individual size of aggregate entering each batch of concrete shall be determined by direct weighing. The amount of water shall be added after weighing or volumetric measure. All measuring equipment shall be calibrated correctly and certificate from the competent authority shall be obtained as and when demanded by the Engineer-in-charge. All measuring equipment shall be so designed and operated that the combined inaccuracies in feeding and measuring the materials shall not exceed.

One and half percent for water or cement and two and half percent for each size of aggregate. Any batch of concrete not satisfying this requirement is liable to be rejected. No cement older than 60 days from the date of dispatch from the manufacturer shall be used on the work. The cement to be used shall be in the
older of its receipt so that no stock remains unused for duration longer than 60 days. Cement older than 60 days shall be removed from site as per the directives of Engineer-in-charge.

The ingredients of concrete shall be properly mixed in mixers, designed so as to positively ensure uniform distribution of all the component materials through the mass, at the end of the mixing period. The mixing of each batch shall continue about one and half to two minutes depending upon the revolutions per minute of the mixer and experience after all materials except for the full amount of water are added in the mixer. The minimum mixing period specified above assumes proper control of the rotation of the mixer and of introduction of the materials, including water. The mixing time shall be increased at the discretion of the Engineer-in-charge when the charging operation fails to produce concrete of the required uniformity of composition and consistency within the batch and from the batch of batch. Contractor shall not be entitled for any extra payment for such increase in mixing time. Excessive mixing requiring the addition of the water to preserve the required concrete consistency shall be avoided. If the mixing and charging operations are such that the required uniformity of the concrete is obtained in shorter mixing time than the minimum specified without sacrificed of needed workability, the mixing time may be shortened under order of the Engineer-in-charge. Mixing shall be done by mechanical means only.

Materials corresponding to one bag mix or half bag mix (depending upon the mixer capacity) shall be placed in the skip in sequence of metal cement and sand. The skip shall then be emptied into the drum and specified quantity of water added to material in drum.

The following general principles shall be followed in operation of mixing.

a) The ingredient shall be fed into the mixer simultaneously.

b) A portion of water (between 5 to 10 percent) shall precede and an equal quantity shall follow introduction of the other materials. The remainder of the water shall be added uniformly and simultaneously with the other materials.

c) Care shall be taken that mixing of concrete in the mixer shall be uniform.

1.21.0 TEST FOR CEMENT CONCRETE
Material testing for all materials including cement concrete shall be done as per norms decided by Quality Control Department of WRD and as per relevant Indian Standards.

1.21.1 STIPULATED CRUSING STRENGTH

The crushing strength in Newton per square millimetre on works cubes, at 28 days for each nominal mix shall be as under.

<table>
<thead>
<tr>
<th>Nominal Mix</th>
<th>Equivalent ISS mixes</th>
<th>Preliminary test at 28 days (N/mm²)</th>
<th>Stipulated crushing strength in works tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At 7 days (N/mm²)</td>
<td>At 28 days (N/mm²)</td>
</tr>
<tr>
<td>1:1:2</td>
<td>M-25</td>
<td>32</td>
<td>17</td>
</tr>
<tr>
<td>1:1.5:3</td>
<td>M-20</td>
<td>26</td>
<td>13.5</td>
</tr>
<tr>
<td>1:2:4</td>
<td>M-15</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>1:3:6</td>
<td>M-10</td>
<td>13.5</td>
<td>7.5</td>
</tr>
<tr>
<td>1:4:8</td>
<td>M-7.5</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

4.11.2 PRELIMINARY LABORATORY TEST

Preliminary tests of cubes shall be carried out in the laboratory of Supritending Engineer Quality Control Circle, Nagpur well in advance of commencement of work. These tests should indicate in adequate margin over the stipulated strength specified in Para 4.10.1

4.11.3 WORK TESTS ON CONCRETE

Tests for crushing strength shall be made on standard cubes as per the relevant Indian Standard Specifications. For works tests, samples shall be taken on the job as when directed. For works tests, samples shall be taken once for every 30 cubic meter of each type of concrete laid and at least three times a day, if output is more than 75 cubic meter. The samples for work test is defined as a set of three cubes. The materials required for the samples (concrete, cement, sand and coarse aggregate) shall be supplied by the Contractor free of cost and collection of samples, casting and testing shall be carried out at the Contractor’s cost.

4.11.4 STANDARD OF ACCEPTANCE
Eighty five percent at the test cube have crushing strength equal to or greater than the stipulated strength of concrete. 15% of the samples shall have crushing strength more than 90% of the stipulated crushing strength. Quantity of concrete represented by the sample having crushing strength below 90% and 80% of stipulated crushing strength shall be paid at reduced rates.

4.11.5 **SLUMP TESTS**

In order to test the consistency of the mixed concrete. Slump test shall have to be made by the Contractor when and where required by the Engineer-in-charge, as per Indian Standard Specification. The allowable slump shall be decided by the Engineer-in-charge, depending upon the location of the concrete.

4.11.6 In the case of reinforced concrete work, the workability shall be such as the concrete shall surround and properly grip all the reinforcement. Water cement ratio shall be such as shall give concrete just sufficiently wet to be placed and compacted without difficulty.

4.11.7 Concrete shall have a consistency such that it shall be workable in the required position and in the case of R.C.C. flow around reinforcing steel also.

4.11.8 For vibrated concrete slump shall range between 2.5 cm to 5 cm. The slump shall be the less permitted by workability. The slump shall be determined as detailed in Appendix ‘G’ of I.S. 456-1978 and maintained throughout the concreting operation of member.

**1.22.0 FORMS**

As far as possible Contractor shall use plastic formworks with prior approval of Engineer-In-Charge.

**1.22.1 GENERAL**

Forms to confine the concrete and shape it to the required line shall be used wherever necessary. The form shall have sufficient strength and rigidity to hold concrete and to withstand the pressure of ramming and vibration without excessive deflection from the prescribed lines the more so when the concrete is in vibration. The Contractor shall have to get the design and drawing of the centring approved from the Engineer-in-charge before erection. Formwork shall be of any of the following types.

a) Wooden shuttering with steel plates lining or plywood shuttering.
b) Steel shuttering.
c) Plastic formwork and plastic shuttering pannels

For works costing more than Rs. One Crore, only steel/plastic formwork shuttering to be used. However as per need of site, wooden shuttering would be allowed only if it is free from wrapping and is fabricated true to line and shape. The decision of the Engineer-in-charge as to the suitability of wooden shuttering as per (a) above to be used by the Contractor shall be final and binding on the Contractor. The surface of all forms in contact with concrete shall be clean, rigid, watertight and smooth. Suitable devices shall be used to hold corners, adjacent ends and edges of panel of other forms together in accurate alignment.

1.22.2 DESIGN

The detailed designs of the form work and false work shall be prepared by the Contractor and got approved by the Engineer-in-charge well in time. Such an approval however, shall not relieve the Contractor of his responsibility for the adequacy and strength of the formwork and false work.

Forms shall be as designed and constructed as to be removable in sections without damaging the surface of the concrete and with facilities of removal in ascending order without disturbing the remaining forms required to be removed later.

4.12.3 MATERIAL

The forms and false work shall be made of wood, metal or plastic formwork system. In metal forms, steel sheets of the designed gauge strengthened with framing of angle or other sections shall be used.

4.12.4 FABRICATION

The joints should be made mortar tight. This may be done either by providing tongued and grooved or riveted joint or by caulking or nailing to the construction operation. The nuts and bolt heads inside the form works adjoining the concrete should be countersunk. The formwork should allow finished concrete to have a smooth surface and conform to the shapes, lines and dimensions shown on the plans and true to line and grade. The effect of vibration shall be taken into account in the design and fabrication of form and false work.
4.12.5 TREATMENT OF THE INNER SIDES OF FORMS

Before placing concrete the inner side of the forms which come in contact with the concrete shall be coated with mineral oil or any other suitable materials approved by the Engineer-in-charge which shall prevent adhesion of concrete to the forms but shall not discolour the concrete. When oil is used, it shall be applied before reinforcement is placed. Care shall be taken to see that reinforcement does not come in contact with coating. All chipping saw dust and other rubbish shall be removed from the interior of the forms before concreting.

4.12.6 FALSE WORK

False work shall be built on foundation or base of sufficient strength to carry the loads without settlement. False work cannot be found on solid footing must be supported by piles or other similar devices. False work shall be designed to carry the full loads including that due to construction operation coming upon it.

4.12.7 ERECTION AND REMOVAL OF FORMS

The false work and form work shall be erected with an eye for absolute safety of the form work and concrete work before and after pouring concrete. Watch should be kept to see that the behaviour of centring and form is satisfactory during concreting. Erection should also be such that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed later.

If there is failure of false work and / or form the Contractor shall be responsible for all consequent damages to work, injury to life and damage to property and make good the damage at his cost.

i) Before placing concrete the surface of forms shall be oiled with a suitable non-staining oil such as raw linseed oil so as to prevent sticking of concrete and facilitate the removal of form.

ii) The oil shall cover the forms fully and evenly without excess over drip. Care shall be taken to prevent oil from getting on the surface of the construction joints and on reinforcement bars. Special care shall be taken to oil thoroughly the form strips for narrow grooves so as to prevent swelling of the forms and the consequent damage to concrete prior to or during removal of forms. Immediately before concrete is placed, care shall be taken
to see that all forms are proper alignment and the supports and fixtures are thoroughly secured and tightened.

iii) Where forms for continuous surface are placed in successive units, the forms shall fit tightly over the completed surface so as to prevent leakage of mortar from the concrete and to maintain accurate alignment of the surface.

iv) Forms shall be left in place until their removal is authorised and shall then be removed with care so as to avoid injury to the concrete.

v) Removal of forms shall never be started until the concrete is thoroughly set and hardened adequately to carry its own weight. Beside the live load which is likely to come on the work during constructions. The length of time for which the forms shall remain in place shall be decided by the Engineer-in-charge, with reference to weather conditions, shape position of the structure or structural member and the nature and amount of dead and live loads.

In normal circumstances forms shall be struck after the expiry of the following period.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Walls, columns and vertical faces of all structural members.</td>
<td>48 hours as may be decided by the Engineer-in-charge.</td>
</tr>
<tr>
<td>b)</td>
<td>Slabs (props left under)</td>
<td>14 days</td>
</tr>
<tr>
<td>c)</td>
<td>Beam soffits (props left under)</td>
<td>14 days</td>
</tr>
</tbody>
</table>
| d) | Removal of Props under slabs  
1) Spanning up to 4.5  
2) Spanning over 6 m. | 14 days  
14 days |
| e) | Removing of props under beams and arches.  
1) Spanning up to 4.5  
2) Spanning over 6 m. | 14 days  
21 days |

**Note:** The number of props left under their size and disposition shall be such as to be able to carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing of further construction. In no case shall forms be removed until there is assurance that removal can be accomplished without damaging the concrete surface. No loads shall be allowed to damage the concrete surface. Heavy load shall not be permitted until the concrete has reached its designed strength. The forms shall be removed with
great caution and without harming the structure of throwing heavy forms upon the floor.

**4.12.8 RE-USE OF FORMS ETC.**

Forms required to be used more than once shall be maintained in serviceable conditions and shall be thoroughly cleaned and smoothened before reuse. Where metal sheets are used for lining forms, the sheets shall be placed and maintained on the forms with minimum amount of wrinkles, humps or other imperfections. All forms shall be checked for shape and strength before reuse.

**4.12.9 INSPECTION**

The forms and false work shall be inspected, checked and approved by the Engineer-in-charge before concreting commences. But this shall not relieve the Contractor of his responsibility for strength, adequacy and safety of the form and false work.

**1.23.0 PLACING CONCRETE**

1.23.1 Concrete shall be placed only location where authorised and no-concrete or mortar shall be placed until formwork, installations of embedded parts, preparation of surface or necessary clean-up has been approved.

**1.23.2 ROCK SURFACE**

Rock surface upon or against which concrete is to be placed, shall be prepared as specified in section of excavation for foundation.

**1.23.3 MASONRY SURFACE**

i) Masonry surface on which or against which concrete is to be placed, shall be prepared as described in specification of masonry work of Volume - III. The unit rate for masonry shall cover the cost of such preparation.

ii) If the old layer of masonry which has been paid for is required to be removed as mentioned in para 9.2.2 it shall be back filled with concrete along with upper concrete layer at no extra cost.

**1.23.4 CONCRETE SURFACES**

Before laying of concrete the surface of the concrete in day to day work shall be cleaned by a wire brush and jets of water, so that the surface is thoroughly cleaned and wetted but pools of water are avoided. If the old concrete surface has
remained exposed for than two weeks, if shall be prepared not roughened by chipping to a depth of two centimetres and the surface coated or covered with a layer of cement mortar (1:2) for a depth of 5 to 8 cm. The unit rate of concrete shall cover the cost of such preparation and also the cost of cement mortar. The concrete removed for roughening shall not be paid for.

1.23.5 ALL SURFACES
i) The cleaned rock, masonry or concrete surface shall be applied with cement slurry and then cement mortar coat as.
ii) The first few batches of concrete may, if as required contain half the regular size of coarse aggregate without any extra claims.
iii) The cost of such preparation work stands included in the unit rate of cement concrete.

1.23.6 TIME FOR USE
All concrete shall be placed directly in its final position within thirty minutes of mixing. Any concrete, which has become so stiff that proper placing cannot be assured without re-tempering shall be wasted and shall not be paid for. All surface of forms and metal work including reinforcement that have become encrusted with dried mortar of grout concrete previously placed shall be cleaned of all such mortar or grout before surrounding or adjacent concrete is placed.

1.23.7 METHOD OF PLACEMENT
Before starting placing of concrete, it should be made certain that the transporting and placing equipment is clean in proper order and that equipment along with the operating staff is arranged to deliver the concrete in the final positions without undue delays and objectionable segregation. The methods and the equipment used for transport and placing of concrete shall be such as shall permit the delivery of concrete of the required consistency into the work without objectionable segregation porosity or excessive loss of workability. Excessive segregation from whatever cause shall be prevented in handling and placing operation by avoiding or controlling lateral movement of the concrete as in dumping at an angle depositing continuously at one point and allowing the concrete to flow. Concrete shall not be dropped from excessive heights and free fall should be kept to a minimum. Concrete shall be deposited in continuous
horizontal layers in a thickness of approximately 30 cm in normal work to 45 cm for mass concrete excess that nothing herein shall be construed to permit placement of the additional horizontal layers of mass concrete before the entire area to be concreted is covered by previous layers. On flat, horizontal surfaces, where congestion of steel near the forms makes placing of concrete difficult, a mortar of the same cement, sand ratio as used in the concrete shall be first deposited to cover the forms and shall stand included in the unit rate of concrete before the entire area to be concreted is covered by previous layers.

1.23.8 RATE OF PLACING
Concreting should be continued without interruption until the structure of section is completed or until satisfactory construction joints can be made. Location of construction joints shall be as directed by the Engineer-in-charge. Concrete shall not be placed, faster than the placing crew can compact it properly. In placing thin members and columns precautions shall be taken against too rapid placement which may result in movements or failure of the form due to excessive lateral pressure. An interval of at least 12 hours and preferably 24 hours should elapse between the completion of columns and walls and the placing of slabs beams or girders supported by them in order to avoid cracking due to settlement. All concrete shall be placed in approximately horizontal lift not exceeding 1.25 meter in thickness per day. Concrete in arches shall be done in strips extending from one pier to another. No through joints shall be kept in the span.

1.23.9 CONCRETING AT NIGHT TIME
If concrete is to be placed at night adequate lighting arrangements shall be made, as directed by the Engineer-in-charge.

1.23.10 CONCRETING DURING RAINS
When concreting is required to be done or continued while it shall be seen that the concrete is not damaged due to rain while it is being transported and placed. After placing the green concrete it shall be adequately covered for a period of 24 hours when it shall be capable for being cured by splash of water. The surface of fresh concrete should be maintained on a slope sufficient for result in the self-drainage of the rainwater. The work shall however be discontinued when the rain is so severe that water collects in pools or washes the surface or the fresh concrete and it is not possible to provide adequate shelter.
1.24.0 COMPACTATION

1.24.1 GENERAL

In all concrete works, required nos. of vibrators, with standby in working condition shall be kept ready at site as per the instructions of the Engineer-in-charge.

1.24.2 All concrete shall be vibrated by mechanical vibrator of approved type so as to ensure dense concrete. Hand tamping and rolling shall not be used for compaction of concrete except in special circumstances with the express permission of the Engineer-in-charge. When immersion type vibrators are used they shall be used vertically at about 45 cm apart. The vibrators shall be inserted to the full depth of the newly laid concrete layer. The concrete shall be thoroughly compacted during depositing to get a dense concrete and thoroughly worked in to the edges and corners of the form work and also along it faces and around reinforcement in the case of R.C.C. by means of suitable tools such as trowel and rods to gets a good finish without honeycombing. The vibrator shall however, not re-vibrate concrete, which has commenced its final set. Special care shall be taken to see the vibrator touching the reinforcement of embedded part does not disturb the concrete below, which has commenced its final set. The concrete shall not be vibrated excessively so as to cause segregation.

1.24.3 Each layers of concrete, for surfaces which is required to be smooth and for all surfaces which shall be permanently exposed to the weather, and for all surfaces next to embedded metal work shall be worked and vibrated by mechanical vibrator of approved type only so as to obtain a concrete of maximum density and imperviousness and to assure close contact of the concrete with forms, reinforcement bars and other embedded parts. If the methods of transporting and placement have been conductive to air entertainment segregation of stiffening, the work of compaction should receive special attention.

1.24.4 For concrete surface exposed to flow of water special precaution shall be taken to minimise and to prevent surface pitting and protrusions without resorting to over manipulation of the concrete mix to the forms. No plastering for getting a smooth finish shall be permitted at these locations. Any protrusion shall be ground smooth.
1.25.0 CURING AND PROTECTION.
All concrete shall be protected against injury until final acceptance. Exposed finished surface of concrete shall be protected from the direct rays of sum of at least 72 hours after placement. Concrete shall be kept continuously moist for not less than 21 days. Construction joins shall be cured in the same ways as other concrete and shall be kept moist for at least 72 hours prior to the placing of additional concrete upon the joints. Approximately horizontal surfaces shall be cured by sprinkling, pounding or by covering, or by damp sand or may be cured by the use of wet quills or mats. Vertical surfaces shall be cured by covering with wet jute bags. If damp sand or quilting is used for curing, it shall be removed completed later. Should the concrete that has become dry or powdery through neglect of curing the Contractor shall rectify the work as his own extra cost. If curing arrangements by the Contractor are not satisfactory the Engineer-in-charge may in his discretion engage labour and provided material and equipment for curing and recover expenditure thus involved from Contractor.

1.26.0 FINISHING
1.26.1 GENERAL
Finishing of formed and unformed surface shall be performed only by skilled workmen. All exposed concrete surfaces shall be cleaned of all encrustations of cement mortar or grout. Unsightly stains shall be removed.

1.26.2 FORMED SURFACES
Surface of concrete finished against form shall be smooth, free from projections and filled thoroughly with mortar. Immediately upon removal of forms, all unsightly ridges of fines shall be removed and any local bulging on exposed surfaces shall be remedied by tooling and rubbing. All holes left by the removal of fasteners shall, after being reamed with toothed reamer, neatly filled with dry patching mortar. All porous and fractured concrete and surface concrete to which additions are required to bring it to the prescribed lines shall be sharp edged and keyed shall be filled to required line with fresh concrete used for filling the chipped openings and these shall not be less than 8 cm in depth and the concrete filling shall be reinforced and doweled to the surface of the opening. Honey combed
surfaces and surfaces, which give a hollow sound, shall be rectified by guniting at the Contractors cost.

1.26.3 DRY PATCHING
Dry patching mortar shall consist of one part of cement to 2 parts of sand by volume and just enough water so that the mortar so used, shall stick together on being moulded into a ball by a slight pressure of hands and shall not exclude water when pressed but shall leave the hands damp. The mortar shall be placed in layers of not more than 2 cm thickness. After being compacted each layer shall be roughened by being scratched to provide an effective bond with the succeeding layers. The last of finishing layer shall be smooth to form a surface continuous with the surrounding concrete. All patches shall be bonded thoroughly to the surface of the chipped opening and shall be sound and free from shrinkage cracks.

1.26.4 FINISHING PERMANENTLY ESPOSED SURFACE
Except as otherwise specified or directed all permanently exposed concrete surface and other waterway surface requiring durability under water (except the outlet) shall be finished in the following manner immediately upon the removal of the form the surface shall be wetted and all surface pits and air bubbles filled by rubbing mortar composed of cement and fine sand in proportion (1:2) in to the pits with burlap so at to secure a uniformly dense and smooth face. The rubbing shall be performed in such a manner as to leave the surface free from mortar not used for filling the pits. Should the filling operation be unduly delayed and the surfaces of the pits become coated with dirt or other contaminating materials, they shall be thoroughly cleaned and washed and shall be maintained in a moist condition, until the mortar filling is placed. Such cleanings shall be done by means of air and water jets and chipping or brushing or other satisfactory means without damaging the surrounding concrete. All operations in connection with the filling of surface pits shall be handled as quickly as practicable to minimize the period during which the concrete and mortar filling are exposed to the drying. When the treatment of a surface has been completed the surfaces shall be neat and of the same colour and texture as the adjoining concrete.

1.26.5 FINISHING CONCEALED SURFACE ARCHES.
For exterior concealed surfaces below ground or back fill level or like surfaces not otherwise specified, no finish is necessary except that sand streaks metal pockets, honey combing or other imperfections which are of consequence affecting strength, water tightness or protection of reinforcing steel from corrosion, shall be corrected and repaired as prescribed for formed surface.

1.26.6 FINISHING UNFORMED SURFACE

Unformed surface shall be finished by one or more of the operation of Screeding floating and trawling of the surface should be done at proper time employing experienced men and should be just sufficient to produce the desired finished. Screeding which gives the surface its approximate shape by striking of surplus concrete immediately after compaction shall be accomplished, by moving a straight edge or template with a sawing motion across wood or metal strips that have been established as guides. Where the surface is curved special screed should be brought true to form and grade by working it with a wooden float. If a coarse textured finish is desired or if the surface is to be steel trawled a section or final floating should be performed after some stiffening has occurred and the surface moisture film or shine has disappeared. Where smooth dense finish is desired floating shall be followed by steel trawling sometime after moisture film or shine has disappeared from the floated surface and where the concrete has hardened sufficiently to prevent fine material and water from being worked out the surface. Excessive trawling particularly at early time shall be avoided.

1.26.7 CHIPPING AND ROUGHENING CONCRETE SURFACE.

Surface upon or against which additional concrete is to be placed shall be chipped and roughened to a depth not greater than 25 mm. Roughening shall be performed by chipping or other satisfactory methods and in such manner as not to loosen, crack or shatter any part of the concrete beyond the roughened surface. After being roughened the surface of the concrete shall be cleaned thoroughly of all loose fragments, dirt and other objectionable substances and shall be sound and hard in such conditions as to assure good mechanical bond between old and new concrete. All concrete which is not hard, dense and durable shall remove to the depth required to secure a satisfactory surface.

1.26.8 DAMAGE DUE TO FLOODS-COPORATION NOT RESPONSIBLE.
In case of damage of any of the concrete work due to floods. Corporation shall not be responsible and whatever corrective measures are required to be adopted shall be done by the Contractor at his cost.

4.17.0 CONCRETE NOMINAL MIX AND STIPULATED STRENGTH

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Nominal Mix</th>
<th>Cement content in Kg / cum.</th>
<th>Maximum size of aggregate in mm</th>
<th>Stipulated strength at 28 days on 15×15×15 cm. Cubes (works tests) N / mm²</th>
<th>Indicated location</th>
<th>Probable for use</th>
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<tr>
<td>1</td>
<td>1:1.5:3 M-20 (20 MSA)</td>
<td>330.00</td>
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<td>20</td>
<td>R.C.C. beams walls, columns &amp; cross works</td>
<td>Slabs, vertical through ribs of drainage</td>
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<td>2</td>
<td>a) 1:2:4 M-15</td>
<td>282.00</td>
<td>20</td>
<td>15</td>
<td>Slabs, kerbs, beams</td>
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<tr>
<td></td>
<td>b) 1:2:4 M-15 (PCC)</td>
<td>260.00</td>
<td>40</td>
<td>15</td>
<td>Abutment, pier cars, dirt walls</td>
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</tr>
<tr>
<td></td>
<td>c) 1:2:4 M-15 (PCC)</td>
<td>282.00</td>
<td>20</td>
<td>15</td>
<td>Wearing coat of bridges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) 1:2:4 M-15 (PCC)</td>
<td>282.00</td>
<td>20</td>
<td>15</td>
<td>Cast in situ canal lining</td>
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</tr>
<tr>
<td>3</td>
<td>a) 1:3:6 M-10</td>
<td>220.00</td>
<td>20</td>
<td>10</td>
<td>Side template steps</td>
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<td></td>
<td>b) 1:3:6 M-10 (PCC)</td>
<td>220.00</td>
<td>40</td>
<td>10</td>
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<td>4</td>
<td>1:1:2 M-25 (PCC)</td>
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<td>RCC Structure</td>
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5.0 BACK FILLING

5.1.0 GENERAL

Back-filling generally means excavation re-fill up to the ground level by embankment material which is required to be placed in excavation after the structure is built up above, then normal ground level. All the back-fill shall be carefully grade to the lines and grades as shown on the drawings or as directed. The item includes the quarrying, transporting servicing and such other processing operations to produce the materials of desired quality, laying watering and
compacting as directed. The material obtained from the excavation work in this contract shall be allowed to be used for back-filling, if of approved quality, free of cost.

5.2.0 PREPARING SURFACE FOR BACK-FILLING
All loose materials and surface debris shall be removed. The bed sides shall be drenched with water sufficiently so as to prevent absorption of water from back-fill material. Before placing the back-fill material, the surface shall be tamped or otherwise consolidated sufficiently.

5.3.0 BACK-FILLING WITH IMPERVIOUS MATERIAL.
The impervious material may be obtained from excavation stuff free of cost or borrowed from outside from Contractor's own sources if required without any limitation of lead or lift. The quantity of the impervious material should be got approved from the Engineer-in-charge in advance. Water shall be added to the embankment and mixed by suitable means to assure uniform distribution of moisture and be desired standard of compaction.

5.4.0 COMPACTION
The proctor test of soil compaction with approved modification shall govern the construction. Laboratory methods shall be used to determine the optimum moisture content, dry and wet density and permeability and the contraction shall be controlled by field tests and made to determine whether adequate degree of compaction is being attained.

5.5.0 BACK-FILLING WITH PERVIOUS MATERIAL.
The pervious material may be obtained from the excavated stuff free of cost or borrowed from Contractor's own sources if required without any limitations of lead or lift. The quality of the pervious material should be got approved from the Engineer-in-charge in advance. Care shall be taken to see that materials in the different layers are compacted properly and the finished surface shall have a neat appearance.

6.0 STEEL REINFORCEMENT
6.1.0 SCOPE OF WORK
This item shall include supplying, cutting, bending, binding and erecting in position steel reinforcement confirming to relevant Indian Standard Specifications. (As per
PWD standard specification Volume-II Bd.F-17). All work related to reinforcement shall be done according to PWD standard specification Volume-II-2012 including all type of testing.

**The steel confirming to grade Fe-500 shall only be used for the work. No mildsteel stirrups / links shall be allowed in RCC work.**

All reinforcement shall be based on ductile detailing code IS: 13920 with Latest revision for appropriate Earthquake Zone.

### 6.2.0 REINFORCEMENT BARS

**6.2.1** Steel reinforcement bars and fabrics shall be placed in the concrete as shown in the Drawing or as directed. Before steel reinforcement is placed in position the surface of the reinforcement shall be cleaned of rust, scale, dirt and grease and other objectionable foreign substances (heavy flaky crust and Mill scale the cannot be removed by firm rubbing with burlap, or equivalent treatment is considered objectionable). The fact that light or early stage rust has no detrimental effect on bond and hence could be discharged shall not be used as excuse of careless handling and storage of steel. In storing bars of the same size, length shapes and grade shall be assembled in racks and marked distinctly. Before the reinforcement bars are fixed in position it shall be verified that they are of specific size and bent in accordance with the plans and specifications. They shall be accurately placed and secured in position by means of built in concrete block, metallic chairs, hangers, spaces and other suitable devices, at sufficiently close intervals, so that they shall not sag between supports, not be displacing of the concrete or by any operation of the work.

**6.2.2** Special care shall be exercised to prevent any disturbance of the reinforcement in concrete that has already been placed. The reinforcement after being placed in position shall be maintained in a clean condition until it is completely embedded in concrete to prevent further damage to the concrete or unsightly rust stains on exposed concrete surface.

**6.2.3** Reinforcement shall not be straightened or bend in a manner that shall injure or weaken the materials. Bars with kinks or bends not shown on the plans shall not be used. Bars shall be bent to the shape and dimensions shown, on the drawing or as directed, using a bar bender, operated by hand or power, to attain
the proper bending radius. The radius of bend shall not less than 4 times the nominal size of the bar.

6.2.4 Heating of reinforcement bars to facilitate bending shall not normally be permitted when, however, such heating is permitted in the case of large diameter bars, the temperature of the steel shall not exceed the corresponding to a cherry red colour.

6.3 BINDING
Wire for tying reinforcement shall be soft and annealed steel. The wire may be of 1.22 mm to 1.63 mm and shall have to confirm to IS 280-1962. Metal support and spacers shall be fabricated from non-corrodible metal. Dissimilar metal shall not be placed in concrete in intimate proximity with each other or be joined by a connector especially in the continued presence of moisture unless it is know that galvanic action shall not result.

6.4 DISTANCE BETWEEN REINFORCEMENT BARS.
6.4.1 The distance between two parallel reinforcement bars shall be except as provided below in 7.4.1 not less than the greatest of the following distances.

a) The diameter of either bar, if their diameters be equal to.

b) The diameter of the larger bar, if their diameter be unequal.

c) 6 mm more than the nominal maximum size of the coarse aggregate comprised in such concrete.

Note: A greater distance should be provided when convenient.

6.4.2 The vertical distance between two horizontal main steel reinforcements or the corresponding distance at right angles to two inclined main steel reinforcement shall be not less than 12 mm except at a splice or lap and except where one of such reinforcement is transverse to the other.

6.4.3 The pitch of the main bars in a reinforced concrete solid slab shall be not more than three times of effective depth of such slab, or 60 cm whichever less is.

6.5 SPLICING
Bar splices as indicated in the drawing or as specified by the Engineer-in-charge shall only be allowed. The lapped ends shall be placed to ensure full bond on
each bar. Splicing shall not be done in the region of maximum bending moment, and splicing of adjacent bars shall be avoided as far as possible. Welding of bars for splicing may be allowed in place of lapping at the discretion of the Engineer-in-charge at approved locations. When welding is resorted, instead of lapping, the bar to be spliced shall be cleaned off all dirt, scales, rust paint and foreign matter before welding.

All welding shall conform to the relevant Indian Standard Specification. Any weld shall be considered unsatisfactory if it fails to sustain a tensile stress of at least 90% of the tensile stress of the bar in which the weld has been made. The Contractor shall make necessary arrangements, for carrying out the tests as directed by the Engineer-in-charge and with the accepted unit rate of reinforcement.

6.6 COVER (AS PER PROVISION MADE IN IS- 456:2000)

6.6.1 Sufficient concrete cover shall be provided to protect reinforcement from corrosion or as indicated in the drawings. All protruding bars from concrete or masonry to which other bars are to be spliced and which shall be exposed to action of weather for an indefinite period shall be protected from rusting by a thin coat of neat cement grout.

6.6.2 The thickness of concrete cover (exclusive of plaster or other decorative finish) shall be as follow.

a) At each end of reinforcing bar a cover not less than 25 mm nor less than twice the diameter of such rod or bar.

b) For a longitudinal reinforcement bar in a column cover not less than 40 mm nor less than the diameter of such or bar in the case of column of minimum dimension of 18 mm or under those bars which do not exceed 12 mm diameter, 25 mm cover may be used.

c) For a longitudinal reinforcing bar in a beam a cover not less than 25 mm nor less than the diameter of such rod or bar.

d) For tensile, compressive shear or other reinforcement in a slab a cover, not less than 12 mm nor less than the diameter of such reinforcement.

e) For all external work for work against earth faces and also for internal work where there exists particularly corrosive conditions, the cover of the concrete shall be increased by 12 mm beyond the figures given above (a to d)
6.6.3 Where because of splicing, thickness of concrete in between reduces to less than the maximum size of the aggregate a concrete with reduced maximum size of aggregate shall be used so at to allow development of bond in the splice. The extra-cost of such special concrete shall be deemed to have been included in the unit rate for the main concrete and shall be paid at the same rate.

6.7 INSPECTION BEFORE CONCRETING
No concerning shall be started unless the reinforcement as laid is finally checked and certified by the Engineer-in-charge or his authorised representative. Before starting the concerning the Contractor shall make certain that the measurements of the reinforcement placed in have been recorded and that the Engineer-in-charge certifies the correctness of reinforcement used. Failure to do so may mean no payment or payment at the discretion of the Engineer-in-charge for the reinforcement concrete.

6.8 ANCHOR BARS
The cost of anchor bars roper shall be paid under the item of reinforcement.

6.9 TABLE OF WEIGHT FOR REINFORCEMENT.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Diameter of bar in mm.</th>
<th>Weight in Kg. Per meter.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>M.S. round bars</td>
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<tr>
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<td>19</td>
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7.0 PROVIDING AND FILLING FOUNDATION WITH RUBBLE AND HARD MURUM

7.1.0 GENERAL

The item provides for filling rubble and hard murum in foundation including dewatering preparing the bed for foundation, obtaining rubble and hard murum, hand packing and ramming the foundation and filling the voids as directed.

7.2.0 MATERIAL

The rubble and hard murum shall be of approved quality and the percentage of material should be Murum 40% and Rubble 100%.

7.3.0 FILLING

The bed on which rubble and hard murum is to be laid shall be cleared of all loose materials, levelled and compacted and got approved from the Engineer-in-charge before starting rubble and hard murum filling. Such preparation of the base shall be covered by the rate of this item.

The rubble shall be laid with the largest face downward and in close contact with each other in layer not exceeding 30 cm. Each layer of rubble filling shall be hand packed and hard murum shall be filled in the joints and voids so as to fill them completely as possible. The rubble filling shall be roughly levelled at the top with hard murum.

7.4.0 ITEM TO INCLUDE

i) Preparation of foundation for laying rubble and hard murum.

ii) Providing rubble and hard murum for filling.

iii) Laying, packing and compaction including watering of rubble and hard murum.
iv) Any other labour, materials and use of tools required for the completion of the item satisfactorily.

8.0 CLEARING SITE

1.16 SCOPE
The item pertains to the provision of site clearing including cutting small shrubs, vegetation, bushes and clearing stumps and molehills in the works.

1.17 CLEARING SITE
The land width required for component of work shall be cleared for all trees having a girth of 30 cm and less brushwood, vegetation, bushed, stumps and other objectionable material. The roots of trees shall be removed to a depth of 30 cm below the surface of the foundation land and side slopes and the excavation filled up with excavated material in 15 cm. To 20 cm. Layers and the compacted. Brushwood, vegetation, bushes, stumps etc. shall be cut flush with the ground. All the material cleared shall be the property of Corporation. Useful material shall be arranged in convenient stacks as directed, at convenient place of disposal and handed over the Corporation for disposal. Unsuitable material shall be burned or otherwise disposed of by the Contractor at his own cost as directed by the Engineer-in-charge without causing any nuisance, inconvenience or damage to the property of the people in neighbourhood in cases, the material shall be disposed off in a neat manner.

1.18 DISPOSAL OF STUFF REMOVED
All materials removed, as a result of clearance shall be a property of Corporation. Useful material shall be arranged in convenient stacks as directed by the Engineer-in-charge. Useless material shall be disposed off by the Contractor as directed by the Engineer-in-charge without causing any nuisance, inconvenience.

1.19 ITEM TO INCLUDE
Clearing for embankment appurtenant works including cutting trees having a girth of 30 cm removing vegetation roots and molehills and disposal of material removed. All necessary labour, materials and use of tools for carrying out the item shall be arranged by the Contractor.

9.0 DE – WATERING
9.1.0 SCOPE
The item shall include all de-watering and diversion work required in a manner here-in-after specified.

9.2.0 GENERAL
The canal / pumphouse foundation / approach channel / forebay and any other foundation shall be kept dry by resort to pumps along or in combination with manual labour for bailing out water with buckets etc. or any other satisfactory method to be adopted shall be entirely left to the choice of the Contractor provided de-watering is carried out satisfactorily and the scheduled programme is adhered to. The Contractor shall plain, construct, and maintain satisfactorily, safe and full proof arrangement for de-watering to ensure safe excavation and laying concrete and masonry in the dry. The Contractor shall supply details of his proposals for approval of the Engineer, but such an approval shall in no way release the Contractor from his responsibility for the adequacy of de-watering arrangements and for the quality and safety of the work, for all of which the Contractor shall be solely responsible.

Other approved methods may be used by the Contractor at his discretion and cost to prevent or reduce seepage and to protect the area to be excavated if the soil is porous.

9.2.1 PUMPING
Adequate pumping arrangements shall be made for de-watering approach channel and pump house keeping the same dry while lining masonry or concreting. Is in progress and till the mortar has sufficiently set. Pumps of required capacity and in required number and stages shall be provided to ensure the above pumping from the foundation / excavation area shall be done directly from the pit or from a sump inside the excavation as necessary, in such a manner as to precluded the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. No pumping shall be allowed during laying of concrete or masonry and for a period of at least 24 hours thereafter unless. It is done from a suitable sump separated from concrete or masonry by effective means. Pumping shall be done in such a way as not to cause damage to the work or adjoining property by blow subsidence etc.
The Contractor shall make his own arrangements for necessary labour, materials, pumps, engines, well-points and other suitable machinery and devices required for successful execution of the item of de-watering.

9.3.0 CONTRACTOR RESPONSIBLE FOR DIVERSION ETC.
The Contractor shall plan, construct and maintain satisfactorily necessary diversion channels and other temporary diversion, protective works and furnish, install, maintain and operate all necessary pumping and for de-watering the various parts of the work and maintaining the section as free from water as required for approved construction operation.

9.3.1 ADEQUACY OF DIVERSION
All bunds diversions of flow and other arrangements proposed to be made shall be by prior discussion and approval by the Executive Engineer. On approval they shall be constructed and maintained at the Contractor’s cost. Approval of the plans for diversion works shall not relieve the Contractor of the responsibility for the adequacy of diversion and de-watering arrangements.

9.4.0 CONTRACTOR TO DEWATER WHENEVER REQUIRED
The area under all works as necessary shall be maintained free from water. The area shall also be maintained free of water after any part of the work is completed for inspection, safely and or for any other reasons determined as necessary. The Contractor shall pump all water from the site of the works and shall keep the section free of water while excavating, concreting and continue to keep the works free of water for periods as may be required for proper setting of concrete or otherwise required for the completion of works.
The Contractor shall not be entitled to any claims or damages on account of or by reason of any account of water leaking through under or around bunds diversion channels and other diversion or protective works or over顶ping.

9.5.0 DISILTING
If excavation pits are filled due to accumulation of surface flow during the progress of the work or during rainy season or due to any other cause. All pumping required for de-watering the pits and removing silt shall be done without extra cost.
9.6.0 DISPOSAL OF WATER

The water from the excavated section shall be disposed off in the manner detailed below or in any other manners in conformity with the rules in force and approved by the Engineer.

In undeveloped areas such as countryside where sewerage system has not been introduced the water may be led to the nearest natural drain or pond through properly laid and dug channels or through pipes.

Disposal of water shall in no case cause inconvenience or nuisance to the inhabitants of the area or cause damage to the property and structures nearby.

Government regulations shall be complied with and rights. On private land owners shall be respected regarding disposal of water.

Contractor shall be responsible for all the incidental like obtaining permission of local bodies and persons concerned to lead the water to the open digging up channels, making use of land sand properties owned by private persons or public bodies etc. and for the damage caused in the operation of this item.

9.7.0 ITEM TO INCLUDE

1) All labour, materials, pumps, plants, equipment, staging, shoring, strutting, sumps and other arrangements necessary for de-watering during excavation and construction of other item requiring de-watering.

2) De-watering excavation and construction of lining area and keeping the same dry while excavation masonry and concrete work is in progress and till the work comes above the water level and till the Engineer considers that the mortar or concrete has sufficiently set.

3) De-watering till all the items requiring de-watering are fully completed. This shall also include required for final section and taxing measurements of all the items requiring de-watering.

4) Removing stuff of any sort which might find access into the trenches by blowing slip or due to any other cause whatsoever from the sides or bottom of the excavation or from elsewhere during, or due to de-watering.

5) Leading water to the nearest natural or artificial drains, with all incidental requirements concerns any compensations etc.

6) Compensation for the injury to the workmen and the public or damage to the nearby properties during and on account of de-watering and disposal of water.
10.0 OTHER BUILDING SPECIFICATION FOR PUMP HOUSE AND OTHER BUILDING

All other Building specification as per PWD Maharashtra Standard Specification Volume-II: Buildings 2012 as directed by Engineer-in-Charge.

<table>
<thead>
<tr>
<th>Specification No</th>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bd. C</td>
<td>Structural Steel Work</td>
<td>All structural steel work / items required for building as per appropriate specification under Bd. C and as directed by Engineer-in-Charge. Parking shall be structural steel frame work with colour coated steel sheets with architecturally aesthetic view and approved by Engineer-in-Charge.</td>
</tr>
<tr>
<td>Bd. E</td>
<td>PCC</td>
<td>All PCC work / items required for building as per appropriate specification under Bd. E and as directed by Engineer-in-Charge.</td>
</tr>
<tr>
<td>Bd. F</td>
<td>RCC</td>
<td>All RCC work / items required for building as per appropriate specification under Bd. E and as directed by Engineer-in-Charge. Same is applicable for other items like admixtures as directed by Engineer-in-Charge.</td>
</tr>
<tr>
<td>Bd. G</td>
<td>Brick Work</td>
<td>Specification B.7 under Bd. G shall be applicable. Cement Mortar as per B.4</td>
</tr>
<tr>
<td>Bd. H</td>
<td>Stone Masonry</td>
<td>All Stone Masonry work / items required for building as per appropriate specification under Bd. H and as directed by Engineer-in-Charge. Cement Mortar as per B.4</td>
</tr>
<tr>
<td>Bd. J</td>
<td>Water Proofing for Roof and other components &amp; Damp proofing</td>
<td>All Water Proofing work / items required for building as per appropriate specification under Bd. J and as directed by Engineer-in-Charge. Brick Bat Koba with water proofing compound or APP Membrane shall be used.</td>
</tr>
<tr>
<td>Bd. K</td>
<td>Expansion</td>
<td>As per Bd.K.1</td>
</tr>
<tr>
<td>Joints</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Bd. L</strong></td>
<td>Plastering &amp; Pointing&lt;br&gt;Internal Plaster- 12mm thick as per Bd.L.2 &lt;br&gt;External Plaster-20mm thick as per Bd. L.4 &lt;br&gt;Pointing as per appropriate specification as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td><strong>Bd. M</strong></td>
<td>Paving, Floor Finish &amp;Dados&lt;br&gt;Plinth Protection work as per Bd.M.1 all around building.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Floor for Parking</strong>&lt;br&gt;shall be PCC 1:2:4 type using 20mm graded aggregate 50mm thick finished rough &amp; making non-skid by Spike rolling to surfaces or making impressions of expanded metal, whilst the concrete is green over 75mm thick PCC 1:4:8 sub base over Rubble and Murum filling which is properly watered and rammed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Flooring for Pump Location</strong>&lt;br&gt;Heavy duty Industrial flooring shall be provided for Pump House and Control room with as per IS: 4631-1986 and as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>All other Building Flooring &amp; Dado as per scope.</strong>&lt;br&gt;<strong>Flooring</strong>- Vitrified Non Skid Flooring min 600 X 600 over 15mm screed bed of CM 1:6 as approved make by Engineer-in-Charge. &lt;br&gt;Lavatory Block- Glazed ceramic tiles of approved make. &lt;br&gt;Paver Block- As defined in scope of work.</td>
<td></td>
</tr>
<tr>
<td><strong>Bd. N</strong></td>
<td>Wood Finishes&lt;br&gt;All wooden item work finishes shall be as per Bd. N</td>
<td></td>
</tr>
<tr>
<td><strong>Bd. O</strong></td>
<td>Oil Painting&lt;br&gt;As per scope of work and as per appropriate specification under Bd. O and as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td><strong>Bd. Q</strong></td>
<td>Wood Work&lt;br&gt;As per scope of work and as per appropriate specification under Bd. Q and as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td></td>
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<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Bd. S</td>
<td>Glaziers Work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per scope of work and as per appropriate specification under Bd. S and as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td>Bd. T</td>
<td>Door, window, Ventilators &amp; Partitions,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per scope of work and as per appropriate specification under Bd. T and as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td>Bd. U</td>
<td>Iron Work, Rolling shutters &amp; Collapsible Gates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per scope of work and as per appropriate specification under Bd. U and as directed by Engineer-in-Charge.</td>
<td></td>
</tr>
<tr>
<td>Bd. V</td>
<td>Water Supply &amp; Sanitary Fittings</td>
<td></td>
</tr>
</tbody>
</table>
|            | As per scope of work and as per appropriate specification under Bd. U and as directed by Engineer-in-Charge.  
|            | **All fittings make as approved by Engineer-In-Charge.**                    |
|            | Anti-termite treatment                                                      |
|            | All as per Indian code of practice and as directed by Engineer-in-Charge.    |
| Bd. W      | Miscellaneous                                                               |
|            | As per scope of work and as per appropriate specification under Bd. W and as directed by Engineer-in-Charge. |
|            | Furniture                                                                   |
|            | All as per scope of work and as per relevant Indian code and as directed by Engineer-in-Charge and architect until otherwise specified in tender document. |

Item of Building which are not covered under PWD standard Specification Volume-II Building:2012, Relevant CPWD, MES, Mahavitran, Relevant Indian & International code shall be applicable as directed by Engineer-in-Charge.

All other necessary provisions shall be made as per National Building Code of India 2005 and relevant specification as per Indian code and as decided by Engineer-in-Charge shall be applicable.

All measurements shall be based on Approved estimate as per vetted design & drawings. And payment shall be done as per Schedule of Payment, Appendix-F Volume-II.
11. PROVIDING AND FILLING FOUNDATION WITH RUBBLE AND HARD MURUM

11.1 GENERAL
The item provides for filling rubble and hard murum in foundation including de-watering preparing the bed for foundation, obtaining rubble and hard murum, hand packing and ramming the foundation and filling the voids as directed.

11.2 MATERIAL
The rubble and hard murum shall be of approved quality and the percentage of material should be Murum 40% and Rubble 100%.

11.3 FILLING
The bed on which rubble and hard murum is to be laid shall be cleared of all loose materials, levelled and compacted and got approved from the Engineer-in-charge before starting rubble and hard murum filling. Such preparation of the base shall be covered by the rate of this item.

The rubble shall be laid with the largest face downward and in close contact with each other in layer not exceeding 30 cm. Each layer of rubble filling shall be hand packed and hard murum shall be filled in the joints and voids so as to fill them completely as possible. The rubble filling shall be roughly levelled at the top with hard murum.

11.4 ITEM TO INCLUDE
i) Preparation of foundation for laying rubble and hard murum.
ii) Providing rubble and hard murum for filling.
iii) Laying, packing and compaction including watering of rubble and hard murum.
iv) Any other labour, materials and use of tools required for the completion of the item satisfactorily.

12.0 ROLLING SHUTTERS
12.1 Rolling shutter
These shall consist of MS laths 1.25mm thick and 80mm wide laths or as specified. The laths shall be machine rolled and straightened with an effective bridge depth of 16mm and shall be interlocked together throughout their entire length and jointed together at the end with end locks. These shall be mounted on
specially designed pipe shaft. Each lath section shall be continuous single strip piece without any joint. The springs shall be coiled type. The spring shall be manufactured from high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong mild steel brackets.

12.2 Guide Channel
The guide channels shall be of mild steel deep channel section and of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15mm. The minimum depths for guide channels shall be as follows: Clear width of shutter Depth of Guide Channel. Up to 3.5m 60mm 3.5m and above 75mm the gap between the two legs of the guide channel shall be sufficient to allow the free movement of the curtain and at the same time – close enough to prevent the rattling of the curtain due to wind. Each guide channel shall be provided with a minimum of three fixing elates or supports for attachment to the walls or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls. The guide channels shall be attached to the jambs, plumb and true, either in the overlapping fashion, projecting fashion or embedded in grooves, depending on the method of fixing. The cover of shaft, spring etc. shall be of the same material as that of lath.

12.3 Fixing
Brackets shall be fixed on the lintel or under the lintel as specified with raw plugs, and screws bolts etc. the shaft along with the spring shall then be fixed on the brackets. Page 128 Detailed Specifications of Building Works (Civil) the lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with it with ropes etc. the shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The sides guide channels and the cover and frame shall then be fixed to the walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screws bolts, and raw plugs drilled in the wall. The plates and screws bolts shall be concealed in plaster to make their location invisible. Fixing shall be done accurately in a workman like manner that the operation of the shutter is easy and smooth.
12.4 Painting
All surfaces are to be painted with primer coat and minimum two coats of enamel paints as per specification, after drying and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembling, shall receive the full specified protective treatment before assembling.

13.0 M.S. GATES
13.1 GENERAL
The item provide for procuring and fixing of M.S. Gates of specified type and size in position including necessary conveyance and joining and concreting in plumb.

13.2 MATERIALS
C.C. M-20 (20 MSA)
Plumb, Anchorage if required
M.S. Gate of required size as per approved drawing.

13.3 CONCRETING AND FIXING GATE IN PLUMB
The sill beam be fixed in C.C. M-20 (20 M.S.A.) with anchorage arrangement and embedded in this bottom channel duly checking the skill level. The gate frame be erected in plumb and water tight and side concreting be done as per specifications and as per directions of Engineer-in-charge.

13.4 HANDLING OF GATES
All care shall be exercised in handling and fixing of the gates. Any damages or breakage during transport, handling and fixing shall have to be borne by the contractor and repair to gate shall be done as directed by Engineer-in-charge.

14.0 MECHANICAL EQUIPMENT REQUIRED AT PUMP HOUSE
Following equipments are required at pump house locations. Materials / Equipments which are required apart from below shall also be responsibility of contractor.

1. Providing & manufacturing, erecting in position vertical types of gates & trash tracks arrangements of required size & materials including all necessary component parts such as stem rod, girders, rollers, stiffeners, lip lets, and sundries material including fixtures & Fasteners as per approved drawing including fixing commissioning, testing with all leads & lifts etc. complete as per
specification used in mechanical wing of WRD and as per CDO Code of practice with relevant Indian standard code & as directed by Engineer - in – charge.

2. Supply, installation, trial and commissioning of Electrically operated Monorail hoist of required capacity suitable to run on a monorail erected with L. T; Geared trolley, Traversing Girder, Brake, Safety Device, Pendant push button with starter, Panel Board suitable for Pump house including Fabrication of Monorail for the Hoist and erecting the same.

3. Supply, manufacturing & fabrication, erecting in position Stop Log Gates of required size for pump house including all necessary component parts, fixtures & Fasteners as per approved drawings as per specification used in mechanical wing of WRD and as per CDO Code of practice with relevant Indian standard code & as directed by Engineer-in-charge.

4. All other mechanical arrangements / components required at pump house location required for operation & Maintenance, repair purpose as directed by Engineer-in-Charge.

15. ROCK BOLTING & GUNITING WORK

Work related to Rock bolting & Guniting, if required, shall be done according to relevant Indian code of practice used in WRD Maharashtra. No extra payment for this work shall be done to contractor. Contractor shall include such cost in his bid amount.
CHAPTER XVII

PUMPING MACHINERY & ALLIED ELECTRICAL EQUIPMENTS
CHAPTER XVII

PUMPING MACHINERY & ALLIED ELECTRICAL EQUIPMENTS

PUMPS & MOTORS-

Following are the important criteria’s for pump selection.

1. Over the life cycle time of 15 years of the pumps the power should not exceed 3.9 MW and suitable efficiency of the motor and pumps should be chosen such that system efficiency deterioration over 15 year period even with due maintenance is such that the power remains within 3.9 MW.

2. Maintenance proposal shall be binding on the bidder for a period of 15 years for the pump and motor maintenance and successful bidder shall sign a separate agreement for the same along with the agreement for this tender. No extra cost payable for contractor for this maintenance.

3. VFD Panels shall be used for all pumps.

4. The installation of pumping machinery and allied mechanical & electrical equipments including VFD Panels shall be done under the guidance & supervision of representative of Manufacturer.

5. Life of pumping machinery: 15 years after commissioning of scheme.

Note: -
1. Stand By pumps for minimum 25% of Total HP requirement shall be provided.
2. Contractor is allowed to use Centrifugal Pump set. Pumps shall be of standard make and shall got approved from Chief Engineer, Special Project Water Resources Department. Amravati,

3. Over the life cycle time of 15 years of the pumps, the power should not exceed 3.9 MW and suitable efficiency of the motor and pumps should be chosen such that system efficiency deterioration over 15 year period even with due maintenance is such that the power remains within 3.9MW (Maintenance proposal period of 15 years for pumps and motors will be start only after successful commissioning of entire scheme).

4. Maintenance proposal shall be binding on the bidder for a period of 15 years (after commissioning of scheme) for the pump and motor maintenance and successful bidder shall sign a separate agreement for the same along with the agreement for this tender.

A) SPECIFICATION FOR CENTRIFUGAL PUMP SET

Technical Specifications of Wet Installed, Submerged Centrifugal Pump sets.

1. The pump set shall be of Compact Unitary construction. The pump casing shall be of high efficiency, volute Casing type with the Impeller mounted directly onto the Extended Solid Motor Shaft (without any couplings).
2. The pump set should be Single / two Stage types i.e. it should have only one / two impeller(S) & one / two Casing – more than two stages shall not be allowed. Pump Casing shall be high efficiency, Centrifugal Volute type.

3. The pumps are to be installed directly into the water body (Canal / Sump / River or unscreened Jack well), so it may suck up lot of silt, clay, pebbles & vegetation. Hence it should be reliable & robust.

4. Installation
4.1 The pumps should always be suitable for Vertical or Horizontal mounting; Permanent or Portable Installation & be interchangeable between these modes throughout their working life time (by suitable use of base frames / auto coupling systems which can be ordered either during the main P.O. or at a later stage).

4.2 Installation Arrangements
The detailed scope of supply & mode of installation shall be as per the specific tender data sheets or as per instructions of the Engineer-in-Charge.

4.2.1 Auto Coupling System
a) The pump set should be coupled to the rising mains by an Automatic Coupling System within built integrally cast bend. The automatic coupling system should have a pedestal (which is bolted on to sump bottom by pre grouted foundation bolts) which is permanently bolted on to the rising mains with Guide pipe Arrangement.
b) Auto coupling design should be such that the lifting chain’s hook can be engaged to the pump’s lifting hook without the need for man to enter the wet sump to engage the same.

5. Pump End Design
5.1 Speed
5.1.1 To achieve best efficiency, reasonable cost & yet long life, the speed of the Pump set should be such that the Specific Speed (Ns) of the pumps (calculated as per for Single Stage, Single Suction Impeller pumps assuming duty point as the best efficiency point ); should not exceed:

- 58 for up to DN 100,
- 70 for pumps up to DN 200,
- 87 for pumps up to DN 300,
- 106 for pumps up to DN 400,
- 116 for pumps up to DN 500 &
- 125 for larger pumps.

Where Specific Speed (Ns) as per given formula

\[ Ns = \frac{N(Q)^{1/2}}{(H)^{3/4}} \]

Where Ns- Specific Speed  
N- Pump Speed, rpm  
Q- Flow in m3 / hr.  
H- Head in Meter. (Values shall take at best efficiency point)

5.1.2 in addition to 5.1.1; Motors > 113 kW & / or with Pump’s duty point flow rate > 100 Lpsshall be limited to not more than 1500 rpm.

5.2 The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.

5.3 The Head - Capacity (H-Q) curve shall be continuously rising towards shut off with the highest at shut off. The shut off head shall be at least 120% of the specified duty point head. The Impeller shall be of high efficiency Multi Channel Enclosed type (except for Specific Speeds ≥ 90 where Semi Open Impellers shall be allowable).

5.4 Suction Strainer
5.4.1 The pump fitted directly with a Suction Bell mouth to which is compulsorily fitted with a Heavy duty Strainer (to avoid pick up of gravel, pebbles, vegetation, etc.)
5.4.2 Sizing of the Suction Strainer should be as per the Larger of the two: 
5.4.2.1 At the duty point flow, the Suction Velocity (at Strainer Holes), should never exceed 3.0m / s.
5.4.2.2 At the duty point flow, the total cumulative Suction Area of all the Strainer Holes should always be 2.0 times the Impeller’s Suction Eye Area.
5.4.3 However Large & Slow Speed pumps (with Solid Handling Ability 75mm & of Speeds 1000 rpm) may be offered without Suction Strainer.

5.4.4 The pump’s solid handling size & maximum hole size of suction strainer should be as per below mentioned chart.

<table>
<thead>
<tr>
<th>Pump Delivery Size</th>
<th>Min Thickness of Suction Strainer</th>
<th>Max. Permissible Hole Size of Suction Strainer</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN 25, DN 32 &amp; DN40</td>
<td>2 mm</td>
<td>Not more than 4mm</td>
</tr>
<tr>
<td>DN50 &amp; DN65</td>
<td></td>
<td>Not more than 6mm</td>
</tr>
<tr>
<td>DN 80</td>
<td></td>
<td>Not more than 8mm</td>
</tr>
<tr>
<td>DN 100</td>
<td></td>
<td>Not more than 10mm</td>
</tr>
<tr>
<td>DN 125</td>
<td>3 mm</td>
<td>Not more than 12mm</td>
</tr>
<tr>
<td>DN 150</td>
<td></td>
<td>Not more than 14mm</td>
</tr>
<tr>
<td>DN 200</td>
<td></td>
<td>Not more than 21mm</td>
</tr>
<tr>
<td>DN 250</td>
<td>5 mm</td>
<td>Not more than 30mm</td>
</tr>
<tr>
<td>DN 300 &amp; 350</td>
<td></td>
<td>Not more than 40mm</td>
</tr>
<tr>
<td>DN 400 &amp; Above</td>
<td>7 mm</td>
<td>Not more than 50mm</td>
</tr>
</tbody>
</table>

5.6 The pump set shall be suitable for starting with delivery valve open as well as closed at any operating point. The motor should also start accordingly. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

5.7 Complete Performance Curve, Data Sheets, and GA drawings showing Installation Sizes shall be submitted along with the Technical Bid.

5.8 Pump having less than minimum guaranteed efficiency i.e. 80% is not acceptable

6. Induction Motor End Design

6.1 The motor shall be of Squirrel Cage, Induction type, Resin Filled yet capable of Water Immersion up to 20mwc for S1 duty with IP-68 Protection – Motors with
Oil or Water filled windings shall not be allowed. It shall comply with IS9283 (2013).

6.2 It is rated for 415 V, ±10 %, 50 Hz ± 5%, (10% ± Combined Voltage & frequency), 3 phase, A.C.Power Supply. Its winding should be of Class “H” insulation * (withstanding winding hot spot temperature of up to 185°C respectively) while the nominal temp rise of winding hotspot should not exceed that of class “B” i.e.130°C.

6.3 It should be wound using Dual Coated, Super Enamelled; Copper wire with high temperature index as per I.S. 4800 Part-13.

PVC / Poly propylene – poly ethylene insulation for winding wires shall not be allowed.

6.4 Motor’s Insulation should be Vacuum Pressure (VPI) Resin Impregnated & Oven Baked to ensure Moisture Impervious & Mechanically Resin poor type insulation. Dip or Pour type Air Dry Varnishing shall not be allowed.

6.5 The Power rating of the motor shall be the higher of the following:

6.5.1 Motor rating shall be below 200 Kw as per IS-325 and rated for 415 Volts.

6.5.2 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 50 Hz.

6.5.3 105% of the maximum power input while operating solo or in parallel within maximum and minimum system resistances corresponding to the speed at 50 Hz.

6.6 The Motor’s Rotor shall be of Copper Bar type* to assure:

6.6.1. Long Corrosion free Service life (in presence of high moisture inevitable in submerged motors, Aluminium corrodes much faster than Copper),

6.6.2. Ease of Onsite Repairing.

6.6.3. Beneficial Fly Wheel type inertial effect (as compared to aluminium rotor, copper rotoris heavy) which reduces detrimental effects of water hammer.


6.7 MOTOR COOLING:
In Horizontally / vertically installed pump set, the dead water level in the sump exceeds 1.5m from the pump centreline, the motor can be cooled just by water immersion or surface cooled by circulation of water through jacket shell. IP68

6.8 MOTOR PROTECTION

6.8.1. Motor Winding: Thermal Overload Protection by 1 each for each phase inbuilt overload

6.8.1.1. Bimetallic Switch < 115 kW

6.8.1.2. Bimetallic Switch & also a PT 100 sensor for > 115kW

6.8.2. RRP: Reverse Rotation Protection to detect pumps direction (for > 30kW).

6.8.3. BTD: Upper & Lower Bearing Temperature Detector to detect temperature of DE & NDE bearing.

6.8.3.1. Bimetallic Switch for > 37 kW

6.8.3.2. Bimetallic Switch + PT 100 Sensor > 112 kW @ 4P & 150 kW @ 6P

6.8.4. LSLD: Primary (Lower or Inboard) Seal Leakage Detector (to detect the lower mechanical seal failure) for All Pump sets

6.8.5. USLD: Secondary (Upper or Outboard) Seal Leakage Detector to detect the upper mechanical seal failure (for > 225kW @4P).

6.8.6. CCWLD: Cable Connection Chamber Water Leakage Detector (to detect water in cable connection chamber) (for ≥ 75 kW @ 4P, 6P, 8P)

6.8.7. SBWLD: Stator Body Water Leakage Detector (to detect water leakage in to stator body).(For ≥ 75 kW @ 4P, 6P, 8P)

6.9. CABLES

6.9.1 A water tight Cable Junction Box sealed from the motor shall be provided for the motor power and signalling cables.

6.9.2 The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length, minimum 10 m to be terminated in an IP
67 junction box outside adjacent to the wet well & above the HFL They shall be sized in accordance with the electricity utility regulations and BS 7671.

**6.9.3** It should have Power as well as Control Cables of Dual Sheathed EPRS / PVC Armoured type with Copper Core of required size as per detail engineering. However, the Cross Section of the cable shall be ample enough to ensure a Voltage Drop of not more than 2% at actual site conditions.

### 7. SHAFT & BEARINGS

**7.1.** The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum L10 life of 1,00,000 hours in accordance with BS 5512.

**7.2.** The bearings should be lubricated with Premium Quality, High Temperature, Long Life Grease there by obviating the need of re-lubrication for upto L10 life of the bearings. The bearing should be of Metric Series (& not Imperial one) with re-greasing interval of not less than 45,000 hours for motor rated > 450 kW & 1,00,000 hours for motors rated ≤ 450 kW.

**7.3. Oil Lubricated bearings shall not be allowed.**

**7.4.** In case the motor is to be driven via a VFD, atleast one of the bearings (DE or NDE) should be Oxide coated Current Insulated to prevent “electric fluting damage” caused by Harmonics.

### 8.0 STUFFING BOX / OIL CHAMBER

**8.1.** The pressurized entry of water into the motor (from the pump’s volute casing) should be prevented by two separate mechanical seals in mounted in a Tandem mode within an oil chamber.

**8.2.** The Primary (Inboard) seal should be of Silicon Carbide or Tungsten Carbide faces to withstand erosive wear due to any silt particles. The Secondary (Outboard) seal should be of Carbon v / s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide – i.e. Thermally Unstable materials like Alumina / Aluminium Oxide shall not be allowed.

**8.3.** For material of Construction of mechanical sea- Refer Table2.

### 9. TESTING
9.1. The pump sets shall be tested at the pump manufacturer’s works in accordance of IS 5120 (Tolerance Class 2), IS 325, IS 4029, IEEE 112, IS 10981, ISO 9906; with or without VFD

9.2. The Flow shall be measured by full Bore Electro-Magnetic or Ultrasonic Flow Meters (of 0.5 % or less accuracy class.)

9.3. In case of MNC pump manufacturer not having adequate testing facility within reasonable distance (i.e. decided by the area of operation of the TPI); the pumps should be tested at the Alternative Test Bed or at Field within 30 days of installation which the contractor / manufacturer is bound to offer at free of cost.

The Field Testing shall include the following:

9.3.1. Motor Routine Tests:

9.3.1.1. IR

9.3.1.2. HV

9.3.1.3. No Load Amperes, Vibration, etc.

9.3.2. Pump Performance Testing (in accordance with IS 5120 (Tolerance Class 2), IS 10981, ISO 9906.

9.3.2.1. Measurements of Head, Discharge, Motor Input at least for 6 different points to plot the Actual Performance Curves

9.3.3. Motor should be tested in accordance with IS 325, IS 4029 and IEEE 112.

All the Extra Charges for such Field Testing shall be borne by the Contractor. It is clarified that, incase of Field Testing Failure; Client / End user reserves the right to detain the pumps in their custody until the contractor replaces the failed pumps with new pumps which shall again be subjected to Re-Testing. No extra charges shall be allowed by Client / End user to the contractor.
<table>
<thead>
<tr>
<th>Table 2: Materials of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor Casing, Oil Chamber &amp; other parts</strong></td>
</tr>
<tr>
<td><strong>Motor’s (Squirrel Cage) Rotor</strong></td>
</tr>
<tr>
<td><strong>Mechanical Seals</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Elastomers:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Fasteners</strong></td>
</tr>
<tr>
<td><strong>Pump (Volute) Casing</strong></td>
</tr>
<tr>
<td><strong>Suction Bell mouth &amp; miscellaneous pump parts</strong></td>
</tr>
<tr>
<td><strong>Impeller</strong></td>
</tr>
<tr>
<td><strong>Wearing Rings (Suction Head Casing &amp; Impeller)</strong></td>
</tr>
<tr>
<td><strong>Pump-Motor Shaft</strong></td>
</tr>
<tr>
<td><strong>Suction Strainer</strong></td>
</tr>
</tbody>
</table>
Table 2: Materials of Construction

| Portable Stand | MS (C15) Fabricated with Epoxy Coating |

I / We are bound to supply the above Item of stated manufacture having rated capacity, material of construction and other requirements mentioned in the data sheet.

Signature of Contractor ____________________  Signature of Pump Manufacturer / Dealer ____________________

Data Sheet for Dry Motor, Wet Installed Centrifugal Pump sets

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Application</td>
</tr>
<tr>
<td>1.1</td>
<td>Mode of Installation</td>
</tr>
<tr>
<td>2</td>
<td>Type of motor</td>
</tr>
<tr>
<td>3</td>
<td>Rated Flow</td>
</tr>
<tr>
<td>4</td>
<td>Rated Head</td>
</tr>
<tr>
<td>5</td>
<td>Rated Speed</td>
</tr>
<tr>
<td>6</td>
<td>No. of units.</td>
</tr>
<tr>
<td>7</td>
<td>Supply neutral</td>
</tr>
<tr>
<td>8</td>
<td>Rated KW &amp; Voltage</td>
</tr>
<tr>
<td>9</td>
<td>No. of Phases &amp; frequency</td>
</tr>
</tbody>
</table>
| 10 | Supply condition | ± 10% voltage variation  
± 5% frequency variation  
± 10% combined voltage and frequency variation |
<p>| 11 | Speed | ____ rpm (Syn.) |
| 12 | Duty condition as per IS325 or equivalent | S1 suitable for constant operation |
| 13 | Method of starting | Star-Delta / DOL / ATS / Microprocessor Soft Starter / VFD |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Starting torque &amp; Pull Out Torque</td>
<td>Sufficient enough to start the pump with delivery valve open and when other pumps are running. Sufficient to bring the motor to normal speed in minimum time</td>
</tr>
<tr>
<td>15</td>
<td>Class of Insulation &amp; temp. rise by thermometer</td>
<td>Minimum Class “H” but Temperature rise restricted to that of class “B” i.e. 75°C</td>
</tr>
<tr>
<td>16</td>
<td>Ambient temperature</td>
<td>45° C</td>
</tr>
<tr>
<td>17</td>
<td>a) Type of Cooling b) Degree of protection</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Cable details</td>
<td>__R x __C x __ sq. mm, with required Earth core, 415 V PVC / EPRS Copper Conductor cable</td>
</tr>
<tr>
<td>19</td>
<td>Shaft orientation</td>
<td>Pump-set should be suitable for Horizontal position</td>
</tr>
<tr>
<td>20</td>
<td>Type of bearings</td>
<td>Ball / Roller / Thrust Anti Friction type, life time lubricated bearing.</td>
</tr>
<tr>
<td>21</td>
<td>Bi Metallic Thermal Over Load Relay for Winding required?</td>
<td>Yes, one in each phase; for trip, alarming and indicating set to trip @ 1200 C</td>
</tr>
<tr>
<td>22</td>
<td>Bearing Over Temperature Detectors</td>
<td>Required Bi Metallic Overload Thermal Switches set to trip @ 95 °C</td>
</tr>
<tr>
<td>23</td>
<td>Winding connections</td>
<td>Delta Wound (requires 6 leads at line side starters)</td>
</tr>
<tr>
<td>24</td>
<td>Standards to be followed</td>
<td>IS 325, IS 4029, IS 8225, IS 4889, IS 4772, IEEE 112, IS 4691 and other relevant Indian Standard or equivalent BSS with suitable adaption for Relevant Mono shaft product. Testing as per ISO 9906 or IS 9137 or IS 5120 or IS 10981</td>
</tr>
<tr>
<td>25</td>
<td>PI value of Motor</td>
<td>PI value shall be not less than 2.</td>
</tr>
<tr>
<td>26</td>
<td>Scope of Supply</td>
<td>Pump set with __m Cable along with __m Alloy Steel Chain</td>
</tr>
</tbody>
</table>

Pump set fitted with M. S. Base Frame Horizontal, Portable; Wet (Submerged) Installation
Technical Data Sheet of Centrifugal Pump sets

(To be filled up & Co-Stamped by the Contractor & the Pump Manufacturer / his Authorised Dealer & Compulsorily submitted in Technical Bid failing which the Commercial bid shall not be opened)

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Description</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Make of Pump set</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Design Capacity</td>
<td>m³/hr</td>
</tr>
<tr>
<td>4</td>
<td>Total Head</td>
<td>m WC</td>
</tr>
<tr>
<td>5</td>
<td>Shut Off Head</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Rated Speed &amp; Supply Frequency</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>No of Stages</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Type of Casing &amp; no of casing</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Pump Efficiency @ duty point</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Pump Input (bkW) @ duty point</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Maximum Pump Input throughout the Curve</td>
<td></td>
</tr>
<tr>
<td>12.1</td>
<td>Motor Efficiency @ Full Load</td>
<td></td>
</tr>
<tr>
<td>12.2</td>
<td>Motor Efficiency @ Duty Point</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Overall Efficiency of Pump-motor set @ duty point</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Motor Input @ Duty Point</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Motor Rating &amp; Voltage / Frequency</td>
<td>___ kW &amp; ___ V / ___ Hz</td>
</tr>
<tr>
<td>16</td>
<td>Class of Insulation of Motor</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Fill of Motor</td>
<td>Air</td>
</tr>
<tr>
<td>18</td>
<td>Type of Bearings &amp; its rated L10 life</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>19</td>
<td>Type of Lubrication</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Cable Size &amp; MoC</td>
<td>Power Cables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control Cables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MoC of Conductors</td>
</tr>
<tr>
<td>21.1</td>
<td>Pump’s Delivery &amp; Suction Nozzle size</td>
<td>mm</td>
</tr>
<tr>
<td>21.2</td>
<td>Suction Strainer Provided?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>22</td>
<td>Material of Construction (MoC)</td>
<td></td>
</tr>
<tr>
<td>22.1</td>
<td>Motor Rotor</td>
<td></td>
</tr>
<tr>
<td>22.2</td>
<td>Motor-Pump Shaft</td>
<td></td>
</tr>
<tr>
<td>22.3</td>
<td>Pump Casing</td>
<td></td>
</tr>
<tr>
<td>22.4</td>
<td>Impeller</td>
<td></td>
</tr>
<tr>
<td>22.5</td>
<td>Impeller’s Wearing Ring</td>
<td></td>
</tr>
<tr>
<td>22.6</td>
<td>Casing’s Wearing Ring</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Weight of Pump set</td>
<td>kg</td>
</tr>
<tr>
<td>24</td>
<td>Whether the Testing of pumps at manufacturer’s works shall be offered with full bore Electromagnetic or Ultrasonic Flow Meter of maximum 0.5 % accuracy class?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>25</td>
<td>Testing and Inspection</td>
<td></td>
</tr>
<tr>
<td>25.1</td>
<td>Pump Performance testing Standard</td>
<td></td>
</tr>
<tr>
<td>25.2</td>
<td>Hydrostatic Test Pressure</td>
<td>kg / cm²</td>
</tr>
</tbody>
</table>

I / We are bound to supply the above Item of stated manufacture having rated capacity, material of construction and other requirements mentioned in the data sheet.
2. **Induction Motor**

2.1 **Design Requirements**

2.1.1. The motors shall generally conform to IS:325 or relevant equivalent internationally approved standards. Additionally, the specific requirements mentioned in the following clauses shall also be met.

2.2 **Performance and Characteristics**

2.2.1. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

a) Variation in supply voltage $\pm 10\%$

b) Variation in supply frequency $\pm 5\%$

c) Combined voltage and frequency variation $\pm 10\%$

2.2.2. LV motors shall be suitable for star-delta starting.

2.3. **Insulation**

2.3.1. Any joints in the motor insulation such as coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.

2.3.2. Motors shall be given power house treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersions and baking shall be applied to the assembly.
2.4 Constructional Features

2.4.1 The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

2.4.2 Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

2.4.3 The rotor bars shall not be insulated in the slot portion between their on core laminations for squirrel cagemotors.

2.5 Terminal Box

2.5.1 Terminal boxes shall be of weather proof construction designed for out door service. To eliminate entry to dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees.

2.5.2 The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable gland sand cable lugs shall be supplied to match specified cables.

2.6 Accessories

Two independent earthling points shall be provided on opposite sides of the motor, for bolted connections. These earthling points shall be in addition to earthling stud provided in the terminal box.
## TECHNICAL DATA SHEET FOR INDUCTION MOTOR AT RAW WATER INTAKE PUMPING STATION

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Description</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Application</td>
<td>Vertical turbine Pump &amp; Others</td>
</tr>
<tr>
<td>2.0</td>
<td>Type of motor</td>
<td>Squirrel cage induction</td>
</tr>
<tr>
<td>3.0</td>
<td>Make</td>
<td>As per approved make</td>
</tr>
<tr>
<td>4.0</td>
<td>No.of units.</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>Supply system fault level.</td>
<td>250 MVA</td>
</tr>
<tr>
<td>6.0</td>
<td>Supply neutral</td>
<td>Resistance earthed</td>
</tr>
<tr>
<td>7.0</td>
<td>No.of Phases &amp; frequency</td>
<td>3 Phase &amp; 50Hz.</td>
</tr>
<tr>
<td>8.0</td>
<td>Supply condition</td>
<td>±10% voltage variation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±5% frequency variation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±10% combined voltage and frequency variation</td>
</tr>
<tr>
<td>9.0</td>
<td>Duty condition as per IS325 or equivalent</td>
<td>S1 suitable for continuous operation</td>
</tr>
<tr>
<td>10.0</td>
<td>Method of starting</td>
<td>DOL</td>
</tr>
<tr>
<td>11.0</td>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Duty point</td>
<td>95% (minimum)</td>
</tr>
<tr>
<td></td>
<td>b) Full Load</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td>c) 0.75 Load</td>
<td>94.5%</td>
</tr>
<tr>
<td></td>
<td>d) 0.5 Load</td>
<td>93.4%</td>
</tr>
<tr>
<td>12.0</td>
<td>Power Factor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Full Load</td>
<td>0.86%</td>
</tr>
<tr>
<td></td>
<td>b) 0.75 Load</td>
<td>0.82%</td>
</tr>
<tr>
<td>13.0</td>
<td>Starting torque % of full load torque</td>
<td>Sufficient starting torque to start the pump with Delivery valve closed and when other pumps are</td>
</tr>
<tr>
<td>14.0</td>
<td>Pull out torque % of full load torque</td>
<td>Sufficient to bring the motor to normal speed in Minimum time</td>
</tr>
<tr>
<td>15.0</td>
<td>Class of insulation &amp; temp. Rise by thermometer</td>
<td>Class “F” but Temperature rise restricted to that Of class “B” i.e. 65°C. / 75°C.</td>
</tr>
<tr>
<td>18.0</td>
<td>Ambient temperature</td>
<td>46°C.</td>
</tr>
<tr>
<td>19.0</td>
<td>Location</td>
<td>Indoor</td>
</tr>
<tr>
<td>20.0</td>
<td>Hazardous area division</td>
<td>N.A.</td>
</tr>
<tr>
<td>21.0</td>
<td>Atmosphere</td>
<td>Humid,Dusty at a time</td>
</tr>
<tr>
<td>22.0</td>
<td>a) Type of Cooling</td>
<td>CACA</td>
</tr>
<tr>
<td></td>
<td>c) Degree of protection</td>
<td>IP–55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>23.0</td>
<td>Terminal box</td>
<td>Phase segregated terminal box for line and neutral side. And shall be suitable for termination of heat shrinkable termination kit or push on type termination kit.</td>
</tr>
<tr>
<td>24.0</td>
<td>External cable details.</td>
<td>3 As per single line diagram</td>
</tr>
<tr>
<td>a) No. of cores.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.0</td>
<td>Shaft orientation.</td>
<td>Vertical solid shaft</td>
</tr>
<tr>
<td>Horizontal / Vertical / Hollow shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.0</td>
<td>Type of Couplings</td>
<td>Flexible</td>
</tr>
<tr>
<td>27.0</td>
<td>Type of bearings</td>
<td>Antifriction Ball / Roller Bearing</td>
</tr>
<tr>
<td>28.0</td>
<td>Colour shade of paint if special</td>
<td>Grey shade 632 as per IS 5</td>
</tr>
<tr>
<td>29.0</td>
<td>Space heater for motors required</td>
<td>240 V, 1 Ph., 50Hz., A.C. for winding heating</td>
</tr>
<tr>
<td>30.0</td>
<td>Thermistors / RTD’s / required for</td>
<td>For trip, alarming and indicating</td>
</tr>
<tr>
<td>31.0</td>
<td>Bearing temp. Detectors</td>
<td>Required for alarm / trip.</td>
</tr>
<tr>
<td>32.0</td>
<td>Winding connections</td>
<td>6 Terminals</td>
</tr>
<tr>
<td>33.0</td>
<td>Standard to be followed</td>
<td>IS325, 8225, 4889, 4772, 4029, 4691 and other Relevant Indian Standard or equivalent BSS or JEC 37</td>
</tr>
</tbody>
</table>

### 2.7 Inspection

The inspection of the motor at factory site shall be carried at by the Corporation and or inspection agency appointed by the Corporation, in the manufacture’s work shop. All the tests as required as per IS shall be carried out in presence of inspecting agency. The motor shall be dispatched only after issue of test certificate by the inspecting agency for satisfactory performance of test motor. The inspection charges for such tests shall be borne by the turn key agency.

### 2.8 Material Testing of Equipment

The Contractor shall furnish the material composition certificates for all the important components of pump and motors. Random test certificates for raw stock
materials and typical test certificates for special stock items like bearing metal etc., used for the manufacture of the several components shall also be furnished.

2.9 QUALITY ASSURANCE PLAN

The quality assurance plan for all the components of the pump, controller / governor and associated equipment’s shall be furnished for the approval of Owner indicating the tests at factory with customer witness points. The same shall be generally according to the Quality assurance Plan.

2.10 MODEL TESTS GENERAL

Before commencement of manufacture of proto type pumps the Contractor shall perform model tests to demonstrate that the efficiency and other guarantees as well as requirements of the specifications for the performance of the pumps shall be met.

The test shall comply with the international code for model acceptance of hydraulic pump IEC publication no.193

The place where model tests would be conducted shall be indicated by the Contractor in his Bid. A team of Owners Engineers shall be deputed to the manufacturer’s works where the model test is proposed to be conducted for witnessing the model tests. The Contractor shall extend all facilities to witness the tests.

2.11 MODEL PUMP

After the award of contract, the Contractor shall build a model of the pump. The water passages of the model shall be fully homologous with those of the proto type from the upstream draft tube termination point of the pump to the delivery valve. The draft tube shall be transparent to permit observation and for taking photographs of the vertex flow pattern and cavitation phenomenon. The Contractor shall submit to the Owner, drawings, description covering details of the proposed model, testing equipment, instrumentation, and test procedures for individual tests, method of interpretation and computation of test results for approval of Owner.
2.12 TESTS ON PUMP MODEL

The final model test series shall include the following tests: Pump performance (efficiency) tests under various conditions. Cavitation tests. Run away speed test. Pressure fluctuation tests. Hydraulic thrust test. Wicketgate / torque test.

The model test shall simulate all possible normal operating conditions of the prototype for the entire range of reservoir and delivery levels, wicketgate openings etc.

2.13 STEP-UP FORMULA

In deriving prototype pump from model tests data, step-up formulae if any as per relevant IEC or any other equivalent standards may be used. The Contractor shall indicate the step-up formulae proposed to be used with justification and reference to standards.

2.14 THE MODEL TEST REPORT

After completion of the model test studies, the Contractor shall furnish the model test reports to the Owner within one month from date of completion of model test for owners review and approval. The test report shall include but not necessarily be limited to the following:

- Model hill curve
- Model efficiency curves extended to the run away speed.
- Proto type performance diagrams in compliance with all applicable requirements.
- Curves showing sigma versus efficiency and sigma versus unit power and unit discharge for specified head with envelope curves drawn.
- Photographs and sketches of the cavitation phenomenon.
- A sample calculation for each computation in a complete manner.
- Curves showing relationship between guide vane angle and servo motor stroke related to maximum opening of guide vane and clear opening between two adjacent guide vanes.
- Curves showing the relationship between the head and power for the full range of operation.
• Record of calibration of all test instruments and Equipment's.
• Description of test equipment and test procedures.

2.15 CHARGES FOR MODEL TEST

The charges for the Model test shall be deemed to be included in the ‘C’ contract price.

2.16 MODEL ACCEPTANCE

The Contractor shall notify to the Owner, at least one month in advance, the readiness of the model for witnessing the test and to carry out the dimensional checks of the model.

Should the model fail to meet the guarantees and requirements, it shall be optional for the Owner to conditionally accept the model and direct the Contractor to modify the model unit to comply with the requirements. All expenses involved for the modifications and subsequent model tests shall be borne by the Contractor.

The Owner reserves the right to get the model tested in an independent laboratory or suggest the laboratory where the model testing is to be conducted from among the pre-approved labs indicated by the supplier.

The Contractor shall also furnish detailed calculations for impeller setting, the basis for selected plant sigma and critical sigma as per model test. The Contractor shall guarantee the operation of the pumps without undue cavitation under the above conditions.

2.17 PERFORMANCE GUARANTEES AND PENALTY FOR SHORTFALL IN EFFICIENCY AND OUTPUT

The pump should be designed to have maximum efficiencies at the outputs corresponding to the rated head with as flat a curve of efficiency as possible between half and full loads.

2.18 DUTYPOINT

(A) Power input to each pump and motor shall be calculated as follows:

\[
\text{Power input to pump} = \frac{Q \times H}{367.2 \times e_p}
\]
Power input to motor in kW = (Motor output) / (me)

Where,

\[ \begin{align*}
Q & \text{ in m}^3 / \text{hr.} \\
H & \text{ in m as specified above.}
\end{align*} \]

\[ \begin{align*}
\text{ep} & = \text{Pump efficiency at duty point.} \\
\text{em} & = \text{Motor efficiency at duty point.}
\end{align*} \]

The Engineer-in-Charge reserves the right to reject the motor if the efficiency of the motor at the duty point and full load during test is less than the guaranteed value, even if the power input to motor is within the guaranteed value.

### 2.19 PENALTY FOR SHORTFALL IN PERFORMANCE:

For each kW differential in the actual motor input over the guaranteed motor input at duty point indicated in the schedule of Technical Particulars (without any further tolerance), penalty shall be levied at Rs. 52,000/- per kW per pumpset.

For this purpose the power input measured during performance test on the full size pump at the purchaser's site shall be considered.

Should the performance test results deviate from the guaranteed values subject to the tolerances specified in IEC, the Contractor shall correct his equipment at no extra cost to the Owner and repeat the performance tests within a reasonable period as agreed to by the corporation. As regards the power consumption, if the Contractor fails to meet the guaranteed values, the corporation shall levy a penalty as indicated above. However, if the deviation in power consumption exceeds 5% of the guaranteed value or the Contractor is unable to meet the guarantee for items under correction, the corporation retains the option to reject the equipment in which case contractor shall replace the entire equipment with the one that meets the guaranteed values.

### 2.20 PERFORMANCE WITHIN GUARANTEE PERIOD:

The corporation / Purchaser reserves the right to carry out further test to check the performance and efficiency of the plant at the end of one year. Adjustments to the plant as may be considered part of normal operating routine shall be carried
out prior to these tests. The results of such repeat tests carried out by the corporation. / Purchaser indicate that performance values deviate from Guaranteed value or the Power consumption exceeds 1.0% of the guaranteed value, then the contractor shall be given an opportunity to take corrective measures and carry out further test, all at his own expense. Should the test indicate performance and Power consumption values below the guaranteed value then are duction in the contract price may be issued by the corporation.

2.21 CRITICAL PLANT SIGMA AND PUMP HILL CHART

Value of Thoma's Co-efficient as computed by IEC code on the basis of model tests shall be given in the form of curves, efficiency vs. sigma for different heads of operation. Curves of critical sigma for different operating conditions, as determined by the IEC code on the basis of model tests for different heads of operation shall be furnished and the plant sigma values shall also be plotted on it to clearly show the safety margin. The Contractor shall also submit model test report on cavitation.

2.22 RECTIFICATION TO MEET GUARANTEE

The Contractor shall make good and meet the guarantees again within a period of four (4) months from the date of witnessing the original field test, should the original tests be unsuccessful to meet the guarantees. The penalty or rejection shall apply if the second attempt is also unsuccessful in meeting the guarantee.

2.23 CAVITATION GUARANTEE

The Contractor shall guarantee the impeller, stay ring, guide vanes and other hydraulic passages against excessive pitting caused by cavitation’s for 60 months from date of commissioning.

Excessive pitting shall be defined as the removal of metal from impeller and other passages exceeding a weight of \( W = 0.1D^2 \) per 1,000 hrs. Of operation during the guarantee periods defined above,

where \( W \) is weight in kg. And \( D \) is the throat diameter of impeller in meters. The Contractor shall indicate the method which he proposes to use for measuring the amount if the metal removed on account of cavitation, which shall be subject to the approval of Owner.
In case of excessive cavitation being present, the Contractor at his cost shall correct the condition and rectify and / or replace the part thus affected. The pump after such modifications and repairs and / or replacements of part or parts shall be subject to the same cavitation guarantee as for the original equipment.

In determining whether or not excessive pitting has occurred, metal removed by erosion, corrosion by the presence of injurious foreign element in water or by chipping and grinding preparatory to repairing the pitted area, shall be excluded. The manufacturer shall adopt necessary improvements modifications in the designs, manufacturing to minimise the cavitation pitting within the permissible limit. Within the guarantee period, within 6 months after commissioning, the contractor shall be entitled for joint inspection to make sure that cavitation damage is not caused or aggravated by local defects of pump shape as well as to repair damages that might have been caused and take steps to prevent future cavitation. If the inspection reveals that cavitation guarantee is not sustained ,the Contractor shall supply a full set of new impeller and throat ring free of charge delivered and installed at site.

2.24 TEST AT WORKS

The test to be conducted at works shall include the following:

(1) All the static parts of the pump shall be completely assembled in the manufacturer's shop and properly match marked and doweled to ensure correct assembly and alignment at site. Dowels required for insertion after erection at site shall also be supplied.

(2) Assembly of Guide apparatus, measurement of Guide vane clearances and recordings.

(3) Guide vane servo motor: Pressure test, functional test, measurement of stroke, check function of the lock in open and closed position.

(4) **Shaft Seal:** Assembly of ring with static seal. Check function of the static seal.

(5) Static balancing of impeller.

(6) All pipes, fittings, pressure tanks and other components of the controlling / governing system shall be tested under a pressure equal to 150% of
the maximum operating pressure maintained for not less than half an hour and the
equipment shall withstand this pressure without any signs of leakage, distortion,
and failure.

(7) Assembly of guide bearing housing with top cover and dummy shaft and
dimensional checks etc.,

(8) Functional tests of all equipment’s wherever applicable.

(9) In addition to the above, each mechanical and electrical sub assembly shall
be tested for proper functioning and continuity of electrical circuits.

(10) Mechanical Over speed Device: Calibration of over speed device.

(11) Testing of auxiliaries including cooling water system, air compressor system,
dewatering and drainage system, oil pressure system, etc.

(12) Testing of controllers / governors, both hydro mechanical and electrical
cubicle jointly for functional checks.

(13) Inspection of flow metering equipment at works for calibration, performance
and discharge measurement. The Owner reserves the right to be present during
the above tests and also for the inspection of the equipment at the Contractor /manufacturer’s works / sub-supplier’s works unless waived in writing. The
Contractor shall furnish detailed testing procedures for all the above tests and
routine tests on all the equipment’s to be conducted as per international standards
for the review and approval of the Owner well before witnessing the tests.

Material testing of important casting / forging fabricated steel works shall be
according to the enclosed Quality Assurance Plan.

The Contractor shall furnish inspection reports in respect of assembly of main
pump and other associated equipment’s duly mentioning the key points, such as
limits of tolerance etc., or such information for use / guidance during erection /
maintenance at site.

Any other tests and inspection that the Owner consider necessary to satisfy itself
that the pump confirms to these specifications in performance, workmanship,
design and quality of materials.

2.25 FIELD ACCEPTANCE TESTS
Field acceptance tests of pump (Efficiency and output tests)

The Contractor shall furnish in detail the method proposed by him to do the field efficiency test on the pump in gun it.

Finalization of measurement section and location of installing various instruments shall be done after obtaining the permission of the Owner.

The layout, scheme and details of the tapings etc., Stainless steel tubing along with the valves and fittings for various tapings, which are to be embedded shall be included in the scope of supply.

The calibration of instruments, arrangement of all required instruments, arrangement of personnel for testing, supervision of field tests at site etc. shall be the responsibility of the Contractor.

After complete installation of the pumping units at site the units shall be tested in accordance with IEC standard.

2.26 DRAWINGS

The contractor shall furnish 6 sets of assembly drawings, wiring diagrams, etc., for approval. The drawings shall include but not be limited to:

(a) Layout drawings indicating the location of various equipment's.

(b) Detailed foundation drawings to withstand hydraulic thrust, magnitude of forces due to unbalanced rotating parts, mass of rotating parts, etc., in a complete manner.

(c) Loads on foundation for civil structure designs.

(d) Drawings showing ducts, openings, pipe routings, etc.

(e) Drawings showing embedment of pipes and foundation parts.

(f) Assembly and sub-assembly drawings of all assemblies / components showing elevations, plans & sections for the pump, controller / govern or parts, control panels, etc.

(g) Control gear diagrams for pump, controller / govern or oil system, CW system, DD system, compressed air system, etc.
h) Detailed drawings showing draft tube profiles, controller / governor, guide bearing, shaft gland, etc.

i) Wiring and schematic diagram for control, protection and indication, etc.

j) Drawing showing parts to be welded at site, method of welding with details of type and quantity of electrodes and capacity of welding sets.

k) Schematic and detailed drawing for all piping, lubrication and cooling arrangement.

l) Drawings indicating lifting arrangement of important components / assemblies with crane clearances.

m) Part list of all the components with details viz. Part numbers, quantity, reference drawing numbers, packing list, weight and dimensions etc.

n) The assembly / subassembly drawings of Pump guide bearing, shaft gland, Impeller, volute casing, draft tube, air valve, test equipment’s for Impeller, metallic volute etc.

o) Drawing of the main cross-section of the pump showing the various components / parts / assemblies for the pump to the extent possible.

p) Drawing showing combined cross section of pump and motor. q) Schematic drawings of piping system.

r) Efficiency curves and hill chart

s) Curve showing areas and velocities at different sections of the draft tube.

3. STATIC EXCITATION SYSTEM

A) STATIC EXCITAION EQUIPMENT AND AUTOMATIC VOLTAGE REGULATOR SCOPE:

This section covers the technical specification for providing micro process or based excitation system with thyristor or control for Pump motors.

Pump starting equipment shall be by using soft starter. VFD panels and its associated requirement as per the system design shall be provided for all pumps.
3.1 DESCRIPTION OF THE EXCITATION SYSTEM

Micro processor based excitation system with thyrist or control shall be provided to suit the motor characteristics for each unit. The AC power required for the excitation shall be tapped from the motor terminal, stepped down by means of rectifier transformers and rectified by fully controlled thyrist or bridges and then fed to the motor field there by controlling the motor voltage input. Any change in the motor terminal voltage shall be sensed by anerr or detector and cause the voltage regulat or to advance or retard the firing angle of the thyrist or there by controlling the field excitation of the motor. The excitation system for each unit shall consist of the following:

1. Dry type excitation transformer

2. A Set of thyrist or converters of suitable numbers such that even in case of ONE bridge failure, the remaining bridges shall cater to the maximum continuous and ceiling current requirements.

3. Arrangement for initial excitation start up

4. Field breaker and field discharge and suppression equipment’s

5. Automatic voltage e regulat or with auto and manual channels with all standard limit or functions.

6. Features for motor dry out with the stator terminals short circuited.

7. Static energy meter in the primary circuit of excitation transformer for measurement of kW, KV AR, Max demand etc.

8. Interfacing equipment’s for data communication.

3.2 EXCITATION TRANSFORMER

The excitation transformer shall be three phase dry castres in coil type transformer connected to motor terminals by segregated phase Bus ducts. The transformer shall be designed and manufactured in accordance with relevant latest standard and shall be housed in a cubicle.

The transformer shall be sized such that its supplies rate dexcitation current at rated voltage continuously and shall be capable of supplying ceiling current at the
ceiling excitation for a short period. The rated field current and field voltage shall suit the requirement of the Motor. The transformer shall be self-cooled in door enclosed dry type. Since the high voltage winding is connected directly to the motor terminals, full design consideration shall be given to the frequency increase rate, voltage build up rate, motor fault level and insulation co-ordination. The high voltage and low voltage windings shall be of copper conductors Surge transmission from the high voltage side to the low voltage side shall be prevented by suitable means. Full rated capacity taps on the high voltage winding shall be provided to accommodate the complete range of operation. The transformer shall have taps of +5%, +2.5%, −2.5% and −5% on HV side.

A set of thermistors shall be embedded and used for providing transformer temperature high alarm / trips. The temperature surveillance unit suitable for these thermistors shall be provided in the AVR panels.

The 11 kV terminations of the transformers shall be connected to the bus duct in an appropriate manner. The low voltage terminals shall be suitable for terminating copper cable of adequate size and run perphase to be approved by the owner. The transformer shall be housed in acubicle with IP-20 protection.

The transformer shall be completely assembled at the factory and shall be subjected to standard type and routine tests. All routine and commissioning tests / checks shall be carried out at site also. The transformer shall be provided with necessary protections.

The Contractor shall furnish calculations justifying the rating and ratio of the transformers elected shall be furnished in the bid and the same is subject to the approval of the Owner.

3.3 THYRIST OR CONVERTOR

The thyrist or bridges shall be housed in one or more cubicles. Number of bridges shall be such that in case one bridge fails during operation, the remaining bridges shall have adequate capacity to meet the rated continuous output of the excitation system. Fans mounted in the cubicle shall cool the thyristor bridges. Adequate protection and monitoring is to be provided for the thyristors and cooling fans.

Each thyristor bridge shall comprise of six thyristors working as a six pulse fully controlled bridge. Thyristors shall be so designed such that their junction
temperature rise is well within its specified rating. By changing the firing angle of the thyristors variable output shall be obtained. Each bridge shall be controlled by one final pulse stage.

The thyristors shall be provided with fast acting semiconductor fuses in series to protect in case of over current. The fuses shall have micro switches for monitoring purpose. The coordination of thyristors and semiconductor fuses shall be properly done with calculations.

An RC network shall be provided across each thyristor for protection against over voltages. An air flow monitor relay to monitor the air flow shall be provided. The thyristor shall be of silicon controlled type and shall have a PIV rating of not less than four times the maximum RMS voltage of the input. During deexcitation thyristors shall be driven to inverter mode before tripping the field breaker. The rated continuous output of the excitation system shall suit the rated continuous input to the Motor rotor. Means shall be provided to equalize the reverse voltage. Voltage spike protection shall be provided. It shall be possible to isolate any Thyristor bridge while unit is in operation for any required replacement for which isolators on both AC & DC side shall be provided.

3.4 FIELD FLASHING

Necessary arrangement for initial building up of voltage shall be made by using supply from start-up equipment.

As soon as the motor is synchronized the excitation requirement shall be met by the supply tapped from the bus duly isolating the initial start-up supply.

3.5 FIELD BREAKER

A direct current circuit breaker shall be provided in the field circuit for ensuring definite disconnection from the supply source and subsequent discharge of energy in the field circuit in the event of fault or disturbance.

The field breaker shall be suitable for providing protection by isolating the D.C source from the field in the event to severe internal fault for three-phase short circuit on motor terminals or a short circuit on the sliprings. The magnetic field energy in such a case shall be dissipated through a field discharge resistor, which shall get connected across the field during such operation.
The discharge resistor shall be such that the rapid de-excitation takes place and the voltage developed across the discharge resistance following the 3 phase fault current is less than the insulation level of the field winding.

The circuit breaker shall be electrically operated by means of control switches provided in the panel. The control voltage for the breaker shall be the station battery voltage. Anti-pumping feature for the breaker shall be provided.

The trip coil of breaker shall be supervised by a relay and shall give an alarm in case of failure of trip coil.

The field breaker shall have polarity change over links for equal abrasion of brushes. Necessary shunts for field current measurement and rotor temperature indicator cum recorder shall be provided. Sufficient nos. of auxiliary NO and NC contacts for indication and interlocking shall be provided.

**3.6 AUTOMATIC DIGITAL VOLTAGE REGULATOR**

The voltage regulator shall be of the continuously acting type, responsive to the voltage of all the three phases.

The voltage regulator shall automatically actuate the controlled rectifiers and shall be capable of performing the following functions:

a) Maintain the average 3 phase motor voltage within + / - 0.5% without hunting when operating under steady load conditions for any change of load or excitation within operating range of motors.

b) The voltage regulator shall restore the motor terminal voltage to a value not more than 5% above the voltage being held before load rejection following any load rejection upto 115% of the rated load and shall maintain the voltage within this limit throughout the period of the motor over speed.

c) Under steady state conditions, for any over speed upto 150% of normal, maintain motor voltage within plus or minus 5 percent of the value that the voltage regulators were holding before over speed. Also under steady state conditions for an overspeed between 150 percent and maximum permissible overspeed, maintain motor voltage within plus or minus 10% of the value, the voltage regulator was holding be foreover speed.
d) Permit continuous stable operation of the motor under the control of voltage regulators, while meeting the line charging requirements.

The AVR shall be designed with highly stable elements so that variation in ambient temperature does not cause any drift or change in the output level.

The AVR shall consist of the following:

1. Voltage and current measuring and digitizing of signals.
2. Central processing unit.
3. Digital firing and control modules
4. Manual control with follow up facility for bump less transfer from auto to manual mode & vice versa.
5. Pulse amplifier and final pulse stage
6. Rotor temperature measurement
7. Micro terminal
8. Monitoring

1. **Voltage & Current Measuring & Digitizing Of Signals**

The electrical measured values such as motor voltage, motor current etc. Shall be fed to the semodules from PTs & CTs. Here the values have to be converted to filtered standard values. These signals shall be rectified wherever necessary filtered and converted to pulse signal for active and reactive measurement. These signals have to be digitized using analog digital converters.

The AVR shall also have builtin frequency dependent circuit, so that when the motor frequency lies outside as certain frequency range either during run up or after trip, the pulse shall be given from internal pulse motor. Further when the machine is running below a particular frequency the regulated voltage should be proportionally reduced with frequency. The circuit shall be made to respond proportionally to voltage above a particular frequency. The frequency shall be settable between 40 and 60 HZ.

2. **CENTRAL PROCESSING UNIT**
The central processing unit shall accept the digitized input signals, compare with these values and parameters and shall calculate on output variable corresponding to field voltage.

3. DIGITAL FIRING AND CONTROL MODULES

These modules shall convert the digital values received from the central processing unit to a gate pulse train. These pulses shall be synchronized to the AC input voltage of the thyristor converter.

4. MANUAL CHANNEL

As separate manual control channel operating as a field current regulator is to be provided. The control output shall be converted into a standard value and then fed to digital firing and pulse generation module where gate pulse trains are produced. These gate pulse trains shall be in synchronism with the inputs up to thyristor converter.

To ensure bumpless transfer from automatic to manual control and vice versa the position of pulses in both channels should be identical. A pulse comparison unit to detect any difference in the position of the pulses and to adjust the reference to eliminate any difference shall be provided. A balance voltmeter shall be provided to ascertain bumpless transfer.

A change over between automatic to manual channel and vice versa shall be affected by blocking or releasing the pulses of the corresponding intermediate pulse stage.

5. PULSE AMPLIFIER & PULSE FINAL STAGE

Output pulses from the digital firing modules (auto & manual) shall be amplified in intermediate pulse stage. Output of intermediate pulse stage shall be paralleled and fed to pulse final stage. There shall be separate pulse final stage for each converter. The output of the same shall be fed to gate circuit of thyristor via pulse transformer to provide galvanic isolation between power circuit and control circuit.

A pulse supervision unit shall detects curious pulses or loss of pulse on the bus bar and transfer control from AUTOMATIC channel to MANUAL channel.
Each thyrist or bridge shall have its own final pulse stage. Pulses shall be blocked to respective bridges incase of

a. Failure of one or more thyristor fuses
b. Failure of power supply of the final stage
c. Failure of convertor cooling fan.
d. Opening of input / output isolators.

6. ROTOR TEMERATURE MEASUREMENT

Rotor temperature measurement shall be done through micro processor, the standard signals of field current and field voltage being obtained using transducers and fed to processing unit for rotor temperature measurement. The measurement shall take into account the brush drop to calculate the rotor temperature. The output shall be connected to recorder and also to the remote System.

7. MICRO TERMINAL / MAN MACHINE INTERFACE

It shall be possible to read the data / parameters fed to the micro processor using the micro terminal. Further the plant dependent parameters shall be made accessible to the purchaser. This shall work like tool in trouble shooting by verifying the level of signal flow.

8. MONITORING

It shall be possible to monitor the following.

a) Actual value of Motor and field currents / voltages.
b) Program sequence checks
c) A / D & D / Ac converters Digital input and output modules Pulse output checks for short circuits Output voltages of power supply modules.

3.7 VOLTAGE REGULATOR FEATURES

The voltage regulator shall also be provided with the following features:

a) CONTROL OF MOTOR VOLTAGE
Motor voltage reference value shall be set by giving logic signals. Limitations of motor voltage shall be keyboard configurable. DVR has to give processed signal to firing circuit to maintain the motor voltage at the set value. Reference value of the motor voltage can be set by:

a. Adjusting the voltage set point in auto channel.

b. Adjusting the internal reference value in manual channel for soft start.

c. Adjusting the field current in manual channel.

**b) LOAD ANGLELIMITER (MINIMUM EXCITATION LIMIT)**

An adjustable minimum excitation limit device shall be excited from potential and current transformers and shall automatically limit the decrease in synchronous motor excitation below that value which may result in pull out of the motor when operating under any specified operating conditions. The characteristics of the minimum excitation limiter shall closely match the motor capability curves.

c) **ROTOR CURRENT LIMITER**

An adjustable maximum excitation limit function shall automatically limit the excitation of the motor to safe value with the excitation under control of the regulator. The device shall have an adjustable time delay features to permit short time operation (subject to thermal limitation) with ceiling excitation.

d) **STATOR CURRENT LIMITER**

An adjustable max stator current limit function shall automatically limit motor stator current to its rated value.

**e) LIMITATION OF VOLTS / HERTZ**

This function shall prevent over fluxing of the motor transformer.

**f) POWER SYSTEM STABILISER**

Slip stabilization for damping the oscillations and improving the dynamic stability shall be provided. It shall be possible to cutting or cut-out this feature.

**g) SOFT START**
Facility for smooth build-up of motor voltage to prevent over shoots of the machine terminal voltage during excitation build up shall be provided.

**h) LINE DROP COMPENSATION**

Provision shall be made for inclusion of transformer and line drop compensation function. It shall be adjustable over range of 0 to 15%.

**i) BLOCKING OF PULSES IN DC SHORT CIRCUIT**

The field current shall be maintained such that when it reaches a certain adjustable threshold value, pulses shall be blocked to avoid failure of thyristors and fuses, flashover at slip ring etc., in case of slip ring short circuit.

**j) CONDUCTION MONITORING**

Conduction monitoring of thyristors shall be provided to monitor the conduction status of thyristors.

**k) TEST FACILITY**

A switch for selecting TEST & SERVICE shall be provided. On selection to test it shall be possible to test output pulses by using station AC supply. Separate transformer to simulate synchronizing pulses, to check air flow monitors etc., shall be provided for this purpose.

**3.8 CAPABILITY**

With rated AC supply voltage, the excitation system shall be capable of delivering continuously, within rated temperature rise, required value of field current required by the motor.

**3.9 CEILING VOLTAGE**

The exciter ceiling voltage shall be 2.0 times the excitation voltage required for rated field current of the motor at full load and rated terminal voltage. With positive field current flowing, the exciter shall be capable of providing an adjustable
maximum negative ceiling voltage which is not less than 70 percent of the corresponding positive ceiling voltage for forcing the field current down to zero.

3.10 OVER VOLTAGE

The excitation system shall be capable of withstanding or be adequately protected against over voltages, which may be induced into the field during abnormal system conditions, or by opening the field breaker.

The voltage of the excitation system shall be capable of withstanding impulse wave (1.2x50 microsec) voltage having a crest value of 75 kV applied at the H.V. terminals of the excitation transformer.

All components of the excitation equipment shall be capable of withstanding these over voltages, without damage including all necessary isolating, protective & regulating devices in equipment.

3.11 POWER SUPPLY TO REGULATOR

Redundant power supply shall be provided. Suitable AC / DC and DC / DC converters shall be used.

The excitation system shall be complete including its power supply transformer connected to the motor terminals, circuit breaker and all necessary devices for indication, protection, alarm and control of the equipment.

3.12 PT FUSE FAILURE DETECTION

A trip manual control shall be initiated by the detection of failure of any of the AVR PT fuses or loss of pre-set signal.

3.13 PROTECTION

Thyristors shall be provided with fast acting semiconductor fuses of trip indicating type to protect the devices against short circuits.

An over voltage protection to protect the insulation of the field winding and the static excitation equipment from induced over voltages in the field. Suitable equipment shall be provided for over voltage protection under all conditions of regulator in or out of operation or mal-operation. The protective circuitry shall be responsive only to the excite terminal voltage and its operation shall be separate
from and in addition to the operation of the maximum excitation limiter and its associated controls. The equipment shall have an adjustable time delay feature and a means for adjusting the operation voltage level so as to permit operation that does not interfere with the normal regulator functions. Fan exciter output over voltage condition persists for as sufficient time, such conditions shall initiate the following action: To operate motor lock out relay and trip main and field breakers. To provide annunciation An over current relay shall be provided to protect the excitation transformer. It shall initiate an auto to manual change over command as a first stage and a trip command to the field breaker as a second stage if the current fail stored uneven after auto to manual changeover. Additionally, it shall trip the field breaker on instantaneous over current. The transformer shall also be protected against high winding temp with alarm and trip contacts, operated by thyristors embedded in the excitation transformer.

Rotor earth fault protection shall be provided to give an alarm on reduction of rotor insulation below a set value as first stage. The sensitivity shall be independent of fault location, the excitation voltage value, its ripples and total capacitance to earth of the complete rotor circuit.

A second stage rotor earth fault shall also be provided with necessary accessories to trip the unit. Details of Ir value of Rotor Earth fault stage-I and Rotor Earth fault stage-II shall be furnished in the bid.

3.14 The following protections shall also be built in the system

1. Delay in field flashing to Trip the field breaker


3. DC short circuit to trip motor master trip relay

4. Rotor temperature monitoring disturbed to initiate an alarm

The final pulse to the bridge shall be blocked on following conditions

1. Thyristor fuse fail

2. Loss of cooling.

3. AC / DC isolators open
4. Power supply pulse final stage fails.

3.15 Control shall changeover from auto to manual on following

1. Auto channel failure.
2. Power supply to auto channel fail
3. AVR PT fuses fail (motor voltage actual value failure)

3.16 CURRENT TRANSFORMERS

One set of current transformers for O/C relay in the primary side of the excitation transformer shall be provided to trip the unit. One set of CTS shall also be provided for energy meter in the primary circuit of SEE transformer to measure the kW, kV A etc.

3.17 CONTROL, INDICATION AND ANNUNCIATION

3.18 CONTROLS AND INDICATIONS

The following controls and indications shall be provided by illuminated push buttons

1. Voltage raise / lower in manual with max & min position indication.
2. Voltage raise / lower in auto with max and min position indication.
3. Field breaker close / open
4. Auto / Manual channel ON
5. Local / Remote selection
6. Provision shall be made for taking analog / digital signals to the remote system for remote operations / graphic display.

3.19 ANNUNCIATIONS

The following annunciations shall be provided with provision to take it to remote either as an individual or as a group alarm.
• Thyristor bridge failure
• Auto channel failure
• Protective changeover to manual
• Regulator power supply fail
• Field flashing delayed
• Field breaker trip coil faulty
• Limiters inaction
• Thyristor fuse failure
• Thyristor cooling fan failure
• Excitation transformer temperature high
• Excitation transformer temperature very high
• Excitation transformer over current delayed / instantaneous.
• Rotor over voltage
• DC short circuit
• Parameters change
• Fan supply change over
• Power supply to final stage failure
• AVR in test
• AC / DC isolators open
• Motor voltage actual value failure (in Auto mode)
• Field current actual value failure (in Manual mode)
• Channel-1 pulse failure
• Rotor earth fault
• Manual channel in operation.
• Rotor temperature monitoring disturbed.
• Any other annunciation relevant to the system offered
• Conduction failure Contractors shall indicate the annunciation provided for the equipment of freed in the bid. There shall be provision for resetting the local panel alarm indications from remote.

3.20 REMOTE CONTROL & METERING

The following indications control and metering shall be provided in unit sequencer panel for remote control. Field breaker close / open with indications Auto / Manual
channel ON indication Auto / Manual change over switch with balance meter
Voltage raise / Lower in manual Voltage raise / Lower in auto Field current Field
voltage.

**3.21 MICRO TERMINAL FOR MANMACHINEINTERFACE**

Each regulator shall be provided with a terminal for local control and display. It
shall be possible to obtain display of measured values, set values and binary
status signals through key pad of the terminal. Changing of set values of Limiters
and controller shall also be possible from this terminal. If all these are not possible
in MM terminal and if separate PC based too is required the above shall be
supplied without additional cost.

**3.22 TRANSFORMER FOR HEAT RUN**

A suitable transformer for conducting OCC and SCC tests shall be supplied
separately.

**3.23 SPARES**

The necessary spares shall be supplied.

**3.24 TESTS TO BE CONDUCTED AT WORKS TESTS ON EXCITATION
TRANSFORMER**

1  Checking of dimensions & GA

2  Measurement of winding resistance HV&LV

3  Ratio tests

4  Polarity & vector group tests IR measurement & HV tests

a) HV – 35 kV for one minute

b) LV – 3 KV for one minute

c) Induced over voltage tests as per relevant standards. Measurement of no load
   loss & full load loss & impedance volts Tests on CTs & temperature detectors,
   thyristors mounted on transformer Tests on CTs & temperature detectors,
   thermistors mounted on transformer Partial discharge test & temperature rise
test on transformer.
- **TESTS ON AVR, FIELD BREAKER & THYRISTOR CUBICLES**

1. Dimensional checks as per approved GA & mechanical assembly & mounting of all components

2. Checking of wiring

3. *All functional checks as per approved schematics & functional checks of regulation Limiters etc.*

4. Operation of field circuit breaker at +10 % & - 15 % control voltage & measurement of closing & opening times

5. IR & HV tests

   a. DC / AC bus bars- 3 KV for one-minute b. 415 V AC circuit- 2.5 KV for one minute

   b. 220 VDC, PT & CT circuits– 1.5 KV for one minute

   c. All other control voltage circuits– 0.5 KV for one minute

6. Heat run test of thyristor cubic less by passing rated current & measurement of temperature at heat sinks & joints

7. Light load test on thyristor bridges.

**DRAWINGS AND DATA**

The Contractor shall furnish the following along with the bid.

1. General arrangement drawings of SEE panels, Excitation Transformer

2. Transformer kV A & voltage ratio calculations

3. Thyristor rating calculations

4. A brief write up of SEE & Transformers Following drawings and literatures shall be submitted after award of contract.

5. Detailed general arrangement drawings & foundation details of all panels, transformers etc.

6. Schematic drawings of SEE
7 Inter panel wiring details, internal wiring details, external cable connection
details etc.

8 Detailed drawing of each module

9 Signal flow & logic diagrams

10 Operating and maintenance instruction manual.

11 Test reports.

12 Scheme drawing of protective relay with write-up.

13 Catalogue of sub-supplied items along with write-up and address.

**PUMPS STARTING EQUIPMENT**

For starting of pumps the Contractor shall quote either Static frequency converter
(SFC) system Starting equipment offered shall be suitable to start the pump-
motor smoothly and without in rush current. The motor shall be soft started and
reach 90% of rated speed within 5 Minutes. The Contractor shall include the
necessary transformer, H.T. Switch gear, and all the control equipment in their
scope of supply. The starting equipment offered shall be of proven design and
shall be robust and can withstand no. Of starts in a day. The Contractor shall
quote 2 sets of starting equipment 2 SFC. All the control equipment for selection
of the pumps to be started, and all interlock, indication, and alarm and
annunciation circuits shall be included in the scope supply. Drawings for the
starting isolators to be furnished by the Contractor.

All the protection and control circuits of starting equipment shall be in
porate in the system. The system shall be suitable to start one pump at a time either from
local panel or from remote control panel / control desk / panel in the Control
Room.

The Power Circuit Panels (11 KV System) shall be designed so that it can with
stand fault system fault currents during starting of pump. The starting equipment
shall be housed in sheet steel cubicles of thickness not less than 14 gauges and
painted with anticorrosion resistive paint the colour of the final paint shall finalized
with the successful Contractor. The high voltage equipment of the starting
equipment shall be type tested. The manufacturer shall conduct all the routine tests as per IEC standards on the equipment offered.

**Automation for Pump & Motor Control**

Pumping machinery shall be controlled by Variable frequency Drive Panels (VFD Panels), level sensors and total system shall be controlled with SCADA.

Specification for VFD panel is given under Specification for Wireless Automatic Irrigation System.

**Note:** Items required for pumping machinery and allied electrical equipment whose specification not covered under specification of Pumps, relevant mechanical / Electrical department, WRD Maharashtra technical specifications shall be applicable.
CHAPTER- XVIII

33 kV TRANSMISSION

LINE & SWITCH YARD

SECTION- XVIII

33 kV TRANSMISSION LINE & SWITCH YARD

SCOPE AND GENERAL TECHNICAL CONDITIONS

1.1.0 INTENT OF THE SPECIFICATION

1. Design, Planning, Construction / Execution, Installation, Fabrication, Supply, Commissioning and Testing & Trial Run, Third Party Inspection of various electrical components of 33 kV suspension type transmission line by using RSJ pole of size 152 mm x 152 mm transmission line including all infrastructure from Lalkhadi 132 kV substation to proposed pump house location 33 kV substation / switchyard at pump house location, all related components / Equipments required to carry 3.9 MW load required for Lower Pedhi Project.

2. Latest technical and work related specifications of Maharashtra State Electricity Distribution Co. Ltd. (A Government of Maharashtra Undertaking) shall be used. Detailed specification of each component / Item shall get approved
from Chief Engineer before approval of final estimate based on vetted & approved designs and drawings.

3. As contractor is allowed to use centrifugal pumps as per his choice hence 33 kV substation shall be designed and installed as 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV and as per requirement. Accordingly MSEDCL / MSETCL standards are applicable.

4. Design of each component shall be based on relevant Indian code of practice. Third Party Inspection of Each component. Inspecting Agency shall be decided by Chief Engineer. Defect liability for all materials, Equipment shall be 5 Years after completion of work. All other miscellaneous works required for successful commissioning of Entire scheme shall be the responsibility of contractor.

5. Necessary safety provisions shall be made as per MSEDCL / MSETCL standard practices.

6. All permissions required for transmission lines, 33 kV substation etc. including all crossing, right of way permissions from any land, all statutory clearances with contractors own cost.

7. All related required work as directed by Engineer-in-Charge shall be executed by the contractor.

8. Testing charges shall be borne by Contractor.

9. Operation & Maintenance, Repairs & replacements of 33 kV substation and allied equipments for 5 Years after commissioning and testing of scheme.

10. Handling over of 33 kV suspension type transmission line after commissioning & testing to MSEDCL / MSETCL shall be the responsibility of contractor. Operation & maintenance, repairs and replacement of 33 kV suspension type transmission line and allied equipments upto handling over to MSEDCL shall be the responsibility of contractor with his own cost.

11. All the technical specifications for 33 kV transmission line and allied equipments and also the work carried out will be strictly as per the regulations, rules, circulars, etc. of MSEDCL.

**Materials**

All materials, equipments required shall be approved make of MSEDCL and should be ISI mark or as per standard requirements and as directed by Engineer-in-Charge.
1.2.0 SCOPE

1.2.1 The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer’s works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, civil foundation work, erection and commissioning at site of various equipment and materials including power transformers, substation structures and civil foundations for equipment as specified in subsequent Clauses and Sections for unmanned 33 kV sub-stations & 33 kV Transmission line from Lalkhedi 132 kV substation including necessary connection.

1.2.2 The scopes of works also include site development, design & construction of boundary walls, fencing, gate and other facilities at substations as specified in the Bidding Document.

1.2.3 It is not the intent to specify completely herein all details of design and construction of the equipment and accessories. However, the equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation up to the Contractor’s guarantees in a manner acceptable to the Corporation. The Corporation shall interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance there with.

1.2.4 Whether called for specifically or not, all accessories and work required for the completion of the work are deemed to be considered as a part of the Contractor’s scope, unless and until mentioned very clearly as excluded.

1.2.5 The major items of works included in the scope of this specification are listed below:-

i.) Supply, erection, testing and commissioning of transformers and all switch & control gears such as circuit breakers, isolators, current transformers, relay & control panels, Lightning Arresters etc. including mounting structures and civil foundations.

ii) Supply, erection, testing and commissioning of Substation local Communication Equipment as specified in Bidding Document.

iii) Design, supply and erection of 33 kV substation structure and 33 kV transmission line from 132 kV Lalkhadi substation to newly proposed 33 kV substation.
iv) Design and construction of cable trenches and earth mat including supply of all materials.

V) Other works includes site development, construction of Boundary Walls / Security Fencing, Design and installation of illumination system for switchyard etc. as brought out In the Specification and Schedule of Requirements.

(Bidder shall visit 132 kV substation and collect necessary information required in respect of fault level).

1.2.6 The name of substation that is to be built under the scope of this specification is listed below:

i) 33 / 6.6 kV OR 33 kV / 11 kV / 433 V substations (rep sa AVM)

(Being ‘C’ tender bidder has to design 33 kV / 6.6 kV OR 33 kV / 11 kV / 433 V substation according to the system requirement. Vetting to this design shall be obtained from SE, Hydro Electrical wing, Nagpur in consultation with SE, Mechanical, Nagpur)

1.2.7 The various items of works are described very briefly in Bid Form, Prices & Other Schedules. The various items as defined in these schedules shall be read in conjunction with the corresponding section in the technical specifications including amendments and, additions if any.

1.2.8 The Contractor’s rates shall be based on the description of activities in the schedules as well as necessary operations detailed in Technical Specifications.

1.2.9 As this is ‘C’ Contract, quantities are not fixed. All quantities required for 33 kV substation & transmission line shall be the responsibility of contractor.

1.3.0 CONTRACTOR TO INFORM HIMSELF FULLY

1.3.1 The contractor should ensure that he has examined the General Conditions, Specifications and Schedules as brought out in other sections and this Section and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein shall be levied.

1.3.2 The Corporation shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Corporation.
1.4.0 SERVICE CONDITIONS
1.4.1 The plant and materials supplied shall be suitable for operation under the following climatic and other conditions:
   a) Peak ambient day temperature in still air: 47°C
   b) Minimum night temperatures: 8°C
   c) Reference ambient day temperature: 45°C
   d) Relative Humidity a) Maximum: 100 %
      b) Minimum: 10 %
   e) Altitude: Below 500 M above MSL
   f) Maximum wind pressure: As per IS: 802 latest codes.
   g) Other Data: Refer Meteorological data pertaining to the locations.
   h) Seismic Intensity zone-II as per IS 1893.

1.5.0 CONFORMITY WITH INDIAN ELECTRICITY RULES & OTHER LOCAL REGULATIONS:
1.5.1 The contractor shall note that all substation works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, about the rules and regulations that may be applicable.
1.5.2 The Contractor shall also comply with the Minimum Wages Act 1948 and the payment of Wages Act (both of the Government of India and Government of Maharashtra) and the rules made there under in respect of any employee or workman employed or engaged by him or his Sub-Contractor.
1.5.3 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the statutory laws and its amendments from time to time during erection in respect of the Substation Works, ultimately to be owned by the Corporation, shall be to the account of the Corporation. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and / or registration shall be borne by the Contractor.

1.6.0 STANDARDS
1.6.1 The equipment covered by this specification shall, unless otherwise stated be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards (ISS) / IEC and shall conform to the regulations of local statutory authorities and as per MSEDCL / MSETCL practices.

1.6.2 In case of any conflict between the standards and this specification, this specification shall govern.

1.6.3 Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance than that specified under Clause 1.6.4 above shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid.

1.7.0 CONTRACTOR’S REQUIREMENT

1.7.1 The Contractor should be in possession of a valid H.V. Electrical License issued by the Chief Electrical Inspector, Govt. of Maharashtra / MSEDCL / MSETCL or concerned authority as per the provision of Law. An attested copy of the mentioned License must be handed over to the Corporation for his record prior to handing / taking over of sites. The Corporation shall assist the Contractor in obtaining the requisite license.

1.7.2 All the works shall also be inspected by authority decided by Chief Engineer, Special Project, Water Resources Department, Amravati. It is the responsibility of the Contractor to obtain pre-requisite commissioning clearance of any equipment from the said Inspectorate. The Contractor shall pay necessary fees to the Inspectorate, which it may levy.

1.8.0 ENGINEERING DATA

1.8.1 The furnishing of engineering data by the Contractor shall be in accordance with the Bidding Document. The review of these data by the Corporation shall cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Corporation shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

1.8.2 All engineering data submitted by the Contractor after review by the Corporation shall or part of the contract document.
1.9.0 DRAWINGS AND DOCUMENTS FOR APPROVAL

1.9.1 In addition to those stipulated in clause regarding drawings in General Conditions of Contract, the following sub clauses shall also apply in respect of Contract Drawings.

1.9.2 All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

1.9.3 Each drawing submitted by the Contractor shall be clearly marked with the name of the Corporation, the specification title, the specification number and the name of the Project. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

1.9.4 The drawings submitted for approval to the Corporation shall be in quadruplicate. One print of such drawings shall be returned to the Contractor by the Corporation marked "approved / approved with corrections". The contractor shall there upon furnish the Corporation additional prints as maybe required along with one reproducible in original of the drawings after incorporating all Corrections.

1.9.5 The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Corporation, if so required.

1.9.6 All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the drawings shall be at the Contractor's risk. The contractor may make any changes in the design which are necessary to conform to the provisions and intent of the contractor and such changes shall again be subject to approval by the Corporation.

1.9.7 The approval of the documents and drawings by the Corporation shall mean that the Corporation is satisfied that:

   a) The Contractor has completed the part of the Works covered by the subject Document (i.e. confirmation of progress of work).

   b) The Works appear to comply with requirements of Specifications. In no case the approval by the Corporation of any document does imply compliance with neither all technical requirements nor the absence of errors in such
documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

1.9.8 All drawings shall be prepared using AutoCAD software version 2000 or later only. Drawings, which are not compatible to AutoCAD software version 2000 or later, shall not be acceptable. After final approval all the drawings shall be submitted to the Corporation in readable CD's.

1.9.9 The following is the general list of the documents and drawings that are to be approved by the Corporation:

a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.
b) General Layout of Switchyard: Plan and Sections.
c) Earthling layout and details.
d) Cable Trench Layout and details.
e) Foundation layouts and details of main and auxiliary structures
f) Detail design calculations and drawings for structures, equipment supports and foundations including transformer pad.
g) Cable Schedule, as applicable
h) For equipment and items in the scope of supply:
   i.) General arrangement drawing with full dimensions.
   ii) Electrical schematic diagram, where applicable.
   iii) Wiring diagram, where applicable.
   iv) Architecture of Local Automation System.

1.9.10 All Designs / Drawings / Calculations / Data submitted by the Contractor, from time to time shall become the property of the Corporation and Corporation has the right to use or replicate such designs for future contracts / works without the permission of the Contractor. The Corporation has all rights to use / offer above designs / drawings / data sheets to any other authority without prior Permission of the Contractor.

1.10.0 FINAL DRAWINGS AND DOCUMENTS

1.10.1 The successful Contractor shall require providing following drawings and documents for each substation in printed form:

(a) All approved drawings (AS BUILD) of equipment and works related to a particular substation in three (3) copies.
(b) Instruction manuals of all equipment related to a particular substation in three (3) copies. These instruction manuals shall generally consist of-
   (i.) Operation Manuals, (ii) Maintenance Manuals and (iii) Spare Parts Bulletins.
   (c) Copies of routine test reports (in triplicate) of relevant equipment.
   (d) Final Guaranteed and Other technical particulars of relevant equipment.

1.10.2 In addition to the above the Contractor shall provide five (5) sets of all the drawings and documents to Corporation in printed form for his reference and record.

1.11.0 APPLICATION AND SYSTEM SOFTWARE
1.11.1 Contractor shall provide copies of licensed copies application software / configuration & system software in the form of CD (in duplicate) for all IEDs, meters, etc.

1.12.0 DESIGN IMPROVEMENTS
The Corporation or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

1.13.0 DESIGN CO-ORDINATION
1.13.1 Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material / item to provide the best co-ordinate performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.14.0 DESIGN REVIEW MEETING
1.14.1 No design review meeting before opening of tender. Only queries replied through email as mentioned in Volume-1.

1.15.0 QUALITY ASSURANCE, INSPECTION & TESTING
1.15.1 Quality Assurance
The Contractor shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i.) The structure of organization

ii) The duties and responsibilities assigned to staff ensuring Quality of work

iii) The system of purchasing, taking delivery and verification of Materials

iv) The system for ensuring quality of workmanship

v) The quality assurance arrangements shall confirm to the relevant requirement of ISO 9001 on ISO 9002 as applicable.

vi) Statement giving list of important raw materials, names of sub-supplies for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of suppliers representative, copies of test certificates.

vii) Information and copies of test certificates as on (i.) above in respect of bought out items

viii) List of manufacturing facilities available

ix) Level of automation achieved and list of areas where manual processing exists.

x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such test and inspection.

xi) List of testing equipment available with the Contractor for final testing of equipment specified and test plant limitation, if any vis-a-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in "Schedule of Deviations" from the specified test requirement.

1.15.2 The contractor shall within 30 days of placement of order, submit the following information to the purchaser.

i) List of the raw material as well as bought out accessories and the names of subsuppliers selected from those furnished along with the offer.

ii) Type test certificate of the raw material and bought out accessories if required by the purchaser.

iii) Quality Assurance Plant (QAP) withhold points for purchaser’s inspection. QAP and purchasers hold points shall be discussed between the purchaser and contractor before the QAP is finalized. The contractor
shall submit the routine test certificates of bought out accessories and central excise asses for raw material at the time of routine testing if required by the purchaser and ensure that the quality assurance requirements of specification are followed by the sub-contractor.

1.15.3 The Quality Assurance Programme shall give a description of the Quality System and Quality Plans with the following details.

i) **Quality System**

- The structure of the organization.
- The duties and responsibilities assigned to staff ensuring quality of work.
- The system of purchasing, taking delivery of verification of materials.
- The system of ensuring of quality workmanship.
- The system of control of documentation.
- The system of retention of records.
- The arrangement of contractor internal auditing.
- A list of administrator and work procedures required to achieve contractors Quality requirements.

These procedures shall be made readily available to the purchaser for inspection on request.

ii) **Quality Plans**

- An outline of the proposed work and program sequence.
- The structure of contractor’s organizations for the contract.
- The duties and responsibilities ensuring quality of work.
- Hold and notification points.
- Submission of engineering documents required by this specification.
- The inspection of the materials and components on request.
- Reference to contractors work procedures appropriate to each activity.
- Inspection during fabrication / construction.
- Final inspection and test.

**1.15.4 Training of Personnel**

The contractor shall provide necessary facilities for training personnel at their works / principals works relating to design, manufacture, assembly and testing and operation maintenance for four personnel free of cost. However, travel and
incidental charges of the personnel shall be borne by the purchaser. The contractor shall provide 15 days hands on training for operation and maintenance of substation for four personnel free of cost against each substation prior to handing over of substation to Corporation.

1.16.0 CORPORATION’S SUPERVISION

1.16.1 To eliminate delays and avoid disputes and litigation it is agreed between the parties to the Contract that all matters and questions shall be resolved in accordance with the provisions of this document.

1.16.2 The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the Corporation, pursuant to the contract, shall include but not be limited to the following.

A. An Interpretation of all the terms and conditions of these Documents and Specifications.
B. Review and interpretation of all the Contractors drawings, engineering data etc.
C. Witness or authorize his representative to witness tests at the manufacturer’s works or at site, or at any place where work is performed under the contract.
D. Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.
E. Issue certificate of acceptance and / or progressive payment and final payment certificate.
F. Review and suggest modification and improvement in completion schedules from time to time, and
G. Supervise the Quality Assurance Programme implementation at all stages of the works.

1.17.0 INSPECTION & INSPECTION CERTIFICATE

1.17.1 The Corporation, his duly authorized representative and / or outside inspection agency acting on behalf of the Corporation shall have, at all reasonable times, access to the premises and works of the Contractor and their sub-contractor(s) / sub-vendors and shall have the right, at the reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.
1.17.2 All routine and acceptance tests whether at the premises or works of, the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall carry out such tests free of charge. Items such as labour, materials, electricity, fuel, water, stores apparatus and instruments as may be reasonably demanded by the Corporation / inspector or his authorized representative to carry out effectively such tests in accordance with the Contract shall be provided by the Contractor free of charge.

1.17.3 If desired by the Corporation, the Contractor shall also carry out type tests as per applicable Standards for which Corporation shall bear the expenses except in cases where such tests have to be carried out in pursuance to Clause 1.18.3. The Contractor is required to quote unit rates of type test charges in a separate Schedule (if such schedule is provided in the Bidding Document) in pursuance to this Clause.

1.17.4 The inspection by Corporation and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the Contract.

1.17.5 **Tests**

The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

i) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to Commencement of commercial production against the order. The Contractor shall indicate his schedule for carrying out these tests.

ii) Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

iii) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.

iv) Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the product to be supplied by him.
v) The norms and procedure of sampling for these tests shall be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Corporation.

1.17.6 The standards and norms to which these tests shall be carried out are specified in subsequent Sections of this Specification. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified or as mutually agreed to between the Contractor and the Corporation in the Quality Assurance Programme.

1.17.7 For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Contractor or applicable Standards, as applicable.

1.18.0 TYPE TEST REPORTS

1.18.1 Equipment, which has never been tested for critical performance, shall not be accepted. In such cases, a promise or agreement by a Contractor to have the equipment tested after award of a contract is not acceptable.

1.18.2 All Bids must be accompanied by the Type Test Certificates of equipment offered (refer Clause 1.18.5 below).

Such type test certificates shall be acceptable only if:-

   (a) Tests are conducted in CPRI, ERDA and KEMA laboratory, or approved by MSEDCL / MSETCL.

   (b) Tests are conducted in manufacturer’s own laboratory. In this case
       (i) The laboratory must have NABL accreditation and ISO 9000 (or its equivalent) series certification; and

   (ii) Tests have been witnessed by technically qualified representatives.

1.18.3 Test reports to be acceptable must be related directly to the equipment offered i.e. it is fully identical in design, rating and construction with the equipment for which the type test certificates have been submitted.

1.18.4 Type Test Reports older than three (3) years on the date of Technical bid opening shall not be accepted.

1.18.5 Full Type Test Reports of at least the following equipment must be submitted:

   1. Transformers

   2. Auto Reclosers

4. Capacitor bank
5. Lightening Arrester
6. Isolators
7. Numerical Relays
8. Gateways & Data concentrators
9. XLPE Power cable & Control cable
10. Battery & Battery Charger

1.19.0 SPARE PARTS

1.19.1 Recommended Spare Parts
The Contractor shall also furnish an item wise list of recommended spare parts and quantity for Three years satisfactory operation of the equipment with unit price of each part in a separate Schedule. Prices of these spare parts shall not be taken in to account in comparing Price Bid. Also, they shall submit an undertaking to supply all spare parts for a minimum period of 10 (ten) years as and when any request is made before them on a chargeable basis.

1.19.2 Mandatory Spare Parts
The Contractor shall also quote for the mandatory spares list of which is furnished in ‘List of Mandatory Spare Part. Prices of these spare parts shall be taken into account in comparing price Bid.

1.20.0 GUARANTEED TECHNICAL PARTICULARS

1.20.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Contractors in the prescribed schedules of this Specification
1.20.2 with the Technical Bid. The Contractor shall also furnish any other information’s as in their opinion is needed to give full description and details to judge the item(s) offered by them.
1.20.3 The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (as per the requirement of the specification) required. A Contractor may guarantee a value more stringent than the specification requirement. However, for testing purpose or from performance point of view, the material shall be considered performed successfully if it achieves the minimum / maximum value required as per the technical specification. No preference what so
ever shall be given to the Contractor offering better / more stringent values than those required as per specification except where stated otherwise.

1.21.0 PACKING

1.21.1 All the materials shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

1.21.2 The Contractor shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road.

1.21.3 All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.

1.21.4 The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e. fragile, handle with care, use no hook etc. wherever applicable.

1.21.5 Each package shall be legibly marked by the Contractor at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the Contractor etc.

1.22.0 CONSTRUCTION TOOLS, EQUIPMENTS ETC.

1.22.1 The Contractor shall provide all the construction equipment, tools, tackle and scaffoldings required for construction, erection, testing and commissioning of the works covered under the Contract. He shall submit a list of all such materials to the Corporation before the commencement of work at site. These tools and tackle shall not be removed from the site without the written permission of the Corporation.
1.23.0 MATERIALS HANDLING AND STORAGE

1.23.1 All the supplies under the Contract as well as Corporation supplied items (if any) arriving at site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.

1.23.2 Contractor shall be responsible for examining all the shipment and notify the Corporation immediately of any damage, shortage, discrepancy etc. for the purpose of Corporation's information only. The Contractor shall submit to the Corporation every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection at site. Any demurrage, and other such charges claimed by the transporters, railways etc., shall be to the account of the Contractor.

1.23.3 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all items received by him for the purpose of erection and keep such record open for the inspection of the Corporation.

1.23.4 All items shall be handled very carefully to prevent any damage or loss. The materials stored shall be properly protected to prevent damage. The materials from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such materials at Site.

1.23.5 All the materials stored in the open or dusty location must be covered with suitable weatherproof and flameproof covering material wherever applicable.

1.23.6 The Contractor shall be responsible for making suitable indoor storage facilities, to store all items/materials, which require indoor storage.

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

1.24.0 CONTRACTOR’S MATERIALS BROUGHT ON TO SITE
1.24.1 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the work under intimation to the Engineer. All such goods shall, from the time of their being brought vest in the Corporation, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Engineer. The Contractor shall never the less be solely liable and responsible for any loss or destruction thereof and damage there to.

1.24.2 The Corporations shall have a lien on such goods for any sum or sums, which may at any time, be due or owing to him by the Contractor, under in respect of or by reasons of the Contract. After giving a fifteen (15) days’ notice in writing of his intention to do so, the Corporation shall be at liberty to sell and dispose of any such goods, in such manner, as he shall think fit including Public auction or private treaty.

1.24.3 After the completion of the Works, the Contractor shall remove from the Site under the direction of the Engineer the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the Engineer. If the Contractor fails to remove such materials within fifteen (15) days of issue of a notice by the Engineer, the Engineer shall have the liberty to dispose of such materials as detailed under clause 3.31.2 above and credit the proceeds there to the account of the Contractor.

1.25.0 COMMISSIONING SPARES

1.25.1 It shall be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Corporation declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Corporation.

1.25.2 These spares shall be received and stored by the Contractor at least 3 months prior to the schedule date of commencement of commissioning of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of performance and guarantee test shall be the property of the Contractor and he shall be allowed to take these parts back at his own cost with the permission of Corporation’s Representative.
TECHNICAL SPECIFICATION FOR CONSTRUCTION WORKS IN SUBSTATIONS

2.1.0 GENERAL

2.1.1 The intent of this Section of the Specification is to cover requirements which are to be followed in construction of switchyards including civil works in the switchyard as per MSEDCL specifications.

2.1.2 The work shall be carried out according to the design / drawings to be developed by the Contractor and approved by the Corporation based on Drawings supplied to the Contractor by the Corporation with this specification. For all structures, foundations, etc., necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance based on the input provided (drawings and design parameters) by the corporation in this technical specification. Certain minimum requirements are indicated in this Section for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

2.1.3 A set of drawings are enclosed for reference of the Contractor. The drawings shall be treated as forbidding purpose only.

2.1.4 The contractor shall maintain the overall dimensions of the substation, bay length, bay width, phase to earth clearance, phase to phase clearance, ground clearances, sectional clearances, clearances between buses and bus heights but may alter the spacing between equipment based on actual dimensions equipment offered to obtain the statutory electrical clearances required for the substation and to suite the physical requirements of available land for the Substation etc.

2.2.0 GEO-TECHNICAL INVESTIGATION

2.2.1 The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate, general as well as specific information about the soil profile and the necessary soil parameters of the Site in order that the foundation of the various structures can be designed and constructed safely and rationally.

2.3.0 SCOPE OF WORK

2.3.1 This clause of the specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering
supervision and technical personnel, skilled and unskilled labour, etc., as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-Technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata for the various structures of the substation. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the Corporation. All the work shall be carried out as per latest edition of the corresponding Indian Standard Codes.

2.3.1.1. Electrical Resistivity Test
This test shall be conducted to determine the Electrical resistivity of soil required for designing safe grounding system for the entire station area. The specifications for the equipment and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to relevant IEEE. The test shall be conducted using Wagner’s four electrode method as specified in IS: 1892, Appendix-B2. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the co-ordinate axis. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.5 m up to a distance of 10.0 m.

2.3.1.2. Test Results and Reports
The Contractor shall submit the detailed report in two (2) copies wherein information regarding the geological detail of the site, summarized observations and test data, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the report shall be submitted by the Contractor in draft form and after the draft report is approved, the final report in four (4) copies shall be submitted. The test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of Corporation.
2.4 PREPARATION

2.4.1 The Contractor shall be responsible for proper levelling of switchyard site as per layout and levels of switchyard finalized during detailed engineering stage. The Contractor at his own cost shall make the layout and levels of all structure, etc.

2.4.2 Site levelling shall be in the scope of the Contractor.

2.4.3 As per contour of the switchyard site, the Contractor shall have to prepare the site by earth cutting or filling as per site condition to arrive at the required F.G.L.

2.5.0 SURFACE PREPARATION AND STONE SPREADING

2.5.1 Apart of anti-weed measures, stone spreading shall be done in the area covered by the earthmat including area extending one (1) meter all around the earth mat provided for switchyard.

2.5.2 Before stone filling, the area shall be thoroughly de-weeded including removal of roots.

2.5.3 A surface course of minimum 100 mm thickness of 20 mm nominal size river pebbles or (single size ungraded) broken stone shall be spread.

2.6 SITE DRAINAGE

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

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

2.6.3 for design of RCC pipes for drains and culverts IS: 456 and IS: 783 shall be followed.
2.6.4 The Contractor shall ensure that water drains are away from the site area and shall prevent damage to adjacent property by this water. Adequate protection shall be given to site surfaces, roads, ditches, culverts, etc., to prevent erosion of material by water.

2.6.5 The drainage system shall be adequate without the use of cable / pipe trenches. (Pipe drains shall be provided in areas of switchyard where movement of crane shall be necessary in operating phase of the substation).

2.6.6 Open surface drains shall be provided with the Cement Concrete 1:2:4 of minimum thickness of 100 mm or more as per design condition.

2.6.7 All internal site drainage system, including the final connection / disposal to Corporation acceptance points shall be part of Supplier’s scope including all required civil work, mechanical and electrical systems. The Contractor shall connect his drain(s) at one or more points to out fall points as feasible at site.

2.6.8 The drainage scheme and associated drawings shall be got approved.

2.7 TRANSFORMER FOUNDATION AND OIL RECOVERY SYSTEM

2.7.1 The Contractor shall provide an oil recovery system for all power transformers containing insulating oil, integrated with the transformer foundations.

2.7.2 The oil recovery system shall be provided in order to avoid spread of fire by the oil, and for environmental protection. Each transformer including oil conservator tank, etc., shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall from the transformer shall be 20% of the transformer height or 0.8 m whichever is more. The oil collection pit thus formed shall have a void volume equal to 125% volume of total oil in the transformer. The grating shall be made of Galvanized MS flat of size 40 mm x 6 mm placed at 30 mm centre to centre and 25 mm x 6 mm GI MS flat at a spacing of 150 mm at right angle to each other. Maximum length of grating shall be 2000 mm and width shall not be more than 500 mm. The gratings, supported on Galvanized ISMB 150 mm, shall be placed at the formation level and shall be covered with 100 mm thick layer of broken / crushed / non-crushed stone having size 35mm to 45 mm.

Each oil collection pit shall be drained towards a sump pit within the collection whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry and clean.
2.7.3 The retaining walls which make up the oil collection pit shall be made of fire resistant material such as reinforced cement concrete, fire brick etc., and shall be impervious to oil. The minimum height of the retaining walls shall be 15 cm above the finished level of the ground to avoid outside water pouring inside. The bottom of the pit shall have a uniform slope towards the sump pit.

2.7.4 Drainage
A device showing level of sump pit shall be provided by Contractor fitted along with the automatic / manual pumping system, which shall have sufficient capacity to evacuate the rainwater from the sump pit. The Contractor may propose other better scheme, if agreed by Corporation. If the heights of the retaining walls, which form the oil collection pit, exceed 60 cm, steps shall be provided to facilitate access to the oil collection pit. When designing the oil collection pit, the movement of the transformer must be taken into account.

2.7.5 Transformers shall be mounted on a rails fitted on top of the foundation for its easy removal from foundation / oil collection pit.

2.8 CABLE TRENCHES AND CABLE TRAYS
2.8.1 Design and construction of cable trenches with pre-cast removal R.C.C cover.
2.8.2 Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12 mm thick 1:6 cement sand mortar.

2.9 FOUNDATION AND RCC CONSTRUCTION
2.9.1 General
2.9.1.1. Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, control cubicles, bus supports, transformer, marshalling kiosks, auxiliary equipment and systems, buildings, tanks, boundary wall or for any other equipment or service and any other foundation required to complete the work.
2.9.1.2. Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification . A minimum grade of
M15 concrete (1:2:4 mix) shall be used for all structural / load bearing members as per latest IS 456.

2.9.1.3. If the site is sloppy, the foundation height shall be adjusted to maintain the exact level of the top of structures to compensate such slopes.

2.9.1.4. The switchyard foundation’s plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

2.9.1.5. Minimum 75 mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches, etc., to provide a base for construction.

2.9.1.6. Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

2.9.1.7. The design and detailing of foundations shall be done based on the approved soil data and subsoil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil / sub-soil conditions and superimposed loads shall be provided.

2.9.2 Design

2.9.2.1. All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-15. Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Corporation.

2.9.2.2. Limit state method of design shall be adopted unless specified otherwise in the specification.

2.9.2.3. For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. TMT bars (Fe-500 N / mm2) conforming to IS: 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade-I) conforming to IS: 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

2.9.2.4. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and or superstructure and other conditions, which produces the maximum stresses in the
foundation or the foundation component and as per the relevant IS Codes of foundation design.

2.9.2.5. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

2.9.2.6. Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental / harmful to the concrete foundations.

2.9.2.7. RCC columns shall be provided with rigid connection at the base.

2.9.2.8. All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

2.9.2.9. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:
   a) Full water pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (application only to structures, which are liable to be filled up with water or any other liquid).
   b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
   c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

2.9.2.10. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

2.9.2.11. The foundations of transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

2.9.2.12. The equipment foundations shall be checked for a factor of safety of 2.0 for normal condition and 1.50 for short circuit condition against sliding, overturning and pull out. The same factors shall be used as partial safety factor overloads in limit state design also.
2.9.3 **Admixtures & Additives**

2.9.3.1. Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

2.9.3.2. Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Corporation shall approve concrete Admixtures / Additives.

2.9.3.3. The Contractor may propose and the Corporation may approve the use of a water-reducing set retarding admixture in some of the concrete. The use of such an admixture shall not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

2.9.3.4. The water reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.

2.9.3.5. The water proofing cement additives shall be used as required / advised by the Corporation.

1.10. **SECURITY FENCING, GATES AND SECURITY BOOTH**

2.10.1 **SECURITY FENCING**

Security fencing shall be made of M.S. angle panels each of 2.5 meter height and 3.0 meter breath with following specification:-

a. Each panel shall consist of ISA 50x50x5 mm M.S. Angles on four sides with one horizontal and one vertical bracing of 50x5 mm M.S. flats welded on both ends. The panels shall have 6 mm dia. M.S. rods @ 12 mm c / c horizontally and vertically, effectively restrained on the M.S. Angle frame with proper welding.

b. Every panel shall have protruding legs of ISA 50x50x5 mm, 75 cm long at both ends for embedment in RCC / CC footings. Angle of every two adjacent panels shall be tack welded and protruding legs of two adjacent panels shall be embedded together in RCC. A50 cm long lean over section both ways made of 50x50x5 mm M.S. Angles with arrangement for fitting 2 (two) lines of barbed wire of 12 swg x 2 plies x 4 points, 15 cm apart.
c. The M.S. panels before erection shall be thoroughly cleaned and painted with one coat of red oxide primer and two coats of synthetic paint.

d. The protruding legs of the panels shall be fixed with RCC column / foundations wall as per design.

e. Half brick wall of 500 mm height shall have to be constructed with 1st class bricks in cement mortar of prop. 1:4 over F.G.L. RCC column foundation, tie beams shall be as per approved drawing, design and site condition. All exposed surfaces of brick wall, RCC structures shall have plaster of cement sand meter of prop.1:4.

2.10.2 Security Gates

a. The Gate frame shall be made of medium duty MS pipe conforming to relevant IS with welded joints.

b. The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.

c. Gates shall be fitted with approved quality iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of pad lock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

d. Gates shall be fitted with galvanized chain hook or gate hold back to hold gates open. Double gates shall be fitted with centre rest and drop bolt to secure gates in closed position

e. Gates shall be installed in locations shown on drawings. Next to the main gate, a men gate (1.50 m wide, single leaf) shall also be provided.

f. Bottom of gates shall be set approximately 40 mm above ground surface and necessary guiding mechanism shall be fitted.

2.10.3 EQUIPMENT ROOM FOR PANELS etc.
Equipment cum Security room shall be provided at the switchyard. The minimum dimension of the room shall be 9.0 m length and 5.6 m width. The roof shall be of CI sheet and aesthetically pleasing. Necessary doors and sliding aluminium windows shall be provided for vigilance all around. Therefore said room shall be complete with lights & fans, paintings etc.

2.11 SUBMISSION
The following information shall be submitted for review and approval to the Corporation as far as Civil Works are concerned:

a) Contour Plan for substation area.

b) Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.

c) Structural design calculations and drawing (including constructions / fabrication) for all reinforced concrete and structural steel structures.

d) Fully, dimensioned concept plan including floor plans, cross-sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.

e) Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.

f) A door and window schedule showing door types and locations, door lock sets and latch and other door hardware.

g) Any other data, drawings and information required to be submitted as per various clauses of the specification. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

2.12 BUS BARS AND BUS BAR SUPPORTS
2.12.1 The bus bars shall be outdoor rigid and strung bus bars with ACSR conductor supported on lattice / pole.
2.12.2 Aluminium IP tubes of adequate current carrying capacity shall be used for main bus. Flexible chord of adequate size is to be used for connection to equipment.

2.13 ACSR CONDUCTORS
2.13.1 The Conductor shall conform to IS: 398 (latest edition) except where otherwise specified here in.

1. Specification to which the finished : IS-398Part-II-1976
2.13.2 The details of the ACSR Zebra and ACSR Panther conductors are tabulated below:

<table>
<thead>
<tr>
<th>Particulars of Aluminium strands</th>
<th>Unit</th>
<th>ACSR 'Panther'</th>
<th>ACSR 'Zebra'</th>
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</thead>
<tbody>
<tr>
<td>i) Diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Standard</td>
<td>mm</td>
<td>3.00</td>
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<td>b) Maximum</td>
<td>mm</td>
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<tr>
<td>c) Minimum</td>
<td>mm</td>
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<td>2.19</td>
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<tr>
<td>ii) Cross sectional area of standard diameter wire</td>
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<td>7.942</td>
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<td>iii) Weight per Km</td>
<td>Kg</td>
<td>19.11</td>
<td>21.47</td>
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<tr>
<td>iv) Minimum breaking load</td>
<td>KN</td>
<td>1.17</td>
<td>1.29</td>
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<tr>
<td>a) Before stranding</td>
<td></td>
<td>1.11</td>
<td>1.23</td>
</tr>
<tr>
<td>b) After stranding</td>
<td></td>
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<td>9.91</td>
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<tr>
<td>v) Maximum D.C. resistance at 200C</td>
<td>Ohm / Km</td>
<td>4.107</td>
<td>3.651</td>
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<tr>
<td>vi) Joints in strands of 12 wire Aluminium layer if any</td>
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<tr>
<th>Particulars of Steel strands</th>
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</tr>
<tr>
<td>a) Standard</td>
<td>mm</td>
<td>3.00</td>
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<tr>
<td>b) Maximum</td>
<td>mm</td>
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<td>c) Minimum</td>
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<td>ii) Cross sectional area of standard diameter wire</td>
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<td>iii) Weight per Km</td>
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<td>61.95</td>
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<td>iv) Minimum breaking load</td>
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<td>10.43</td>
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<td>a) Before stranding</td>
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<tr>
<td>b) After stranding</td>
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</table>

- Conductor conforms
- Purity of Aluminium Rods: 99.5% Minimum
- Percentages of Carbon in steel wire / rods: 0.50 to 0.85 (Preferably 0.65%)
- Purity of Zinc: 99.95%
<table>
<thead>
<tr>
<th>Particulars</th>
<th>ACSR 'Panther'</th>
<th>ACSR 'Zebra'</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Quality of Zinc</td>
<td>99.95% purity</td>
<td>99.95% purity</td>
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<td>b) Process of galvanising</td>
<td>Hot Dip</td>
<td>Hot Dip</td>
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<tr>
<td>c) Minimum weight of coating</td>
<td>gm / m²</td>
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<tr>
<td>d) Minimum no of dips of one minute duration which the strand can withstand (under preace test)</td>
<td>Nos.</td>
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3. Particulars of Complete Conductor

i) Code words, if any
   - ACSR 'Panther'
   - ACSR 'Zebra'

ii) Copper equivalent Area
    - mm²: 310, 260

iii) Nominal aluminium area
     - mm²: 200, 420

iv) Sectional area of aluminium
    - mm²: 212.10, 428.91

v) Total sectional area
    - mm²: 261.50, 484.50

vi) Overall diameter
    - mm: 21.00, 28.62

vii) Stranding, lay and wire diameter
     - a) Aluminium
       - mm: 30 / 3.00 Right / Hand lay
       - mm: 54 / 3.18
     - b) Steel
       - mm: 7 / 3.00
       - mm: 7 / 3.18

viii) Lay ratio
      - Min. / Max.°
      - a) Steel core
        - i) 6 wire Layer
          - Max.: 28
          - Min.: 13
        - b) Aluminium
          - i) 12 Wire 1st Layer
            - Max.: 16
            - Min.: 10
          - ii) 18 Wire 2nd layer
            - Max.: 14
            - Min.: 10
          - iii) 24 Wire 3rd Layer
            - Max.: -
            - Min.: 10
      - x) Approximate calculated breaking load
        - KN: 89.67, 130.32
      - xi) Final modules of Elasticity (Practical)
        - GN / m²: 80 / 69
      - xii) Coefficient of linear expansion
        - Per°C: 17.8 x 10⁻⁶, 193 x 10⁻⁶
      - xiii) Approximate total weight per Km
        - a) Steel Section
          - Kg: 388.00, 437.00
        - b) Aluminium Section
          - Kg: 586.00, 1184.00
        - c) ACSR Composite
          - Kg: 974.00, 1621.00
      - xiv) Calculated D.C. resistance at 20°C (Maximum)
        - Ohm / Km: 0.1390, 0.06885
      - xv) Standard length of conductor (with tolerance, if any)
        - Metres: 1500+5%, 1500+5%
      - xvi) Number of standard length in one reel (drum)
        - Nos: One
      - xvii) Random lengths (Maximum percentage of the lengths ordered)
        - %: 10

2.14 ELECTRICAL CLEARANCES
2.14.1 Following minimum electrical clearances (outdoor) shall be maintained in the switchyard:

### TABLE 1 MINIMUM ELECTRICAL CLEARANCE FOR OUTDOOR SWITCHGEAR

*(Clause 2.1.9)*

<table>
<thead>
<tr>
<th>Voltage Rating (Highest System Voltage)</th>
<th>Impulse Withstand Level*</th>
<th>Minimum Clearance to Earth†</th>
<th>Minimum Clearance Between Phases</th>
<th>Minimum Clearance from any point Where the man may be Required to Stand to the Nearest Unscreened Conductor in Air (Sectional Clearance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>kV (rms)</td>
<td>kV (peak)</td>
<td>mm</td>
<td>mm</td>
<td>Mm</td>
</tr>
<tr>
<td>12</td>
<td>60 (List I)</td>
<td>90</td>
<td>90</td>
<td>2 600</td>
</tr>
<tr>
<td></td>
<td>75 (List II)</td>
<td>120</td>
<td>120</td>
<td>2 600</td>
</tr>
<tr>
<td>36</td>
<td>145 (List I)</td>
<td>—</td>
<td>270</td>
<td>2 750</td>
</tr>
<tr>
<td></td>
<td>170 (List II)</td>
<td>320</td>
<td>320</td>
<td>3 000</td>
</tr>
<tr>
<td>72.5</td>
<td>325</td>
<td>630</td>
<td>630</td>
<td>3 500</td>
</tr>
<tr>
<td>123</td>
<td>450</td>
<td>900</td>
<td>900</td>
<td>3 500</td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>1 100</td>
<td>1 100</td>
<td>4 000</td>
</tr>
<tr>
<td>145</td>
<td>450</td>
<td>900</td>
<td>900</td>
<td>3 500</td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>1 100</td>
<td>1 100</td>
<td>4 000</td>
</tr>
<tr>
<td></td>
<td>650</td>
<td>1 300</td>
<td>1 300</td>
<td>4 000</td>
</tr>
<tr>
<td>245</td>
<td>650</td>
<td>1 300</td>
<td>1 300</td>
<td>4 000</td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>1 500</td>
<td>1 500</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>850</td>
<td>1 600</td>
<td>1 700</td>
<td>4 500</td>
</tr>
<tr>
<td></td>
<td>950</td>
<td>1 900</td>
<td>1 900</td>
<td>4 500</td>
</tr>
<tr>
<td></td>
<td>1 050</td>
<td>2 400</td>
<td>2 100</td>
<td>5 000</td>
</tr>
</tbody>
</table>

* The impulse withstand levels are as given in IS: 2165-1977 Insulation coordination. *(Second revision).* For guidance regarding choice between List I and List II (as in col 2) for rated voltages 12 kV and 36 kV and between levels against higher rated voltages, see IS: 2165-1977.

† The values of minimum clearance to earth are based on Table 6A of IS: 3716-1978 Application guide for insulation coordination.
2.15 EARTHING SYSTEM

2.15.1 Plate / Pipe Type Earthing

Supplying and erecting galvanised cast iron / copper earth plate type / G.I. pipe type earthing with / without C.I. cover as per instructions from the site engineer.

Material

Earth Plate: Galvanised cast iron / Copper earth plate or G.I. pipe as per specifications given in below table.
CI Cover: CI cover as per specification given in below table.
Earthing Conductor: Copper / GI strip / Annealed bare copper wire / GI earth wire of size as per specifications given in below table.
GI Pipe: As per specification (CW-PLB / GP) mentioned chapter no. 17.5 for watering, and as enclosure for Earth wire, refer specifications given below in table.
Hardware: Screw / nut bolts with required washer of dimensions, Rawl plug / clip / ‘U’ nails and material as per specifications given in below table.
Filling material: Coal / Charcoal / salt as per specifications given in below table.
Lugs: As per specification (CB-LG / AL, CB-LG / CU) Aluminium lugs as per specifications given in below table.

Method of construction:
Pit is to be dug of required dimension and depth for the earthing at site, and laying of Galvanised cast iron / Copper earth plate or G.I. pipe shall be as per below table. The earth connection to equipment / switch gear and earthing electrode shall be connected as shown in the diagram and as per IS 3043 amended up to date. The connections shall be made either by strip or double run of earth wire with drilling, welding, riveting, brazing and nut bolting to plate or pipe, where ever required in an approved manner. As far as possible continuous strip shall be used, but where ever jointing of strip is unavoidable, the overlap portion must not be less than 21 / 2 times the width of the strip either welded / brazed / soldered by all sides or 6 inches overlap with two nut bolts / riveting of adequate size with required washer and covered by anti-corrosive paint as per approved jointing practice in the industry and as per directives from site engineer in charge.

<table>
<thead>
<tr>
<th>Detailed Specifications of various types of Earthing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Earthing</td>
</tr>
</tbody>
</table>

Contractor | No. of corrections | SDE | Ex. Er.
<table>
<thead>
<tr>
<th>S.No</th>
<th>Particulars</th>
<th>casting iron earth plate type without C.I cover</th>
<th>earth plate type with C.I cover</th>
<th>cast iron earth plate type with C.I cover</th>
<th>earthing without C.I cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Depth from top of plate Up to Ground level</td>
<td>1.5 m</td>
<td>1.5 m</td>
<td>1.5 m</td>
<td>1.5 m</td>
</tr>
<tr>
<td>2</td>
<td>Size &amp; type of material for pipe / Plate type earthing.</td>
<td>Cast iron earth plate size 60x60x0.6 cms</td>
<td>Copper earth plate size 60x60x0.6 cms</td>
<td>Cast iron earth plate size 60x60x0.6 cms</td>
<td>‘B’ grade G. I. pipe 40mm. dia. 2.5 mtr. Long or 20 mm dia. G. I.Rod</td>
</tr>
<tr>
<td>3</td>
<td>Salt / charcoal</td>
<td>30 Kg. charcoal and salt each</td>
<td>30 Kg. charcoal and salt each</td>
<td>40 Kg. charcoal and salt each</td>
<td>N A</td>
</tr>
<tr>
<td>4</td>
<td>Type of Wire</td>
<td>Double G.I. wire 8 SWG</td>
<td>Double G.I. wire 8 SWG</td>
<td>Double G.I. wire 6SWG</td>
<td>Double G.I. wire 8 SWG</td>
</tr>
<tr>
<td>5</td>
<td>Wire enclosure</td>
<td>12mm. dia. G. I. pipe 2 mtr. Long</td>
<td>12mm. dia. G. I. pipe 2 mtr. Long</td>
<td>12mm. dia. G. I. pipe 2.5 mtr. Long</td>
<td>N A</td>
</tr>
<tr>
<td>6</td>
<td>Nut bolts</td>
<td>12 mm dia. Cadmium / GI</td>
<td>12 mm dia. Cadmium / GI</td>
<td>12 mm dia. Cadmium / GI</td>
<td>N A</td>
</tr>
<tr>
<td>7</td>
<td>Washers</td>
<td>GI</td>
<td>GI</td>
<td>GI</td>
<td>N A</td>
</tr>
<tr>
<td>8</td>
<td>Watering pipe</td>
<td>19mm. dia. G.I. pipe</td>
<td>19mm. dia. G.I. pipe</td>
<td>19mm. dia. G.I. pipe</td>
<td>N A</td>
</tr>
<tr>
<td>9</td>
<td>Lugs</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>funnel</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
2.15.2 Summary of Earthling System

1. Main Earthling Conductor to be buried in ground 75mm x 10 mm MS Flat. as per MSEDCL specifications.

2. Conductor above ground & earthling leads (for equipment) 65mm x 12 mm GI Flat.

3. Conductor above ground & earthling leads (for columns & aux. structures) 65mm x 12 mm GI Flat.

4. Earthling of indoor LT panels, Control panels and outdoor marshalling boxes, MOM boxes, Junction boxes & Lighting Panels etc. 65mm x 12 mm GI Flat.

5. Earth Electrode (earth pit) 150 mm dia, 3000 mm long CI pipe as per MSEDCL specifications.

2.16 PROTECTION AGAINST DIRECT LIGHTNING

2.16.1 Protection against direct lightning shall be provided by lightning masts (SPIKES) and the height of the lightning masts shall be worked out through DSLP calculation. The DSLP design shall be approved by the Corporation.

2.16.2 G.I. wires for shielding shall not be considered in this package.

2.17 INSULATORS AND HARDWARE FITTINGS

2.17.1 General

a) The Contractor shall supply polymer insulators of suspension, tension and post type as required complete with all necessary hardware and accessories, including fittings for fixing insulators to steel structures as required.

b) The polymer insulator shall be sound, free from defects and smoothly glazed.

c) Unless otherwise specified, the glaze shall be brown colour.

d) The design of the insulator shall be such that stress due to expansion and contraction in any part of the insulator shall not lead to deterioration.

e) Pins and caps shall be made of drop forged steel, duly hot dip galvanized as per IS 2629. These shall not be made by jointing, welding, shrink fitting or any other process.

f) Security clips / split pins shall be made of good quality of stainless steel.
g) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings.

h) Post type insulators shall be of solid core type for all voltage classes. These shall be complete with necessary fittings to hold aluminium tubes or acsr conductor as required.

i) The items of hardware and fittings shall make complete assemblies which are necessary for their satisfactory performance. Such parts shall be deemed to be within the scope of this specification.

2.17.2 Disc Insulator Strings

Each insulator string shall consist of following numbers of Disc Insulator units for 33 kV / 11 kV / 433 V OR 33 kV / 6.6 kV, Suspension 3 & 2 Nos, Tension 4 & 3 Nos

2.17.3 Parameters

2.17.3.1. Disc Insulators

a) Type: Ball and Socket
b) Colour: Brown
c) Surface: Glazed
d) Locking Device: W or R type security clip
e) Diameter: 254 mm
f) Size of Pin Ball: 16 mm
g) Creep age Distance (min): 320 mm
h) Electro mechanical Strength: 70 KN
i) Power frequency withstands test voltage: 75 KV Dry: 45 KV Wet
j) Minimum dry Impulse withstand: 125 KV peak Test voltage (+ / - wave)
k) Puncture Voltage: 1.3 X actual dry flash over voltage

2.17.3.2. Post Insulators

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Parameters</th>
<th>33 KV</th>
<th>6.6 KV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Highest system voltage</td>
<td>38 kV</td>
<td>15 kV</td>
</tr>
<tr>
<td>2</td>
<td>Dry one minute power frequency test voltage</td>
<td>85 kV</td>
<td>28 kV</td>
</tr>
<tr>
<td>3</td>
<td>Wet one minute power frequency test voltage</td>
<td>75 kV</td>
<td>28 kV</td>
</tr>
<tr>
<td>4</td>
<td>Impulse voltage withstand test</td>
<td>170 kV</td>
<td>95 kV</td>
</tr>
<tr>
<td>5</td>
<td>Minimum Creep age Distance</td>
<td>1100mm</td>
<td>400mm</td>
</tr>
</tbody>
</table>
CLAMPS, CONNECTORS AND SPACERS

2.18.1 Clamps and connectors shall conform to IS 2121 unless otherwise mentioned hereunder.

2.18.2 Clamps and connectors shall be made of materials listed below:

i) For connecting ACSR: Aluminium alloy casting conforming to designation A 6 of IS: 617

ii) For connecting equipment: Bimetallic connectors made from aluminium alloy Terminals made of copper casting conforming to designation A 6 of IS 617.

iii) For connecting GI Shield wire: Malleable iron casting.

iv) Expansion Connectors: Copper lamination to grade FRTP-2 of IS 191.

v) Bolts, nuts, plain washers: Hot dip galvanized mild steel. And spring washers for items (i), (ii) and (iii).

ILLUMINATION SYSTEM

2.19.1 The Contractor shall design, supply and install illumination system for the entire substation. The average illumination level substation shall be 35 lux.

2.19.2 The lighting system of a particular area whether indoor or outdoor shall be designed such away that uniform illumination level is achieved. In outdoor switchyard illumination shall be aimed as far as possible towards transformers, circuit breakers, isolators etc.

2.19.3 LED cluster type lamps with water tight fitting shall be used for various location of the substation.

2.19.4 Provisions shall be made in the switchyard steel structures for mounting of lamps for switch yard.

STATION SERVICE SUPPLY

2.20.1 A station service transformer of following ratings and specification shall be supplied complete with necessary LT and HT fuses for auxiliary ac power supply requirement of substation.

   a. Type of cooling: ONAN

   b. Normal Voltage Ratio: 33 kV / 0.433 kV or as per design requirement

   c. Rating: 100 kV A
d. Vector Group: Dy11  
e. %age Impedance: 4.5%  
**Note: No negative tolerance is allowed.**
f. Maximum allowable losses:  
1. Maximum Losses at 50% loading: 560 Watts  
2. Maximum Losses at 100% loading: 1820 Watts  
Note: No positive tolerance is permissible. Losses found more than specified shall be penalized as per prevailing practice of MSEDCL.
g. Winding material: Aluminium  
h. Temperature rise limits:  
   (i). Rise of Winding Temperature above ambient: 45°C  
   (ii). Rise of Oil Temperature above ambient: 40°C  
i. Maximum Flux Density at rated voltage at frequency: **1.6 tesla**  
j. Maximum current density: **1.4 Ampere / sq. mm**

**FIRE FIGHTING EQUIPMENT**

2.21.1 All the equipment in the switchyard shall be protected by portable fire extinguisher. These fire extinguishers are to be put at appropriate locations.  
2.21.2 Relevant Indian Standards or equivalent shall govern the Portable fire extinguishers.  
2.21.3 The fire fighting equipment shall consist of following:  
   (i). Carbon Dioxide type fire extinguishers (capacity 3 kg) - 2 nos.  
   (ii). Dry Chemical Powder (DCP) type fire extinguishers (capacity 5 kg) - 2 nos.  
   (iii). Fire Bucket with sand (9 litre) – 4 nos.  
   (iv). Wheel / trolley mounted Dry Chemical Powder (DCP) type fire extinguishers (capacity 25 kg) - 1 nos.  
2.21.4 Necessary fixtures / covered stands / covered shade etc. shall also be provided for safe keeping of the above items.  

**2.22 Furniture & Fixture**
2.22.1 Godrej make 4’ x 2.5’ table with drawer 1 no. Short back with coaster chair 3 (three) and standard computer table with key board rack 1 no. All the furniture shall be of Godrej make.

2.22.2 One 1 KV A UPS with 2 hours power back-up of repute make.

2.23.0 SUBSTATION T & P

2.23.1 Following Tools & Plants of reputed make are in the scope of supply of the Contractor:

1 Chain Pulley Block 2.5T capable of lifting up to ten feet-No 1
2 Tirfur capable of pulling 2.5 Ton load-No 1
3 Hand gloves (to operate 33 KV ) & Boots free size-Set 2
4 Hook Stick (Folding type) resin bond-No 1
5 Tool box

5.1 Pliers of various sizes – 6”, 8”, 12” -Set 1
5.2 Insulated Screw drivers of various size – 6” to 18” -Set 1
5.3 Wire Stripers – 6” -No 2
5.4 Slide wrench – 12” & 18” -Set 2
5.5 Nose Pliers – 6” -No 2
5.6 Ratchet Spanner of various sizes (8 to 42 mm)-Set 1
5.7 Box Spanner – Ring & D-Spanner (6 to 42 mm)-Set 1
6.1 2.5 kV Insulation Tester-No 1
6.2 Digital Millimetre-No 1
6.3 Tongue Tester (Capable of measuring AC & DC current 1Ato 500A and Voltage up to 700V, accuracy 0.5%), earthling rod, ladder, spanner rod, etc.-No 1 Each.
SPECIFICATIONS FOR DESIGN AND FABRICATION OF SUBSTATION STRUCTURES

3.1.0 SCOPE
3.1.1 This section covers the specification for galvanized steel RSJ pole, channel cross arms, bolts & nuts, other accessories etc. for Substations covered under this Bid Document as per MSEDCL / MSETCL specifications.

3.2.0 MATERIALS (As per MSEDCL / MSETCL standard specifications)
3.2.1 Structural Steel:
The structures shall be of structural steel conforming to any of the grade, as appropriate, of IS 2062 (latest edition). Steel conforming IS 8500 may also be used. Medium and high strength structural steels with known properties conforming to any other national or international standards may also be used.
3.2.2 Bolts:
Bolts used shall conform to IS12427 or bolts of property class 4.6 conforming to IS 6639 may also be used. High strength bolts, if used (only with steel conforming to IS 8500) shall conform to property class 8.8 of IS 3757.
3.2.3 Nuts shall conform to IS 1363 (Part 3). The mechanical properties shall conform to property class 4 or 5 as the case may be as specified in IS 1367 (Part 6) except that the proof stress for nuts of property class 5 shall be as given in IS 12427. Nuts to be used with high strength bolts shall conform to IS 6623.
3.2.4 Washers shall conform to IS 2016. Heavy washers shall conform to IS 6610. Spring washers shall conform to type B of IS 3663. Washers to be used with high strength bolts and nuts shall conform to IS 6649.
3.2.5 Galvanization Steel RSJ poles, Structural members, plain and heavy washers shall be galvanized in accordance with the provisions of IS 4759. Spring washers shall be hot dip galvanized as per service grade 4 of IS 4759 or IS 1537.
3.2.6 Other Materials other materials used in the construction of the supporting structures shall conform to appropriate Indian Standards wherever available.

3.3.0 DESIGN PARAMETERS
3.3.1 The design shall be checked for following two loading conditions:
(A) Normal Conditions (all wires intact) under this condition, the loads shall be taken as under:
   (i) Wire Tension: - Maximum Wire tension as specified in Clause 3.3.3.
(ii) Wind Load: - Loads due to 100% Design Wind Pressure (after accounting for drag coefficient and gust factor) on structures, wires, insulators, equipment etc. Design wind pressure shall be as per Clause 3.3.2.

(iii) Short Circuit Forces: Loading due to a 3 phase short circuit current of 25 kA shall be considered for 33 kV subject to minimum of 10% of maximum wire tension as considered in (i) above.

(B) Broken Wire Condition

Under this condition design shall be checked with all wires broken on one side and load shall be as under:

(i) Wire Tension: - Wire tension for intact wires shall be taken as 100% of Clause 3.3.3(A)(i). for broken wires it shall be taken as zero.

(ii) Wind Load:- same wind load as calculated in clause 3.3.3 (a) (ii) shall be considered.

(iii) Short Circuit Forces: - Short circuit forces shall be considered only for intact wires.

(iv) Dead Weight: - Same dead load as calculated in Clause 3.3.3 (A) (IV) shall be considered.

3.3.2 Design Wind Pressure

The design wind pressure for the purpose of this specification shall be taken as per relevant indian code. this wind pressure corresponds to terrain category and reliability level as per is 802(part 1 / section 1).

3.3.3 Wire Tensions

For design purpose tension in each power and shield wires shall be taken as under

A. for Power Conductors

(i) 33 kV switchyard. @6000 N for each Bus Bar conductor and other Jumpers / jack buses.

B. for Shield Wires

(i) 33 kV @6000 N for shield wire between Line gantry@5000 N for shield wires at other Location.

Note: Structures with earth peak shall assume to have four earth wires for design purpose in normal condition.
3.3.4 Spans
Following Spans shall be considered in design of all structures as applicable:

a). Line gantries (structures to terminate lines):
   (i) For 33 kV Switchyard: 5 Meter, wind & weight span.

b). All other Structures
   (i) For 6.6 kV OR 11 KV / 433V Switchyard: 4 Meter, wind & weight span.

3.3.5 Conductors and Shield Wires
A) Following sizes of power conductors if not otherwise specified in the drawings, shall be used for design of structures:
   a) For 33 kV switchyard:
      (i) ACSR ‘PANTHER’ conductor for Main Bus Bars and jumpers between two Segregated Main Bus Bars.

B) For protection against direct lightning G.I. rod of minimum 25 mm shall be considered for all switch yards.

3.4.0 DESIGN DRAWINGS

3.5.0 ACCESSORIES
3.5.1 Step Bolts
3.5.2 Insulator Strings and Conductor Clamps Attachments
   (i) Earth wire Clamps Attachment
      i. Suspension Clamp
      The detailed drawing shall be submitted by the Contractor for Corporation’s approval. The Contractor shall also supply U-bolts, D-shackles wherever required.
      ii. Tension Clamps
      Earth-wire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The contractor shall also supply the U-bolts wherever required and take Corporation's approval for details of the attachments before the mass fabrication.

3.6.0 FABRICATION
3.6.1 Erection mark

3.7.0 GALVANIZING AND PAINTING
3.7.1 Galvanizing of the Pole and various members of the structures shall be done only after all works of sawing, shearing, drilling, filing, bending and matching are completed. Galvanizing shall be done by the hot dip process as recommended in IS: 2629 or other such authoritative international standards and shall produce a smooth, clean and uniform coating of not less than 610 gm. per square meter. The preparation for galvanizing and the galvanizing process must not affect adversely the mechanical properties of the treated materials.

3.7.2 All assembly bolts shall be thoroughly hot dip galvanized after threading. Threads shall be of a depth sufficient to allow for the galvanized coating, which must not be excessive at the root of the threads, so that the nut shall turn easily on the completed bolts without excessive looseness. The nut threads shall not be galvanized, but oiled only.

3.7.3 The outside surface shall be galvanized. Sample of galvanized materials shall be supplied to the galvanizing test set out in IS 729 or other such authoritative international standards.

3.8.0 EARTHING

3.8.1 To keep provision in the Pole / structures for earthling, holes shall be drilled on two diagonally opposite legs of the mounting structures. The holes shall be suitable for bolting 75 mm X 10mm MS strips and shall be such that the lower hole is about 350 mm above the ground level, clear of the concrete muffing, for connecting the earthling strip.

3.9.0 TEST AND TEST CERTIFICATE

3.9.1 Each consignment ready for transportation shall be offered to MSEDCL for inspection before dispatch giving a minimum time of not less than 15 days. Samples of fabricated structure materials shall be subjected to following tests:

- a. Steel: The structural steel shall conform to IS 226 and IS 8500, BS 4360-1068 or ISO / R630 other such authoritative international standards. Manufacturer’s test certificate shall be submitted for all used steel.
- b. Galvanizing: The galvanizing shall be as per IS 2633 or BS 729 other such authoritative international standards. Zinc coating over the galvanized surfaces shall not be less than 610 gm. per square meter.
- c. Bolts and nuts: Manufacturer’s test certificate as per standard practice shall be submitted.
3.9.2 **Test at Contractor's Premises**

3.9.2.1 GI Pole and structures shall be tested at fabricator works as per relevant IS. If any pole or structure is found to be weak or damaged the design should be suitably modified and shall have to re-test.

**TECHNICAL SPECIFICATION FOR POWER TRANSFORMERS**

**4.1.0 SCOPE**

4.1.1. These specifications are intended to cover design, engineering, manufacture, testing / inspection before dispatch, forwarding, packing, transportation to site, insurance (both during transit & storage), storage, erection, supervision, testing and commissioning of 33 kV / 6.6 kV OR 33 kV / 11 kV / 433V step-down on an transformers complete with all accessories / fittings and spare parts as specified herein as per MSEDCL / MSETCL standard specifications.

**4.2.0 BIDDING**

4.2.1. Each Technical Proposal must be accompanied by each of the following information / documents with sufficient details along with other documents and information mentioned elsewhere to enable the purchaser to make an appraisal of the quality and suitability of the material and equipment offered.

(a) Type test certificates of transformer of identical design from a NABL recognized laboratory, preferably at CPRI laboratory. The Type test certificates should not be more than 3 (three) years old. The type rest certificates should also be accompanied by the drawings of equipment tested so that the test certificates can be directly linked to the equipment’s offered. In this regard following points shall also be noted:

(i) Equipment which have not been type tested as above shall not be accepted. A promise or agreement by a Contractor to have the equipment tested after award of a contract is not acceptable.

(b) Type Test reports to be acceptable must relate directly to the equipment offered. Type Test reports for a higher class / rating of equipment are acceptable.
with a commitment from Contractor that the type test shall be performed free of charge on the particular equipment after the award of contract.

(c) Guaranteed and Other Particulars in the standard formats of MSEDCL / MSETCL. The bid should also be accompanied by manufacturer’s literatures and brochures.

4.2.2. Failure to meet the requirement of this Clause 4.2.0 shall render a Bid non-responsive.

4.3 SPECIFIC TECHNICAL REQUIREMENTS (STANDARD CONDITIONS)

i. Rated MVA: 6.3 *(Bidder has to provide 6.3 MVA capacity, 33 kV / 6.6 kV or 33 kV / 11 kV / 433V main transformer)*

ii. Type of cooling: ONAN

iii. Number of Phases: Three

iv. Type of Installation: Outdoor

v. Frequency: 50 Hz.

vi. Cooling medium: Insulating Oil.

vii. Rated Voltage

a) High Voltage Winding: DELTA

b) Low Voltage Winding: STAR

Viii. Highest Continuous System Voltage:

a) High Voltage: 36 KV

b) Low Voltage: 7.2 KV

ix. Method of System Earthling:

a) High voltage: Unearthed

b) Low voltage: Solidly Grounded.

x. Type of tap changer: OFF LOAD

xi. Range of tapping: (+) 3% to (-) 9% in steps of 3%

xii. Neutral terminal to be brought out: On LV Side only.

xiii. Impedance on rated MVA at 75° C: 1.6 MVA *(Without (-) tolerance) 6.25%. 8.35%.*

xiv. Type of Insulation and: 6.6 KV 33 KV Insulation level

a) Type of insulation: Uniform

b) One min. PF withstand: 20 KV 70 KV test voltage (KV RMS)

c) Impulse withstand test: 60 KV 170 KV Voltage (kV p)
xv. a) Winding connection: Delta (HV) Star (LV)
b) Material: Electrolytic Copper
xvi. Vector group: Dyn-11
xvii. Type of cooling: ONAN
xviii. Neutral Earthling: LV neutral shall be solidly earthed by using earth pits.
xix. Terminal Details
a) 33 kV Termination (outdoor): ACSR WOLF conductor
xx. Outdoor Lightning Arrestor mounted on brackets.
b) 6.6 KV Termination: 1C-500 mm2 XLPE cable 2 nos. each

4.3.1. Maximum Temperature rise over an ambient of 50° C
a) Temperature rise of top oil = 40°C (measured by Thermometer)
b) Temperature rise of winding = 45°C (measured by resistance)

4.3.2. Maximum LOSS (without positive tolerance)
a) No-load loss: 2.0KW / 5.4 KW
b) Load Loss at 750°C: 14.0 KW / 33.0 KW

4.3.3. RATING & SERVICES
4.3.4. Over load capacity: As per IS: 6600
4.3.5. NOISE LEVEL AT RATED VOLTAGE & FREQUENCY: As per NEMA PubTR-1.
4.3.6. MARSHALLING BOX:
One sheet steel (3.15mm size) weather proof marshalling box of suitable construction shall be provided. Degree of Protection IP-55.

4.3.7. CAPITALIZATION OF LOSSES AND LIQUIDATED DAMAGES:
The capitalization of guaranteed losses of the transformer shall be calculated and considered while evaluating the bids. The guaranteed values of no load losses and load losses shall be stated in the bid. Liquidated damages shall be applied to successful Contractor for not achieving the quoted guaranteed figures. (See clause 4.13.26).

4.4 PERFORMANCE:
i. Transformer shall be capable of withstanding for three seconds for 25 KA without damage to any external short circuit, with the short circuit MVA available at the terminals.
ii. The maximum flux density in any part of the core and yoke at normal voltage and frequency shall be such that the flux density under 10% over voltage condition shall not exceed 1.60 Tesla. With limiting value as (VI) below.

iii. Transformer shall under exceptional circumstances due to sudden disconnection of load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.

iv. The Transformer may be operated continuously without danger on any particular tapping at the rated MVA ±10% of the voltage corresponding to the tapping.

v. The thermal ability withstand short circuit shall be demonstrated by calculation.

vi. With combined voltage and frequency variation of +10%, the flux density shall not exceed 1.7 Tesla.

4.5 AUXILIARY POWER SUPPLIES:

The following power supplies shall be available at site:

i) AC, 3-Phase, 400 Volts, 50 Hz. Earthed.

ii) AC, 1-Phase, 230 Volts, 50 Hz. Earthed.

iii) 48 V DC

(Only 110 V capacity batteries and battery charger shall be installed at pump house in appropriate Amp-Hour (AH) capacity)

4.6 DRAWINGS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID:

(i) General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.

(ii) Height of centre line of HV and LV connectors of transformers from the rail top level.

(iii) Dimensions of the largest part to be transported.

(iv) GA drawings / details of various types of bushing.

(v) Type test certificates of similar transformers.

(vi) Illustrative & descriptive literature of the Transformer.

(vii) Maintenance and operation Instructions.
4.7 SPARE PARTS:
The mandatory spare parts shall include but not be limited to the following for each rating of transformer.

(i) Bushings:
   a. High Voltage - 1 No.
   b. Low Voltage - 1 No.
   c. Neutral Bushing - 1 No.

(ii) Complete set of gaskets for all - 1 Set openings on the tank requiring gasket.
(iii) Magnetic oil level gauge with low oil - 1 No. level alarm contacts.
(iv) Oil temperature indicator with alarm - 1 No. and trip contacts and maximum reading pointer.
(v) Winding temperature indicator with alarm and trip - 1 No. contacts and maximum reading pointer
(vi) Set of all types of valves comprising one in each type - 1 Set
(vii) Silica gel breather - 1 No.
(viii) Buchholz Relay - 1 No.

Note: The quantities indicated above are for each transformer.

4.8 WARRANTY
4.8.1. The contractor shall be responsible to replace, free of the cost with no transportation and insurance expenses to the purchaser up to the destination of materials specified in schedule of dispatch, the whole or any part of the material which under normal and proper use and maintenance proves defective in material or workmanship within 12 months from the date of commissioning or 18 months from the date of dispatch whichever express earlier, provided the purchaser gives prompt written notice of such defects. Such replacement shall be effected by the contractor with a reasonable time actually required to do so. Contractor’s liability upon the expiration of the period mentioned above shall terminate.

4.8.2. The above provisions shall also actually apply to the material replaced by the contractor under this clause, in case, the same is again found to be defective within 12 months of its replacement / repair.

4.89.0 GUARANTEES
4.9.1. The contracting firm shall guarantee among other things the following:
a) Quality and strength of the material used.
b) Adequate factors of safety for all parts of equipment to withstand the mechanical and on electrical stresses developed therein. These shall be stated in the tender.
c) Suitability of the design and workmanship of the equipment for the conditions envisaged in the specification.
d) Efficiencies, Temperature rise and other performance data on equipment which shall be furnished in the tender.

4.9.2. The Contractor shall be responsible for replacing at site free of cost any part or parts of the equipment that may prove faulty or fail manufacturing defects on one or more of the reasons given in clause 4.8.1 stated above within 5 years commencing from the date of commissioning.

4.9.3. In case of failure of the transformer, the supplier shall take back the faulty transformer from its plinth for repair at their own cost (or replace the transformer with a new transformer) and deliver, at their own cost, unload at the destination sub-station transformer plinth within 45 days, from the date of intimation of defects to the satisfaction of the owner, at free of cost. If the repair/replacement shall not be completed within 45 days, then the supplier shall pay penalty @ 0.5% of the contract price for each calendar week of delay from the end of 45 days from the date of intimation of defects. Also, the Purchaser reserves the right for forfeiture of the total Composite Bank Guarantee and all the Securities, available with MSEDCL, in case the Supplier fails to pay the penalty by one month before the expiry of the guarantee period. Also, this shall be taken as adverse in all future tenders.

4.9.4. The Contractor shall furnish copies of test certificates of materials used for manufacture and also the test certificates of the tests conducted on the equipment after manufacture. The contractor shall also furnish the test certificate of bought out components for approval by the purchaser.

4.10.0 MISCELLANEOUS

i. Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever applicable.

ii. Foundation bolt for wheel locking devices of transformer shall be supplied by the contractor.
4.10.1. **DELIVERY:**
The equipment shall be delivered for Destination.

4.10.2. **CONFLICT IN CLAUSE:**
In case of any conflict between the Specific Technical Requirements and General Technical Requirements, the requirements indicated as Specific Technical Requirement shall prevail over the General Technical Requirements.

4.10.3. **SERVICES AND EQUIPMENT:**
The following is also in the Contractor’s scope of work for turnkey executions.
   
i. Design of soak pit, cable trenches and foundations for transformers and other ground mounted equipment.
   
ii. All civil works.

4.10.4. **SCHEDULES:**
All schedules annexed to the specification, shall be duly filled by the Contractor separately.

4.10.5. **ALTITUDE FACTOR:**
If the equipment is to be installed in the hilly area, necessary correction factors as given in the Indian Standard for oil temperature rise, insulation level etc. shall be applied to the Standard Technical Parameters given above.

4.11.0 **NAME PLATE**
The following plates or an approved combined plate shall be fixed to each transformer Tank at an average height of 1500 mm above the ground level:

   (a) A rating plate bearing the data, specified in IEC60076 Part - I. This place shall also include:

   (i) The short circuit current rating.
   
   (ii) Time factor for each winding measured.
   
   (iii) Measured no load current and no load losses at rated voltage and rated frequency.

   (iv) Measured load losses at 75°C (Normal tap only).
   
   (v) D.C. resistance of each winding at 75°C.
(b) A diagram plate showing in an approved manner, the internal connections and the voltage vector relationship of the several windings, in accordance with IEC 60076 Part-I with the transformer voltage ratio for each tap and, in addition, a plan view of the transformer giving the correct physical relationship of the terminals.
(c) A plate showing the location and function of all valves and air-release cocks or plugs.
(d) Diagram plate, indicating the oil levels in the conservators dependent on the oil temperature.
(f) Loading plan plate, showing transport dimensions and masses. This plate shall also warn the erection staff not to remove any cover, before filling the tank with oil to such a level where the windings are not exposed to the atmosphere. This shall be fixed directly on to the transformer tank and shall not be removed for transport.
(g) Identification plates, alpha-numerical number in an approved manner, for marshalling cabinets, breathers, valves, cocks, accessories etc. (minimum size: 110mm x 50mm) rigidly fastened by rivets on corrosion proof base plates. In addition, the function (description) of the related devices shall be clearly indicated on these plates. The alphanumerical numbers on the identification plates shall be of such a size as to be clearly legible from the floor level.
(h) Plates, showing all control, measuring and monitoring circuits and terminal blocks. These plates shall be rigidly fixed at the inner side of the hinged door of the concerned marshalling kiosk.

4.12.0 GENERAL TECHNICAL REQUIREMENTS
4.12.1. CODES & STANDARDS
i. The design, material, fabrication, manufacture, inspection, testing before dispatch, erection, testing, commissioning and performance of Power Transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment shall be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the contractor of this responsibility.
ii. Transformers shall conform to the current applicable standards (IS & IEC) and codes of practice as specified in **clause no. 4.12.2.**

4.12.2. The equipment, materials and service covered by this specification shall conform to the latest applicable provision of the following standards:

- IS: 5: Colour for ready mixed paints.
- IS335: New Insulating oil for Transformer, Switchgears.
- IS: 1271: Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services.
- IS: 2026 (Part I to IV): Power Transformer.
- IS: 2071: Method of high voltage testing.
- IS: 2099: High Voltage Porcelain Bushing.
- IS: 2147: Degree of protection
- IS: 2705: Current Transformers.
- IS: 3347: Dimensions for porcelain Transformer Bushings.
- IS: 3637: Gas operated relays.
- IS: 3639: Fittings and accessories for power transformers.
- IS: 10028: Code of practice for selection, installation and Maintenance of transformers, Part I, II and III.
- IEC 60076 (Part I-VIII): Power Transformer

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

4.12.3. **DRAWINGS:**

a) The contractor shall furnish, within fifteen days after issuing of letters Award, six copies each of the following drawings / documents incorporating name of project and transformer rating for approval.

i. Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimension, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for unthanking, size of lugs
and eyes, bushingLifting dimensions, clearances between HV and LV terminals and ground, quantity ofInsulating oil etc.

  ii. Foundation plan showing loading on each wheel and jacking points with respect toCentre line of transformer.

  iii. GA drawing / details of bushing and terminal connectors.

  iv. Name plate drawing with terminal marking and connection diagrams.

  v. Wheel locking arrangement drawing.

  vi. Transportation dimension drawings.

  vii. Interconnection diagrams.

  viii. Over fluxing withstand time characteristics of transformer.

  ix. GA drawing of marshalling box.

  x. Control scheme / wiring diagram of marshalling box.

  xi. Technical leaflets of major components and fittings.

  xii. As built drawing of schematic, wiring diagrams etc.

  xiii. Setting of oil temperature indicator, winding temperature indicator.

  xiv. Completed technical data sheets.

  xv. HV / LV conductor bushing.

  xvi. Bushing assembly.

  xvii. Bi-metallic connector for connection to “Wolf” / PANTHER ACSR / AAACConductor / Flexible connectors

  xviii. Radiator type assembly.

b) All drawings / documents, technical data sheets and test certificates / results / calculations shall be furnished.

4.12.4. Any approval given to the detailed drawings by the purchaser shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the purchaser shall be general with overall responsibility with Contractor.

4.12.5. SERVICE CONDITIONS

The equipment has to be designed to suit the following climatic conditions

  i. Maximum temperature of air in shade: 40° C

  ii. Minimum temperature of air in shade: 2° C

  iii. Maximum temperature of air in sun: 45 °C

  iv. Maximum humidity: 99%

  v. Average number of thunder storm days per annum: 45 days.
vi. Maximum rainfall per annum: 3500 mm
vii. Average rainfall per annum: 2280 mm
viii. Wind pressure: 97.8 Kg / M²
ix. Altitude above MSL: 100 M to 1000 M

4.12.6. GUARANTEE FOR TECHNICAL LOSSES
The Contractor shall indicate values of no load losses at rated voltage and frequency at normal tap, load losses and auxiliary losses at rated output, voltage and frequency at normal tap. The Contractor shall indicate Maximum firm losses without tolerance. The no load loss value and no-load current at (-) 90%, (+) 112.5% and 100% of rated voltage and frequency. The load loss values shall also be furnished for operation at Rated frequency and +3% and -9% and taps in addition to normal taps.

4.13.0 DESIGN, STANDARDIZATION AND GENERAL CONSTRUCTION FEATURES.
i. All material used shall be best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.
ii. Similar parts, particularly removable ones, shall be inter-changeable.
iii. Pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be of hot deep galvanized.
iv. Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washers or locknuts.
v. Exposed parts shall not have pockets where water can collect.
vi. Internal design of transformer shall ensure that air is not trapped in any location.
vii. Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated.
viii. Labels, indelibly marked shall be provided for all identifiable accessories like relays, switches, current transformers etc. All label plates shall be of in corroding material.
ix. All internal connections and fastening shall be capable of operating under overloads and over-excitation, allowed as per specified standard without injury.

x. Transformers and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.

xi. No patching, plugging, shimming or other, such means of overcoming defects, Discrepancies or errors shall be accepted.

xii. Schematic Drawing of the wiring, including external cables shall be put under the propane sheet on the inside door of the transformer marshalling box.

4.13.1. CLEANING & PAINTING

i. The Painting details are given as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Surface</th>
<th>Primer coat</th>
<th>Finish coat</th>
<th>Dry Film Thickness</th>
<th>Colour Shade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main tank, pipes, conservator, oil storage tank etc.</td>
<td>(Externalsurface) Shot Blast cleaning SA21 / 2 (ISO 8501-1) Epoxy base zinc primer (60Tm) Aliphatic Poly urethane 2 coats (25Minimum 110Tm Shade No. RAL70328501-1) Tm / coat</td>
<td>Main tank, pipes, conservator, oil storage tank etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main tank, pipes, conservator, oil storage tank etc.</td>
<td>(Internalsurface) Shot Blast cleaning SA21 / 2 (ISO8501-1) Hot oil resistant, non corrosive varnish or paint or epoxy- Minimum 30Tm Glossy white for paint Radiator.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ii. Metal parts not accessible for painting shall be made of corrosion resistant materials.

iii. Interior surfaces of mechanism chambers and marshalling kiosks shall receive three coats of paint after proper cleaning. The final coat shall be of light coloured anti-corrosion paint.

iv. All paints shall be carefully selected to withstand heat, rain and extreme of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

v. In case finish paint chips off or crinkle during transit or installation, the contractor shall arrange for repainting transformer at site at his cost. The paint for repainting shall be supplied by the contractor.

vi. The paint used shall be ISI marked.

vii. The paint work done shall be guaranteed for a minimum period of 5 years from the date of receipt of the equipment.
viii. One coat of additional paint shall be given at site by the purchaser. Supplier shall supply the requisite of paint.

4.13.2. **DETAILED DESCRIPTION:**

a) **Tank**

i. The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction.

ii. Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.

iii. All beams, flanges, lifting lugs, braces and permanent parts attached to the tank, shall be welded and where practicable, they shall be double welded.

iv. The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760 mm of Hg.

v. Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.

vi. All connections, bolted to the tank shall be fitted with suitable gas oil resistant gaskets, made of such a material that no serious deterioration occurs under service conditions. Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness. All gaskets shall be of closed design (without open ends) and shall be of one piece only. Rubber gaskets, used for flange connections of the various oil compartments shall be laid in grooves or in groove-equivalent retainers on both sides of the gaskets throughout their total length. Care shall be taken to secure uniformly distributed mechanical pressure over the gaskets and retainers throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded cork or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.

vii. Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

b) **Tank Cover.**
The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. The gasket should be of nitrile rubber. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rain water. Each tank cover shall be of adequate strength and shall not distort when lifted. Inspection openings shall be provided as necessary to give easy access to bushing, for changing ratio of winding connections or testing the earth connections. Each inspection opening shall be of ample size for the purpose for which it is provided, and at least two openings are at each end of the tank. The tank cover and inspection cover shall be provided with suitable lifting arrangements. The tank cover shall be fitted with pockets for thermometer and for the bulbs of the oil and winding temperature indicators and same should be placed at the centre of the top cover. The thermometer pockets shall be fitted with a captive screw cap to prevent the ingress of water.

4.13.3. UNDER CARRIAGE
i. The transformer tank shall be supported on steel structure with detachable forged steel flanged wheels suitable for moving the transformer completely filled with oil. Rail gauge shall be 1462+0 mm in both directions. Flanged wheels shall be spaced accordingly. Wheels shall be provided with suitable bearings which shall resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

ii. Jacking pads shall be provided on the transformer. It shall be possible to change the direction of the wheels through 90° when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse directions.

iii. Suitable hydraulic jacks (4 nos.) for lifting the transformer shall be supplied by the contractor, for each rating of the transformer.

4.13.4. CORE (MAGNETIC CIRCUIT)
i. The magnetic circuit shall be constructed from high grade cold rolled non-ageing grain oriented silicon steel lamination of M-4 grade or better and thickness should not be more than 0.27 mm.

ii. The primary core material is only to be used. The Contractor should offer the core for inspection and approval by the purchaser or third party Inspection Agency
during the manufacturing stage. Contractor’s call notice for the purpose should be accompanied with the following document as applicable as a proof towards use of Prime Core material.

(a) Invoice of supplier,
(b) Mill’s test certificate.
(c) Packing list,
(d) Bill of loading,
(e) Bill of entry certificate to customs

Core material should be directly procured from either the manufacturer or their accredited marketing organization of repute and not through any agent.

iii. The transformer shall be designed in such a way that the maximum flux density in any part of the core and yoke at rated M.V.A, minimum frequency (48.5 HZ) and highest system voltage shall not exceed 1.6 Tesla. The Contractor shall establish this by calculation as per given format (Annexure-I).

iv. The laminations shall be free of all burns and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

v. Core should be of BOLTLESS type.

vi. The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute.

vii. The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core stack shall not deviate from the vertical plane by more than 25 mm.

viii. All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

ix. The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

x. The core clamping structure shall be designed to minimize eddy current loss.

xi. The framework and clamping arrangements shall be securely earthed.

xii. The core shall be carefully assembled and rigidly clamped to ensure adequate strength.

xiii. Oil ducts shall be provided where necessary to ensure adequate cooling. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.

xiv. The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure
and production of flux component at right angle to the plane of the lamination which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

xv. The construction is to be of ‘core’ type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assembly shall be so fixed in the tank that shifting shall not occur during transport or short circuits.

4.13.5. MAGNETIC CIRCUIT

4.13.5.1. The design of the magnetic circuit shall be such as to avoid static discharges, development of short-circuit paths within itself or to the earthed clamping structure and the production of flux compartments at right angles to the plane of the lamination which may cause local heating.

4.13.5.2. Every care shall be exercised in the selection, treatment and handling of core steel to ensure that as far as is practicable, the lamination are flat and the finally assembled core is free from distortion.

4.13.5.3. The oxide / silicate coating given on the core shall be adequate; however, laminations can be insulated by the manufacturers if considered necessary.

4.13.5.4. Oil ducts shall be provided where necessary to ensure adequate cooling. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts.

4.13.6. MECHANICAL CONSTRUCTION OF CORES

4.13.6.1. All parts of the core shall be of robust design of withstanding any shocks to which they may be subjected during lifting, transport, installation and service.

4.13.6.2. All steel sections used for supporting the core shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding.

4.13.6.3. Any non-magnetic or high resistance alloy shall be of established quality.

4.13.6.4. Adequate lifting lugs shall be provided to enable the core and windings to be lifted.

4.13.6.5. Adequate provision shall be made to prevent movement of the core and winding relative to the tank during transport and installation or while in service.
4.13.6.6. The supporting framework of the copper shade is so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve, or cause trapping of air during failing.

4.13.7. INTERNAL EARTHING

4.13.7.1. EARTHING OF CORE CLAMPING STRUCTURE
   i. All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.
   ii. The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more of the following methods:
      a. By connection through vertical tie-rod to the top structure.
      b. By direct metal to metal contact with the tank base.
      c. By connection to the top structure on the same side of the core as the main earth connection to the tank.

4.13.7.2. EARTHING OF MAGNETIC CIRCUIT.
   i. The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.
   ii. Core clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.

4.13.7.3. SIZE OF EARTHING CONNECTIONS
   i. All earthing connections with the exception of those from the individual coil clamping rings shall have a cross-sectional area of not less 0.2 Sq. cm.

4.13.8. WINDING
   i. All windings shall be made of electrolytic high conductivity copper shall be fully insulated as defined in IS: 2026. All neutral points shall be insulated for the voltage specified in IS: 2026. The winding shall be so designed that all coil assemblies of identical voltage, rating shall be interchangeable.
ii. Current density shall not exceed 2.5A/mm². For HV and LV winding.

iii. Power transformers shall be designed to withstand the impulse test voltages as per IS: 2026.

iv. The transformer shall withstand the power frequency voltage test as per IS: 2026.

v. The winding shall be designed to reduce to a minimum the out-of-balance forces in the transformers at all voltage ratios.

vi. The insulation of transformer winding and connection shall be free from insulating composition leading to soften Ooze out shrink or collapse during service.

vii. The stacks of windings shall receive adequate shrinkage treatment before final assembly.

viii. The coil clamping arrangement and the finished dimensions of any oil ducts shall be such as shall not impede the free circulation of oil through the ducts.

ix. The conductors shall be transposed at sufficient intervals in order to minimize eddy current and equalize the distribution of currents and temperature along the windings.

4.13.9. BRACING OF WINDINGS.

i. The windings and connections of all transformers shall be braced to withstand shocks, which may occur during transport or due to switching and other transient condition during service.

ii. Coil clamping rings, if provided shall be of steel.

iii. Any metal pieces in contact with laminated rings shall be designed and secured that they do not weaken the electrical or the mechanical properties of the wings.

iv. If the transverse winding is built up of section of disc coils, separated by spacers, the clamping arrangements shall be such that equal pressures are applied to all columns of spacers. All such spacers shall be securely located, shall be of suitable material and shall receive adequate shrinkage treatment before assembly.

v. Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

vi. All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.
vii. Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.
viii. Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or the otherwise affected under the operating conditions.
ix. Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which shall seal the coil and prevent evacuation of air and moisture and impregnation by oil.
x. Winding and connections shall be braced to withstand shocks during transport or short circuit.
xi. Permanent current carrying joints in the windings and leads shall be through cold crimping. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitable treated.
xii. Terminals of all windings shall be brought out of the tank through bushings for external connections.
xiii. The completed core and coil assembly shall be dried in vacuum at not more than 0.5 mm of mercury absolute pressure and shall be immediately impregnated with oil after drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum cover or in the transformer tank.
xiv. The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.
xv. Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.
xvi. Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.
xvii. Tapping’s shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of the transformer at all voltage ratio.
4.13.10. **INSULATING OIL.**

i. The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.

ii. The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The Contractor shall quote the price of transformer complete with first filling of oil plus 10% extra. However, the rate of transformer oil in Rupee per litre shall be quoted separately also. The transformer oil shall be supplied in non-returnable drums.

iii. The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

iv. The contractor shall warrant that oil furnished is in accordance with the following specifications.

**Characteristic Requirement Method of Test**

1. Appearance of the oil shall be clear and transparent and free from suspended matter or sediment a representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.

2. Density at 20° C Max 0.89 g / cm² IS: 1448

3. Kinetic Viscosity at 27° C Max 27 CST IS: 1448

4. Interfacial at 27° C Min 0.03 N / m IS: 6104

5. Flesh Point 140° C IS: 1448

6. Pour Point Max. -6° C IS: 1448

7. Neutralization Value (Total Acidity) Max 0.03 mg / KOH / g IS: 335

**Characteristic Requirement Method of Test**

8. Electric Strength (Breakdown Voltage) Min
   
   a. Less than 72.5 KV 40 KV Class
   
   b. 725.5 KV Class 50 KV

9. Dielectric dissipation factor tan-δ at 90° C Max 0.05 IS: 6262

10. Min. specific resistance (resistivity) at 90° C 1 X 1012 ohm cm IS: 6013

11. Oxidation stability
   
   a. Neutralization value after max.
   
   b. Total sludge after oxidation 0.40 mg / KOH / g 0.10% by weight

12. Presence of oxidation inhibitor the oil shall not contain anti-oxidant additives IS: 335

13. Water content Max.
a. Less than 72.5 KV Class25 papIS: 2362

4.13.11. COOLING

For the cooling of transformers of ONAN type, the transformers shall be equipped with natural oil circulation type for the transformer. The transformers shall be capable of giving a continuous output without exceeding the specified temperature rise at least equal to that stated in schedule of requirements with all the artificial cooling out of service.

4.13.12. RADIATORS & VALVES

4.13.12.1. RADIATORS

i. Radiators shall be designed so that all painted surface can be thoroughly cleaned by hand and subsequently.

ii. Radiators shall be designed so as to avoid pockets in which moisture collects and shall withstand the pressure tests. Radiators shall be detachable and shall be provided with machined or ground flanged inlet and outlet branches. Air release plug shall be provided at the top of each radiator for draining and filling.

4.13.12.2. VALVES

i. Valves shall be of forged carbon steel up to 50 mm size and of gun metal or of cast iron bodies with gun metal fittings for sizes above 50 mm. They shall be of full way type with screwed ends and shall be opened by turning counter clock wise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

ii. Each valve shall be provided with an indicator to show the open and closed position and shall be provided with facility for pad locking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Pad locks with duplicate keys shall be supplied along with the valves.

iii. All valves except screwed valves shall be provided with flanges having machined faces drilled to suit the applicable requirements. Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required, the Contractor shall supply the same.

iv. Each transformer shall be provided with following valves on the tank.

   a. Drain valve so located as to completely drain the tank.

   b. Two filter valves on diagonally opposite corners, of 50 mm size.
c. Oil sampling valves not less than 8 mm at top and bottom of main tank
d. One 15 mm air release plug.
e. Valves between radiators and tank.
f. Valve prior to and after the Buchholz Relay.
g. Sludge removal valve at bottom 15 mm.

Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

4.13.13. ACCESSORIES & FITTINGS
4.13.13.1. BUSHINGS

Bushings for 36 KV and below shall be of solid porcelain type. These bushings shall be suitable for bare ACSR conductor connections / Flexible connectors. All bushings shall be equipped with suitable terminals of approved type and size and all external current carrying contact shall be adequate silver plate. All ends as well as tops of the coil shall be brought to terminals. In case of connections required outside the tank, these shall be brought out to their respective terminals through well insulated bushings which shall be detachable and replaceable without disturbing internal connections. Bushings which pass through the cover shall be removable without disturbing the transformer cover.

i. The bushing shall have sufficient insulation to avoid leakage to ground and shall be so located as to provide adequate electrical clearance between bushing and various voltages and between business and grounded parts. The insulation class of the high voltages neutral bushing shall be properly co-ordinate with the insulation class of the neutral of the high voltage winding.

ii. Stresses due to expansion and contraction in any part of the bushing insulator shall not lead to the development of defects. Outdoor insulators and fittings shall be unaffected by atmospheric conditions due to weather, fuses, ozone, acids, dust and rapid changes of air temperature. Any stress shield shall be considered as integral part of the bushing assembly.

iii. Porcelain shall not engage directly with hard metal and where necessary gaskets shall be interposed between the porcelain and the fittings. All porcelain clamping surface in contact with gasket shall be accurately grounded and free from glaze.

iv. Fixing material used shall be of suitable quality and properly applied and shall not enter into chemical action with the metal parts or cause fracture by contraction.
expansion in service. Cement thickness shall be as small and even as possible and proper care shall be taken to centre and locate individual parts correctly during cementing. All porcelain insulators shall be designed to facilitate clearance.

v. Each porcelain bushing or insulator, and paper bushing shall have marked upon it the manufacturer’s identification mark, and such other marks as may be required to assist in the representative selection of batches for the purpose of the sample tests.

vi. Clamps and fittings made of steel or galvanized. The bushing flanges shall not be re-entrant type (shape) which may trap air.

vii. Each bushing shall be so coordinated with the transformer insulation that the flashover shall occur outside the tank.

viii. All porcelain used in bushings shall be of wet process, homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour (brown) and free from blisters, burns and other defects. Porcelain shall be thoroughly vitrified and shall be impervious to moisture.

ix. All bushing shall have puncture strength greater than dry flashover value.

x. Creep age distance shall be kept 27 mm / KV. Bushings may be provided with weather shield.

xi. The Contractor is requested to give the guarantee withstand voltage for the above and also furnish a calibration curve with different settings of the coordination gap to enable the purchaser to decide the actual gap settings. Contractor’s recommendations are also invited to this respect. During spark gap flashover, the arc shall remain away from the housing insulator.

xii. Each terminal (including neutral) shall be distinctly marked and coloured for phase voltage and phase rotation on the primary secondary and tertiary sides in accordance with the diagram of connection supplied with the transformer, the system of marking shall conform IS 2026-1962 amended up to date.

xiii. All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.

xiv. Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.

xv. Bushing shall be designed and tested to comply with the applicable standards.

xvi. Bushings rated for 400A and above shall have non-ferrous flanges and hardware.

xvii. Fittings made of steel or malleable iron shall be galvanized.
xviii. Bushing shall be so located on the transformer that full flashover strength shall be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.

xix. All applicable routine and type tests certificates of the bushings shall be furnished for approval.

xx. Bushings shall be supplied with bimetallic / terminal connectors / clamp suitable for fixing to bush terminal and the PURCHASER’S specified conductors. The connectors / clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 55° C over ambient of 40° C. The connector / clamp shall be designed to be corona free at the maximum rated line to ground voltage.

xxi. Bushing of identical voltage rating shall be inter-changeable.

xxii. Each bushing shall be so coordinated with the transformer insulation that all flashover shall occur out side tank.

4.13.14. PROTECTION & MEASURING DEVICES


a. The conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment’s.

b. The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.

c. The conservator tank shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

d. The conservator tank shall be fitted with flexible diaphragm type.

e. Transformer shall be provided with thermo siphon filters for ratings of 6.3 MVA to prolong the life of the transformer oil. The minimum capacity should be of 2% of total oil volume of the transformer.

f. The conservator should have “Air Cell”.


i. The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the
hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contacts shall be provided.

ii. Unless otherwise approved the relief device shall be mounted on the main tank, and if on the cover shall be fitted with skirt projecting 25 mm inside the tank and of such a design to prevent gas accumulation.

4.13.14.3. **Buchholz Relay**

A double float type Buchholz Relay shall be provided. Size should not be less than 50 mm for 1.6 MVA and 80 mm for 6.3 MVA. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

4.13.14.4. **Temperature Indicator.**

**a. Oil Temperature Indicator (OTI)**

The transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts preferably of mercury. Number of mercury contacts should be minimum of four pairs. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be less than equal to 1% or better.

**b. Winding Temperature Indicator (WTI)**

A device for measuring the hot spot temperature of the winding shall be provided.

It shall comprise the following.

i. Temperature sensing element.

ii. Image Coil.

iii. Auxiliary CTS, if required to match the image coil, shall be furnished and mounted in the local control panel.
iv. 150 mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, one for high winding temperature alarm and one for trip. It should have at least four pairs of mercury contacts.

v. Calibration device.

vi. Accuracy class of WTI shall be ±1% or better.

1. **Oil Preservation Equipment**

**Oil Sealing**

The oil preservation shall be diaphragm type (Air cell) oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

4.13.14.6. **Breather**

Each conservator vessel shall be fitted with a breather in which silica gel is the dehydrating agent and designed so that:

a. The passage of air is through the silica gel.

b. Silica gel is isolated from atmosphere by an oil seal.

c. The external atmosphere is not continuously in contact with the silica gel.

d. The moisture absorption indicated by a change in colour of the tinted crystal can be easily observed from a distance.

e. All breathers shall be mounted approximately 1200 mm above the ground level.

f. Quantity of Silica gel should be of minimum 1Kg for 2000 lit of oil.

4.13.14.7. **Thermo-siphon Filter:**

Thermo-siphon filter shall be fitted for 6.3 MVA rating or above capacity of transformers. To extract the harmful constituents like water, acid etc. from oil, thermo siphon filter of cylindrical shape with perforated steel trays filled with absorbents such as active alumina should be provided.

The filter assembly shall be mounted on the transformer as well as ground supported and connected with pipes and shut off valves. Suitable instructions required to be followed for commissioning, dismantlement and maintenance of filter arrangement, re-generation and storage of the absorbent etc. must be
included in the instrumentation manual. A detailed drawing showing internal arrangement shall be submitted.

The oil & absorbent capacity required in the thermo-siphon filter is as under.

i. Quantity of oil - 2.0% of total oil by weight

ii. Quantity of absorbent - 0.2% to 0.25% of total oil by weight.

4.13.14.8. MARSHALLING BOX

i. Sheet steel of 3.15 mm thick vermin proof, well ventilated and weatherproof marshalling box with watertight hinged and padlocked door of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55.

ii. The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a propane sheet.

iii. The marshalling box shall accommodate the following equipment's:
   a. Temperature indicators.
   b. Control & Protection equipment's.
   c. Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipment except (c) shall be mounted on panels and back of panel wiring shall be used for interconnection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door(s) of the compartment(s) shall be provided with glazed window of adequate size.

iv. To prevent internal condensation, an approved type of metal clad heater with Thermostat shall be provided, controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

v. All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than 450 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress from the cable trench.

4.13.14.9. OFF LOAD TAP CHANGER.
i. The transformers shall be provided with voltage control equipment of the tap changing type on the HV side for HV variation of +3% to (-) 9% in equal 5 steps of 3.0% for varying its effective transformation ratio whilst the transformers are off-load. The tap changing device shall be off circuit type. The tap changing shall be carried out by means of an externally operated tapping switch capable of being located and locked in any required position.

ii. The location of tap changing device shall be such that an operator can very easily change the tap, while standing on the ground without the aid of any climbing platform. A warning plate indicating that switch shall not be operated in “ON” position is to be provided.

iii. The contact resistance between the contact points should be less than 20TW. The manufacturer should show the resistance to the inspector at the time of inspection.

4.13.15 FITTINGS

The following fittings shall be provided on the transformer:

Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.

i. Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.

ii. Prismatic / toughened glass oil level gauge.

iii. Silica gel breather with oil seal and connecting pipe complete first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level

iv. A double float type Buchholz Relay with isolating valve, bleeding pipe and a testing cock, the test cock shall be for suitable for a flexible (pipe connection for checking its operation). A 5 mm dia. Copper pipe shall be connected from the relay test cock to a valve located about 1.25 meters above ground level to facilitate sampling of gas with the transformer in service. Inter connection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired up to transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tankside.
v. Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.

vi. Air release plugs in the top cover.

vii. Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.

viii. Winding temperature (hot spot) indicating device for local mounting complete in all respects.

Winding temperature indicator shall have four sets of contacts to operate at different settings:

a. To provide winding temperature high ‘alarm'

b. To provide temperature too high ‘trip’.

ix. Dial thermometer with pocket for oil temperature indicator with three set of alarm and one set of trip contacts and maximum reading pointer.

x. Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.

xi. Jacking pads.

xii. Protected type mercury / alcohol in glass thermometer and a pocket to house the same.

xiii. Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.

xiv. Top and bottom sampling valves.

xv. Drain valve with pad locking arrangement.

xvi. Rating and connection diagram plate.

xvii. Two numbers tank earthling terminals with associated nuts and bolts for connections to purchaser’s grounding strip. Size of terminal should minimum 40x 40 mm.

xviii. Bi-directional flagged rollers with locking and bolting device.

xix. Marshalling Box (MB)

xx. Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.

xxi. Cooling Accessories:

a. Requisite number of radiators provided with

- One shut off valve on top
- One shut off valve at bottom.
xxii. Oil Preservation Equipment: Air cell, Thermo syphon Filter.

Note: (i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.

(ii) The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

4.13.16 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARDS AND FUSES.

i. Normally no fuses shall be used anywhere. Instead of fuses MCB’s (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.

ii. All wiring connections, terminal boards, fuses, MCB’s and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.

iii. Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.

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

v. All box wiring shall be in accordance with relevant IS. All wiring shall be of stranded copper (48 strands) of 1100 volts grade and size not less than 2.5 sq.mm.

vi. All wires on panels and all multi-core cables shall have ferrules which bear the same number at both ends, as indicated in the relevant drawing.

Vii. at those points of interconnection between the wiring carried out by separate contractors, where a change of number cannot be avoided double ferrules shall
be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

viii. The same ferrule number shall not be used on wires in different circuits on the same panels.

ix. Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesive of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.

x. Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wringingshall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.

xi. All circuits in which the voltage exceeds 125 volts shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.

xii. Terminal board rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.

xiii. Terminal boards shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails.

xiv. All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.

xv. The schematic diagram shall be drawn and fixed under a transparent pros pane sheet on the inner side of the marshalling box cover.

xvi. As a rule, the fuses shall be replaced by Miniature Circuit Breakers (MCBs) in the control and other supplies.

xvii. To avoid condensation in the MB, a space heater shall be provided with an MCB and thermostat.

xviii. Suitable 11 W, CFL light shall be provided in the Marshalling Box for lighting purpose.

4.13.17 **RADIO INTERFERENCE, VIBRATION AND NOISE**

i. Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimize interference with communication
circuits. Transformer noise level, when energized at normal voltage and frequency shall not be more than 5 decibels above the NEMA Standard Publication TR-1.

ii. Every care shall be taken to ensure that the design and manufacture of all transformers and auxiliary plant shall be such as to reduce noise and vibration to the level of that obtained in good modern practice.

4.13.18 **SUPPRESSION OF HARMONICS**
The transformers shall be designed with particular attention to the suppression of harmonic voltage specially the third and fifth, so as to eliminate wave from distortion and from any possibility of high frequency disturbances, inductive effect or of circulating currents between the neutral points at different transforming stations reaching such a magnitude so as to cause interference with communication circuits. For achieving this suppression of harmonics, delta connected stabilizing winding should be avoided.

4.13.19 **CENTRE OF GRAVITY**
The centre of gravity of the assembled transformers shall be low and as near to the vertical centre line as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric relating to track either with or without oil, its location shall be on the outline drawing.

4.13.20 **BOLTS AND NUTS**
i. Steel bolts and nuts exposed to atmosphere with suitable finishes like cadmium plated or zinc plated passivity shall be used for diameter above 6 mm. Brass bolts and nuts of less than 6 mm size shall not be used for electrical connections. Where smaller size is required, stainless steel or phosphor bronze may be used. Sizes and threads shall be as per Indian Standard, wherever available, otherwise equivalent British Standard shall be followed. All nuts and bolts and pins shall be locked in position with exception of those external to the transformer. The bolts shall be fitted in such a manner that in the event of the nut working loose and falling off, the bolts shall remain in position. All bolts, nuts and washers in contact with non-ferrous parts which carry current and are exposed to atmosphere shall be of phosphor bronze, where transfer of current is through bolt. If bolts and nuts are placed that are in accessible by means of ordinary spanner, suitable special spanners shall be provided by the supplier.
4.13.21 FOUNDATION AND FIXING
The transformers shall be provided with complete set of foundation holding down bolts, washers, nuts, plates and other fixtures as may be required and these shall be supplied by the Contractor. These fittings shall be fixed by the purchaser in the foundation, unless otherwise specified as soon as possible after the contract drawings have been approved. Foundations drawings (6 sets) shall be supplied by the contractor well before the dispatch of the equipment.

4.13.22 INSPECTION AND TESTING:
(i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. An indicative of inspection is given under clause 4.13.22.1. This is, however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by the purchaser.
(ii) The contractor shall carry out type tests and routine tests on the transformers.
(iii) The charges for conducting each of type tests shall be indicated separately in the bid.
(iv) The pre-shipment checks shall also be carried out by the contractor.
(v) The requirements on site tests are as listed in these specifications.
(vi) Certified test report and oscillograms shall be furnished to the Purchaser/Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser's evaluations of the test results without any extra charges to the Purchaser. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.
(vii) The Contractor shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the Contractor shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing's.

4.13.22.1 INSPECTION AND TESTING
The Contractor shall carry out a comprehensive stage inspection and testing program during manufacture of the transformer. An indicative of inspection is given under Clause No. 4.13.22.2.

This is, however, not intended to form a comprehensive program as it is contractor’s responsibility to draw up and carry out such a program duly approved by the Corporation.

The inspection and testing shall consist of following:

(i). Inspection and testing at different stages of manufacture.
(ii). All routine and other tests as specified on the transformers and accessories.
(iii). Pre shipment checks as specified.
(iv). Site tests are as listed in hereunder.
(v). The contractor shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the contractor shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing.
(vi). Full details of the proposed methods of testing including connection diagrams shall be submitted by the Contractor for approval at least one month before testing. All tests shall be witnessed by the Corporation.

4.13.22.2. STAGE INSPECTION

a) Tank and Conservator

(i). Inspection of major weld.
(ii). Crack detection of major strength weld seams by dye penetration test.
(iii). Check correct dimensions between wheels, demonstrate turning of wheels, through 900 and further dimensional check
(iv). Leakage test of the conservator.
(v). Measurement of film thickness of:-

- Oil insoluble varnish.
- Zinc chromate paint.
- Finished coat.
(vi). Tank pressure test
(vii). Vacuum test

b) Core
(i). Sample testing of core materials for checking specific loss properties, magnetization characteristics and thickness.

(ii). Check on the quality of varnish if used on the stampings.

(iii). Check on the amount of burrs.

(iv). Visual and dimensional check during assembly stage.

(v). Check on completed core for measurement of iron loss.

(vi). Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

(vii). High voltage test (2 kV for one minute) between core and clamps.

c) Insulating Material

(i). Sample check for physical properties of materials.

(ii). Check for dielectric strength

(iii). Check for the reaction of hot oil on insulating materials.

d) Winding

(i). Sample check on winding conductor for mechanical and electrical conductivity.

(ii). Visual and dimensional checks on conductor for scratches, dent mark etc.

(iii). Sample check on insulating paper for PH value, electric strength.

(iv). Check for the bonding of the insulating paper with conductor.

(v). Check for the reaction of hot oil and insulating paper.

(vi). Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.

(vii). Check for brazed joints wherever applicable.

(viii). Check for absence of short circuit between parallel strands.

e) Checks before Drying Process

(i). Check condition of insulation on the conductor and between the windings.

(ii). Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.

(iii). Check insulating distances between low voltage connections and earth and other parts.

(iv). Insulating test for core earthing.

f) Checks during Drying Process
(ii). Check for completeness of drying.

g) Assembled Transformer
(i). Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
(ii). Jacking test on the assembled Transformer.

h) Oil
All standard tests in accordance with IS: 335 shall be carried out on transformer oil sample before filling in the transformer.

i) Test Reports for bought out items
The contractor shall submit the test reports for all bought out / sub contracted items for approval.
(i). Bucholz relay
(ii). Winding temperature indicators.
(iii). Oil temperature indicators.
(iv). Bushings
(v). Marshalling box
(vi). Air Cell
(vii). Thermo syphon filter
(viii). Off Load Tap changer
(ix). any other item required to complete the works.
Porcelain, bushings, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS. If such equipment is purchased by the contractor on a sub-contract, he shall have them tested to comply with these requirements.

4.13.22.3. FACTORY TESTS
(i). All standards routine tests in accordance IS: 2026 & IEC 60076 shall be carried out.
(ii). Following additional tests shall also be carried out on each transformer as routine test:

   a) Magnetic Circuit Test: Each core shall be tested for 1 minute at 2000 volts.
   b) Measurement of zero-sequence impedances
   c) Measurement of capacitance and tan delta to determine capacitance between winding and earth. Value of Tan (δ) should not be more than 0.5% at 20°C.
   e) Measurement of the harmonics of the no-load current
   f) Oil leakage test on transformer
   g) Magnetic balance test
      a) Measurement of magnetization current at low voltage
      b) Lightning Impulse Test shall be carried out in accordance with IS-2026 on one transformer of each rating.

(iii). Following type tests shall be conducted on the transformer of each rating:

   Temp. Rise test as per IS: 2026 (Part-I). This test shall be carried out at maximum negative tap.

(iv). All auxiliary equipment shall be tested as per the relevant IS & IEC. Test certificates shall be submitted for bought out items.

(v). High voltage with stand test shall be performed on auxiliary equipment and wiring after complete assembly.

4.13.22.4 TANK TESTS

Routine Tests

a) Oil leakage Test:

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS: 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the Corporation, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure...
plus 35 KN / m² whichever is lower, measured at the base of the tank and maintained for one hour.

4.13.22.5 ROUTINE TESTS ON BUSHINGS
The following tests shall be conducted on bushings:

(i) Measurement of creep age distance.
(ii) Dry power frequency test on terminal and tapping.

4.13.22.6. PRE-SHIPMENT CHECK AT MANUFACTURERS WORKS
(i) Check for proper packing and preservation of accessories like radiators, bushings, explosionsvent, dehydrating breather, rollers, bushels relay, control cubicle connecting pipes & conservator etc.
(ii) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.

4.13.22.7. INSPECTION AT SITE
The contractor shall carry out detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below. This is however not intended to form a comprehensive program as it is contractor’s responsibility to draw up and carry out such a program.

(a) RECEIPT AND STORAGE CHECKS

(i) Check and record condition of each package visible parts of the transformers etc. for any damage.

(b) INSTALLATION CHECKS

i) Oil impregnation or drying under vacuum at site shall be done with the transformer and oil at a temperature not exceeding 70°C.
ii) The minimum safe level of oil filling (if different from the Buchholz level) to which the transformer shall be oil filled under vacuum, shall be indicated in the manual.
iii) Procedures for site drying, oil purification, oil filling etc. shall be submitted for approval and complete instructions shall form part of the manual.
iv) The Ultra High Vacuum type oil treatment plant of suitable capacity (preferably 2500 litres per hour) suitable for treatment of oil in EHV class transformer shall be used in order to achieve properties of treated oil.

v) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.

vi) Check the leakage for Air Cell.

vii) Check the whole assembly for tightness, general appearance etc.

4.13.22.8. PRE-COMMISSIONING TESTS

(a) Check the colour of silica gel in silica gel breather.

(b) Check the oil level in the breather housing, conservator tanks, cooling system, etc.

(c) Check the bushing for conformity of connection to the lines etc.

(d) Check for correct operation of all protection devices and alarms:
   i) Buchholz relay.
   ii) Excessive winding temperature.
   iii) Excessive oil temperature.
   iv) Low oil flow.
   v) Low oil level indication...

(e) Check for the adequate protection on the electric circuit supplying the accessories.

(f) Check resistance of all windings on all steps of the tap changer.

(g) Insulation resistance measurement for the following:
   i) Control wiring.
   ii) Main windings.

(h) Check for cleanliness of the transformer and the surroundings.

(i) Continuously observe the transformer operation at no load for 24 hours.

(j) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

(k) Phase out and vector group test.

(l) Ratio test on all taps.

(m) Magnetizing current test.
(n) Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to Corporation for future record.

(o) The following additional checks shall be made:
   i) All oil valves are in correct position closed or opened as required.
   ii) All air pockets are cleared.
   iii) Thermometer pockets are filled with oil.
   iv) Oil is at correct level in the bushing & tank etc.
   v) Earthling connections are made.
   vi) Colour of Silica gel is blue.
   vii) Bushing arcing horn is set correctly and gap distance IS recorded.

4.13.23. DUTY UNDER FAULT CONDITIONS:

(i) Except where modified below, it is to be assumed that the amount of generating plant simultaneously connected is such that normal voltage shall be maintained on one side of any transformer when there is a short circuit between phases or to earth on the other side. Any transformer may be directly connected to an underground or overhead transmission line and switched into and out of service together with its associated transmission line (all transformers shall be capable of with standing according to IS 2026 without damage due to external short circuit between phases).

(ii) The transformer and all its accessories shall be capable of withstanding short circuit current of 25KA for three (3) seconds without damages any external short circuit to earth.

(iii) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding.

(iv) Transformers shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute.

4.13.24. TEST PROCEDURE AND COSTS:

i. The purchaser, at his option, may waive impulse tests provided type test reports of impulsetests carried out on essentially identical units within 3 years in their factory in India are furnished by the manufacturer.
ii. No load losses and exciting current shall be measured at rated voltage, rated frequency and at 90% and 110% of rated voltage, both before and after the lightning impulse tests.

iii. The method of test loading shall be described in the test report for determination of both average and hottest spot temperature. Where the winding temperature equipment is specified, data shall also be included for calibration of hottest spot temperature indicator.

iv. Resistance of each winding of each phase shall be measured at principal and at all the taps and corrected to 75°C.

v. Impedance voltage shall be measured at principal and at all taps, and should be corrected to 75°C.

vi. Certified test report and oscillograms shall be furnished to the Purchaser / Consultants for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the Purchaser’s evaluations of the tests without any extra charges to the Purchaser. Manufacturer’s test certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

vii. The Contractor shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the Contractor shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing.

4.13.25. WITNESSING OF TESTS AND EXCESSIVE LOSSES:

i) The Purchaser and / or his representative or third party nominee reserves the right to witness any or all tests.

ii) The Contractor / manufacturer should submit the details of loss calculation (as per Annexure-II) at the time of bidding. Failing to submit the Annexure – II, the Contractor shall be treated as non-responsive.

iii) The Purchaser reserves the right to reject the Transformer if losses exceed the declared guaranteed losses by more than 20% or if temperature rise of oil and winding exceed the values specified elsewhere.

4.13.25.1 Tests are not required to be performed on bought out equipment like oil actuated relays etc. at the works of the transformer manufacturer. Furnishing test certifications from. The original equipment manufacturers works shall be deemed to be satisfactory evidence. Inspection of tests at the sub-contractor’s works shall be arranged by the supplier wherever required.
4.13.25.2 The purchaser has all the rights to conduct the tests including type tests, at his own cost by an independent agency whenever there is dispute regarding the quality of supply, or interpretation of test results. In the event of failure of transformers in such tests the expenses incurred in testing shall be to the supplier's account. The failed unit shall not be accepted for supply to the purchaser even after repairs.

4.13.25.3 MSEDCL authorized representative shall be present at the time of commissioning of Power Transformer.

4.13.25.4 The Contractor shall mention in his tender the place of manufacture, testing and inspection of the various components of the equipment included in the specification. Authorized representative of the purchaser shall be present at the time of the test and contractor shall provide necessary facilities to them.

4.13.25.5 The purchaser's representatives shall be entitled, at all reasonable times during manufacture, to inspect, examine and test on the contractor's premises the material and workmanship of all equipment to be supplied under this contract and if part of the said equipment is being manufactured on other premises, the contractor shall obtain the purchaser's representatives permission to inspect, examine and test as if the equipment were being manufactured on the contractor's premises. Such inspection, examination and testing shall not release the contractor from any of his obligations under this contract.

4.13.25.6 The contractor shall give the purchaser's representatives one month's notice in writing of the date and the place at which the equipment shall be ready for testing and unless the purchaser's representative shall inspect within the period so indicated, the contractor may proceed with the tests and forward to the purchaser duly certified copies of the test certificates.

4.13.25.7 All the tests detailed in respective sections of these specifications for equipment shall be carried out at the manufacturer's expenses at his works except where agreed to otherwise.

4.13.25.8 If any special test, other than those provided in the contract and the relevant specifications are required by the purchases, whose shall be paid by the purchaser over and above the contract price.

4.13.26 CAPITALISATION OF LOSSES AND LIQUIDATED DAMAGES FOR EXCESSIVE LOSSES:

i) LOSSES:
Transformers with lower losses shall be preferred. The Contractor shall indicate the values of load and no-load losses of the transformer in his bid. He shall indicate whether losses are firm or subject to tolerance. If nothing is indicated regarding tolerance on losses, it shall be considered that losses are subject to tolerance.

ii) CAPITALISATION OF LOSSES:
For total cost evaluation, the capitalized cost of losses shall be taken into account as per the following:

Capitalized cost of Transformer = Initial cost of Transformer + Rs. A x WI + Rs. B x We + Rs. ex Wp

where: WI = Iron loss in KW
A = Rupees for iron loss = Rs 2,37,682.00
WC = Copper loss in KW
B = Rupees for copper loss = Rs 96,974.00
WP = Auxiliary loss in KW
C = Rupees for Aux loss = Rs 95,073.00

The no load loss in KW at the rated voltage and frequency and the load loss in KW at rated voltage, rated frequency, rated output and at 750°C shall be quoted and these figures shall be guaranteed. Penalty shall be applied to the successful Contractor in case he is unable to achieve the quoted guaranteed figures at the following rates:

i) For each KW of excess of no-load loss: Rs. 4,75,364.00
ii) For each KW of excess of load loss: Rs. 1,93,948.00
iii) For each KW of excess of Auxiliary loss: Rs. 1,90,146.00

4.13.27 REJECTION:
The Purchaser may reject any transformer if during tests or service any of the following conditions arise:

i) No load loss exceeds the guaranteed value by 20% or more.
ii) Load loss exceeds the guaranteed value by 20% or more.
iii) Impedance value exceeds the guaranteed value by (\cdot) 10% or more.
iv) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
v) Oil or winding temperature rise exceeds the specified value.
vii) Transformer fails on impulse test.
vii) Transformer fails on power frequency voltage withstand test.
viii) Transformer is proved to have been manufactured not in accordance with the agreed specification.

4.13.28 SPARE PARTS:

4.13.28.1 The Contractor shall quote separately for the following spares.
   a. HT bushing
   b. L T bushing
   c. Neutral bushing
   d. One set of gaskets
   e. One set of thermometers
   f. One oil gauge

4.13.28.2. In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the Purchaser to fabricate or procure spare parts from other sources.

4.13.28.3. In preparing the list of spares, recommended, the Contractor shall clearly indicate nature of spares i.e. 'C' consumable, 'E' for Emergency use and 'S' Susceptible to failure during erection, testing and commissioning. For category 'C' spares, approximate frequency of replacement shall also be indicated.

Required spares shall be ordered at the quoted prices after Engineering drawings have been finalized and released for manufacture and thus ordering time of spares may extend up to the taking over the plant.

4.13.29 INSTRUCTIONS MANUAL:

Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst others, the following particulars:

a) Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.
b) Detailed dimensions, assembly and description of all auxiliaries.
c) Detailed views of the core and winding assembly, winding connections and tapings, tap changer construction etc. These drawings are required for carrying out over hauling operation at site.

d) Salient technical particulars of the transformer.

e) Copies of all final approved drawings.

f) Detailed O&M instructions with periodical check lists and pro-forma etc.

4.13.30 COMPLETENESS OF EQUIPMENT:

a) All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the plant, shall be deemed to be included in the specification and shall be furnished by the contractor without extra charges. The equipment shall be complete in all details, whether such details are mentioned in the specification or not, without any financial liability to the Purchaser under any circumstances.

b) All deviations from this specification shall be separately listed under the requisite schedules, in the absence of which it shall be presumed that all the provisions of the specification are complied with by the Contractor.

4.13.31 TOOLS & TACKLES:

A complete outfit of tools, spanners, gauges, lifting, devices, instruments and all other appliances necessary as convenient for the complete assembly, erection at site, dismantling and maintenance of the plant and equipment covered by the contract, together with suitable racks for holding them, shall be supplied by the contractor.

4.13.32 STORAGE AT SITE

Complete instructions regarding the storage of the equipment at site shall be furnished by the contractor. If, at any time after the arrival of equipment at site, the contractor or his representative desires to draw the attention of the purchaser to the conditions of stores, which in his opinion might affect the state of the equipment stores, he shall do so in writing to the purchaser.

4.13.33 QUALITY ASSURANCE PLAN:
The Contractor shall invariably furnish following information along with his offer, failing which the offer shall be liable for rejection.

(i) Statement giving list of important raw materials, names of Sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw material in presence of Contractor’s representative, copies of test certification.

(ii) Information and copies of test certificates as in (i) above in respect of bought out items.

(iii) List of manufacturing facilities available.

(iv) Level of automation achieved and list of areas where manual processing exists.

(v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspection.

(vi) Special features provided in the equipment to make it maintenance free.

(vii) List of testing equipment’s available with the Contractor for final testing of equipment specified and test plant limitation, if any, vis-a-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in ‘Schedule of Deviations’.

(viii) Name of the raw materials as well as bought-out accessories and the names of sub suppliers selected from those furnished along-with the offer.

(ix) Type test certificates of the raw material and bought out accessories.

(x) Quality Assurance Plan (QAP) withhold points for purchaser’s inspection. The QAP and holdpoints shall be discussed between the purchaser and the supplier before the QAP is finalized. The QAP shall include all the quality checks as stipulated in this specification.

(xi) The supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the fully assembled transformer.

**MAXIMUM FLUX DENSITY AND CORE WEIGHT CALCULATION**

Name of the Contractor: -

Address: -

Type and Grade of Core: -

Thickness [in mm]: -

**Core weight calculation**: -
Core dia [in mm] = Window height [in mm] = Limb centre [in mm] = Weight of core =
[3 x window height + 4 x limb centre + 2 x max. width] x Net iron area x Density
of Core

NB: - 1 specific loss vs. Flux density graph for the type of core lamination to be
used has to be furnished.
2. VA / Kg. Vs. flux density graph for the core lamination to be used has to be
furnished.
3. Any other factor assumed for above calculation to be explained with reasons.

N.B.: The Contractor may use its own method of calculation towards
determination of maximum flux density and weight of the core. But the same shall
be supported with proper plantation and justification.

Place:
Date:

Signature of Contractor
With seal of Company.
ANNEXURE-II

DETAILS OF LOSS CALCULATIONS FOR POWERTRANSFORMER

1.0 Name of the Firm
2.0 Flux density at
   a. 36 / 7.2 KV and 48.5 Hz [Tesla]
   b. 33 kV / 6.6 kV OR 33 / 11 KV / 433 V & 50.0Hz [Tesla]
3.0 Core weight in Kg.
   a. Gross core area [mm²]
   b. Stacking factor.
   c. Net core iron area [mm²] [ii x iii]
4.0 [a] Specific losses [W / Kg.]
   (i) At maximum flux density corresponding to 36 / 7.2 KV and 48.5 Hz.
   (ii) At maximum flux density corresponding to 33 / 11 KV and 50Hz.
[b] Volt ampere / Kg
   (i) At maximum flux density corresponding to 36 / 7.2 KV and 48.5 Hz.
   (ii) At maximum flux density corresponding to 33 kV / 11 KV / 433 V OR
33 kV / 6.6 kV and 50 Hz.
5.0 Calculated / guaranteed iron loss in KW at:-
   (i) Acted voltage and rated frequency
   (ii) Maximum system voltage and lowest system frequency
6.0 Current density [A / Sq. mm] for
   (i) HV
   (ii) Regulating
   (iii) LV
7.0 Conductor size [in mm²]
   a) HV winding
(i) Bare
(ii) Insulated
(iii) No of conductors in parallel

b) Regulating winding
(i) Bare
(ii) Insulated
(iii) No of conductors in parallel

c) L.V. winding
(i) Bare
(ii) Insulated.
(iii) No. of conductors in parallel.

8.0 Copper weight
(i) H.V. windings
(ii) Regulating windings
(iii) LV windings
(iv) For tap connections, star connection and any other [please specify]

(v) Total copper weight = [i] + [ii] + [iii] + [IV]

9.0 L.V. winding resistance in ohms at 75°C / Phase.

10.0 H.V. winding resistance in ohms at 75°C / Phase.
(i) At normal tap position
(ii) At maximum tap position
(iii) At minimum tap position

11.0 Stray losses and eddy current losses [in KW] at 75°C
(i) At normal tap position
(ii) At maximum tap position
(iii) At minimum tap position

12.0 Resistively of copper to be used for winding
13.0 $I^2R$ loss at 75°C
   (i) At normal tap position [in KW]
   (ii) At maximum tap position [in KW]
   (iii) At minimum tap position [in KW]

14.0 Calculated guaranteed copper losses [in KW] at 75°C [$I^2R$ loss + stray losses]
   (i) At normal tap position
   (ii) At maximum tap position
   (iii) At minimum tap position

15.0 Guaranteed cooler loss [in KW]

16.0 Computed / guaranteed total loss in KW at rated voltage and rated frequency
   [Copper loss + cooler loss + Iron loss]
   (i) At normal tap position
   (ii) At maximum tap position
   (iii) At minimum tap position

NB: - 1. Approximate values in weight and losses etc. are not allowed.
2. Tolerance of $+5\%$ in weights may be quoted without any approximation

Place:
Date
Contractor’s name:
Signature, designation, seal
TECHNICAL SPECIFICATION OF 33 kV & 6.6 kV OR 11 kV / 433 VAUTO RECLOSER

5.1.0. SCOPE
The specification covers the design, manufacturing, testing, supply, installation, testing and commissioning of 33 / 11 kV / 433V OR 33 kV / 6.6 kV Un-manned substation made with outdoor pole mounted auto reclose that have programmable protection features and integrated remote operation capability and that are intended for distribution networks at nominal A.C. voltages of 36 / 7.2 kV. Please note that VCB used for Transformers and Capacitor Bank, auto-reclosing feature is not required and it shall be pole mounted type with all protective features as specified (VCB 1600 Amp is to be used as an autocloser circuit breaker. VCB shall be operated on AC / DC supply).
A primary objective of this specification is to foster modularity and a maximum level of Inter-changeability and integration to central HSCADA system by supporting MODBUS / DNP3 / IEC-103 and IEC60870-5-101 / IEC60870-5-104 communications protocols.

5.2.0. APPLICABLE STANDARDS
The following standards contain provisions that, through reference in the text, constitute requirements of this specification at the time of publication the revisions indicated were valid. All standards are subject to review and parties to purchasing agreements based on this specification are encouraged to investigate the possibility of applying the most recent revisions of the Standards listed below.

ANSI / IEEE C37.60-1981: Requirements for overhead, pad mounted, dry vault, and submersible automatic circuit reclosers and fault interrupters for AC systems (RI993)
IEC 60255, Electrical relays
IEC - 607221
IEC 60529:1989, Degrees of protection provided by enclosures (IP Code).
5.3.0 **CLIMATIC CONDITIONS**

The Substation shall be suitable for satisfactorily working under the following climatic conditions:

The switch Switchgears and Auto-re-closers used shall be suitably designed and treated for normal life and satisfactory operation under the hot and hazardous tropical climate conditions and shall be dust and vermin proof. All interior and exterior ferrous surfaces of auto-re-closers and control cabinets shall be manufactured from marine grade stainless steel. All support structures and associated bolts and nuts with these parts, shall be hot-dip galvanized.

5.4.0 **TECHNICAL DATA SHEET FOR AUTO RECLOSER**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Unit Data for No. 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCB</td>
<td>1600 Amp. (Operated on AC / DC Supply)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(VCB type auto closer circuit breakers needs to be installed on both sides of the transformer. Capacitor bank shall be installed in series with motors accommodated at pump house and one set of capacitor bank shall be installed at 33 kV switchyard so as to minimize required for line losses.)</td>
</tr>
<tr>
<td>2</td>
<td>No of poles</td>
<td>3 3 (3 Phase Ganged Unit)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Auto Recloser required is 3 Phase Ganged Unit)</td>
</tr>
<tr>
<td>3</td>
<td>Service Outdoor</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rated System Voltage</td>
<td>33 kV / 11 kV / 433V OR 33 kV / 6.6 kV</td>
</tr>
<tr>
<td>5</td>
<td>Highest System Voltage</td>
<td>kV 38 15.5</td>
</tr>
<tr>
<td>6</td>
<td>System earthing</td>
<td>Solidly earthed System Solidly earthed system</td>
</tr>
<tr>
<td>7</td>
<td>Rated Voltage of AR</td>
<td>kV 36 7.2</td>
</tr>
<tr>
<td>8</td>
<td>Rated Continuous Current Amps</td>
<td>a) For lines 800 630</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. Ambient Temperature 55°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min. Ambient Temperature 2°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. Relative Humidity 100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min. Relative Humidity 56%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Altitude Below 1000 meters above mean sea level.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sl. Particulars Unit Data for No. 33 kV AR / VCB 33 kV / 11 kV / 433 V OR 33 kV / 6.6 kV AR / VCB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) For Transformers 400 630</td>
</tr>
</tbody>
</table>
9 Rated Frequency Hz 50 50
10 Rated Short Circuit breaking current (I) 3secs - symmetrical RMS 25 163 sec 3 sec.
11 Rated Short Circuit making current kA PEAK 2.5*I 2.5*I
12 Interrupting medium Vacuum
13 Insulation medium VCB
14 Closing mechanism LV Solenoid / Spring Solenoid / Spring
15 Opening mechanism Springs
16 Mounting type Single pole Single pole
17 Enclosure 316 grade stainless steel
18 Duty cycle O-1strt-CO-2ndrt-CO-3rdrt-COCOO-1strt-CO-2ndrt-CO-3rdrt-COCO
19 Insulation level
   i) Power Frequency with Stand Voltage kV RMS 70 20
   ii) Impulse withstands Voltage kV Peak 170 11020 Minimum clearances between phases mm 400 375 Minimum clearance between phase to earth400 29521 Minimum Creep age Distance (Total) mm 1100 50022 operating mechanism: Solenoid-Spring / Spring-Solenoid-Spring / Spring

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Particulars</th>
<th>Unit</th>
<th>Data for No. 33 kV AR / VCB</th>
<th>33 kV</th>
<th>11 kV / 433V OR 33 kV</th>
<th>6.6 kV AR / VCB</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>reclosing</td>
<td></td>
<td>three phase</td>
<td>three phase</td>
<td>auto reclosing</td>
<td>auto reclosing</td>
</tr>
<tr>
<td>24</td>
<td>Support structure</td>
<td></td>
<td>Galvanized (Painted / Galvanized)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) Rated voltage of Shunt trip coil & operating range
V. DC 48[50% - 110%] 48 [50% - 110%]
c) Rated voltage of Closing coil & Operating range
V. DC 48 [80% - 110%] 480 [80% - 110%]
d) No. of trip coils No 2 per AR 1 per AR
e) No. of closing coils No 1 per AR 1 per AR
f) Nos of expandable auxiliary I / O contacts & contact rating (Required for transformer & Incomer AR) Nos AMPS 12 I / P+8 O / P(per AR)10 A at 240V AC& 16A at 48V DC 12 I / P+8 I / P (per CB)10 A at 240V AC& 16A at 48V DC
g) Minimum thickness of sheet steel for control cabinet 3 mm
h) Enclosure Protection IP55
25 All other parts (Painted / Galvanized)  
Polyurethane AL 7032(90 microns)  
Polyurethane RAL 7032(90 microns)  
26 Minimum size of control wiring(Copper)Sq. mm 2.5  
27 Protections  

5.5.0. DEFINITIONS AND ABBREVIATIONS  

a) Auto-Reclosers (AR): A mechanical switching device that, after opening, closes automatically after a pre determined time. Several enclosures could occur before lock out.  
b) Cold load pick-up (CLP) feature: A feature that allows modification of the over-current protection characteristics in order to prevent relay mal-operation under conditions of system energisation.  
c) Dead time: The time between the instant that the current is interrupted by the AR and the instant the contact of the AR closes as a result of an automatic reclose operation. [IEC 50-448-04-09]  
d) Definite time lag (DTL) protection element: A protection element with a settable time delay that is constant above the pick-up current setting.  

Bidding Document for Construction of 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV New Unmanned Substations 95 Specifications and Drawings MSEDCL / MSETCL.  
e) Delayed protection operation: The protection functionality enabling delayed circuit-breaker operation, whether this is due to an IDMTL or DTL protection element.  
f) Disc reset time: The time required for the disc of an electro mechanical IDMTL protection relay to turn back to its original position after it has turned to the position where a protection operation was initiated.  
g) Effectively earthed system: An earthed system in which the healthy phase power frequency phase-to-earth over voltages associated with earth faults are limited to 80% of the highest phase-to-phase voltage of the system.  
h) Fast curve protection element: A family of curves with operating times approximately constant (slightly inverse) relative to the multiple of pick-up setting.  
i) Instantaneous protection element: An element with no intentional time delay active above a pre-determined pick-up current setting.
j) Inverse definite minimum time (IDMT) protection element: A protection element the minimum operating time of which is adjustable and is inversely proportional to the fault current.
k) Pole-mounted remote terminal unit (PMRTU): A remote terminal unit that is designed for pole mounting and that operates specific pole-mounted equipment remotely.
l) Rapid protection operation: The protection functionality enabling rapid circuit-breaker operation, whether this is due to an instantaneous, fast curve, or a definite time delay protection element with relatively short definite time delay.
m) Reset time: The time duration after a circuit-breaker close operation for which the measured currents are below a fault detecting level. On the expiry of this time the protection sequence resets.
n) Secure control: A single mechanically non-latching switch that affects one state of a control function only. An example of which is either a non-latching switch or two separate push buttons that effect one state of a control function only in each position. If a control is activated repeatedly it only affects that state and does not change the state of the control.
o) Sensitive earth fault (SEF) relay: A relay that is sensitive to very low earth fault currents and in which the operating settings are for current magnitude and definite time delay.
p) Supervisory: Remote control and indications of an AR or a PMRTU by means of a telecommunications link.
q) Toggled control: A single mechanically non-latching switch / push-button that enables a single control functions on the first operation of the switch / push-button and disables the function on the second operation of the same switch / push button.

Bidding Document for Construction of 33 kV / 11 kV / 433 VOR 33 kV / 6.6 kV. New Unmanned Substations 96 Specifications and Drawings MSEDCL / MSETCL.
r) Zone sequence co-ordination (ZSC): The feature that allows protection devices to maintain sequence co-ordination for combinations of rapid and delayed protection operations.

5.6.0. Mounting

5.6.1. The AR shall be suitable for single pole mounting.
5.6.2. Adequately rated lifting eyes shall be provided and they shall be designed to allow the completely assembled AR (surge arresters fitted) to be lifted without.

5.6.3. Suitable mounting brackets for surge arresters shall be provided on the line side and on the load side of the AR, adjacent to the bushings.

5.6.4. The AR shall be fitted with an external M12 earthling stud, complete with a nut, lock nut and spring washer.

5.6.5. The AR shall have laser cut markings on each bushing marked U1 V1 W1 for the normal line side and U2 V2 W2 for normal load side.

5.6.6. A detailed drawing of the single pole AR mounting arrangement with surge arresters fitted shall be provided. The minimum phase-to-earth clearances shall be as per relevant IS and is to be indicated on the drawing.

5.6.7. The mass of the mounting hardware, the AR and the control cabinet and cable shall be stated in the tender documentation (AR is not to be installed at substation).

5.7.0. Bushings

5.7.1. Terminals

a) For 33 KV AR, the preferred arrangement for bushing is a fully insulated bushing arrangement achieved by using cycle aliphatic epoxy resin bushings and silicone rubber bushing boots together with 3 meters 185 mm2, single core, XLPE insulated aluminium water blocked cable tails to provide a fully insulated bushing arrangement.

b) For 6.6 kV OR 11 kV / 433VAR, the preferred arrangement for bushing is a fully insulated bushing arrangement achieved by using cyclo aliphatic epoxy resin bushings and silicone rubber bushing boots together with 3 meters 300 mm2, single core, XLPE insulated aluminium water blocked cable tails to provide a fully insulated bushing.

5.7.2. Material

The following bushing materials are acceptable:

a) Outdoor Cycle aliphatic epoxy resin and / or Silicone rubber

b) Porcelain bushings and EPDM rubber are not acceptable.

c) Minimum acceptable creep age is 1100 mm for 33 kV AR and 300 mm for 6.6 kV OR 11 kV / 433VAR...
5.8.0. **Finish.**
a) All interior and exterior ferrous surfaces of auto-reclosers and control cabinets shall be manufactured from **316 marine grade stainless steel**. All support structures and associated bolts and nuts with these parts, shall be hot-dip galvanized.

b) Suitable precautions shall be implemented to prevent corrosion due to the use of dissimilar materials.

5.9.0. **Control equipment**

5.9.1. **Control cabinet**
a) Cabinets that house equipment for protection and control shall be mounted independently of the AR.

b) Suitable ultraviolet-resistant cable shall be provided to connect the AR to the control cabinet.

c) It shall be possible to disconnect the cable at the AR while the AR is connected to the power system, without causing damage or mal-operation: care shall be taken that CTs are not open circuited. A robust, multi-pin weather proof connector shall be supplied. The female part of the connector shall be mounted on the AR and the male part shall be mounted on the cable. Preference shall be given to products supplying connectors at both the AR and the control cabinet.

d) Cabinets shall be adequately sealed and dust protected and shall be internally treated to prevent moisture condensation. The degree of protection shall be IP 55.

e) The supplier shall ensure that the equipment housed in the control cabinet can withstand the heating effect of direct solar radiation without causing failure and / or mal-operation. Details shall be provided in the tender documentation.

f) The cabinet shall make provision for bottom entry of three cables. This shall be done with a pre-punched suitable sized diameter holes. The holes shall be suitably blanked off.

g) The cabinet shall be fitted with an external M12 earthling stud with a nut, lock nut and aserrated washer.

h) The door of the cabinet shall be fitted with a robust fastening arrangement that is capable of being secured by a padlock that has a shackle of 8 mm diameter.

i) The cabinet shall be easily removable for workshop repair purposes.

5.9.2. **Electronic control equipment**
5.9.2.1. The controls shall not suffer any damage if one or more poles of the circuit breaker fail to respond to either a trip or a close command.

5.9.2.2. Electronic modules shall perform continuous diagnostic monitoring and shall contain hardware and software watch dog checking.

5.10.0. **Protection characteristics**

5.10.1. **General**

i) The ratio of drop-off current to pick-up current shall be at least 95% for all protection functions.

ii) The E/F and SEF functions shall be equipped with harmonic filtering to prevent operation when harmonics are present in the primary residual earth currents. A low pass filter with:

a) 2nd harmonic rejection $> 6 \, \text{dB}$; and

b) 3rd harmonic rejection $> 50 \, \text{dB}$ shall be supplied. Both the SEF function and its filter shall be described in the tender documentation.

5.10.2. All protection functions, i.e. over-current (O/C), earth fault (E/F) and sensitive earth fault (SEF) shall have elements with characteristics that comply with IEC 255.

5.10.3. The sequence of trip and auto-reclose characteristics for O/C, E/F and SEF shall be programmable to enable:

a) The selection of any combination of the available elements for each trip in the trip-and-reclose sequence; and

b) Separate trip-and-reclose sequences for O/C, E/F and SEF.

5.10.4. In case of IDMTL protection elements the AR shall preferably be provided with a disc reset Timer that simulates the resetting functionality of an upstream electro mechanical induction disc relay by implementing a disc reset timer. The length of the time delay shall preferably be settable to enable to simulate the upstream device (settable between 5s and 20s), however, if a fixed time delay is provided it should be between 4s and 5s.

5.10.5. A zone sequence co-ordination (ZSC) feature shall be provided to ensure trip-close sequence coordination for combinations of rapid and delayed protection operations applied to series AR. ZSC functionality shall be such that:
a) an AR senses the presence of an over-current or earth fault, as well as the clearance of that fault by another device and proceeds to the next protection operation in its own sequence; and
b) It precedes in its sequence of rapid protection operations only, allowing the full number of delayed operations to be executed for in-zone conditions.

5.10.6. Loss of Phase (LOP) protection shall be provided to ensure the protection functionality of AR as below:
a) AR should trip with no auto-reclose in case if there is a loss of voltage on one or two phases on the upstream part of the line. Loss of supply on all three phases shall not generate the protection trip.
b) Facility to turn LOP ON or OFF without affecting other protection functions of the device. Password or other form of access control shall be provided.
c) The parameters of configuration of LOP shall include the voltage level (phase to ground) and time of loss of supply on one or two phases. The voltage level shall be configurable from 5000 to 19000 Volts (for 33 KV) and 5000 to 9000 (for 11 KV) with steps not greater than 250 V. Time range shall be configurable from 1 to 60 sec with steps not greater than 1 sec.

5.10.7. The information about LOP operation in case of the protection trip shall be recorded accordingly it indication of the phase(s) causing the trip of AR. The information about LOP operation shall be easily assessable.
d) Rapid protection operation shall be possible by selecting a fast curve or instantaneous protection element. Co-ordination of the fast curves or instantaneous protection elements between two devices in series shall be possible either by selecting suitable curves from a family or by addition of as electable time increment, typically 0.05s to 3s, in 0.05s steps, or any other acceptable solution.

5.10.8. Long protection operating times associated with fault levels marginally above the pick-up setting of the IDMTL protection element shall be avoided by the provision of a Low Set Definite Time element with the following features:
a) It shall be possible to enable or disable the element. When enabled it shall be active simultaneously as an overlay with all selected elements;
b) The element shall have the same pick-up current setting as the IDMTL element; and

c) The time delay shall be selectable from 2s to 10s, in 1s steps. The time delay shall be independent of any curve manipulation.
5.10.9. A High Set Instantaneous element with a selectable time delay shall be provided, with the following features:

a) It shall be possible to enable or disable the element. When enabled it shall be active simultaneously as an overlay with all selected elements;

b) circuit-breaker lock-out as a result of an operation due to the High Set Instantaneous element shall be selectable;

c) The pick-up setting range of this element shall be at least 100 % to 1500 % of the over current setting and shall be independent of any curve manipulation; and

d) The time delay shall be selectable from instantaneous to 1s, in 0.05 s steps. The time delay shall be independent of any curve manipulation.

5.10.10. A cold load pick-up (CLP) feature shall be provided that allows user selectable modification of protection element characteristics under conditions of system energisation. The CLP function may be provided in one of the following two ways:

a) The instantaneous O / C element and the Low Set Definite Time O / C element could be blocked for the CLP time duration; and

b) The pick-up current setting of the IDMTL O / C element and the Low Set Definite Time O / C element may be modified with a settable factor to increase the pick-up current of these elements for the CLP duration. The instantaneous O / C element should be blocked for this time. This is the preferred method.

The CLP function shall have the following characteristics:

i. the CLP function shall not in any way interfere with any of the other functions' / elements' pick-up current settings except as mentioned above;

ii. the CLP functionality shall be such that the active duration of the CLP is selectable from 0 min to 20 min in 1 min steps; and

iii. The modification factor should be settable from 1 to 2 in steps of 0, 1.

5.11.0. Earth fault function

5.11.1. The earth fault setting range shall detect primary earth fault currents down to 20 A.

5.11.2. Delayed protection operation shall be possible by selecting an IDMTL element with NI, VI or Elcurve, or a definite time protection element with time delay from 0.05s to 10s, in 0.05s steps.

5.11.3. Rapid protection operation shall be possible by selecting a fast curve or instantaneous protection element.
5.11.4. Co-ordination of the fast curves or instantaneous protection elements between two devices in series shall be possible either by selecting suitable curves from a family or by addition of as electable time increment, typically 0.05s to 3s, in 0.05s steps, or any other acceptable solution.

5.11.5. A High Set Instantaneous element with a selectable time delay shall be provided with the following features:

a) It shall be possible to enable or disable the element. When enabled it shall be active simultaneously as an overlay with all selected elements;
b) circuit-breaker lockout as a result of an operation due to the High Set Instantaneous element shall be selectable;
c) The pick-up setting range of this element shall be at least 100% to 1500% of the earth-fault setting and shall be independent of any curve manipulation; and
d) The time delay shall be selectable from 0.05s to 1s, in 0.05s steps. The time delay shall be independent of any curve manipulation.

5.12.0. **Sensitive earth fault (SEF) function**

5.12.1. A primary earth fault current of 4A to 20A in steps not exceeding 1A shall be detectable. Delayed protection operation shall be possible by selecting a definite time protection element with time delay from 3s to 25s, in 1s steps.

5.13.0. **Auto-reclose operation parameters**

5.13.1. The number of sequential trips to reach lockout shall be selectable to be 1, 2, 3 or 4.

5.13.2. Reset times shall ideally be separately selectable for SEF and the combination of over current and earth fault functions. The reset time shall be selectable from 5s to 120s in 1s steps.

5.13.3. Dead times shall ideally be separately selectable for SEF and the combination of over-current and earth fault functions. The dead time between each successive enclosure shall be independently selectable from instantaneous to 5s for the first enclosure and from a minimum of 2s up to a maximum of 120s for subsequent enclosures.

5.13.4. A close instruction initiated locally or remotely during a dead time shall result in lockout if the fault is still present upon closure.

5.14.0. **Statistical measurement functions**
5.14.1. The characteristics of the statistical measurement functions shall be as follows

5.14.2. Measurement shall be done with three-phase-4-wire method.

5.14.3. Quantities to be measured / calculated with class 0.5 accuracy are:
   a) r.m.s. phase-to-phase and phase-to-neutral voltage of all three phases:
   b) r.m.s current per phase
   c) Three phase active power in kW
   d) Three phase reactive power in kVARs
   e) Total three-phase active energy in kWh
   f) Power factor
   g) Maximum demand
   h) Harmonic analysis
   i) Wave form capture
   j) Fault stimulator

5.14.4. The real power energy, reactive energy and apparent energy measurement should be cumulative. While maximum demand measurement shall be integrated with respect to time. With selectable time integration periods of 5 min, 15 min, 30 min or 60 min. The data buffer shall work on the FIFO principle and a minimum size for the data buffer shall store values for 4 months.

5.14.5. The voltage factor of the voltage transformers shall be a minimum of 1.9 for 8 hours.

5.14.6. CB and Control element shall have the facilities to record the number and duration of outages. The information shall be assessable locally or remotely using SCADA system. The following parameters shall be recorded:
   a) Cumulative total number of outages
   b) Cumulative total outage duration
   c) Time and duration of each outage.

5.15.0. Local control and indication:

5.15.1. All local controls and indications shall be accessible in adverse weather condition.

5.15.2. The AR shall be provided with external levers to permit manual operation, using an insulated operating stick, to open, close, lock-out and reset the AR from ground level. Where these operations can be performed at the control cabinet, it
shall only be necessary to provide a mechanical means to open and lockout the circuit breaker using an insulated operating stick.

5.15.3. The AR status shall be clearly visible from ground level. “Opened” shall be indicated with a green “O”. “Closed” shall be indicated by a red “I”. Alternative indications shall be subject to approval by the purchaser.

5.15.4. Pressure relief facilities shall be provided to enable the AR to withstand safely the effects of excessive pressure rise due to an internal fault.

5.15.5. Malfunction of the AR shall not pose a safety hazard to the operator due to the recoil or back lash of items such as external operating rods, ranks and levers.

5.15.6. Easily available (i.e. maximum of one keystroke) local indication of protection operation shall be provided for at least the last operation of the AR. The function, phase involved and the current magnitude shall be indicated.

5.15.7. Switches used for local control shall offer the type of control described in table 1 i.e. secure or toggled control. Electronic keypad controls shall offer ‘quick key’ (maximum of one keystroke) access to the controls in table 1 if not implemented with switches.

5.15.8. ARs using VCB, as an arc extinguishing / Insulating medium shall:

a) Provide a low gas pressure indication at a gas pressure that enables safe operation of the AR

b) Prevent closing of the AR after it has opened under the above-described condition

c) Be provided with a method of inhibiting any operation of the AR in the event of the gas pressure dropping below a safe pressure.

5.17.0. Local Engineering

5.17.1. The AR controller shall contain a real time clock (with leap year support) that can be set both locally and remotely. It shall be possible to synchronize the clock with the control HSCADA centre, using the time synchronizing standards (IEC-101 / IEC-104 or SNTP protocol.

5.17.2. A facility for selecting all the protection, operating and communications characteristics shall be locally available in the control cabinet. Optional password protection against unauthorized changes shall be available.

5.17.3. Non-Volatile memory storage shall be sized to store the following minimum data:

5.17.4. All operating, protection and communications parameters.
5.17.5. An event record containing at least 3000 events (a protection event is defined as all operations in a sequence until successful sequence reset or lockout). The actual number available shall be stated in the tender documentation.

5.17.6. Refer to clause 5.14.4

5.17.7. Maximum demand information Maximum demand shall have the facilities to be configured for weekly or monthly demand.

5.17.8. A pointer shall be provided to indicate up to where the data was last read. This shall enable regular uploading of the data without re-loading of previously read data...

5.17.9. All events shall be time and date stamped with a resolution of at least 10 ms relative to the on board real time clock.

5.18.0. Tele-control requirements

5.18.1. The AR controller shall detect and report disconnection of the control cable between the controller and AR.

5.18.2. It shall be possible to operate AR, change the active protection group, turn Auto-Re-closers capabilities ON / OFF and turn E / F and SEF ON / OFF remotely using the protocol specified in

5.19.0. Communications

5.19.1. Communication Overview


5.19.1.2. A local control room in the substation shall have all the controls of switchgear from local PCfor the Local & Remote control, monitoring and adjustments software solutions shall be provided to carry out following tasks as minimum

- ON / OFF Operations
- Change the protection and control settings
- Up-Load the Event / Data and Demand Log
- Monitor Contact wear and Breaker health
- Monitor VCB Battery and Battery Charger
- Communications settings
- Apply Work-Tags for maintenance
• Call-out configuration (In the event of pre-programmed alarm for call-out, the device call-backs the remote station to log the alarm)

• Send messages to the concerned field staff, in case of a call-out, by means of SMS, Voice Call, E-Mail etc. (Depending on the local resources available, GSM Service, LAN Administrator etc.)

(HSCADA is required for AR and complete substation)

5.19.1.3. Event Logging, configured History & Demand Reports
The system is capable of logging very comprehensive data in three different categories.

a) Event Logging
This log should have all the events observed by the device including ON / OFF operation, Local commands, protection element pick-up and trip, change of settings, Aux supply, fault level (Interrupted current values) Battery low etc.

b) Demand Logging
Should upload from the devices all records of weekly and monthly demand, which can be uploaded by the software from any remote location and used for analysis of load behaviour on each feeder including the total no of outages and duration of outages

c) Configured History
Should be able to up-load recorded user defined parameters periodically at user defined frequency i.e. 15 / 30 / 60 min. This data can be up-loaded from local or remote software

d) Alarms / Call-outs
There are several types of alarms that can be configured to initiate an emergency call-out. If any of the user defined alarm occurs in any of the substation feeders, the device immediately calls up the Remote Control Centre which in turn initiates an alert system by sending SMS messages, Pre-recorded Voice Messages and E-Mails etc. to user configured locations

e) Provision for GPRS Routers with built-in Modbus / IEC Gateways for data transmission, connecting cords / cables, antenna etc. shall be kept. The utility in its discretion may also ask for commissioning and training / handholding, trouble shooting from the supplier
f) Computer System the firm shall also offer a Xeon Server and a node of the good quality suitable computer system (IBM, HP or Dell make) with latest configurations

g) Specification of Server
a. Industrial grade processor with advance configuration
B. 3.2 GHz or higher speed
C. 2 MB or higher L2 ECC Cache
d. Ultra-fast Through out with 800 MHz FSB
e. 4 GB of DDR2 RAM operating at 400 MHz or higher expendable up to 16GB
f. Server works / Intel server class chipset
g. 3x73 GB Ultra Wide SCSI-III Disk (15000rpm) Hot Swap
h. Dual Channel Ultra-III SCSI Controller (320MBPS) with RAID (0, 1, 5) having 128MB RAM
i. Minimum 5 PCI / PCI-X Slot
j. Auto-sensing full duplex 10 / 100 / 1000 MBPS Ethernet Card
k. Minimum 6 Hot Swap 1.0" drive bays & two 5.25" bays free
l. DVD Writer
m. 17" LCD Colour Monitor
n. 1.44MB FDD
o. PS / 2 104Keys Keyboard
p. Server Management features
q. Server Configuration and Software Loading Facility
r. Windows 2000 / 2003 Server
s. UPS 2 KV A battery with 3 hrs Backup
t. GSM Modem for SMS
u. Multimedia Speakers for alarm annunciation
h) Specification of Laptop
a) HP / Dell
b) Windows 7
c) Intel Core 2 Duo, 300 GB HDD, 1 GB RAM, DVD R / W
d) Internal Modem
The firm shall also offer Computer room furniture (two computer desks & six chairs) of reputed make and ACs of standard make to be installed, at Central Stations.
5.19.1.4. As a minimum, following independent communication ports shall be provided, that allow for Simultaneous operation
1. RS 232 (Configurable for Mudbugs, DNP3, IEC 101
2. RS 485 (Configurable for Modbus, DNP3, IEC 101
3. Ethernet. (Configurable for IEC 104)
4. USB Port for Local connection of Laptop PC
5.19.1.5. To upload the non-volatile data to and from a personal computer. The requirements of the personal computer shall be stated in the tender documentation.
5.19.1.6. To interface to remote communications equipment (e.g. GSM / CDMA / GPRS / PSTN modems, radio-modems and Fibre Optic Modems).
5.19.1.7. One of the RS-232 ports shall support full asynchronous V.24 functionality.
5.19.1.8. The protocol to be supported by the AR controller for remote communications shall be as follows:
   a) Support of IEC 870-5-101 & IEC 870-5-104 protocol for Remote SCADA
   b) MODBUS protocol over RS 485 to communicate with the External Numerical Relays / Energy meters / RTCC Panels the communication interface should be designed in such a way that the RTU can communicate both local remote station as well as SCADA... The controller should include on board RTU and a radio power supply user programmable between 5-15 V dc and rated for 3 A continuous, or 5 A for 30 seconds with a 20 % duty cycle.

5.20.0. Power supplies
5.20.1. The AR system shall provide power for the electronics, operation of the AR and operation of the communications equipment (e.g. radio or GSM-modem).
5.20.2. Primary supply: Preference shall be given to the ability to obtain primary power directly from the HV power system requiring no additional primary supply connection.
5.20.3. Test supply: The AR shall accept an external AC 230 V 50 Hz supply.
5.20.4. Auxiliary supply: An auxiliary supply with the following minimum characteristics shall be provided
5.20.5. One battery and constant voltage charger with current limiting shall be part of the AR. Battery stand by time shall not be less than 24 h, allowing for ten AR
operations and a Transmit: Receive: Standby duty cycle of 5:5:90 from a 5 W output ratio. The battery shall recharge to 80% of its capacity in a maximum of 15 h. The total number of circuit-breaker operations under the above communications scenario shall be at least 10 AR operations preventing closing if the battery shall not have enough stored energy to open the circuit-breaker for a protection trip condition. Details shall be stated in the tender documentation.

5.20.6. Batteries shall be disconnected at the manufacturer's specified minimum voltage.

5.20.7. Battery Low' indication shall be available locally and remotely and shall include a battery test. The indication of "Battery Low" status shall allow for a further ten AR operations.

5.20.8. The minimum battery life expectancy shall be 5 years. Details of the guaranteed life expectancy of the battery shall be stated in the tender documentation.

5.21.0. Maintenance and commissioning

All the communications equipment shall be easily accessible in the control cabinet. Wiring of "communications links in the control cabinet shall permit the connection of a temporary protocol-Monitor. It shall be possible to perform secondary injection testing while the AR is communicating with the centre.

5.21.1. It shall be Possible to disconnect the AR circuit breaker and connect a simulated breaker to the control cabinet for testing purposes.

5.21.2. The AR shall not malfunction while the radio is transmitting via an antenna in close proximity and the control cabinet door is open.

5.21.3. Provision shall be made in the control cabinet for individually isolating the power supply to/from the following:
   a) Battery;
   b) Battery charger;
   c) Radio; and
   d) Primary supply to the control cabinet electronics.

5.22.0. Rating plate

Each AR shall bear a rating plate of an intrinsically corrosion-resistant material, indelibly marked with the sea-level rating for which the equipment has been type tested. The rating plate shall be indelibly marked with:
a. the manufacturer's name;
b. the equipment type designation and serial number of the AR;
c. the mass, in kilograms;
d. the date of manufacture;
e. the voltage transformer ratio, class and burden.
f. auxiliary supply voltage (if applicable); and

5.23.0. **Additional information**
The following shall be submitted with the tender.

5.23.1. Circuit breaker details
a) manufacturer;
b) Type designation;
c) Place of manufacture;
d) Short circuit breaking capacity; 3s 1s
e) Asymmetrical breaking current;
f) Peak making current; and
g) Critical current (maximum instantaneous peak).

5.23.2. A schematic-wiring diagram of the AR offered.

5.23.3. A general-arrangement drawing of the AR offered.

5.23.4. Details of the maintenance and operating equipment and procedures needed and a detailed parts list of the various components.

5.23.5. A description of the AR operation, with instruction and maintenance manuals, including maintenance schedules, protection characteristics, communications facilities, the method of applying settings to relays and controls, together with any software required and the cost thereof. The software requirements shall be stated in the tender documentation.

5.23.6. A list of recommended spares and tools, quoting the prices of each item and its availability.

5.23.7. Details of technical back-up facilities available. These details shall be stated in the tender documentation.

5.23.8. Details of the class, ratio(s) and burden of the protection current transformer and voltage transformer, if supplied, shall be stated in the tender documentation.

5.23.9. Where applicable details of the low gas pressure alarm / lock-out philosophy;
5.23.10. Details of AR service history:
a) How many in service, where and for what period; and
b) Contact names and numbers.
5.23.11. Details of LV trip / close coil if available as an option
5.23.12. Power requirements for a close operation
5.23.13. The maximum achievable separation between the control unit and the circuit breaker.
5.23.14. Full details of the protocol implementation and the complete point database.

5.24.0. TESTS
5.24.1. Type tests
a) The AR shall have been type tested in accordance with, and found to comply with, therequirements of either IEC 62271 or ANSI / IEEE C37.60-1981 for the following, and the appropriate values shall be stated in the tender documentation:
b) Interrupting performance (automatic operation).
c) Interrupting performance (manual operation).
d) Operating duty.
e) Making current.
f) Minimum tripping current.
g) Insulation (dielectric tests).
h) Radio interference voltage.
i) Temperature rise.
j) Mechanical operations.
k) Control equipment surge withstand capability.

5.24.2. The control cabinet and associated electronics shall have been type tested in accordance withUNIPEDE NORM (SPEC) 13 (1995): Automation and Control Apparatus for Generating Stationsand Substations: Electromagnetic Compatibility Immunity Requirements. The environment shallbe considered as failing in the HV substation category, according to NORM (SPEC) 13.

5.24.3. Test records (on identical equipment) in the form of validated copies of test certificates issuedby a recognized testing authority shall be submitted with the tender documentation.
5.24.4. Routine tests
Routine tests, as required in the relevant standards, shall be carried out as a normal requirement of the contract and, unless otherwise agreed upon, shall be witnessed by the Corporation or by his appointed representative. No additional charge is applicable for such tests or for the production or presentation of documentation related to routine tests.
A duplicate copy of routine test certificates shall be supplied together with the equipment when the latter is delivered to the final destination stated in the order.

5.25.0. PACKING / DOCUMENTATION
5.25.1. Packing
All equipment shall be carefully packed to prevent damage or deterioration during normal transportation, handling and storage.
Each container shall bear the following information on the outside of the container:
a) The address of the destination
b) The gross mass, in kilograms
c) The name of the manufacturer
d) The purchaser's order number and port of destination

5.26.0. Documentation
Each AR shall be supplied complete with the documentation specified in Items as per clause 5.23.1, 5.23.2, 5.23.3 And 5.23.4, together with the routine test certificates specified in clause 5.24.4.

5.27.0. SPECIAL TOOLS AND TACKLES
5.27.1. The Contractor shall furnish a list of any special tools and tackles required for maintenance and operation purposes with recommended quantities for each substation.
TECHNICAL SPECIFICATIONS OF OUTDOOR CURRENT AND POTENTIAL TRANSFORMERS

6.1.0. SCOPE OF CONTRACT
6.1.1. This Section of the Specification covers general requirements for design, engineering, manufacture, assembly and testing at manufacturer's works of 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV outdoor Current and Potential Transformers as per MSEDCL / MSETCL standard specifications.

6.2.0. STANDARDS
6.2.1. The equipment covered by this specification shall, unless otherwise stated be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory authorities.
6.2.2. In case of any conflict between the Standards and this specification, this specification shall govern.
6.2.3. The current transformer shall comply also with the latest issue of the following Indian standard.
   (i) IS: 2705(Part-I) Current transformers: General requirement.
   (ii) IS: 2705(Part-II) Current transformers: Measuring Current transformers
   (iii) IS: 2705(Part-III) Current transformers: Protective Current transformers
   (iv) IS: 2705(Part-IV) Current transformers: Protective Current transformers for Special purpose application.
   (v) IS: 3156(Part-I) Potential transformers: General requirement.
   (vi) IS: 3156 (Part-II) Potential transformers: Measuring Potential transformers
   (vii) IS: 3156 (Part-III) Potential transformers: Protective Potential transformers

6.3.0. GENERAL REQUIREMENTS
6.3.1. The cores of the instrument transformers shall be of high grade, non-aging CRC steel of low hysteresis loss and high permeability.
6.3.2. Instrument transformers shall be of Dead Tank design or Live Tank design.
6.3.3. The instrument transformers shall be truly hermetically sealed polycrrete type
6.3.4. A complete leak proof secondary terminal arrangement shall be provided with each instrument
Transformers, secondary terminal shall be brought into weather, dust and vermin proof terminal Box. Secondary terminal boxes shall be provided with facilities for easy earthing, shorting, insulating and testing of secondary circuits. The terminal boxes shall be suitable for connection of control cable gland.

6.3.5. All instrument transformers shall be of single phase unit.
6.3.6. The instrument transformers shall be so designed to withstand the effects of temperature, windload, short circuit conditions and other adverse conditions.
6.3.7. All similar parts, particularly removable ones, shall be interchangeable with one another.
6.3.8. All cable ferrules, lugs, tags, etc. required for identification and cabling shall be supplied complete for speedy erection and commissioning as per approved schematics.
6.3.9. The instrument transformers shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics.
6.3.10. All steel work shall be degreased, pickled and phosphate and then applied with two coats of Zinc Chromate primer and two coats of polyurethane paint.

6.4.0. COMMON MARSHALLING BOXES
6.4.1. The outdoor type common marshalling boxes shall conform to the latest edition of IS 5039 and other general requirements specified hereunder.
6.4.2. The common marshalling boxes shall be suitable for mounting on the steel mounting structures of the instrument transformers.
6.4.3. One common marshalling box shall be supplied with each set of instrument transformers. The marshalling box shall be made of sheet steel and weather proof. The thickness of sheet steel used shall be not less than 3.0 mm. It is intended to bring all the secondary terminals to the common marshalling.
6.4.4. The enclosures of the common marshalling boxes shall provide a degree of protection of not less than IP 55 (As per IS 2147).
6.4.5. The common marshalling boxes shall be provided with double hinged front doors with pad locking arrangement. All doors and removable covers and plates shall be sealed all around with neoprene gaskets or similar arrangement.
6.4.6. Each marshalling box shall be fitted with terminal blocks made out of moulded non-inflammable plastic materials and having adequate number of terminals with binding screws washers etc. Secondary terminals of the instrument
transformers shall be connected to the respective common marshalling boxes. All out going terminals of each instrument transformer shall terminate on the terminal blocks of the common marshalling boxes. The terminal blocks shall be arranged to provide maximum accessibility to all conductor terminals.

6.4.7. Each terminal shall be suitably marked with identification numbers. Not more than two wires shall be connected to any one terminal. At least 20% spare terminals shall be provided over and above the required number.

6.4.8. All terminal strips shall be of isolating type terminals and they shall be of minimum 10 A continuous current rating.

6.4.9. All cable entries shall be from bottom. Suitable removable gland plate shall be provided on the box for this purpose. Necessary number of cable glands shall be supplied fitted on to this gland plate. Cable glands shall be screw on type and made of brass.

6.4.10. Each common marshalling box shall be provided with two numbers of earthing terminals of galvanized bolt and nut type.

6.4.11. All steel, inside and outside work shall be degreased, pickled and phosphate and then applied with two coats of Zinc Chromate primer and two coats of polyurethane paint. The colour of finishing paint shall be as follows:

i) Inside: Glossy White
ii) Outside (Polyurethane): RAL 7032

6.5.0. TESTS
6.5.1. Routine / Acceptance Tests (all units)
All routine tests shall be carried out in accordance with relevant Standards. All routine / acceptance tests shall be witnessed by the Corporation / his authorized representative.

6.5.2. Type Tests: The Contractor shall furnish type test certificates and results for the all tests as per relevant Standards along with the bid for current and potential transformers of identical design.
Type test certificates so furnished shall not be older than 3 (three) years as on date of Bid opening.

6.6.0. NAME PLATES
6.6.1. All equipment shall have non-corrosive name plates fix at a suitable position indelibly mark with full particular there on in accordance with the standard adapted.
6.7.0. MOUNTING STRUCTURES
6.7.1. All the equipment covered under this specification shall be suitable for mounting on steel structures. Supply of mounting structures is also in the scope of this tender.
6.7.2. Each equipment shall be furnished complete with base plates, clamps, and washers etc. and other hardware ready for mounting on existing steel structures.

6.8.0. SAFETY EARTHING
6.8.1. The non-current carrying metallic parts and equipment shall be connected to station earthing grid. For this two terminals suitable for 40mm X 10mm GI strip shall be provided on each equipment.

6.9.0. TERMINAL CONNECTORS
6.9.1. The equipment shall be supplied with required number of terminal connectors of approved type suitable for ACSR / XLPE cable. The type of terminal connector, size of connector, material, and type of installation shall be approved by the Corporation, as per installation requirement while approving the equipment drawings.

6.10.0. PRE-COMMISSIONING TESTS
6.10.1. Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Corporation without any extra cost to the Corporation. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Corporation for approval.
(a) Current Transformers
   (i) Insulation Resistance Test for primary and secondary.
   (ii) Polarity test.
   (iii) Ratio identification test - checking of all ratios on all cores by primary injection of current.
   (iv) Dielectric test of oil (wherever applicable).
   (v) Magnetizing characteristics test.
(vi) Tan delta and capacitance measurement
(vii) Secondary winding resistance measurement
(viii) Contact resistance measurement (wherever possible / accessible).

(b) Potential Transformers
(i) Insulation Resistance test for primary (if applicable) and secondary winding.
(ii) Polarity test.
(iii) Ratio test
(iv) Dielectric test of oil (wherever applicable).
(v) Tan delta and capacitance measurement of individual capacitor stacks.
(vi) Secondary winding resistance measurement.
TECHNICAL SPECIFICATIONS FOR CONTROL AND RELAY PANELS

7.1.0. SCOPE

7.1.1. This Section is intended to cover the design, manufacture, assembly, testing at manufacturers Works of Relay and Control Panels for Transformer Protection against Unmanned 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV Substations as per MSEDCL / MSETCL standard specifications.

7.1.2. The Control and Relay Panels required are for control and protection of the Power Transformers according to requirements. The supply shall include all accessories, special tools, supporting steels, spare parts, drawings, instruction manuals etc. The panels shall be supplied complete with all accessories as specified and completely assembled and all internal wiring completed.

7.1.3. All the substations shall be controlled from remote sub-station as well as local. The contractor has to supply the C&R panels to match the requirement (HSCADA is required for AR and completesubstation)

7.2.0. STANDARDS

7.2.1. All equipment and all component parts supplied under this specification shall conform in all respects to the latest issue of relevant Indian Standard Specifications except where specified otherwise in this specification. Equipment meeting any other authoritative standards which ensure an equal or better quality may also be acceptable.

7.3.0. TYPE OF PANEL

7.3.1. All panels shall be simplex type. One simplex panel shall be used for one transformer.

7.3.2. Simplex Control and Relay Panels shall consist of vertical fixed front panels with equipment mounted there on and having wiring access from the rear. Each cubicle assembly shall be provided with doors on the rear having handles with built in locking facility. It shall have double leaf doors with lift off hinges at the back for panels of width more than 800 mm.

7.3.3. Equipment with control functions shall be provided on the front of the panels. Other equipment, if required may be provided on back of the panels (door mounted). All types of local communication ports of relays, meters etc. shall be accessible from front or without opening the panel door.
7.4.0. CONSTRUCTIONAL FEATURES

7.4.1. The panels shall be completely metal enclosed to ensure a dust, moisture and vermin proof atmosphere. The enclosure shall provide a degree of protection IP55.

7.4.2. Panels shall be rigid free standing and floor mounting type and comprise of structural frames enclosed completely with specially selected texture finished, cold rolled sheet steel of thickness not less than 3mm for weight bearing members of the panels such as base frame, front sheet and door frames and not less than 2.5 mm for sides, door top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.

7.4.3. All joints shall be made flush and all edges shall be bent at right angles and rounded. All structural members shall be bolted or welded together. Necessary arrangement shall be provided for bolting together the adjacent panels as well as for fastening them to the floor. The opening required for mounting the equipment shall be punched or cut and filed smooth.

7.4.4. All doors, removable covers and panels shall be sealed all around with synthetic rubber gaskets Neoprene / EPDM generally conforming to provision of IS 11149. However, XLPE gaskets can also be used for fixing protective toughened glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

7.4.5. Panels shall have additional rolled channel plinth at the bottom with smooth bearing surface. The panels shall be fixed on the embedded foundation channels with intervening layers of anti-vibration strips made of shock absorbing materials which shall be supplied by the contractor.

7.5.0. MOUNTING OF EQUIPMENTS

7.5.1. All equipment on and in the panels shall be mounted and completely wired to the terminal blocks ready for external connection. All equipment on the front panels shall be mounted flush. Terminal markings shall be clearly visible.

7.6.0. INTERNAL WIRING

7.6.1. Panels shall be supplied completely with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the
devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are located adjacent to each other all interpanel wiring and connections between the panels shall be furnished and wiring shall be carried out internally. These adjacent inter panel wiring shall be clearly indicated in the drawing furnished by the supplier.

7.6.2. Wiring shall be carried out with 1100-Volt grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of stranded copper conductor used for internal wiring shall be as follows:
(a) All circuits except instrument transformers circuits: 2.5 sq. mm. per lead.
(b) Instrument transformers circuit: 4.0 sq. mm. per lead.

7.6.3. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panel running throughout the entire length of the panels.

7.6.4. Wire terminals shall be made with solder less clamping type of tinned copper lugs, which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from blocks.

7.6.5. Interconnections to adjacent panels shall be brought out to a separate set of terminals blocks located near the slots or holes meant for taking the interconnecting wires. Arrangement shall permit easy Interconnection to adjacent panels at site and wires for this purpose shall be provided by the supplier looped and bunched properly inside the panel.

7.6.6. A laminated copy of total schematics is to be fixed on the inside of door.

7.7.0. TERMINAL BLOCKS

7.7.1. All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be of 650 volts grade and have 10 amps continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Terminal block designs include a white fibre-marking strip with clear plastic / silicon chip on terminal covers. Marking on the terminal strips shall correspond to block and terminal number on the wiring diagram.
7.7.2. Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.

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

7.7.4. There shall be a minimum clearance of 250 mm between first row of terminal blocks and associated cable gland plates. Also, the clearance between two rows of terminal blocks shall be a minimum of 150mm. A steel strip shall be connected between adjacent terminal block rows at 450-mm intervals for support of incoming cables.

**7.8.0. PAINTING**

7.8.1. All Sheet steel work shall be phosphate in accordance with IS 6005.

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

7.8.3. After phosphate, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of 2(two) coats of ready mixed, staving type zinc chromate primer. The first coat may be ‘flashing dried’ while the second shall be saved.

7.8.4. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by staving. The second finishing coat shall be applied after completion of tests. The Corporation shall select the exterior colour of the paint at a later date.

7.8.5. Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.

7.8.6. The inside of the panels shall be glossy white.

7.8.7. A small quantity of finishing shall be supplied minor touching up required at site after installation.

**7.9.0. NAME PLATES AND MARKINGS**

7.9.1. All equipment mounted on front and rear side as well as equipment mounted inside the panel shall be provided with individual nameplates with equipment designation engraved. Also, on the top of each panel on front as
well as rear side large and bold name plates shall be provided for circuit / feeder designation.

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

7.9.3. Name plates shall be made of non-rusting metal or 3 ply lamicord. Name plates shall be black with white engraved lettering.

7.10.0. MISCELLANEOUS ACCESSORIES

7.10.1. A 240 Volts, single-phase plug points shall be provided in the interior of each cubicle with ON-OFF switch for connection of head lamp.

7.10.2. Each panel shall be provided with a fluorescent lighting fixtures for the interior illumination of the panel complete with all fittings, i.e. lamp, switch (controlled by panel door)

7.10.3. Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of D.C. and A.C. supplies of various control, signalling, lighting and space heater circuits. All fuses shall be HRC cartridge type mounted on plug - in type fuse bases. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage. The main input A.C. and D.C. circuits shall be protected with miniature circuit breakers.

7.11.0. EARTHING

7.11.1. All panels shall be equipped with an earth bus securely fixed along with inside base of the panels. The materials and the sizes of the bus bar shall be at least 25X4 mm copper. When several panels are mounted joining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. Provisions shall be made for extending the earth bus bar to future adjoining panels on either side.

7.11.2. All metallic cases of equipment shall be connected to the earth bus by independent copper wires of size not less than 2.5 sq. mm. Earthling wire shall be connected on terminals with suitable clamp connectors and soldering shall not be permitted.
7.11.3. PT and CT secondary neutrals or common lead shall be earthed at one place only at the terminal blocks, where they enter the panels.

7.12.0. RECORDING METERS (TRIVECTOR METERS)

7.12.1. GENERAL

All meters shall be housed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. They shall be accurately adjusted and calibrated at works and shall have means of calibration, check and adjustment at site. All these instruments and meters shall be flush mounted type and back connected, suitable for panel Mounting.
TECHNICAL SPECIFICATIONS OF ISOLATORS

8.1.0. SCOPE
8.1.1. This section of the specification is intended to cover design specifications for manufacture and testing of 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV gang operated switch (Isolators) with all fittings and accessories as per MSEDCL / MSETCL standard specifications.
8.1.2. The Isolators are for outdoor installation suitable for horizontal / vertical mounting on pole / mounting structures and for use at sub-stations.
8.1.3. Isolators shall be supplied with Earth Switch as and where specified.

8.2.0. GENERAL
8.2.1. The Isolators and accessories shall conform in general to IS 9921 (or IEC: 62271-102) except to the extent explicitly modified in specification.
8.2.2. All isolating switches and earthing switches shall have rotating blades and pressure releasing contacts. All isolating and earth switches shall operate through 90° from closed position to fully open position.
8.2.3. Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following:
   (i). Isolator assembled with complete base frame, linkages, operating mechanism, control cabinet, interlocks etc.
   (ii). All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.
   (iii). the isolator shall be designed for use in the geographic and meteorological conditions as given in Section 1.

8.3.0. DUTY REQUIREMENTS
8.3.1. Isolators and earth switches shall be capable of with standing the dynamic and thermal effects of the maximum possible short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.
8.3.2. The earth switches, wherever provided, shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and
shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.

8.3.3. In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated else where in this specification.

8.3.4. The earthling switches shall be capable of discharging trapped charges of the associated lines.

8.3.5. The isolator shall be capable of making / breaking normal currents when no significant change in voltage occurs across the terminals of each pole of isolator on account of make / break operation.

8.3.6. The isolator shall be capable of making / breaking magnetizing current of 0.7A at 0.15 power factors and capacitive current of 0.7A at 0.15 power factors at rated voltage.

8.4.0. CONSTRUCTIONAL DETAILS

8.4.1. All isolating switches and earthling switches shall have rotating blades and pressure releasing contacts. All isolating and earth switches shall operate through 90° angle from closed position to fully open position.

8.4.2. Contacts:

a) The contacts shall be self-aligning and self-cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.

b) No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that re adjustments in contact pressure shall not be necessary through out the life of the isolator or earthling switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.

c) Contact springs shall not carry any current and shall not lose their characteristics due to heating effects.

d) The moving contact of double break isolator shall have turn-and-twist type or other suitable type of locking arrangement to ensure adequate contact pressure.
8.4.3. Blades:

a) All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper / aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided oncurrent carrying parts shall be made of copper silicon alloy or stainless steel or equivalent. 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.

b) 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.

c) 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.

d) 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.

8.4.4. Insulators:

a) The insulator shall conform to IS: 2544 and / or IEC-60168. The insulators shall have a minimum cantilever strength of 400 Kgs. for 33 / 11 kV insulators respectively.

b) Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

8.4.5. Base:

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

8.5.0. EARTHING SWITCHES
8.5.1. Where earthling switches are specified these shall include the complete operating mechanism and auxiliary contacts.

8.5.2. The earthling switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

8.5.3. The earthling switches shall be constructionally interlocked with the isolator so that the earthling switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks. Suitable mechanical arrangement shall be provided for de-linking electrical drive for mechanical operation.

8.5.4. Each earth switch shall be provided with flexible copper / aluminium braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earthblade. The transfer of fault current through swivel connection shall not be accepted.

8.5.5. The frame of each isolator and earthling switches shall be provided with two reliable earth terminals for connection to the earth mat.

8.5.6. Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

8.5.7. The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

8.6.0. OPERATING MECHANISM

8.6.1. The Contractor shall offer manual operated Isolators and earth switches...

8.6.2. Control cabinet / operating mechanism box shall be made of aluminium sheet of adequate thickness (minimum 3 mm).

8.6.3. Gear should be of forged material suitably chosen to avoid bending / jamming on operation after a prolonged period of non-operation. Also all gear and connected material should be so chosen / surface treated to avoid rusting.

8.7.0. OPERATION

8.7.1. The main Isolator and earth switches shall be gang operated.

8.7.2. The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interlope operating rods
shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator and earth switches shall be provided with “over centre” device in the operating mechanism to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

8.7.3. Each isolator and earth switch shall be provided with a manual operating handle enabling one man to open or close the isolator with ease in one movement while standing at ground level. Detachable type manual operating handle shall be provided. Suitable provision shall be made inside the operating mechanism box for parking the detached handles. The provision of manual operation shall be located at a height of 1000 mm from the base of isolator support structure.

8.7.4. The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolate or closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator. Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods / pipes shall be provided with suitable universal couplings to account for any angular misalignment.

8.7.5. All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rust proof.

8.7.6. Signalling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signalling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.

8.7.7. The position of movable contact system (main blades) of each of the Isolators and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the Isolators and earthing switch. The indicator shall be of metal and shall be visible from operating level.

8.7.8. The contractor shall furnish the following details along with quality norms, during detailed engineering stage.
(i) Current transfer arrangement from main blades of isolator along with mill volt drop immediately across transfer point.
(ii) Details to demonstrate smooth transfer of rotary motion from motor shaft to the insulator along with stoppers to prevent over travel.

8.8.0. TEST AND INSPECTION
8.8.1. The switches shall be subjected to the following type test in accordance with IS: 9920.
I) Dielectric test (impulse and one minute) power frequency withstands voltage.
II) Temperature rise test
III) Rated off load breaking current capacity
IV) Rated active load breaking capacity
V) Rated line charging breaking capacity
VI) Rated short time current
VII) Rated peak withstand current
VIII) Mechanical and Electrical Endurance
8.8.2. The equipment shall be subjected to the following routine test.
I) Power frequency voltage dry test
II) Measurement of resistance of the main circuit
III) Operating test.
8.8.3. The porcelain shall have pull out test for embedded component and beam strength of porcelain base.

8.9.0. CONNECTORS
8.9.1. Each isolator shall be provided with appropriate number of bimetallic clamping type connectors as detailed in the schedule of requirement. The maximum length of jumper that may be safely connected or any special instruction considered necessary to avoid under loads on the post Isolators should be stated by the Contractor.

8.10.0. SUPPORTING STRUCTURES
8.10.1. 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 Contractor. The isolators should have requisite fixing details ready for mounting them on switch structures.

8.11.0. PRE-COMMISSIONING TESTS

8.11.1. Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Corporation without any extra cost to the Corporation. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Corporation for approval.

(a) Insulation resistance of each pole.
(b) Manual operation and interlocks.
(c) Insulation resistance of control circuits and motors.
(d) Ground connections.
(e) Contact resistance.
(f) Proper alignment so as to minimize to the extreme possible the vibration during operation.
(g) Measurement of operating Torque for isolator and Earth switch.
(h) Resistance of operating and interlocks coils.
(i) Functional check of the control schematic and electrical & mechanical interlocks.
(j) 50 operations test on isolator and earth switch.
TECHNICAL SPECIFICATIONS FOR SURGE ARRESTORS

9.1.0. SCOPE
9.1.1. This Section covers the specifications for design, manufacture, shop & laboratory testing before dispatch of 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV 10 kA, Station class heavy duty, gapless metal (zinc) oxide Surge Arrestors complete with fittings & accessories as per MSEDCL / MSETCL standard specifications.

9.2.0. STANDARDS
9.2.1. The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 unless otherwise specifically specified in this Specification.

9.3.0. GENERAL REQUIREMENT
9.3.1. The surge arrester shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
9.3.2. The surge arrester shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified creep age distance.
9.3.3. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.
9.3.4. The surge arrester shall be provided with line and earth terminals of suitable size. The ground side terminal of surge arrester shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrester and second end to a separate ground electrode. The Contractor shall also recommend the procedure which shall be followed in providing the earthing / system to the Surge Arrester.
9.3.5. The surge arrester shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrester shall change over to the conducting mode.
9.3.6. The surge arrester shall be suitable for circuit breaker performing 0-0.3 sec.-CO-3min-CO- duty in the system.
9.3.7. Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain / silicon polymeric housing and providing path for flow of rated fault currents in the event of arrester failure.
9.3.8. The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
9.3.9. The Surge Arrestor shall be thermally stable and the Contractor shall furnish a copy of thermal stability test with the bid.

9.3.10. The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

9.4.0. ARRESTOR HOUSING

9.4.1. The arrestor housing shall be made up of silicon polymeric housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown colour, free from blisters, burrs and other similar defects. Arrestors shall be complete with insulating bases, surge counters with leakage current meters (33 kV LA) and terminal connectors.

9.4.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrestor. The arrestors shall not fail due to contamination. The arrester housings shall be designed for pressure relief class as given in Technical Parameters of the specification.

9.4.3. Sealed housings shall exhibit no measurable leakage.

9.5.0. FITTINGS & ACCESSORIES

9.5.1. The surge arrestor shall be complete with insulating bases, surge counters with leakage current meters (for 33 kV LA) and terminal connectors.

9.5.2. The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built-in clamping device which can be adjusted for both horizontal and vertical take-off.

9.6.0. SURGE MONITOR

9.6.1. A self-contained discharge counter suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit. Leakage current meter with suitable scale range to measure leakage current of surge arrestor shall also be supplied within the same enclosure. The number of operations performed by the arrestor shall be recorded by a suitable kilometric counter and surge monitor shall be provided with an inspection window. There shall be a provision for putting ammeter to record the
current / alarm contacts in the control room if the leakage current exceeds the permitted value. Similar provision shall be considered for surge counter also.

9.6.2. Surge monitor shall be mounted on the support structure at a suitable height so that the reading can be taken from ground level through the inspection window and length of connecting leads up to grounding point and bends are minimum.

9.6.3. Surge monitor shall have to be provided for 33 kV class only.

9.7.0. TESTS

9.7.1. Test on Surge Arrestors

Bidding Document for Construction of 33 kV / 11 kV / 433VOR 33 kV / 6.6 kV New Un-Manned Substations 149Specifications and Drawings MSEDCL / MSETCL.

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 3070 (Part-3). In addition, the suitability of the Surge Arrestors shall also be established for the following:

- Residual voltage test
- Reference voltage test
- Leakage current at M.C.O.V
- P.D. test
- Sealing test
- Thermal stability test
- Aging and Energy capability test
- Watt loss test

Each metal oxide block shall be tested for guaranteed specific energy capability in addition to Routine / acceptance test as per IEC / IS.

9.7.2. The surge arrestor housing shall also be type tested and shall be subjected to routine and Acceptance tests in accordance with IS: 2071.

9.7.3. Galvanization Test

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS: 2633 & IS 6745.
TECHNICAL SPECIFICATIONS OF 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV XLPE

10.1.0. SCOPE
10.1.1. The specification covers the design, testing, supply and delivery in proper packed condition of different grade of 1 or 3 cores. Aluminium Conductor, Cross-linked polyethylene (XLPE) insulated, PVC sheathed, armoured, screened Power Cables as per MSEDCL / MSETCL specifications.

10.2.0. DEVIATION
10.2.1. Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the “Deviation Schedule” with reasons duly supported by documentary evidences and advantages of such deviation. Such deviation suggested may or may not be accepted. But deviation not mentioned in “Deviation Schedule” shall not be considered after wards.

10.2.2. SYSTEM DETAILS
10.2.2.1. Voltage grade (KV) of cable required … 19 / 33 3.8 / 11
10.2.2.2. Service Voltage … 33 kV / 11 kV / 433V OR 33 kV / 6.6 kV
10.2.2.3. Highest Voltage … 36 KV 7.2 KV
10.2.2.4. Earthling System Solidly Earthed Solidly Earthed
10.2.2.5. B.I.L. for Cables 170 KV for 33 kV 60 KV for 11 kV / 433V OR 6.6 kV
10.2.2.6. Fault Level (Maxim.) … See Clause 12.4.5
10.2.2.7. Frequency … 50 C / S 50 C / S.

10.2.3. STANDARDS
a) IS : 7098 (Part – II) (Latest) : Specification for cross-linked polyethylene Insulated PVC Sheathed Cables for working Voltage from 3.3 KV up to and including 33 KV,
c) IS: 5830 – 1984: PVC insulation & sheath of electric cables...
d) IS: 3975 – 1979:Armour for cables (for 3 Crore).

10.3.0. The cable, joints, outdoor and indoor termination and their accessories and fittings may conform to other Indian and / or equivalent standards or important publications to improve upon their performance, but shall not fall short of the requirement of this specification. The Contractor shall clearly indicate such standards in their offers.

10.4.0. ELECTRICAL CHARACTERISTICS & PERFORMANCE:

10.4.1. Description of Cable

a) 19 / 33 kV Grade: Standard compacted circular Aluminium (H4 Grade) Conductor, FR type, following A2xWaY for 1-C and A2xWY& A2xFy for 3-core shielded with black extruded semi conducting compound XLPE insulated, core shielded with black extruded semi conducting compound, black semi-conducting tape and a copper tape, single layer G.I. flat strip armoured and black extruded PVC (Type: ST-2), overall sheathed, conforming generally to IS: 7098 (Part – II).

b) 3.8 / 6.6 kV OR 11 kV / 433 V Grade 1, 3-Crore: Same as above but insulation shielding with black semi conducting tape not necessary. Inner sheath to be wrapped not extruded and strip armoured. The design shall fully conform to IS: 7098 (Part – II)

10.4.2. Size of Cable: 300 mm2 (1-C) 800 mm2 (1-core) 630 mm2 (1-core) 300 mm2 (1-core)

10.4.3. Voltage Grade 19 / 33 KV 3.8 / 6.6 KV OR 11 KV / 433 V


10.4.5. Short Ckt. Current

1a) 28.2 KA for 1 sec. For 33 KV, 300mm2

1b) 28.2 KA (537 MVA) for 1 sec. For 6.6 kV OR 11 KV / 433 V, 300 Sq.mm

2a) 59.22 KA for 1 sec. For 33 KV, 630mm2

2b) 59.22 KA for 1 sec. For 11 KV, 800 mm2

10.4.6. Maxim. Permissible emergency over load temp. At 25% overload to 100 hrs. Per year or 500 hrs. In life of cable: 130°C for one hour

10.4.7. Maxim. Permissible short circuit temperature: 250°C for one hour


10.4.9. Conductor Screening: Extruded, cross linked, semi-conducting compound of 1.0 mm thickness for 33 kV & .5 mm for 6.6 kV OR 11 KV / 433 V
10.4.10. Insulation:XLPE of thickness, 8.8 (Nominal) for 33 KV and 3.6 mm (Nominal)

10.4.11. End Sealing:H.S. Caps (see clause Error! Reference source not found.) (HeatShrinkable)

10.4.12. a) Max. ‘Tan-delta’ at room temp. At nominal phase to neutral voltage (Uo):0.004

b) Maxm. Increment of ‘tan-delta’ between 0.5 Uo to 2 Uo at Room temp:0.002

10.4.13. Partial discharge value:20 Pc (Maxim.) at 1.6 Uo.


10.4.15. H.V. Tests between Conductors & Screen / Armour:48 KV (rms) for 33 kV for 5 minutes and as per ISS for 20 kV for 6.6 kV OR 11 KV / 433 V

12.4.21. Maxim. D.C. Rtance / Km:As per relevant I.S.S

* NB the above parameters are applicable for three core and single core cable, if not otherwisesspecified.

10.5.0. CABLE CONSTRUCTION:

10.5.1. XLPE underground cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials for XLPEsemi-conducting, insulation and XLPE screen.

The inner and outer semi-conducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded during thefore 11 KV / 433 V OR 6.6 kV.

10.4.11. InsulationScreening

For 33 kV: Combination of black extruded semi-conducting tape as the non-metallic part and annealed copper 0.06 mm (minimum) thick tape lapping as metallic part. For 1 core cable, the non-magnetic metal Armour shall act as metallic part insulation screening.

For 11 KV / 433 V OR 6.6 kV: It is same but semi-conducting tape is not required.

10.5.1.1. Inner Sheathing:Black extruded PVC, Type ST-2 compound for 33 kV and wrapped PVC tape for 6.6 kV OR 11 KV / 433 V as per ISS. For 1 core there shall be No inner sheath.

10.5.1.2. Armouring:Single layer of round galvanized steel wires / strip for 33 kV and galvanized steel strips / wire for 6.6 kV OR 11 KV / 433 V (3 cores) as per IS. For 1 core, there shall be non-magnetic metal Armour.
10.5.1.3. Overall Sheathing: Coloured PVC, type ST-2 compound to IS: 5831, extruded for both 33 KV and 6.6 kV OR 11 KV / 433 V thicknesses shall be as per ISS12.4.15. Approx. length of cable in a Drum: 250 meters with a tolerance of ± 5% (for 3 cores), 500 meters ± 5% (for 1 core).

Triple Extrusion Process of manufacturing and main insulation of the Cable is to be extruded unified. The XLPE Cables in this specification does not have any metal sheath and the shortcircuit rating of the cable shall depend on the conductivity and continuity of the strands of the armour wires, which shall be ensured by guarding against corrosion.

10.5.2. **CONDUCTOR SCREENING.**

A semi-conducting cross-linked polyethylene (XLPE) screening shall be extruded over the conductor to act as an electrical shield which together with elimination of the so called “Strand `Effect” prevents to great extent air ionization on the surface of the conductor.

10.5.3. **INSULATION**

The main insulation of the Cable shall be extruded unfilled, chemically cross-linked polyethylene (XLPE) inert gas cured satisfying the requirement of ISS: 7098 (Part- II)

10.5.4. **INSULATING SCREEN:**

10.5.5. The screen shall be made up as given in Clause 12.4.11 the metal screen eliminates tangential stress electrostatic field surrounding the conductor and uniform electrical stress in the insulation. The semi conducting polyethylene (XLPE) screen shall be extruded over the main polyethylene insulating wall to prevent partial discharge at the surface of the insulation. The copper tape shall be wrapped over the semi conducting tape or extrusion as mentioned earlier for 3 core cables. The metal screen so formed around the cores shall be in contact with one another as the cores are laid up at triangular configuration. For single core cable, Aluminium wires armouring shall constitute the metallic part of insulation screen. Conductor screening, insulation and insulation screening shall be extruded in triple extrusion processes so as to obtain continuously smooth interfaces.
10.5.6. The mechanical and chemical properties of the materials for semi conducting screens are much more important than their electrical properties, but for obtaining the high overall degree of electrical properties of an E.H.V. cable, the inner and outer semi conducting, sheaths and the main polyethylene insulation between the sheaths shall be simultaneously extruded during the manufacturing, process known as “triple extrusion”. The advantages are
i) The partial discharge level at the surface of the insulation is brought to a minimum.
ii) There shall be no displacement of the semi conducting screen and insulation during expansion and contraction due to load cycles and bending.
iii) The semi conducting screens are easily removable during joining and termination operations.

10.5.7. ARMOUR
The cable shall be wire armoured / steel strip in case of 33 KV and wire / strip armoured 11 KV, three core cables to insure an adequate return path for the flow of fault current and also provide suitable mechanical protection. Steel wires / aluminium wire / steel strips of required size in requisite number as per clause 10.5.1.3 shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cores section area for flow of maximum fault current within limits of specified temperature rise and duration of fault. Direction of the lay of the armour shall be opposite to that of the cable cores in case of single core cable armour should be of non-metallic material.

10.5.8. OUTER SHEATH
A reliable serving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. Cable shall be therefore finished with extruded PVC over sheath of thickness as per clause 10.5.1.4. The quality of PVC over sheath (jacket) shall be ensured for service reliability against moisture intrusion and shall confirm to type ST-2 of IS: 5831.
The colour of the outer sheath shall be follows:
For 33 kV cable: GREEN
For 11 kV / 433 V OR 6.6 kV cable: Blue
The sheaths shall be protected against white ants, vermin and termites by suitable, durable and reliable measures. The suppliers shall suggest suitable
materials for use, in the event of damage to the over sheath to prevent the passage of moisture along the cable.

10.5.9. **CABLE IDENTIFICATION:**
The following shall be embossed on the outer sheath for the identification.

a) Manufacturer’s Name or Trade Mark.
b) Voltage Grade.
c) Nominal section and material of conductors and number of cores.
d) Year of manufacture.
e) Inscription of length of cables at 1.0 metre interval.
f) Name of purchaser MSEDCL;
g) Marking “Power” shall be embossed throughout the length of the cable at 10 metre spacing.
h) Type of insulation i.e. XLPE

10.5.10. **CEILING OF CABLE ENDS**
The cable ends of the cable in the wooden drum for delivery shall be sealed with heat shrinkable caps.

10.6.0. **WOODEN DRUMS:**
The cable shall be packed in non-returnable wooden drums

12.6.1. The following information shall be marked on each drum.
a) Drum identification number.
b) Manufacturer’s name, Trade name / Trade mark, if any.
c) Nominal sectional area of the conductor of the cable.
d) Number of cores
e) Type of cable and voltage grade with cable code
f) Length of cable in cable drum
g) Direction of rotation of drum (by means of an arrow)
h) Approx. Weight: tare: gross:
i) Year and country of manufacture
j) Purchase order number
k) Date of delivery
l) Name of the purchaser.
Drum shall be proofed against attack by white ant or termite conforming to IS: 10418. The Drums may also be marked with ISI certificate mark, as applicable.

10.6.2. Safe pulling force: 30 N / mm² (for conductor)

10.7.0. Tests to be performed as per IS: 7098 (part II)

10.7.1. Type test all the test mentioned below are to be made as per details given in IS: 10810

a) Test on conductor
   i. Tensile test (For aluminium)
   ii. Wrapping test for aluminium
   iii. Resistance test.

b) Test for armouring wire strips.

c) Test for thickness of insulation and sheath.

d) Physical test for insulation.

   i. Tensile strength and elongation at break
   ii. Ageing in air oven.
   iii. Hot test
   iv. Shrinkage test.
   v. Water absorption (Gravimetric)


e) Physical tests for outer sheath

   i. Tensile strength and elongation at break
   ii. Ageing in air oven.
   iii. Shrinkage test.
   iv. Hot deformation
   v. Heat shock
   vi. Loss of mass in air oven
   vii. Thermal stability
   viii. Thermal Stability

f) Partial discharge test

g) Bending test

h) Dielectric power factor test

I. As a function voltage
   li. As a function of temperature
i) Insulation resistance (volume resistivity) test
j) Heating cycle test
k) Impulse with stand test
l) High voltage test
m) Flammability test

10.7.2. The following test on screen cable shall be performed successfully on the same test sample of completed cable, not less than 10 m. in length between the test accessories.

a) PD test
b) Bending test followed by PD test
c) Di-electric power factor as function of voltage
d) Di-electric power factor as a function of temperature
e) Heating cycle test followed by Di-electric power factor as a function of Voltage and PD test.
f) Impulse with stand test and
g) High voltage test

If a sample fails in test (g) one more sample shall be taken for this test, preceded by Test (b) and (e).

10.7.3. **Acceptance test**: the following shall constitute acceptance test:

a) Tensile test (For aluminium)
b) Wrapping test for aluminium
c) Conductor resistance test
d) Test for thickness of insulation and sheath
e) Hot set test for insulation
f) Tensile strength and elongation at break test for insulation and outer sheath
g) PD test (Screen enables) only on full drum length
h) High voltage test, and
i) Insulation resistance (volume resistivity) test
j) Spark test on extruded un-insulated outer PVC sheath as per provision clause no 3.2 IEC standard (Publication no.229 of 1982.

10.7.4. **Routine test**: 
The routine test shall be carried out on all cables manufacturer in accordance with this Specification. The following routine test shall be made on cable length as specified in ISS.

a) Conductor resistance test
b) Partial discharge test on full drum length
c) High voltage test

10.7.5. Test witness

a) All tests shall be performed in presence of purchaser representatives if so desired by the purchaser.
d) The contractor shall give at least 15 days advance notice for witnessing such tests.

10.7.6. Test Certificate

a) Certified copies of all routine test carried out at work shall be furnished in 6 copies for approval of the Purchaser.
b) The cable shall be dispatched from works only after receipt of Purchaser's written approval of shop test report.
c) Type test certificates of the cable offered shall be furnished. Otherwise the cable shall have to be type tested on similar rating as per clause 10 free of any charges to prove the design.
11.1.0. SCOPE
11.1.1. This section of the specification covers technical requirements for design, manufacture and testing at the manufacturer's works before dispatch of shunt capacitor banks with associated equipment, such as circuit breakers, instrument transformers, reactors, control and relay panels, lightning arresters etc. for their efficient and trouble-free operation and is to be read together with Sections of this specification which covers the other technical requirement.

(Provision of 6.6 kV outdoor type capacitor bank is not required for no load transformer compensation. However, 6.6 kV indoor type capacitor bank for motor compensation is required. Capacitor bank of appropriate capacity outdoor type shall be installed at 33 kV line side)

11.2.0. STANDARDS
11.2.1. The shunt capacitor banks and associated equipment shall conform to the latest edition of the following standards (as amended up to date) except where specified otherwise in this specification.

(a) Capacitors IS: 2834, IS: 13925
(b) Circuit breakers IEC: 62271
(c) Current transformers IS: 2705
(d) Potential transformers IS: 3156
(e) Isolators IS: 9921
(f) Fuses (external) IS: 2208
(g) Protection Relays IS: 3342
(h) Motors IS: 325
(i) Surge Arresters IS: 3070

11.2.2. Equipment meeting the requirement of International or any other authoritative standards, which ensure a quality equal to or better than that as per the standards mentioned above, shall also, is acceptable.

11.3.0. CAPACITOR BANKS
11.3.1. GENERAL
11.3.1.1. The capacitor banks shall be complete with neutral RVT and series reactor as required. Circuit breaker, off load type isolators, instrument transformer,
control and relay panels, connecting material and any other material required for capacitor bank shall be included in the scope of supply.13.3.1.2. The capacitor banks shall be outdoor type suitable for operation in the climatic conditions as given in this specification, and mounting on steel racks to be supplied by the Contractor.

11.3.1.2. The Contractor shall also furnish details of the connections between the capacitor units and groups, together with layout diagrams showing the physical arrangements of banks, complete with dimensions.

11.3.2. **CAPACITOR UNITS**

11.3.2.1. Each capacitor unit of the bank shall be self-contained outdoor type, to give the required total bank capacity at 50 Hz. Bushing shall be of porcelain and shall be joined to the case by soldering or other better method.

11.3.2.2. The capacitor units should be manufactured using HAZY polypropylene as dielectric media and non-PCB impregnate. The impregnation shall be carried out under high degree of vacuum and the unit shall be of totally sealed type.

11.3.2.3. The chemical properties of the insulating fluid used in capacitor units shall be such that contamination of the environment from the points of view of bio-degradability foxy and bio-concentration shall be minimum.

11.3.2.4. Each capacitor unit shall be provided with an internal discharge resistor designed to drain out the residual charge up to 50 Volts or less within 5 minutes after disconnection from supply.

11.3.2.5. Each capacitor unit shall be individually protected by an internal fuse, suitably rated for load current. The characteristics of the fuse shall be such that it shall isolate the faulty unit only and prevent it from mechanical destruction due to internal faults. There shall be provision for indication / alarm for blown fuse. The fuse shall isolate the faulty capacitor unit only and the healthy capacitor units shall not be affected in any way by the isolation of faulty unit.

11.3.2.6. The internal fuses shall conform to relevant Indian Standards or equivalent International Standards. The design of the internal fuses shall be such that residuals from fuse operations shall not causedeterioration of the impregnating fluid.

11.3.2.7. Fuses shall be capable of carrying continuously a current of at least 1.65 times the rated r.m.s. current of the associated unit current.
11.3.2.8. Fuses shall be preferably of the current limiting type but the fuse system shall in any event be designed to ensure that the energy released into a faulty capacitor unit is less than the value that shall cause rupture or bursting of the container.

11.3.2.9. Each capacitor unit shall be suitable for continuous operation of 1.3 times rated current at rated voltage and frequency. This over current factor shall include the combined effect of presence of harmonics and over voltages up to and including 1.1 times the rated voltage.

11.3.2.10. Terminals and mounting arrangement may be in accordance with manufacturer’s standard practice, but should be proportioned with adequate safety margins.

11.3.2.11. The containers of capacitor units shall be of CRCA steel with surface finishing and painting carried out generally as per clause 3.7.0 of this Volume.

11.3.2.12. Contractor should clearly indicate whether sun shadow to protect the capacitors from direct sun-rays during the hot part of the year is essential or not. In case the sun shades are needed they shall form part of the supply of the capacitors.

### MOUNTING RACKS

11.3.3.1. The mounting racks shall be of hot dip galvanized steels sections. Each end of the rack shall have provision to receive incoming line connection. Sufficient space must be provided between rows in a rack for easy replacement of any capacitor unit. The banks shall be connected in two or three tier formation.

11.3.3.2. The racks shall be complete with rack insulators, foundation bolts or any other hardware etc., for assembly into complete bank.

11.3.3.3. The height of the racks of capacitor bank shall be such that for making electrical connections with the other equipment, proper electrical clearances are maintained.

### CAPACITOR BANK SWITCHING CONTROL

11.3.4.1. Switching of capacitor backs would be performed by circuit breakers remote electrical control from the control room. In addition, there would be local manual / electrical control of circuit breakers.
11.3.4.2. A Timer must be included with adjustable setting of 0 to 6 minutes to provide a time lag before which the bank shall not be again switched ‘ON’ (to avoid closing of the circuit breaker on a trapped charge).

11.3.5. PROTECTION

11.3.5.1. The capacitor banks shall be provided with the following protections:

a) Over current and earth fault protection to cover the faults in the capacitor banks and its controlling circuit breaker.
b) Over voltage protection.
c) Unbalance protection.
d) No volt protection

11.3.5.2. Requirement of each of the above protections is described below:

a) Over current and earth fault protection

Combination of two over current IDMT numeric relays having 50-200% settings and one E/F relay of IDMT characteristic with 20-80% setting shall be used with suitable current transformer.

b) Over voltage protection

Shall be provided with an inverse time characteristic. Over voltage relay shall be energized from aVT connected to the main bus bars on the source side of the circuit breaker controlling the capacitor banks. Setting shall be variable from 100% to 130% in steps at least 1% to 2%.

c) Unbalance protection

The unbalance protection shall be provided through current unbalance relay connected to the NCT of capacitor bank connected in double star. Two such relays, one for trip and other for alarm shall be provided. The settings of the relays shall be 10% to 40% or 20% to 80% of the CT secondary current followed by a time delay and through a timer of 0.1 second for transient free operation of the protection. The relay should not operate for healthy state spill current in neutral. Number of units of failure on which alarm shall come and tripping is initiated, shall be clearly mentioned for proper setting of the relays.

d) No Volt protection
No Volt protection should be provided to disconnect the bank under no voltage conditions. This protection shall be energized from the existing bus PT. This protection should not operate in the event of fault on 6.6 kV feeders which may dip the bus bar voltage to 50%. There should be provision for adjustment in setting of voltage and time to coordinate 6.6 kV lines protection with the no voltage protection to avoid maloperation of No voltage relay under line fault conditions.

11.4.0. CIRCUIT BREAKER
11.4.1. The circuit breaker shall be vacuum, outdoor type as per SECTION – 5 of this Specification.

11.5.0. ISOLATOR AND ISOLATOR-CUM-EARTHSWITCH
11.5.1. The isolator shall be triple pole gang operated having horizontally rotating (centre pole rotating) blades as per of this SECTION -8 Specification.

11.6.0. CURRENT TRANSFORMERS
11.6.1. The current transformers shall be of the outdoor type single phase, 50Hz, oil immersed, self-cooled type generally as per SECTION - 6 of this bid document and clause 13.10.0 of this Section.

11.7.0. SERIES REACTOR
11.7.1. The series reactor of 0.45% of capacitor bank rating shall be provided for limiting the inrush current due to parallel switching of capacitor banks on the same bus.
11.7.2. The series reactors shall be of outdoor type, three phase, 50Hz, air cooled.
11.7.3. The series reactor would be connected towards neutral of the shunt capacitor.
11.7.4. The series reactors shall be complete in all respects including clamps, fixing bolts and nuts and other accessories and shall conform to the latest edition of IS:5553 / IEC-259.
11.7.5. Requisite number of suitable and matching terminal connectors shall also be supplied along with thereactor and accordingly, the prices may be quoted.

11.8.0. FITTINGS AND ACCESSORIES
11.8.1. Any fittings or accessories which might not have been mentioned in the specification but which are usual or necessary in the equipment are to be provided by the contractor without extra cost. All equipment must be complete in all details whether mentioned in the specification or not.

11.9.0. TESTS

11.9.1. All equipment offered shall comply with type test stipulated in relevant IS / IEC. Test reports for all typetests shall be submitted along with the tender.

11.9.2. All equipment shall be subjected to routine and acceptance tests in accordance with relevant standards without any extra cost to the purchaser.

11.9.3. No equipment shall be dispatched until the test reports are duly approved by the purchaser.

11.9.4. The endurance test as per the procedure given below shall be carried out on one capacitor unit of each rating and size specified or on a small unit of rating not exceeding 4.4 kV and 10 kV AR which is equivalent in all respects to the unit to be manufactured. In case, a small unit is used for testing, overLoad run test at Sl. No. (a) 6 below shall be repeated on complete unit also.

a) ENDURANCE TESTING OF CAPACITOR UNIT

Aim of the test endurance test is a type test on power capacitors for checking the design and the manufacturing process of the capacitor and specifically to establish that the capacitor shall withstand the service conditions with a high reliability. Specification for endurance test on power capacitors:

A summary for the test sequence for endurance testing of power capacitors for AC power system is as follows:

(UN = Rated voltage of the capacitor unit)

1. Routine voltage test the test unit shall be subjected to the routine voltage test between the terminals by applying 2.15UN A.C or 4.3 UN D.C. for 10 sec. duration.

2. Conditioning of the capacitors before the test

The test unit shall be exposed to not less than 1.1 UN A.C. at an ambient temperature of not less than + 10o C for 16 to 24 hours.

3. Initial capacitance and loss measurement

The test unit shall be placed for at least 12 hours in de-energized state in a chamber with a forced air circulation having temperature selected from the range + 60o C to +75o C with a permitted
Variation of + 2°C. The unit at the same ambient temperature shall then be subjected to UN. The capacitance and the losses shall be measured 4.5 to 5.5 minutes after the voltage application.

4. Transient over voltage test
The unit shall be placed for at least 12 hours in the un-energized state in a chamber with forced aircirculation having a temperature not exceeding the lower limit of the temperature category. The test unit shall then be placed at an ambient temperature of +15°C to +35°C and exposing it to a voltage of 1.1 UN A.C within 5 minutes after taking it out of the low temperature chamber. The test unit shall be exposed to an over voltage (AC + DC superimposed) of 2.25 UN for a period of one second duration. The voltage 1.1 UN is applied during five minutes followed by a new over voltage period. This sequence is repeated to 100 times a day. The daily cycles are performed UNTIL 1000 over voltage periods have been applied.

5. Capacitance and loss tangent measurement
Repetition of test at Sl. No. 3

6. Over load run test
Within one hour after the end of the over voltage test, the test unit shall be exposed to not less than 1.4 UN a...c voltage for at least 500 hours. The test unit shall be placed in a still air at an ambient temperature of +15°C to 60°C.

7. Capacitance and tangent delta measurement
Repetition of test at Sl. No. 3

8. Reduce routine voltage test
Repeat of test at Sl. No. 1 at 75% of the original test voltage.

9. Final capacitance and loss tangent measurement
Repetition of test at Sl. No. 3

10. Acceptance criteria
The test unit is considered to have passed the endurance test successfully if no breakdown has occurred either in two test units out of two or two test units out of three. The capacitance measurements performed at 3, 5, 7, and 9 steps shall not differ less than an amount corresponding to either breakdown of an element or operation of an internal fuse. The variation of the dielectric loss angle evaluated by this test at 3, 5, 7, 8 and 9 steps shall not exceed beyond the limits Specified in Cl. 14 of IS: 2834-1986.11.9.5. Corporation also intends to have 'Capacitive current switching test' repeated on the circuit breaker. Contractor shall quote his charges for the test.
## TECHNICAL SPECIFICATIONS OF RSJ POLE

### 12.1.0. SCOPE

12.1.1. This specification covers the general requirements towards design, manufacture, testing at manufacturers works, supply and delivery for RSJ poles of circular cross section (swaged type) for overhead lines. Poles as per MSEDCL standard practice if circular poles are not using in Maharashtra.

### 12.2 RSJ Pole Specifications as per MSEDCL Specification No: DIST / MM / I / RSJSPEC-2006

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Requirement as per Company’s Specification</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>1</td>
<td>Designation (D x B) (mm x mm)</td>
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<tr>
<td>2</td>
<td>Length of joist-Meter</td>
<td>11m / 13m</td>
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<tr>
<td></td>
<td>With + / - 100 mm tolerance</td>
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<tr>
<td>3</td>
<td>Weight (kg / M)</td>
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<td>4</td>
<td>Sectional area (A) (Sq.cm.)</td>
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<td>Depth of section (D) (mm)</td>
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<td>6</td>
<td>Width of flange (B) (mm)</td>
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<td>7</td>
<td>Thickness of flange (Tf) (mm)</td>
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<td>Thickness of Web (Tw) (mm)</td>
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<td>9</td>
<td>Radius of fillet or root (R1)(mm)</td>
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<tr>
<td>10</td>
<td>Radius of tow (R2) (mm)</td>
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<tr>
<td>11</td>
<td>Moment of Inertia</td>
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<td></td>
<td>(i) Ixx (cm$^4$)</td>
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<tr>
<td></td>
<td>(ii) Iyy (cm$^4$)</td>
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<td>Radius of Gyration GR xx (cm)</td>
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<td>Modulus of Section</td>
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<td></td>
<td>(i) Zxx (cm$^3$)</td>
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<tr>
<td></td>
<td>(ii) Zyy (cm$^3$)</td>
<td>91.9</td>
</tr>
<tr>
<td>14</td>
<td>Tolerance in dimensions plus / minus</td>
<td>----------------</td>
</tr>
</tbody>
</table>
12.3.1 A base plate made out of CI and of size 300 mm x 300 mm x 10 mm shall be welded continuously at the pole bottom.

12.3.2 Provision for terminating the earthwire coming from the earthing station shall be made for the pole at a height of 3.0 mtr. from the pole bottom with 16 mm dia, 50 mm long G.I. bolt and G.I. washers.

12.3.3 The pole shall be erected in a perfectly vertical alignment by excavating a pit of size 0.8 mtr. x 0.6 mtr. x 2.15 mtr. deep with 1:3:6 ratio cement concrete with duly plastered plinth or muffing of width 400 mm and height of 600 mm from the ground level and of appropriate shape. The center to center distance between two consecutive poles shall be as per the I.E. rules & regulations and local Electricity Supply Authority.

12.3.4 The poles shall be subjected to surface treatment with wire brushing and cleaning prior to painting with one coat of red oxide and two coats of black bituminous paint upto 2.5 mtr. height and for remaining portion with alluminium paint of two coats.
TECHNICAL SPECIFICATIONS FOR GALVANIZED CHANNEL CROSS ARMS

13.1.0. SCOPE:
This specification covers the design, manufacture, testing at manufacturer’s works, transport to site, insurance, storage, erection and commissioning of Galvanized Cross Arm and channel used for 33 / 11 kV / 433 V OR 33 kV / 6.6 kV, Polemounted substation complete with all accessories as specified.

13.2.0. Standards
13.2.1. The Galvanized Cross Arm and channel supplied under this specification shall conform the latest issue of the relevant Indian Standards IS – 226:1975, Regulations etc. except where specified otherwise.
13.2.2. The rolling and cutting tolerance for steel product conforming to IS: 266 shall be those specified in the IS: 1852-1973 with latest revision.
13.2.3. Galvanization conforming to latest version of IS:2629
13.2.4. In the event of conforming to any standards other than the Indian Standards, the salient features of comparison shall be clearly set out separately

13.3.0. GENERAL REQUIREMENT:
13.3.1. The cross arm shall be fabricated grade of mild steel of channel section as per requirement.
13.3.2. All steel members and other parts of fabricated material as delivered shall be free of warps, local deformation, unauthorized splices, or unauthorized bends.
13.3.3. Bending of flat strap shall be carried out cold. Straightening shall be carried out by pressure and not by hammering. Straightness is of particular importance if the alignment of bolt holes along a member is referred to its edges.
13.3.4. Holes and other provisions for field assembly shall be properly marked and cross referenced. Where required, either by notations on the drawing or by the necessity of proper identification and fittings for field assembly, the connection shall be match marked.
13.3.5. A tolerance of not more than 1mm shall be permitted in the distance between the centre lines of bolt holes. The holes may be either drilled or punched and, unless otherwise stated, shall be not more than 2mm greater in Diameter than the bolts.
13.3.6. When assembling the components force may be used to bring the bolt holes together (provided neither members nor holes are thereby distorted) but all force must be removed before the bolt is inserted. Otherwise strain shall be deemed to be present and the structure may be rejected even though it may be, in all other respects, in conformity with the specification.

13.3.7. The back of the inner angle irons of lap joints shall be chamfered and the ends of the members cut where necessary and such other measures taken as shall ensure that all members can be bolted together without strain or distortion. In particular, steps shall be taken to relieve stress in cold worked steel so as to prevent the onset of embitterment during galvanizing.

13.3.8. Similar parts shall be interchangeable.

13.3.9. Shapes and plates shall be fabricated and assembled in the shop to the greatest extent practicable. Shearing, flame cutting and chipping shall be done carefully, neatly and accurately. Holes shall be cut, drilled or punched at right angles to the surface and shall not be made or enlarged by burning. Holes shall be clean-cut without torn or ragged edges, and burrs resulting from drilling or reaming operations shall be removed with the proper tool.

13.3.10. Shapes and plates shall be fabricated to the tolerance that shall permit field erection within tolerance, except as otherwise specified. All fabrication shall be carried out in a neat and workmanlike manner so as to facilitate cleaning, painting, galvanizing and inspection and to avoid areas in which water and other matter can lodge.

13.3.11. Contact surfaces at all connections shall be free of loose scale, dirt, burrs, oil and other foreign materials that might prevent solid seating of the parts.

13.3.12. Welded joints not permissible.

13.3.13. The rolling and cutting tolerance for steel product conforming to IS: 266 shall be those specified in the IS: 1852-1973 with latest revision. All dimensions are subject to the following tolerances:

A) dimensions up to and including 50mm: +1mm: and
b) Dimensions greater than 50mm: +2%

13.3.14. The channel cross arm shall be properly brushed to make it free from rust.
TECHNICAL SPECIFICATIONS FOR DISTRIBUTION TRANSFORMER

14.1.0. SCOPE
14.1.1. This section of the specifications is intended to cover requirements for design, engineering, manufacture, testing / inspection at manufacturer’s works before dispatch, forwarding, packing, transporting and delivery at site of outdoor type naturally air-cooled, 33 kV / 433-250V Distribution Transformers of capacities 250 kV A complete with all accessories / fittings and spare parts. The Contractor shall quote the price of transformer complete with first filling of oil. ([Auxiliary transformer of capacity 250 kV A is required at 33 kV capacity switch yard]).

14.2.0. BIDDING
14.2.1. Each Technical Proposal must be accompanied by each of the following information / documents with sufficient details along with other documents and information mentioned elsewhere to enable the purchaser to make an appraisal of the quality and suitability of the material and equipment offered.
(a) Type test certificates of transformer of identical design from a nationally recognized laboratory, preferably at CPRI / ERDA laboratory. The Type test certificates should not be more than 3 (three) years old. The type rest certificates should also be accompanied by the drawings of equipment tested so that the test certificates can be directly linked to the equipment offered. In this regard following points shall also be noted:
   Equipment which have not been type tested as above shall not be accepted. A promise or agreement by a Contractor to have the equipment tested after award of a contract is not acceptable.
(b) Type Test reports to be acceptable must relate directly to the equipment offered. Type Test reports for a higher class / rating of equipment are acceptable with a commitment from Contractor that the type test shall be performed free of charge on the particular equipment after the award of contract.
(c) Guaranteed and Other Particulars in the standard formats of MSEDCL / MSETCL. The bid should also be accompanied by manufacturer’s literatures and brochures.
14.2.2. Failure to meet the requirement of this Clause 4.2.0 shall render a Bid non-responsive.

14.3.0. STANDARDS
14.3.1. The Transformer and associated accessories shall conform to the latest issues of the standards as given below, except to the extent explicitly modified in this specification.

(1) CBIP manual on Transformers. Publication no 275
(2) Power Transformers IS: 2026, IEC 76
(3) Insulating oils for transformers and switchgears IS: 335
(4) Bushings for alternating voltages above 1000 V IS: 2099
(5) Creep age distance (mm) IS: 3347
(6) Outdoor Bushings IS: 3347, DIN 42531 to 33
(7) Specification for low voltage bushings IS: 7421
(8) Dimensions for clamping arrangements for bushings IS: 4257
(9) Specification for Al Wire rods IS: 5434, ASTM B-233
(10) Specification for Insulating Kraft Paper IS: 9335, IEC 554
(11) Specification for Insulating Press Board IS: 1576, IEC 641
(12) Code of practice for installation and maintenance IS: 10028 Of transformers
(13) Guide for loading of oil immersed transformers IS: 6600
(14) Paper covered Aluminium conductor IS: 6162
(15) Rectangular Electrical conductor for electrical machine IS: 6160
(16) Electrical Power connector IS: 5561
(17) Colours for ready mix paints. IS: 5
(18) Ready mixed paint, brushing zinc chromate, priming IS 104
(19) Specification for Copper wire rod IS 12444, ASTM B-49
(20) Testing for steel sheets and strips and magnetic circuits IS-649

1.1 In case equipment conforms to other international standard which ensure equivalent or better performance than that specified under Clause 16.3.1, then relevant Standards shall be forwarded with the bid.

14.4.0. GENERAL SERVICE CONDITION
14.4.1. The climatic conditions at site under which the equipment shall operate satisfactorily are as follows:-
(a) Maximum temperature of air in shade 50° C
(b) Minimum temperature of air in shade: -2° C
(c) Maximum average daily ambient air temperature 400C
(d) Maximum yearly weighted average ambient temperature 320C
(e) Maximum Humidity: 100%
(f) Average of rainy days per annum: 150
(g) Average number of days of thunderstorm per annum: 45
(h) Average number of days of dust storm per annum: 25
(i) Average annual rainfall: 2280 mm
(j) Number of months of tropical monsoon per annum: 5 (May to Sept)
(k) Maximum wind pressure: 150Kg / m²
(l) Altitude (above mean sea level): 50 to 200 m

14.5.0. GENERAL TECHNICAL SPECIFICATIONS:

14.5.1. The Distribution transformer shall be 3-phase; oil immersed and shall have core type construction, and should be suitable for outdoor service in hot and humid tropical climate.

14.5.2. The transformers and all its accessories shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding of values and duration specified in IS-2026.

14.5.3. The transformer shall be capable of being loaded in accordance with IS: 6600. There shall be no limitation imposed by bushings etc.

14.5.4. The transformer shall be capable of being operated without danger on any tapping at the rated kV A with voltage variation of plus or minus 10% corresponding to the voltage of that tapping with normal temperature rise. The design adopted to achieve this shall be indicated in detail in the offer.

14.5.5. The transformer shall be suitable for continuous operation with frequency variation of ± 5% from normal 50Hz. Combined voltage and frequency variation should not exceed the rated V / f ratio by 10%.

14.5.6. Transformer shall be capable of withstanding thermal and mechanical stress caused by symmetrical or a symmetrical faults on any winding. The calculation for the same to be submitted along with the offer.

14.5.7. Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation, which produces the following over fluxing conditions:
14.5.8. i) 125% for 1 minute or 140% for 5 seconds

16.5.9. ii) Over fluxing withstand characteristics up to 140% shall be submitted along with the bid.

14.5.10. The thermal ability to withstand short circuit shall be demonstrated by calculation.

14.5.11. The maximum flux density in any part of the core and yokes, at normal voltage and frequency of transformer shall be such that the flux density under over voltage condition as per Clause 16.5.5 above shall not exceed 1.9 Tesla.

16.5.12. Maximum Flux Density in any part of the core and yoke at rated KV A, Maximum System voltage [36 KV ]and minimum system frequency [48.5 HZ] shall not exceed 1.6 Tesla.

14.5.13. The maximum magnetizing current at 110% rated voltage shall not be more than 125% of that at 100% rated voltage. Accordingly, the operating flux density for design should be carefully chosen within the stipulated value to achieve the above requirement. The Contractor shall quote the practically achievable no load current at different percentages of rated voltage as per Guaranteed Technical Particulars which shall be verified during no load test.

14.5.14. The maximum current density in any winding shall not exceed 2.50A / sq.mm.

14.6.0. SUPPRESSION OF HARMONICS

The transformers shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave form distortion.

14.7.0. CENTRE OF GRAVITY

The centre of gravity of the assembled transformers shall be low and as near to the vertical centre line as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric relating to track either with or without oil, its location shall be shown on the outline drawing.

14.8.0. GENERAL CONSTRUCTIONAL FEATURES

14.8.1. GENERAL

14.8.1.1. All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of
temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses in any part and also without effecting the strength and suitability of the various parts for the work which they have to perform.

14.8.1.2. Similar parts, particularly removable ones, shall be inter changeable.

14.8.1.3. Pipes, screws, studs, nuts and bolts used for external connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.

14.8.1.4. Nuts, bolts and pins used inside the transformers and tap changer shall be provided with lockwashers or locknuts.

14.8.1.5. Exposed parts shall not have pockets where water can collect.

14.8.1.6. Internal design of transformer shall ensure that air / gas is not trapped in any location.

14.8.1.7. Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface incontact with oil shall not be galvanized or cadmium plated.

14.8.1.8. Labels, indelibly marked, shall be provided for all identifiable accessories. All label plates shall be of non-corrodible material.

14.8.1.9. All internal connections and fastenings shall be capable of operating under overloads and over excitation, allowed as per specified standards without injury.

14.8.1.10. Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.

14.8.1.11. No patching, plugging, shimming or other such means of overcoming defects; discrepancies or errors shall be accepted.

14.9.0. SURFACE PREPERATION & PAINTING

14.9.1. GENERAL

Refer to Clause 4.13.1, 4.13.2, of Section – 4 16.9.1.1. Of this document.

14.10.0. CORE (MAGNETIC CIRCUIT) AND CONSTRUCTIONAL FEATURES OF CORE

14.10.1. Refer to Clause No. 4.13.4, 4.13.5, 4.13.5, 4.13.6, 4.13.7, of Section-4, of this bidding document.

14.11.0. WINDING
14.11.1. GENERAL
i) The current density of copper in any part of the windings shall not exceed 2.50 Amps / Sq. mm.
ii) All windings shall be made of electrolytic high conductivity copper for transformer of capacity 250 KV A and above and shaped and braced to provide for expansion and contraction due to temperature changes. Winding shall be fully insulated as defined in IS: 2026. All neutral pointsshall be insulated for the voltage specified in IS: 2026. The winding shall be so designed that all coil assemblies of identical voltage, rating shall be interchangeable.
iii) HV winding shall be of continuous disc type.
iv) LV coil shall be spiral type winding construction.
v) Coil shall be clamped by 8 (eight) numbers of stud and the size should not be less than 20 mm.
vi) LV winding shall be such that neutral formation shall be at top.
vii) Conductor covering for HV winding shall be TPC with minimum 0.35 mm thickness and for LV conductor TPC with minimum 0.50 mm thickness.
viii) Interlayer insulation shall be Nomex / Epoxy dotted Kraft Paper.
ix) Distribution Transformers shall be designed to withstand the impulse and power frequency test voltages as per IS: 2026.
x) Magnitude of impulse surges transferred from HV to LV windings by induction and capacitance coupling shall be limited to B.I.L. of LV winding.
xi) The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied ineither vacuum oven or in the transformer tank
xii) Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage inservice.
xiii) Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.
xiv) Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or
other adhesive be used which shall seal the coil and prevent evacuation of air and moisture and impregnation by oil.

xv) The winding shall be designed to reduce to a minimum, the out-of-balance forces in the transformers at all voltage ratios.

xvi) The insulation of transformer windings and connection shall be free from insulating composition liable to soften, ooze out, shrink or collapse during service and be non-catalytic and chemically inactive in transformer oil.

xvii) The coil clamping arrangement and the finished dimensions of any oil ducts shall be such as shall not impede the free circulation of oil through the ducts.

xviii) Terminals of all windings shall be brought out of the tank through bushings for external connections.

xix) The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.

xx) All leads from windings to terminals shall be rigidly supported to prevent injury from vibration. Guide tubes may be used where possible.

14.11.2. BRACING OF WINDINGS

14.11.2.1. The windings and connections of all transformers shall be braced to withstand shocks, which may occur during transport or due to switching and other transient conditions during service.

i) Coil clamping rings shall be of suitable insulating material.

ii) Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

iii) Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turns shall have additional protection against abnormal line disturbances.

iv) Coil should be clamped by 8 (eight) numbers of 20 mm dia tie rods between top and bottom yoke support channels.

14.11.3. BOLTS AND NUTS

14.11.3.1. Steel bolts and nuts exposed to atmosphere with suitable finishes like cadmium plated or zinc plated passivity shall be used for diameter above 6 mm.
14.11.3.2. Brass bolts and nuts of less than 6 mm shall not be used for electrical connections. Where smaller size is required, stainless steel or phosphor bronze may be used. Sizes and threads shall be as per Indian Standard, wherever, available, other wise equivalent British Standard shall be followed.
14.11.3.3. All nuts and bolts and pins shall be locked in position with the exception of those external to the transformer. The bolts shall be fitted in such a manner that in the event of the nut working loose and falling off, the bolts shall remain in position.
14.11.3.4. All bolts, nuts and washers in contact with non-ferrous parts which carry current and are exposed to atmosphere shall be of phosphor bronze, where transfer of current is through bolts.
14.11.3.5. If bolts and nuts are placed that are in accessible by means of ordinary spanners, suitable special spanners shall be provided by the supplier.

14.12.0. INSULATION MATERIAL:
14.12.1. Electrical grade insulation epoxy dotted Kraft Paper / Nomex and pressboard of standard make or any other superior material subject to approval of the purchaser shall be used.
14.12.2. All spacers, axial wedges / runners used in windings shall be made of pre-compressed Press board solid, conforming to type B 3.1 of IEC 641 – 3 – 2. For cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulationshearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations.
14.12.3. Insulating Oil
14.12.3.1. Refer to Clause No. 4.13.10, of Section-4 of this bidding document.

14.13.0. ACCESSORIES & FITTINGS
14.13.1. BUSHINGS:
14.13.1.1. The bushing shall conform to the relevant standards specified and shall be of outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for HT bushings. The test as per latest IS: 2099 and IS: 7421 shall be conducted on the transformer bushings.
14.13.1.2. The HV side shall be protected by HRC fuse and the fuse shall be kept prior to bushings. The termination of both the LV and HV bushing shall be through XLPE cable of appropriate ratings.
14.13.1.3. Both HV and LV side bushings shall be mounted horizontally and shall be covered steel sheet of minimum 3.15 mm. The protection class of cover shall be IP55 grade.
14.13.1.4. For protection of LV side, appropriate ACB / MCCB shall be mounted inside the LV bushings outercover and necessary arrangement shall be made for terminations of LV side outgoing cables.
14.13.1.5. The LV side bushing should be of epoxy type conforming to relevant standards.
14.13.1.6. For 33 kV, 36 kV class bushing and for 0.433 kV, 1.1 kV class bushing shall be used.
14.13.1.7. Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS: 4257.
14.13.1.8. Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as per relevant standards
14.13.1.9. Brazing of all inter connections; jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section-IX.

14.13.2. TERMINAL CONNECTORS
14.13.2.1. HV side terminal arrangement shall be connected by ACSR WOLF conductor. Connector shall be of universal type.
14.13.2.2. For LV side of 1600 MVA, terminal arrangement shall be designed to accommodate 4 nos. 1-coe 1000 mm2 XLPE cable in one phase and total gland shall be 21 nos.
14.13.3. Earthling Terminal
14.13.3.1. Two earthling pads (each complete with two nos. (2) tapped holes, M 8 bolts, plain and springwashers) suitable for connection to 40x6 mm galvanized steel flat shall be provided each at position close to the two (2) diagonally bottom corners of the tank.

14.14.0. PROTECTION & MEASURING DEVICES
14.14.1.1. The conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of the expansion of the total cold oil volume in the transformer from minimum ambient temperature to 90°C. The total volume of conservator shall be 10% of total oil in the transformer.
14.14.1.2. The conservator feed pipe shall be extended 25 mm upwards from the conservator bed so that a sump is created and the design of feed pipe to transformer tank should be such that the oil from conservator does not fall directly to the core & coil assembly.
14.14.1.3. The conservator should have one oil filling hole of 32 mm size with casketed cover. One air release plug of 15mm size shall be required.
14.14.1.4. The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.
14.14.1.5. The conservator tank shall be fitted with prismatic oil level gauge with minimum and maximum marking.
14.14.1.6. The conservator tank shall be provided in a position not to obstruct the electrical connections to the transformers.
14.14.1.7. Conservator tank shall be fitted with dial type MOLG for rating 1.6MVA.
14.14.2. Pressure Relief Device
14.14.2.1. Pressure relief device shall be provided at suitable locations which shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to the equipment. The device shall operate at the static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted directly on the tank.
14.14.3. Oil Preservation Equipment
14.14.3.1. Conservator shall be fitted with Air Cell for rating 1.6 MVA with two numbers 8mm air release valve.
14.14.3.2. Air Cell healthy alarm is required; as such device to detect failure of air cell is to be fitted.
14.14.4. Oil sealing breather
14.14.5. The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that
   i) Passage of air is through a dust filter & Silica gel
   ii) Silica gel is isolated from atmosphere by an oil seal.
iii) Moisture absorption indicated by a change in colour of the crystals can be easily observed from a distance.
iv) Breather is mounted not more than 1200 mm above rail top level.
v) The breather should have at least 3000g of silica gel per KL of oil.

14.14.6. BUCHHOLZ ELAY
14.14.6.1. Buchholz relay with alarm and trip contact shall be provided for transformer rating 1.6 MVA.

14.15.0. RADIATORS & VALVES
14.15.1. Radiators shall be of press steel having thickness of 1.2 mm Cold Rolled Continuously Annealed(CRCA) sheet. And design should be such that all painted surface can be thoroughly cleaned by hand
14.15.2. VALVES
14.15.2.1. One no. 50 NB valve for oil filtration and 32NB valve for 250 KV A transformers.
14.15.2.2. One no 50 NB bottom drain valve and 32NB valve for 250 KV A transformer.
14.15.2.3. Radiators shall be connected through appropriate size of butterfly valve.
14.15.2.4. 8 mm valves for top and bottom oil sampling to be fitted.
14.15.2.5. 15 mm air release plug at the top cover.
14.15.2.6. 15 NB bottom valve for sludge removal.
14.15.2.7. Valves shall be of Gun metal.

14.16.0. FITTINGS AND ACCESSORIES
14.16.1. The following fittings shall be provided on each transformer
a) Conservator fitted with oil filling hole and cap.
b) Air cell for transformer rating 1.6 MVA.
c) MOLG for conservator
d) Oil and Winding dial type temperature meter with alarm and trip contact for transformer rating 1.6MVA.
e) Buchholz relay for rating 1.6 MVA
f) Prismatic type oil gauge
g) Silica gel breather with oil seal.
h) Pressure relief device for main tank.
i) Pocket on tank cover (placed at mid position) for thermometers.
j) Compensation CT for winding temperature.
k) Clamps for HV side LA with earthling strip.
l) Oil level indicator for transformer tank.
m) Valves:- as referred to Clause No. 16.15.2
n) Earthling terminals with lugs- 2 nos.
o) Rating and diagram plate, non-detachable.
p) Lifting lugs for main tank and top cover.
q) Inspection covers.
r) Terminal connectors on the HV / LV bushing
s) Bi-directional flanged rollers with locking and bolting device.
t) Base channel
u) IP 55 protected 3.15 mm sheet steel Marshalling box with gland plate, Paint shall be polyurethane.(For 1.6 MVA)
v) Foundation bolts for wheel locking devices of Transformer shall be supplied by the Supplier
w) Rating Plate.

**DRAWING AND APPROVAL FROM ELECTRICAL INSPECTOR**

The Contractor shall get approved the required drawings from the concerned Electrical Inspector before commencement of the work. The Contractor shall furnish drawings, data and any other details, information required by Electrical Inspector and to arrange for his inspection, payment of fees to obtain Electrical Inspector’s Clearance Certificate. Work shall be commenced and carried out only after obtaining necessary approval of relevant drawings from Electrical Inspector of the & region. Prior intimation shall be given to the Electrical Inspector about commencement of work After completing the work as per approved drawing, approval from the Electrical Inspector shall be obtained before charging the installation.
SECTION- VII
PRESSURISED DISTRIBUTION NETWORK
SECTION- VII: PRESSURISED DISTRIBUTION NETWORK

PIPE DISTRIBUTION NETWORK

All pipes for main pipe line, ie. Pump house to first node shall be of MS / DI. All pipes having diameter above 600 mm to be used for distribution network from main to sub chak of 3 Ha shall be of MS / DI / HDPE. For Pipes of diameters 110 to 500 mm, HDPE pipes (PN6 or above as per actual Design) shall be used. Upto Outlet Management System (OMS), HDPE pipes of 110 mm or more shall be used. For pipes less than 110 mm diameter below OMS, PVC pipes of approved quality shall be used.

SPECIFICATIONS FOR MILD STEEL PIPES (M.S. PIPES) FOR PDN

1.0 SCOPE OF WORK


2.0 APPLICABLE I.S CODES & ISO CODES

The following specifications, standards and codes are made a part of the specification. All standards, tentative specifications, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern.
<table>
<thead>
<tr>
<th>SR NO</th>
<th>I.S.CODE</th>
<th>NAME OF IS CODES</th>
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<tbody>
<tr>
<td>1</td>
<td>IS: 2062:2011</td>
<td>Specification for Hot Rolled Medium and High Tensile Structural Steel</td>
</tr>
<tr>
<td>3</td>
<td>BS: 639</td>
<td>Specification for Covered electrodes for manual metal arc welding of mild steel and medium tensile steel.</td>
</tr>
<tr>
<td>5</td>
<td>IS: 2074:1992</td>
<td>Specification for Ready Mixed Paint, Air Drying, Red Oxide Zinc Chrome and Priming</td>
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<tr>
<td>7</td>
<td>IS: 1786:2008</td>
<td>Specification for High strength Deformed Steel Bars and wires for concrete reinforcement</td>
</tr>
<tr>
<td>8</td>
<td>IS: 432:1982 (Part -I)</td>
<td>Specification for Mild Steel Medium Tensile bars and hard drawn steel wire for concrete reinforcement : Mild Steel and medium tensile steel bars</td>
</tr>
</tbody>
</table>
Vidarbha Irrigation Development Corporation, Nagpur

welders. (Manual Metal Arc Welding)


25 IS: 3600:1985 (Part-2) Destructive test on welds in metallic materials :Transverse Tensile Test


32 IS: 4853:1982 Recommended Practice for Radiographic Examination of Fusion Welded Butt Joints In Steel Pipes.

33 IS: 3589:2001 Specification for Steel pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter).

Note: The provisions of various clauses of the above IS
code are deemed to be applicable to diameters above 2540mm as well.

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<td>38</td>
<td>IS: 5822:1994</td>
<td>Note: The provisions of various clauses of the above IS code are deemed to be applicable to diameters above 2540mm as well.</td>
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<tr>
<td>40</td>
<td>IS: 808:1989</td>
<td>Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections</td>
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<td>42</td>
<td>IS: 3664</td>
<td>Code of Practice for Ultrasonic Pulse echo testing by contact and immersion methods.</td>
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<td>43</td>
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<td>48</td>
<td>I.S.4736-1986</td>
<td>Hot-dip Zinc Coatings on Mild Steel Tubes</td>
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<td>49</td>
<td>I.S. 9595-1980</td>
<td>Metal Arc Welding of Carbon and Carbon Manganese</td>
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3.0 SPECIFICATIONS AND REQUIREMENTS OF PIPES

3.1 MATERIALS

a) Steel Plates - The steel plates for pipes, fittings, specials and stiffeners shall be of mild steel grade Fe410 conforming to IS 2062:2011. All the materials shall be procured from reputed manufacturers such as JINDAL, SAIL, ESSAR, ISPAT, and TISCO.


c) Cement - The cement used shall be of one of the following:
   i) Ordinary Portland Cement conforming to IS 269:1989
   ii) Ground granulated blast furnace slag cement conforming to IS 12089:1987
   iii) Sulphate Resisting Portland Cement Conforming to IS 12330:1988

d) Aggregate - The aggregates shall conform to IS 383:1970

e) Water - The water used in preparation of concrete mix shall conform to the requirements of mixing water given in IS 456:2000

f) Steel for Reinforcement shall conform to IS 1786:2008

g) Before fabrication of pipes and specials / fittings is commenced, the original mill sheets and the manufacturer's test certificates for plates and other materials for the fabrication shall be submitted by the Contractor to the Engineer for his approval. When requested by the Engineer in charge, the Contractor shall supply, free of charge to the Employer, for testing in approved laboratory, suitable sample of the materials to be used / used in the works. The cost of such tests shall be borne by the Contractor and shall be included in his item rates.

The contractors shall provide sufficient separate stacking yard for the steel materials, fabricated pipes, and specials scrap in their factory as per the requirements. Size of plates will be measured in millimetres.

The Contractor shall procure plates and other structural steel required for fabricating pipes / specials considering the wastage / scrap etc. and rate quoted shall be inclusive of wastage / scrap etc. The Contractor should note that no claim will be considered on account of scrap wastage / scrap etc.

3.2 WORKMANSHIP / APPEARANCE

All pipes and specials shall be manufactured out of steel plates which shall be free from any Cracks, surface flaws, laminations, excessive pitting or any other
defects. The pipes shall be truly cylindrical and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter / dismantling joint with fixed outer diameter shall not deviate from theoretical one by more than 1mm. To obtain the accuracy the pipe shall be rolled several times, if necessary, as pipe pieces should be truly cylindrical. The external longitudinal welding of this pipe shall be ground smooth flush with surface to the satisfaction of the Engineer in charge. No extra cost shall be charged by the Contractor for this grinding work.

Minor repair by welding or otherwise shall be permitted at the discretion of the Engineer in charge, but such repairs shall be done only after obtaining the previous permission of the Engineer in charge. Any pipe or part thereof which develops injurious defects during shop welding or other operations shall be rejected.

4.0 MANUFACTURING

4.1 MANUFACTURING OF M.S. PIPES

4.1.1 Fabrication of Pipes

The Contractor shall get the fabrication work done in a duly valid licensed factory of his own or that of a nominated sub-contractor. The fabricator shall have all valid licenses for their factory as required by the local authorities / govt bodies. The fabricator shall furnish a list of their staff with qualification and experiences. Necessary certificate in support of performance mentioned in the tender shall be enclosed in this bid. The factory shall be ISO 9001:2008, ISO 14001:2004 and OHSAS 18001 approved. This factory meant for fabrication pipes, specials etc. shall also be involved with testing etc., machining as well as painting. For completing the work under the present contract within the contract period, the factory shall be equipped with adequate number of following equipment and plant but not restricted to:

i) Plate bending machines for rolling of pipe drums
ii) Automatic welding machines suitable (suitable for circumferential as well as longitudinal welding).
iii) Hydraulic Testing Machines
iv) Travelling gantry or crane of suitable capacity
v) Mobile cranes for loading / unloading of plates, pipes etc.
vi) Lathe for machining of the flanges rings, plates and expansion joints.
vl) Channel bending machine of adequate capacity for manufacturing ring girders.
vlill) Equipment for sand blasting and applying paint by spray gun.
ix) Equipment for cold pressing of plates upto 50 mm thick to the required curvature (domes, plug plates, M.H. cover etc.

x) Fully equipped in-house laboratory to carry testing such as bend test, tensile test, Ultrasonic test, Welded Joint Test etc. The laboratory shall possess a universal testing machine for testing mechanical properties, Ultrasonic testing machine with all supportive infrastructures. All the tests shall be conducted in-house in the presence of Municipal staff.

xi) Any other, considered necessary for carrying out the work covered in scope.

The factory shall have adequate area, and shall also have stacking yard for the stacking of plates, structural, fabricated pipes etc. and the scrap.

The Bidder shall furnish with his bid the details of the factory where he intends to get the fabrication done, such as it's location and the equipment, plant and other facilities available in the factory for the manufacture of Pipes and Specials required under this contract.

Specials and other fabricated items shall include the following:-

A- One piece degree cants, composite bends, pipe, pieces with fixed outer diameter.
B- Tapers-concentric and eccentric i.e. level invert tapers.
C- Expansion joints with protective cover
D- Ring girder and stiffener ring channels
E- Ring girder supports, rollers, bridge box covers or rollers
F- Saddle pieces
G- Stiffener Rings
H- Pressure and non-pressure blank flanges
I- Ladders
J- Platforms scour valves, air valves, expansion joints
K- Protective covers for scour valves, air valves, etc
L- By-pass assembly
M- Tee branches
N- Y branches- symmetrical as well as unsymmetrical
O- Dish closures such as domes
P- Dish closures such as flat and dished manhole covers
Q- Flange rings
R- Plug Plates
S- Any odd size or shape specials not covered by above items.

4.1.2 Cutting Plates to Size

The plates shall be indented in such length as to have minimum wastage and so as to make the drums with one longitudinal joint. Contractor shall note that pipes up to the size of 3500mm diameter shall have one longitudinal joint and for pipes above 3500mm and up to 5400mm the contractor will be permitted to have more than one longitudinal joint. Before cutting, all the edges of the plates shall be cleaned by brushing / grinding on both the sides.

The plates shall be cut on all four sides to the exact dimensions and shape required, by a suitable plate cutting machine such as oxy-acetylene cutting machine or a guillotine. Plates shall be cut accurately to the required length with a tolerance of not more than plus or minus 3mm in length and width. The plates shall be given a bevel at the edges wherever necessary, depending upon the type of welding machine to be used by the contractors. The ends of the finished pipe in the factory shall necessarily have bevel edge or v edge with or without shoulder cut / root face to facilitate hand welding in the field. As field welding is to be carried out from inside in the case of bigger diameter pipes i.e. 1200mm and above the bevel for them shall be usually from inside. For pipes of smaller diameter, field welding shall be done from outside and the edges as a rule have bevels to suit welding from outside. The
Engineer may at his discretion make changes, in this respect and order external bevelling for bigger pipes and internal bevelling for smaller pipes. Where the automatic welding machines in the factory have sufficient penetration, the edges of the plate shall have a square cut. The type of joint to be adopted in the factory shall depend upon the welding machines and the method of welding to be adopted. Details such as current, voltage, flux, etc shall be decided after carrying out experimental welding and testing the samples cut out of it. The entire costs of all such preliminary experiments shall be borne by the contractors.

After the plates are cut, the edges shall be made smooth and even by polishing with an electrical or pneumatic grinder to remove all inequalities. Care shall be taken to see that the cut edges of the plate are perfectly straight. Jigs to be used for this purpose shall depend upon the types of cutting machine used. The plates cut to the required shape shall be checked for correctness before they are rolled into pipe drums. If any corrections are required, the Contractor shall do the same by re-cutting, if necessary. If any plate or flat is found to be warped, to have corrugations, the defects shall be removed by putting the plate or flat into a roller press, and no extra payment for this rectification work shall be made. The laminated or corroded plate shall not be used in the manufacturing of the pipe.

4.1.3 Rolling of Plates

The plates cut to the exact size shall be put into a rolling machine to form a pipe of the required diameter. The Contractor shall adjust the rolling machine so as to give a uniform curvature to the pipe throughout its circumference. The curvature obtained shall be checked by the Contractor's foreman during the process of rolling and if proper curvature is not obtained at any place including the ends, the rolling operation shall be repeated at this stage or even after the longitudinal welding of the drum where directed. Heating of plates to obtain the desired curvature shall not be permitted.

4.1.4 Tacking the Drums

The rolled drums shall be kept on an assembly platform for tacking, care being taken to ensure that the tacked drums have their end faces at right angles to the
axis of the pipe. While tacking the drum, a gap of 2 mm to 4 mm shall be maintained, where hand welding is permitted. However, where the welding is to be done on automatic welding machine, there is no need of maintaining such gap depending on the penetration through complete thickness of the welding required. To achieve this objective, clamp spiders, tightening rings and or any other approved gadgets shall be used. Each such drum, before being taken to the assembly platform, shall be numbered on the inside with oil paint, stating the plate thickness as well.

4.1.5 Assembly of Drums into Pipes

The tacked drums shall then be transported to an assembly platform where they shall be tack welded together to form suitable pipe-lengths. Plate shall be bent in the maximum possible width to reduce the number of circumferential joints.

The longitudinal joints shall be staggered at 90°. The drums when tacked together shall have no circumferential gap when the welding is done on automatic welding machine. But when hand welding is adopted as gap of 2 mm to 4 mm shall be maintain, to obtain a good butt welded joint.

The assembly shall be truly cylindrical and without any kinks. The faces shall be at right angles to the axis of the cylinder. A suitable arrangement for testing the correctness of the face shall be provided by the Contractor at the assembly platform.

4.2 WELDING

All components of a standard pipe shall be welded, wherever possible by use of submerged arc welding machine for full welding. The circumferential as well as longitudinal joints shall be welded on this machine. Hand welding shall not be permitted except for sealing runs and such other minor works at the discretion of the Engineer. The strength of the joint shall be at least equal to that of the parent material.
The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and the type of joint. It shall also use with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer in charge shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds.

All the shop and field joints shall be welded, all welding shall conform to the requirements of IS 823:1964 and IS 4353:1995.

All longitudinal and circumferential joints shall be double welded butt joints. Due to non accessibility of both side welding, field girth joints shall be accomplished using back up plates.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surfaces of plates match to provide streamlined joints without alteration in the internal diameter. As far as practicable, welding of dissimilar thickness of shells shall be carried out in the shops.

The welding shall be of the best workmanship free from, flaws, burns, etc. and the Contractor shall provide for his own, electrodes and equipment, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall be tested by the Contractor before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operation shall conform to the requirements of IS 7307:1974 and IS 7310:1974. Periodical tests as regards their efficiency shall also be taken at an interval of about 6 months and those found inefficient shall be removed from the job; only those who pass the test, shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully, checked by X-ray in addition to the regular X-ray inspections. The defects if any, shall be set right to the satisfaction of the Engineer. All such check tests
and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Site welds shall be done by specially selected welders.

The welded joint after welding should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal, and is to retain its original ductility. No allowance will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate.

Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer for his approval the "welding procedure" he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer for his approval. Manual welding shall be adopted for specials only.

4.2.1 Fabricating of Specials in Fabrication Shop

Specials, such as tees, Y-Pieces, bends, tapers, dished ends shall necessarily be in steel and shall be manufactured as per standards and tested in the same manner as the pipe. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have the same strength as the pipeline to which they are to be joined.

4.2.2 Pre-heating of Plates

The metal adjacent to weld shall be preheated where thickness of plate exceeds 32 mm but less than 38 mm so as to reduce the cooling rate of welding, to obtain tough deposit of metal and to prevent development of cracks.

4.2.3 Thermal Stress Relieving
All heavy and rigid parts, specials such as shell piece with manholes, when the nominal thickness of the plates is more than 38 mm and when the welded joints connect plates of different thicknesses they shall be thermally stress relieved. Stress relieving shall be done in a suitable furnace. Where this is not possible then stress relieving may be done by induction coil heating method. No stress relieving for joints in steel pipes is required where thickness of plates is 32 mm or less. For thicknesses between 32 mm and 38 mm, the joints shall be preheated before welding as stipulated in IS 5878 part-6.

4.2.4 Tolerance

The shell in the completed work shall be substantially round. The difference between maximum and minimum inside diameters at any cross section shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm. Machined parts shall be within the following limits:

a) For mitred finished surface = + 20 minutes of arc  
b) For elbow angles = + 20 minutes of arc  
c) For length of elbow pieces = + 6 mm

Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane. There shall be no negative tolerances on specified thicknesses of various types of steel materials used for this work.

4.2.5 Extra Cutting and Welding

In course of work, the Contractor may be called upon to either cut steel Plates, pipes and specials etc. or carry out certain welding jobs which are not covered by other fabrication items of the Bill of Quantities. Such special jobs shall be paid for separately, under relevant items.

After cutting the edges shall be made smooth and even by the use of electrical or pneumatic grinders so as to remove all inequalities. Care shall be taken to see
that the shape of the materials cut, is not deformed in any way at the time of cutting.

Welding may be done either by electric arc welding or by gas welding and payment shall be per meter of pipe length welded. The Engineer in charge shall specify the leg length in case of lap joints required for each job as well as the gauge of the electrodes to be used.

4.2.6 Gas Cutting

In the course of the work, the Contractor may be called upon to cut steel pipes, specials, etc. on site. Gas cutting shall be adopted for preparing on site, distance pieces, straps, etc. cutting out holes in the pipeline laid for manholes, scour valves, air valves and other appurtenances, holes required for blast cleaning operation, cutting of pipe faces to form kinks or bends, holes required for bye-pass arrangement.

After cutting, the edges shall be made smooth and even, by using electrical or pneumatic grinder so as to remove all inequalities. Care shall be taken to see that the item is not deformed in any way at the time of cutting. The ends of the pipe shall have bevel edges or ‘V’ edges to facilitate hand welding. As field welding is to be carried out from inside in the case of pipes of diameter 1200 mm and above, the bevel shall be from inside. For pipes of smaller diameter, as field welding has to be done from outside only, the edges of pipes shall have bevels to suit the above.

4.2.7 Blank Flanges

Blank Flanges shall be provided at all ends left unattended for the temporary closure of work,
and also for commissioning a section of the pipe line or for testing the pipeline laid. For temporary Closures, non pressure blank flanges consisting of mild steel plates, tack welded at the pipe ends may be used. For pipes subjected to
pressures, the blank flanges domes suitably designed as per Engineer’s requirement shall be provided.

**4.2.8 Stiffener Rings**

The stiffener rings shall have to be provided wherever directed. The contractors shall weld the same to the pipes with one circumferential run on each side. The pieces of the rings shall also be welded to each other as directed.

If the stiffener rings are fixed in position after the pipes are lowered into the trench, the welding of the stiffener rings shall be carried out in the same welding pit excavated for the field joints and therefore no extra payment will be made for the excavation of the pit for welding of the stiffener ring. Stiffener rings shall be paid on MT basis and welding under relevant item for field welding.

**4.2.9 Straps**

Wherever pipe laying work is done from two faces and / or has to be done in broken stretches due to any difficulty met with at site, the final connection has to be made by introducing straps to cover gaps up to 300mm in length. Straps shall also be provided as per the procedure of fixing expansion joints by the method described in clause 2.8.6 under “Above-Ground Pipelines”. Such straps shall be fabricated in the fields by cutting pipes, slitting them longitudinally or slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have its inside diameter equal to its outside diameter of the pipe to be connected. A minimum lap of 80mm on either ends of the pipe shall be kept and fillet welds shall be run both internally as well as externally for circumferential joint. In case of pipes 900mm dia and below internal fillet weld may not be provided if so permitted by the Engineer in charge. The longitudinal joints of the collar shall be butt-welded. All fillet welds shall have a throat thickness of not less than 0.7 times the width of weldings.

**4.2.10 Radiography of Welded Joints**

**4.2.10 A) General**
Shop welds in pipes, specials shall be radiographed as per requirements mentioned below: As soon as practicable, after welding is done minimum 15% (fifteen percent) length of the weld at random for each pipe shall be radiographed, to detect welding defects as per the requirement of IS 2598:1966 and as directed by the Engineer. This 15% sampling will be at random but ensure 100% coverage of junctions of longitudinal and circumferential joints. If the results of such radiography fail to conform to the requirements, the Contractor shall carry out as directed additional or 100 percent radiography test for the pipe at the Contractor’s cost to the satisfaction of Engineer.

The provision for conducting radiography shall apply to pipes of diameter 1200mm and above.

For specials like bends, tapers, tees and Wyes radiography test shall be conducted for 100 percent length of welds.

The weld ripples or weld surface irregularities, on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect.

The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment. The radiographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Engineer to identify the defect and determine those which must be removed. Defects that are not acceptable shall be removed by chipping; machining or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer based on the latest standards prescribed by Indian Standard specification.

All X-ray shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be readily
accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable Xray viewing equipment. X-ray films shall be properly maintained by the contractor and shall be handed over to the department on completion of the Contract. All films shall be identified by the No. and chart prepared indicating location of the joint each X-ray photo represents. In the event of additional radiographic inspections required of any work associated with the pipe erection, such inspection shall be performed by the Radiographer at the discretion of the Engineer.

4.2.10 B) Radiographic Inspection of welded joints

All welded joints to be radiographed shall be examined in accordance with
IS 2595:2008-Code of Practice for Radiographic Testing

IS 4853:1982-Recommended Practice for Radiographic Examination of Fusion Welded Circumferential joints Steel Pipes.

IS:1182:1983-Recommended Practice for Radiographic Examination of Fusion Welded Butt-joints

The reinforcement on each side of all butt welded joints shall not exceed 1.5 mm.

A complete set of radiographs and records as described in IS: 2595:2008 Clause 14, for each job shall be retained by the Contractor and kept on file for a period of at least five years.

Radiographers performing radiograph shall be qualified in accordance with SNT-TC-1A.
Supplements and Appendices “Recommended Practice for Non-destructive Testing Personnel Qualification and Certification” published by the American Society for Non-destructive Testing as applicable for the technique and methods used.
Final acceptance of radiographs shall be based on the ability to see the prescribed penetrometer image and the specified hole.

Sections of welds that are shown by radiography to have any of the following types of imperfections shall be judged unacceptable and shall be repaired.

(a) Any type of crack, or zone of incomplete fusion or penetration,

(b) Any elongated slag inclusion which has length greater than 6 mm,

(c) Any group of slag inclusion in line that have an aggregate length greater than thickness in a length of 12 times thickness, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group,

(d) Rounded indications in excess of that specified by the acceptance standards given earlier.

4.3 CLEANING AND EXTERNAL PAINTING OF PIPES & SPECIALS

4.3.1 General
The fabricated pipes and specials shall be painted externally with Primer, one coat of red oxide of iron paint and covering coat of Grey graphite where they will be exposed after erection. But those pipe surfaces which are to be embedded in concrete shall be provided with cement wash in the shop on their exterior surface.

4.3.2 Material
Zinc rich epoxy primer and Heavy Duty bitumen paint (Inertol 49W or equivalent) conforming to the following specification shall be used for painting. Each lot of the paint supplied shall be accompanied by the certified copies of the results of the tests carried out by the manufacturer.

If any sample of the Paint and / or primer is not conforming to the specification, the entire consignment to which the sample way pertain shall be rejected. Only
those primers and painting materials that have been approved by the Engineer / Owner in writing shall be used for this work.

4.3.3 Primer
The primer shall be of Zinc Rich Epoxy type conforming to the specifications given below:

Specification for Zinc Rich Epoxy Primer

1) Description Two pack Zinc Rich consisting of -

i) Base Fine Zinc Dust Ground in Epoxy Resin Solution, supplied in paste form.

ii) Catalyst Abduct Type - The non-volatile portion of the material (mixed) should consist of 92% Zinc Dust and 8-10% Resin and curing agent.

2) Shade Grey

3) Characteristics: - The paint shall provide a complete rust inhibitive barrier coating of high mechanical and abrasion resistance. The film shall be compatible for fusion and spot weld.

4) Pot Life 4 – 6 Hours

5) Covering capacity 8-10 sq.m / litre per coat giving a film thickness of one mil.

6) Mixing Ratio: - The proportion of mixing base and hardener should be as specified by the Manufacturer by weight and volume. The mixed primer shall conform to the specifications detailed under Clause 2.7.1003 (1) to (8).

7) Viscosity of ready Mixed Paint 15-22 in Fort Cup No.4 at: 30° C

8) Drying Time Dust Free – 10- 15 minutes Chamber curing – 24-48 hours.

9) Procedure:-
a) Blaser:- steel surface of the pipes shall be cleaned of duct and grit and shall be primed immediately following cleaning. The surface shall be dry at the time the primer is applied during rain or fog unless protected from weather by suitable housing and subject to the permission of the Engineer. The primer shall be applied by hand spraying and shall be in accordance with the instructions for application as supplied by the manufacturers. The Priming coat shall be uniform and free from floods, runs, sags, drips or bare spots, Any bare spots shall be recoated with an additional application of the primer. All runs, sag, floods or drips shall be removed or all such defects shall be remedied by reblasting and repriming at the discretion of the

b) Application of Zinc Rich Primer: - The primer shall be Prepared as follows:
The primer shall be prepared in the manner and proportion as specified by the manufacturers as mentioned under Clause 2.7.1003 a). However, the mix primer shall conform to the specification as mentioned in Clause 2.7.21 (1) to (8). The mix of Zinc Rich Epoxy primer shall be prepared 15 minutes before applying on the Works site.One coat of Zinc Rich Epoxy primer shall be applied by spray right up to the edge of the pipe giving a film thickness of approximately 1 mil

c) No thinner should be added to the ready mix paint without the previous written approval of the Engineer. Though the priming coats become dust free dry in 10-15 minutes, the finishing coats shall on be applied after allowing the film to cure at least for 48 hours.

e) Shade after application :-) Grey.

4.3.4 Specifications for Red Oxide of Iron Paint

1. Composition

| (a) | Mixed Pigment Dry | 55% + 2% |
(b) Volatile Not more than 5 %

(c) Drier These may be added when necessary in order that the paint may confirm requirements. Such drier shall not contain volatile matter other than turpentine or white spirit; The drier shall be linoleat or napthenate. Tesinate drier shall not be used.

(d) Linseed oil The remainder.

2. Pigment:- The red oxide of iron shall contain not less than 70% of Ferric Oxide (Fe2O3) and shall be free from acid, water soluble salts and all other impurities.

3. Linseed Oil:- The linseed oil shall be of genuine quality prepared from linseed, free from turbidity in water. It shall be of such quality so as to become dry within 8 hours and form a film free from being sticky.

4. Thinners:- The thinners used shall either be turpentine or white spirit of standard quality as approved by the Engineer.

5. Weight:- The minimum weight in kg / 10 litres of paint shall be 15.5 kg within ±3%.

4.3.5 Specification for Covering Coat (Graphite paint)
1. Composition

(a) Mixed Pigment Dry Not less than 45%

(b) Volatile Not less than 10%
2. Pigment:- The pigment shall contain not less than 50% of white lead and 40% of graphite as per IS: 62/50, the balance being barytes (Pure graphite being 24% min.)

3. Linseed Oil:- The linseed oil shall be of genuine quality prepared from linseed, free from turbidity, sediments undissolved in water. It shall have a specific gravity between 0.981 and 0.942 at 30°C. It shall be of such quality so as to become dry within 8 hours and form a film free from being sticky.

4. Thinners:- The thinners used shall either be turpentine or white spirit of standard quality as approved by the Engineer.

5. Weight:- The weight of one litre of paint shall not be less than 1.5 kg and not more than 2.1 kg.


7. Remaining:- Clauses shall be as per the General specifications as stated above.

4.3.6 Inspection and Testing of Zinc Rich Epoxy primer / Red Oxide of Iron Paint and Grey Graphite

(a) Primer
i) Each lot of primer and heavy duty paint supplied shall be accompanied by certified copies of the results of the tests carried out by manufacturers.

ii) The entire procedure of applying the paint as specified shall be rigidly inspected right from blast cleaning stage to the application of the final coat. If, at any time, it is found that the procedure of applying the paint is not as per the standard laid down, all such painting work shall be rejected.

iii) Samples of the paint brought by the Contractor shall be sent to the Testing Laboratory, as directed by the Engineer, for testing as specified. If any sample as found to be not conforming to the specifications, the entire consignment to which the sample may pertain shall be rejected. Samples shall be taken at intervals at the option of the Engineer. The entire cost incidental to such testing, such as the cost of the paint, cost of prescribed testing charges and cost of the transport, etc., shall be deemed to be included in the rates quoted by the Contractor for painting.

(b) Red Oxide of iron Paint, Grey Graphite
One sample from each consignment of paint consisting of 50 drums or less shall be taken by the Engineer and got tested in an approved Laboratory. If the test is satisfactory, the consignment shall be passed for use. If it fails, two more samples from two other separate drums shall be taken for test and the consignment shall be accepted for use provided both samples are found satisfactory. In case one or both of the later two samples fail in the test, the whole consignment of the paint shall be rejected and all the rejected tins of paint shall be marked “Rejected” on the lids with paint. The Contractor shall remove the entire consignment of the rejected paint from his works within three days of such intimation from the Engineer. If the rejected consignment is not so removed within the specified time, the Engineer may remove the same to any Municipal Stores in Greater Mumbai at the Contractor’s risk and cost, and the Corporation shall not be held responsible for its safe custody thereafter. The entire cost in connection with testing of all the samples of paints, whether satisfactory or otherwise shall be deemed to be included in the rates quoted by the Contractor.

4.3.7 Painting
a) General

Except with the permission of the engineer in charge, nothing but ready mixed paints of an approved make and brand shall be used. Thinning or heating of paints will not be permitted except with specific approval and in accordance with instructions. Any warming of paint shall be performed by means of a hot water bath and paint shall not be heated to temperature higher than 40° C. All paint shall be in thoroughly mixed condition at the time of application. On completion of the work, the contractor shall remove any oil stains or paint spots, leaving the structures and equipment in a clean and acceptable condition.

Paint shall be applied only to dry, freshly cleaned surfaces, free from dust, rust, scale, grease or other substances which might affect the adhesion or the durability of the coating. In no case shall paint be applied to surfaces that are not to be applied during rainy or misty weather, unless unavoidable, in which case the work shall have suitable and satisfactory protection and such protection shall be maintained until the paint has dried.

All paint shall be applied by skilled workmen in workmanship manner and the average coverage shall be equal to that recommended for first class work with the type of paint and on the kind of surface being painted.

b) Preparation of Surface for Painting

i) General

All oil and grease shall be removed from surface to be painted by washing with a suitable solvent and by wiping with rags until completely clean. After removal of all oil and greases, surfaces of metal work required to be painted shall be cleaned by removing all rust, loose scale and dirt by sandblasting, grit blasting or other effective means. Surface which will be permanently or intermittently submerged or subjected to moisture from spray or excessive condensation shall be cleaned to clean metals by sand or grid blasting. After cleaning, all surfaces shall be
maintained free from oil, greases, rust, dirt and other contaminations until they have received the final coat of paint.

Surface of stainless steel and bronze and machined surfaces which are attached or adjacent to metal work that is being cleaned or painted shall be protected by adhesive tape or other suitable means during the cleaning and painting operations.

**ii) Sand Blasting**

The surface of the steel pipes and specials painted shall be thoroughly cleaned by sand or shot blast cleaning process to SA 2.5 finish, to remove all rust mill scale etc. Oil and grease shall be removed by applying a suitable cleaning solution and wiping with clean rags. All foreign matter which cannot be removed by blasting process shall be removed as directed by the Engineer / Owner.

Blasting should be done at a pressure of 5.62 kg / sq.cm. (80 p.s.i.) at the compressor end and at 4.93 kg / sq. cm. (70 p.s.i.) at nozzle end. This pressure should be maintained during the entire blasting operations. Improper jointing of hose pipes and resultant reduction in pressure at nozzle end shall be checked and avoided.

The blast cleaned surface shall be primed immediately after blasting is over. The sequence and the programme of blast cleaning application of Zinc Rich Epoxy primer shall be arranged in such a way that the blast cleaned surface shall not remain uncovered with Zinc Rich Epoxy primer for more than 2 hours.

Any deviation from above shall require approval of the Engineer / Employer.

**iii) Manual Cleaning**

Wherever manual cleaning is approved by the Engineer the surface of pipes and specials shall be thoroughly cleaned by using scrapers and wire brushes to remove all rust, mill scale etc. to give a shining metallic (SA 2.5) surface. The surface so cleaned shall be washed with water and allowed to dry. A metal cleaning solution of approved make shall then be applied over it. After it is dry, the
surface shall be again washed with water, crapping wire brushes simultaneously. A copious use of water is necessary at this state to ensure that the metal cleaning solution is completely removed. The primer coat shall be applied immediately after the surface has become dry.

c) Application of Primer

No primer shall be applied without Prior approval of the Engineer in charge / Owner. During rain or fog, shells of the pipes and specials shall be protected from weather by suitable housing.

The proportion of mixing of base and hardener shall be as specified by the manufacturer by weight and volume. The mix of Zinc Rich Epoxy primer shall be prepared at the work site / yard not earlier than 15 minutes before applying the same on pipe and specials surfaces.

One coat of primer shall be applied by spray giving a film thickness of approximately one mil.

No thinner shall be added to the ready mix paint without previous approval of the Engineer / Owner, and the finishing coats on top of the primer coat, shall only be applied after allowing the film to cure for at least 48 hours.

The priming coat shall be uniform in thickness and free from floods, runs, rags, drips, or bare spots. Any bare spots shall be recoated with an additional application of the primer. All runs, sags, floods or drips shall be removed or all such defects shall be remedied by repriming as per the instruction of the Engineer / Owner.

d) Field Painting

The Contractor shall take proper care during loading / unloading and transport of the pipes and specials from the shop to the site of erection to preserve the shop paint in the best practicable condition.
After erection of the pipeline on installation all rust spots, damaged areas and site welded portion of the pipeline shall be cleaned to metal and shall be painted with one coat of red oxide of iron paint and covering coat of Grey graphite.

After lapse of 48 hours of application of repairing coats specified above a finish coat of heavy duty bitumen paint shall be applied to exterior surface of the entire pipeline care being taken to clean the surface with duster prior to application of the said finish coat.

4.3.8 Inspection

The entire procedure of applying the paint as specified will be rigidly inspected right from the cleaning stage to the application of final coat by the Engineer. If, at any time, it is found that the procedure of applying the paint is not as per the standards laid down, all such painting work done shall be rejected and shall be rectified by the Contractor at his own cost, as directed by the Engineer.

4.3.9 Application of Cement Wash

Where the pipeline is to be cement mortar lined, it shall be given a coating of cement wash internally. Also where the pipeline is to be encased in concrete anchor blocks or encasement, it shall be given a coating of cement wash externally.

The pipe shall be first be cleaned manually as specified in Clause 2.7.1007 (b) to the Engineer's satisfaction. Immediately after a short stretch of the pipe is blast cleaned, the Contractor shall commence coating of the pipe with cement wash.

Before painting is started, the inner surface of the pipe shall be thoroughly scrapped by using scrapers, wire brushes to get rid of rust, mill scale etc. and washed with water. A suitable metal cleaning solution of approved make shall be applied over it. After it has dried, the surface shall again be washed with water and scrapped with brushes simultaneously and allowed to dry.
4.4 INTERNAL CLEANING AND PAINTING OF PIPE LINE

4.4.1 Internal Cleaning of Pipeline
Wherever directed by the Engineer in charge, internal surfaces of pipes, specials etc. of all size shall be thoroughly cleaned by repeated hosing of water and simultaneous rubbing with gunny cloth.

Further, when a section of pipeline has been laid and all the work inside it has been completed to the satisfaction of the Engineer in charge, its internal shall be cleaned of all dirt, debris, dust or other deposits.

Pipelines larger than 900 mm diameter shall be cleaned by repeated hosing of copious quantities of water on the pipe surface and simultaneously rubbing the surface with gunny cloth. Cleaning with metal cleaning solution, acid, wire brushed, scrappers or sand paper will not be permitted.

For 900 mm and smaller diameters cleaning of laid pipelines will be restricted to cleansing and scraping out of debris and dirt only.

Cleaning shall be done to the satisfaction of the Engineer. The section of the pipeline once cleaned shall not be entered into for any purpose later. Sufficient precaution shall be taken to prevent the ingress of any dirt, debris, or dust inside the section. Failing this the section shall be cleaned again at the discretion of the Engineer.

In the case of above ground pipeline, the length of the section to be taken up for cleaning shall be decided in consultation with the Engineer from the point of view of ventilation etc. In case of buried pipeline a section shall be taken up for cleaning after the work of back filling around and over the pipeline is completed and the spiders have been removed from inside.

During the pipe laying operation in the adjoining section, the Contractor shall take all precautions to prevent ingress of water, muck, debris, dirt, dust etc. in the cleaned section, failing which the section shall be cleaned again at the discretion
of the Engineer. Where deemed necessary by the Engineer suitable closures shall be provided at the open end or the ends of the cleaned sections. Payment will be made for the work under the relevant items of the Bill of Quantities.

At the end of a season's work, closure shall invariably be provided at all the open ends to protect the Pipeline from ingress of sub-soil water, mud, muck, etc.

No separate payment will be made for the work of cleaning and providing closures. The rates quoted for the laying the pipes, painting etc. shall include the cost thereof.

4.4.2 Internal Painting of Pipes And Specials

The internal surfaces of pipelines shall be coated with 1 coat of a two component solvent-free food grade epoxy coating achieving a minimum dry film thickness of 500 microns. The product shall have certification for use in potable water service as per BS 6920 or ANSI Standard 61. The protective coating must be spray applied to the pipe / liner surface using suitable air spray equipment so as to form a completely impermeable, pinhole free and seamless lining.

Cleaning: The painting can be carried out after fabrication in a yard where blast cleaning will be permitted. The pipe surface shall be blast cleaned to Sa 2.5 standards. If oxidation has occurred between blasting and application, the surface shall be reblasted to the specified standard.

Shop Painting: All application shall be as per manufacturer's specification. The contractor shall take proper care during loading / unloading and transport of the pipes and specials from shop to the site of erection to preserve the shop paint in the best possible condition.

Field painting: after erection all damaged spots and welded portion of the pipeline shall be cleaned to metal and shall be hand painted.
**Quality control:** Each lot of paint supplied shall be accompanied by certified copies of results of tests carried out by the manufacturers. Samples of paint brought by the contractor shall also be sent to testing laboratory as directed by Engineer for testing as specified by paint supplier.

### 5.0 MARKING OF PIPES

Each pipe shall be indelibly marked / engraved in English language at each end. The marking shall show the following.

1. Manufactures name or trade mark.
2. Grade of raw material
3. Class of pipe & pressure rating.
4. Outside diameter
5. Date of coating
6. Smells
7. Colour Band
8. Lot / batch No. and date of manufacture.
9. ISI certification mark.
10. TPI (Third Party inspection) certification mark for each lot
11. Name of Department / Project under which work is to be executed: WRD (GoM) with symbol of QC testing as per design.
12. Any other important matter that the manufacturer deems fit to be inscribed.

Marking shall be stencilled on the coated pipe utilizing a waterproof permanent type paint or ink which shall not rub off when the coated pipe is handled. Stencil, marking and numbering is created by proper stencilling tools or machine. The marking shall be legible from a distance of 0 to 12 feet with letters no less than one half inch heights.
6.0 PRE-DELIVERY TESTING OF PIPES IN FACTORY

6.1 SHOP TESTING

After fabrication, but before application of protective coatings all pipes shall be subjected to a shop hydraulic test as per IS 3589:2001. All Specials on which shop hydraulic test cannot be conducted shall be tested using NDT methods as per IS 3589:2001. Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size.

The test pressure shall ensure that the plate material is stressed to 80% of the minimum yield strength and at least 1.5 times the allowable working pressure as specified by the Engineer. Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.

The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. Shell thickness, diameter, length etc. as directed. The markings shall be done at four locations - two inside the pipe and two outside the pipe. A fifth marking shall be done with hard punch on the pipe surface externally. It shall be entered in the register to be maintained by the Contractor.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as jumps, porosity etc. shall be repaired by gouging and re-welding. The hydraulic test shall be carried out under cover at the fabrication shop, in the presence of and to the satisfaction of the Engineer or the inspection agency appointed by the Employer.

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.
The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be retested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The Contractor shall stack such rejected pipes separately in his yard. The Engineer, shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the fabrication and hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer. The Engineer shall be supplied with two copies of the results of all the tests carried out. Pipes will not be allowed to be dispatched to laying site without hydro testing. Any failure to comply with this may cause the contractors payment to be withheld.

6.2 3LPE (3 Layer Polyethylene coating) for External Surface and Internal Surface Epoxy coating for MS pipes and specials

6.2.1) 3 LAYER POLYETHYLENE COATING FOR MS PIPES & SPECIALS

6.2.1.1 SCOPE
This procedure covers the side extruded 3-layer polyethylene coating with surface preparation by abrasive Blast cleaning, prior to the application of coating following by electrostatic fusion bonded epoxy layer as primer, grafted co-polymer adhesive as tie layer & high density polyethylene coating as top cat, on Pipes.

a) RAW MATERIAL PROPERTIES & TESTING

The Properties of the Raw Material to be used shall be supplied in sealed, damage free containers’ and bags, which are marked with the following information.
A) Name of the Manufacturer
B) Type of Material
C) Batch Number
D) Place ad Date of Manufacturer
E) Manufacturing Standard (Should be marked on the RMTC)
F) Shelf Life / Epoxy Date (if application)
G) Health, Safety & Environmental Instructions
H) Storage Instructions

EPOXY POWDER
CURE TIME
GEL TIME
MOISURE CONTENT
PARTICLE SIZE
DENSITY
THERMAL CHARACTERISTICS

ADHESIVE

MELT FLOW RATE @ 190° C / 2.16 KG
VICAT SOFTENING POINT
SPECIFIC GRAVITY

POLYETHYLENE

Tensile strength @ +25°C
Melt Flow Rate (190°C / 2.16 kg)
Specific Gravity @ + 25°C
Hardness @ + 25°C
Volume resistivity @ + 25°C
Dielectric withstand 1000V / sec Rise @ + 25°C
Vicat softening point
Elongation
Oxidative induction time in oxygen at 220°C, Aluminium Pan,
No screen
Environmental stress cracking resistance
Coating resistivity
Light ageing & heat ageing
Carbon black content

Raw Material Testing (In – house):-

EPOXY POWDER

Gel Time
Thermal Analysis

ADHESIVE

Melt Flow Rate
Vicat softening Point

POLYETHYLENE

Melt Flow Rate
Vicat softening Point

6.2.1.2 DETAILED PROCEDURE

6.2.1.2 A) INLET RACK

Before coating pipe shall be inspected by QC inspector for any damage or deterioration. Each pipe shall be inspected for bevel condition, straightness, dents, gouges, ovality, contamination marking etc. Tally sheets shall be compared with the steel mill documentation and certifications. Pipe seam welds heights shall also checked if it exceeding 3mm in height shall be segregated Corporation. The Seam weld shall be
removed flush with the metal at a distance of 300mm from the pipe end. Every pipe shall be plugged from both ends (with inflated rubber tubes) to avoid shots / abrasive inside the pipes. Then the pipe is conveyed to the shot Blaster. All the ambient conditions such as Relative Humidity, Dew point, ambient temperature shall be recorded in pipe datasheet.

6.2.1.2 B) PREHEATING OF BARE PIPE (IF REQUIRED)

The bare pipe shall be preheated in the range of 65° to 85° C for remove; of any moisture & to maintain uniform temperature throughout the pipe.

6.2.1.2 C) CHEMICAL PRETREATMENT WITH PHOSPHORIC ACID SOLUTION

(Application shall be strictly as per manufacture Recommendation)

All pipes shall be chemically pre-treated with phosphoric acid solution. 10% solution salt & others soluble contamination. The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 49 to 66° C or as per manufacturer recommendation. The phosphoric Acid solution shall be applied through the Spray nozzles. This shall be followed by washing with de-ionized water after recommended dwell time. De-ionized water used shall have not more than 20 ppm of total dissolved solids or 35 µs conductivity contain. The ph. of pipe surface shall be measured before de-ionized water was and shall be maintained between 1 to 2 & after de-ionized water wash as six to or greater.

6.2.1.2 D) ABRASIVE BLASTING

The abrasive particle size shall conform to ISO 11124, which shall be verified with the manufactures test certificate and the external surface of pipe shall be cleaned by steel shots & greets. The abrasive shall not contain 100 ppm chlorides, 100 ppm of sulphates and 2 % by weight of carbonates. Chemical analysis of each abrasive blast cleaning units: - The abrasive blast-cleaning unit shall have an effective dust collection system to ensure total removal of dust generated during the blast cleaning from the pipe surface. The equipment used for blast cleaning operations shall meet the specified requirements and shall be free from oil, water, soluble salts and other forms of contamination to ensure that the cleaning process is not impaired, Traps, separators, and filters shall be checked.
for condensed water and oil at the start of each shift and emptied and cleaned regularly. Abrasive blasted pipe shall be visually examined to ensure that the defects flat ends and other damages detrimental to the subsequent coating shall be repaired and removed. Cleaned surface shall be free of oil, grease or any other contaminants.

6.2.1.2 E) INSPECTION AFTER BLASTING

The standard surface finish of cleaned pipe shall confirm to SIS 055900- SA2 ½ & the Anchor Pattern (Rz) shall be – 50-100µm measured by stylus type Roughness gauge. After determining Anchor pattern, Quality of blasting shall be thoroughly inspected for any surface defects such as silvers scab, burns laminations, weld spatters, gouges scored or any other defect. If found, these shall be removed by filling or grinding and anchor pattern shall be restored by filling. Pipes, which have damages repaired by grinding and have ground areas more than 200 mm² in diameters, shall be re blasted and re inspected. The maximum degree of dust contamination shall be level 2 on the magic tape ad per ISO 8502-3. The cleaned pipe surface shall be protected from rainfall or surface moisture. If rusting occurs or if the surfaces become wet otherwise gets contaminated prior to coating. Pipe shall be reprocessed so as to meet the requirements.

The maximum elapsed Time shall Not Exceed the Maximum Time as given:- Maximum 4.0 Hrs. Any pipe showing flash rusting shall be relisted.

The blast cleaned pipe surface shall be tested for the presence of soluble salts. If the concentration is more than 2µgm / cm², the pipe surface shall be chemically cleaned using phosphoric acid or any other suitable method. The cleaned pipe shall be retested to confirm the removal of soluble salts. Any foreign material or shot / grit present in the pipe shall be removed by suitable means (mechanical brush, high-pressure air jets, etc.) the Blast cleaned surface shall not be contaminated with dirt, dust metal particles. Oil water or any other foreign material, nor shall the surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be thoroughly inspected under adequate lighting to determine anchor pattern, quality of blasting and identify any surface defects prior to coating application.

6.2.1.2 F) CHEMICAL PRE TREATMENT WITH PHOSPHORIC ACID & CHROMATE SOLUTION

Phosphoric application:-
When the phosphoric acid wash and rinse is used for further surface cleaning, etching and removal of soluble salts, it shall be mixed with demonized or RO water according to the manufacturer recommendations. De-ionized and RO water shall be used for the mixture and for the rising the pipe after the wash. The DI & RO water shall have not more than 20 ppm of TDS or 35 µs conductivity. The phosphoric acid wash shall be applied after the blast and after the heating process. The phosphoric acid shall be flooded on the pipe to cover the entire surface for sufficient dwell time. The pipe shall then be rinsed with DI water to remove all traces of chemicals. After DI water wash the PH should have 6 or more. Chemically treated pipe surface shall.

6.2.1.3 EPOXY APPLICATION

6.2.1.3 A) EPOXY POWDER APPLICATION

All the parameters necessary to control during epoxy powder spraying shall be set as per the recommendations of FBE powder manufacturer. These parameters shall be regular production.
Thickness of epoxy layer shall be minimum 200 to 3000 Microns, which shall be measured at Beginning of each shift.
Reclaimed epoxy powder shall not be used more than 20 %. During application air pressure in the spray guns shall be controlled & monitored. Alarm / hooters system shall be fitted in case of any deviation in air pressure beyond the set limits. In case, of pipe coated during air pressure variation shall be rejected this shall be finally stripped off and recoated.

6.2.1.3 B) ADHESIVE APPLICATION

After epoxy application, the adhesive layer shall be applied before gel time of the epoxy and within the application window recommended by the epoxy powder manufacturer. These parameters shall be established during the procedure Qualification. Entrapment of air or void formation along the adhesive layer shall be avoided by forcing the coating on to the pipe during application using silicon pressure rollers. The thickness shall be measured as per specification (Each shift-semi coated). Adhesive thickness shall be of 200 micron minimum. The application temperature shall be as per manufacturer's recommendation to provide the good quality application. The temperature of adhesive film shall be recorded at start of shift and every 2 hrs.

6.2.1.3 C) POLYETHYLENE COATING (TOPCOAT)

The P.E. layer shall be applied just after the adhesive layer, based on the manufactures recommendation. The application temperature of polyethylene shall be as per
manufacturer recommendation to provide the specified thickness and good quality coating. Entrapment of air or void formation along the P.E overlap shall be avoided by forcing the coating on the pipe during application using silicon pressure roller.

6.2.1.4) COOLING OF PIPES

After coating the rotating pipe shall be conveyed through cooling tunnel for quenching. The temperature of water at the inlet of cooling tunnel shall be cool enough so that it does not get damaged during handling. The temperature of pipe after cooling shall be less than 60°C. Same water shall be re-circulated through cooling towers.

6.2.1.5) CUT BACK CLEANING

Immediately after cooling and intermediate visual and dimensional inspection the accepted pipes shall be end brushed up to 150 mm (+) 0 / (-) 25 mm. The brushed end shall have a beveled angle of less than equal to 30°. After completion, coated pipe shall be kicked out on the testing conveyor where the cut-back portion shall be measured and accepted pipes shall be conveyed further for holiday test ad subsequently for the final inspection skid / The exposed pipe surface at the cut back area shall be coated for atmospheric corrosion protection using alkyd steel zinc chromate.

6.2.1.6) INSPECTION AND TESTING

6.2.1.6A) VISUAL INSPECTION

Immediately after cooling, each coated pipe shall be visually checked for imperfections and irregularities of the coating. The coating surface shall be smooth & free of irregularities. In addition to these inside surface of the pipe shall be free of foreign materials such as shots of grits, dust etc.

6.2.1.6B) THICKNESS INSPECTION

Thickness of Epoxy and Adhesive shall be measured at the each shift. The total coating thickness shall be determined by taking at least 10 measurements at locations uniformly distributed over the length and periphery of each pipe. All readings shall meet the minimum thickness can be tolerated on the condition they it does not attain total extent of more than 5 cm² per meter length of the coated pipe, and the actual coating thickness does not drop more than 10 % below the permissible minimum coating thickness at these
locations frequency. Initially every pipe shall be checked which shall be reduced upon consistency of results.

**6.2.1.6C) IMPACT STRENGTH**

This test shall be performed before holiday test. The testing apparatus shall be kept. Vertically on the pipe (Preferably with the help of spirit level attached to the instrument to ensure vertical position of the testing instrument), specified ball of 25mm Dia. shall be released from one – meter height as per DIN 30670. Test shall be conducted at 30 equidistant along the length of the pipe and then impact area shall be checked at high voltage i.e., 25 K.V. holiday test should not show a breakdown of coating at impact areas. Acceptance criteria shall be as per TENDER SPEC. In case of test failure coating shall be stripped off and re coated.

Impact Energy shall be at 65°C>15.Nm, at 23°C 25Nm and -5°C>40Nm

**6.2.1.6D) INDENTATION HARDNESS**

Indentation hardness testing shall be carried out in 2 samples from 1 pipe. Sample shall be not more than 2 mm thick, which has been removed from the pipe and freed of adhesive. It may be necessary to abrade the reverse side of the sample to obtain the required thickness. The indenter shall be a 250 Gems metal rod to which an additional weight can be added. A metal pin with a flat surface of 1.8 mm diameter shall be 2.5 kgs. (Corresponding to a pressure of 10N / mm².) For measurement if indentation depth, a dial gauge permits measurement s to be made to an accuracy of 0.01 mm is required. Testing shall be carried out at temperatures of 23±2°C and the higher temperature being 65±2°C & 80±2°C using temperature controlling water baths if necessary. After conditioning the sample for one hour at the test temperature the indenter without the additional weights shall be slowly and carefully lowered to the test piece, and the zero values set at the dial gauge within five seconds. Following this the additional weight shall be slowly and carefully lowered to the test piece and the zero bales set at the dial gauge within five seconds. Following this the additional weight shall be added to the indenter and after 24 hrs. The depth of penetration shall be read from the dial gauge. And the acceptance criteria are max 0.2 mm for 23±2°C and 0.3 mm for 65±2°C & 80±2°C.

**6.2.1.6E) DEGREE OF CURE**
Epoxy film samples shall be removed from the pipes. Care shall be taken to remove the samples of full thickness avoiding inclosing of steel debris. Glass transition temperature differential ($\Delta T_g$) and % cure ($\Delta H$) shall comply the specified requirements.

a. Frequency of this test shall be once per shift. Inspectors shall select pipe randomly during the middle of a shift. Suitable provisions / arrangements as per the instruction of inspectors shall be made for this purpose.

b. In case of test failure production carried out during the din tire shift shall be rejected. The test result shall be $-2^\circ C < \Delta T < +3^\circ C$.

6.2.1.6F) CATHOLIC DISBANDMENT TEST.

This shall be performed as per ASTM G-42

a. 28 days CD test shall be conducted during PQT.

b. Maximum radius of disbandment 10 mm at $+65^\circ C$ after 28 days & maximum radius of disbandment 5 mm at $+\pm20^\circ C$ after 28 days.

c. Frequency of testing during production: Once per day

d. Maximum radius of disbandment 3 mm at $+20^\circ C$ after 48 hrs. & maximum radius of disbandment 4 m at $+\pm65^\circ C$ after 48 hrs.

6.2.1.6 G) % ELONGATION TEST

This test shall be performed as per DIN 30670. The percentage elongation at failure shall be at least 200%.

6.2.1.6 H) TENSILE TEST

This test shall be performed as per ASTM D638. The tensile strength shall be more than 180 kg / m².

6.2.1.6 I) HARDNESS TEST

This test shall be performed as per ASTM D2240. The Hardness shall be minimum 60 SHORE D.

6.2.1.6 J) RESIDUAL MAGNETISM

Residual magnetism shall be 25 Gauss Max.

6.2.1.6 K) ADHESION TEST (PEEL TEST)
In this test, the force applied for peeling is determined by peeling a fixed dimension strip from surface of coated pipe. Test method shall be as per DIN 30670. Acceptance criteria are Min 35N / cm AT 25±5°C & min 25N / cm at 50±5°C.

7.0 DIMENSIONS OF SPECIALS AND FITTINGS

Spigot & socket dimensions shall confirm I.S. 458-2003 amendments No.2 April-1991 or its latest revision.

8.0 TRANSPORTATION OF PIPES

All pipes and specials fabricated in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The item of transport covers the cost of loading in the factory, transporting to the factory, transporting to the site of laying or to stacking yard selected by the Engineer in its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is made. Props of approved designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re-used for subsequent operations. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth and subsequent rusting. In order to prevent sagging during transit, shavings of steel plates can be utilised by cutting to the required length and tacking the same to the pipe ends, in place of props, if approved by the Engineer.

Materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer.
in charge to avoid congestion in the Contractor's yard. However, materials such as 'T' branches and other complicated items, shall be stacked in the Contractor's yard until they are required for laying in the field. In view of this, the work of fabrication of such materials shall be properly synchronised as far as possible with the laying operations.

Pipe handling equipment shall be maintained in good condition and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded. Under no circumstances shall pipes be dropped, be allowed to strike one another, be rolled freely or dragged along the ground. No defective / damaged pipe shall be used in the works without rectification to the satisfaction of the Engineer in charge.

9.0 STACKING OF PIPES

9.1 General
To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

9.2 Stacking of pipes etc. and inspection
Pipe shall be stacked in such a manner so as to prevent damage to the coating. All pipes shall be stacked on level ground free from foreign materials, stones, vegetation and on supports of a proven load bearing capacity. Pipes shall be suitable spaced from the soil to prevent any contact with the ground and to prevent surface water from entering during the entire storage period.

The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe. The ends of the pipes during handling and stacking shall always be protected with bevel protectors and the pipe stacking padded hook shall be covered with rubber.

Pipe stacks shall be of the same diameter, wall thickness and grade of pipe and shall be marked clearly.
Care shall be taken while unloading of trailers by means of padded hooks with sufficient width & depth to fit inside of the pipes. Rolling and skidding or dragging shall not be carried out and shall not be dumped against any other pipes or objects like trailer body, electric pole / tree etc.

The Contractor shall keep in each section a responsible representative to take delivery of the pipes, specials and appurtenances, etc. transported from the fabricating stockyard or received from any other work site to the site of laying and to stack along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked shall be left at intervals to permit access from one side to the other. The pipes, Specials, appurtenances so received on site shall be jointly inspected and defects recorded, if any, such as protrusions, grooves, dents, notches, damage to the internal coating etc. shall be pointed out immediately to the Engineer at the site and in the acknowledgement challans. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost.

9.3 Handling of pipes, specials

It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating.

Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be
dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. No defective or damaged pipe or special shall be allowed to be used in the work without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer. No separate payment shall be done for the use of props.

9.4 Dents

Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 2 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer in charge may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

10.0 POST–DELIVERY TESTING OF PIPES

10.1 RADIOGRAPHIC TESTING

10.1.1 Radiographic Testing shall be done as per procedure given in IS 4853:1982

Before commencing fabrication, the contractor shall establish a weld identification scheme. The numbering system shall be used for identification purpose on all shop drawing, radiographic, NDE test report and repairs. The notations used for reporting all weld inspection shall be clearly marked on the work in paint to ensure exact location of weld defect reported.

a) All longitudinal butt welds and shop circumferential butt welds shall be examined radiographically for five percent weld length in the location directed by the Engineer-in-charge.

10.1.2 Butt joints in field Circumferential welds and other field welds used for specials shall be tested ultrasonically for ten percent of the weld length at the location directed by the Engineer-in-charge.
10.1.3 All the areas of the welds on which repairs have been made shall be examined 100 percent by the method specified for the original weld. This examination shall be at the contractor’s expense.

10.1.4 In case of machine welding, if any defect is observed for the entire length of the film the adjacent location on either side shall be examined radio graphically at contractor cost. The repairs and retest shall be as approved by the Engineer-in-charge. This procedure shall be repeated as necessary, till such time as the defects are finally removed to the satisfaction of the Engineer-in-charge.

Such repairs shall not be more than two times at the same location. If the fault continues at the spot after two repairs the action to be taken including replacement of damaged plate and pipe shall be decided by the Engineer-in-charge but this would be a contractor’s cost.

10.1.5 When a weld thus examined shows many unacceptable defects distributed over entire length or when the defects envisage need for rectification of more than 25 percent of the weld length may be rejected and the weld shall be cut out & re-welded and shall be re-examined by the methods specified for the original weld at the expense of the contractor.

10.1.6 Radiographic testing:
10.1.6.1 The examination for the soundness of the shop weld shall be carried out as per ASTM-E 1955-04(2009) standard.

10.1.6.2 At least 30 days prior to commencing radiographic examination, the contractor shall submit details of all radiographic equipment, processes and procedures for the approval of the Engineer-in-charge. The type and make of the radiographic films intended to be used shall also be got approved from the Engineer-in-charge /

10.1.6.3 The contractor shall provide at his own expense all materials including radiographic films of 40 cm length and 38 mm wide and all consumables. Equipment’s, etc., necessary for radiographic examination and shall perform all radiographic examination in accordance with the requirements of this specifications and of the Engineer-in-charge within eight working hours after taking the exposure. The films shall then become the property of the Government.
10.1.6.4 Along with each radiograph, the contractor shall finish his interpretation report in duplicate in the proforma. The Engineer-in-charge shall be free to make independent interpretation and ask for the welds, if necessary.

10.1.6.5 Sections of welds the radiographs of which show any of the following types of imperfections shall be judged unacceptable.

a) Any type of crack or zone of incomplete fission or penetration.

b) Any elongated slag inclusion or cavities which has length greater than 10% foot’ in case of length and width and 2% of ‘t’ in plate thickness where ‘t’ is the thickness of the plate.

c) Any group of slag inclusion in line that have an aggregate length greater than ‘t’ in a length or 12th except when the distance between the successive imperfections exceeds 6l where l is the length of the longest imperfections in the group.

d) Porosity of rounded indications in excess of that specified by the acceptance standards given in appendix-IV of ASME boiler and pressure vessels code section-VII Div-I

10.2 Ultrasonic testing

Ultrasonic testing of field welded joints as per Procedure laid down in IS 4260:1986

10.2.1 Ultrasonic examination shall be performed in accordance with the articles-5 of ASME Boiler pressure vessels code section-V. The relevant references from ASTM specification-E 164-74 shall also be taken. The ultrasonic examination shall be performed and supervised by experienced and qualified personnel. If necessary special type of transducers and / or higher test frequency etc. shall be adapted to improve the reliability of the examination. If equipment with recording facility is available in the Indian market such equipment shall be used for ultrasonic examination. The record in such case shall be furnished and the same shall be property of Government.

10.2.2 All indications which produce a response greater than 20 and of the reference level shall be investigated to the extent that the operator can determine the shape identity and location of all such reflectors and evaluate them in terms of the acceptance standard given (i) and (ii) below.

i) Discontinuities shall be unacceptable if the amplitude exceeds the reference level and discontinuities have length which exceed 1 / 3t. Where the thickness of the weld being examined.
ii) Where discontinuities interpreted to the crack, lack of fusion or incomplete penetration, they shall be unacceptable regardless of discontinuities of signal amplitude.

10.2.3 The contractor shall make available continuously throughout the contract all equipment necessary for ultrasonic examination of the welds. The Engineer-in-charge direct which welds are to be examined.

10.2.4 Defects which have detected by ultrasonic examination shall be repaired as directed by the Engineer-in-charge. Any defects which produced and ultrasonic echo that fails to reveal the nature of the defect shall be radiographically examined when so directed by Engineer-in-charge. Radiography carried out to identify defects located by ultrasonic examination shall be included in the measurements for payment.

11.0 DEMARCATION OF SITE

11.1 INSPECTION & DEMARCATION

All materials such as pegs, bamboo’s and strings and temples for marking out slopes, and labour required for line out should be provided by the Contractor at his own cost. The centerline of excavation shall be clearly marked by pegs or by stones at each chain or change of direction or at shorter intervals on curves, in the beginning. The final line out will be done by fixing reference stone at suitable distances on either side of the centerline, beyond the canal edges so that they are not disturbed the construction period. The position of these stones will be marked on the cross section.

11.2 Contractor shall provide and maintain the quarry roads and temporary roads required for conveying and transport of material at his cost.

11.3 The material available from all excavation and remaining surplus after use on the work from adjacent reaches / canal works etc. can be used by the Contractor free of cost provided these materials are used solely or the specific contract work and prior approval of the Engineer In-charge is taken.

12.0 PREPARATION OF SITE

12.1 Clearing the Site
The Contractor shall clear the entire area required for setting out. All tree stumps, roots, brushwood, rubbish of all kinds, loose stones and all other objectionable materials shall be removed by the Contractor. All buried irrigation pipeline, and other structure shall remove by Contractor. The ownership of all the usable material, so removed from clearing site and / or excavation shall rest with the Engineer In-charge. Useful material shall stack as directed. Cutting of all trees up to 0.50 m girth shall be covered in this item. The Contractor shall have to remove all the stumps and roots of trees for which no additional payment shall be made. The roots of trees shall be grubbed below the ground. The Contractor shall dispose off all such materials outside the canal land width as directed by the Engineer In-charge.

12.2 Excavation of trenches and its classification

Except or otherwise provided in these specifications, excavation of structure / Canal trenches shall be carried out as per excavation line shown in the drawing or as directed by Engineer In-charge. Excavation in all sorts of soil includes the dry, wet & slushy condition. Contractor must assume all responsibility for deductions and conclusion as to the nature of the materials to be excavated and the difficulties of making and maintaining the required excavation.

12.2.1 Classification of the soil

Excavation for foundation in overburden, soil and murrum includes all excavation to be done in strata including hard rock which covers excavation in all kinds of soil such as brown soil, reddish soil, black soil, clay, sand, gravel and murrum or mixtures of any of these soils. It shall also include removal of boulders / pebbles up to 70 kg and which are embedded in soil and can be removed by pick bar and shovel without blasting.

12.2.2 Conveyance and disposal of excavated materials

(a) The usable excavated material available from the excavated trenches (PDN) shall be used in back filling. If such usable material is in excess of the requirement of back filling, the same shall be deposited in the spoils as and where directed by the Engineer In-charge.

(b) All suitable materials removed from excavation and in excess of the requirement of trenches (PDN), back filling shall be used in the construction of approaches to the road bridges and backfill around structures up to 1 km. lead for which no extra payment will be made. The remaining material from excavation
shall be used to be deposited in low areas to eliminate tripped drainage or otherwise stacked in spoil banks in regular shape with suitable slopes or spread in other approved locations as directed by the Engineer In-Charge, within a lead of 1 Km. Spoil banks shall not be constructed continuous. A gap of 10 m shall be provided at 150 m interval. The maximum height of spoil bank shall be restricted to 3.0 m with side slope 1.5:1.

(c) When the excavated material is required to be used for adjacent spoil bank, the lead involved shall be measured along the center line of PDN considering 15 m block as a unit and when the excavated material is required to be used for other than approach road and spoil banks, the lead involved shall be measured from the block of 15 m to the place of dumping as a straight-line distance, i.e. shortest possible distance.

12.2.3 Dewatering in PDN trenches and wet excavation

Surface or sub-soil water met with during excavated trench (PDN) and structure excavation shall be diverted to nearby drain / nalla by cutting an open channel from trench. When the drain / nalla bed is higher than the sub-soil water level met with, the bailing out by suitable means of pumping shall be resorted to for dewatering sub-soil water below the drain / nalla bed level. In case where topography of area is such that surface water is not possible to be drained off by excavating the channel, the bailing out by suitable means of pumping shall be resorted to and no separate payment shall be made for the dewatering. No distinction shall be made as to whether the material being excavated is dry, moist wet or slushy. The Contractor shall have to excavate the PDN pipe trench and structure in under water level conditions also i.e. under wet / slushy condition after providing sufficient arrangement of dewatering. The material excavated under water level condition which requires intermediate stacking for drying shall have to rehandle. No extra payment for efforts for drying out of soil, re-handling of dry soil, etc. shall be given. The Contractor shall have to excavate the wet and saturated soils met with above subsoil water level. (Including capillary fringe) No payment for extra efforts for excavation under this condition shall be made.

The payment of excavation shall be made under different item in the same contract

12.2.4 Over Excavation
(a) Over excavation performed by the Contractor for any purpose or reason, except for additional excavation as stated herein above or as may be directed by the Engineer In-charge shall be rectified at the cost of the Contractor. Filling and compaction for such over excavation using the material as directed by the Engineer In-Charge shall also be at the cost of the Contractor.

(b) In the PDN and structure section where expansive type of soil such as CH type of soil encountered and over which PDN cannot be directly laid, the PDN trench and structure shall be over excavated to the extent as directed by the Engineer In-Charge and such over excavated section shall be filled with suitable murrum type soil to be placed in uniformly compacted layers as directed by the Engineer In-Charge. The over excavation made in such strata, filling by suitable soil, and watering and compacting such soil will not be paid additionally. Above provision for over excavating and filling with suitable murrum type or good soil available material shall be applicable in case such treatment is found essential.

13.0 FIXING PERMANENT BENCH MARK IN CONCRETE BLOCKS

(a) In the vicinity of PDN, there are M or B type bench marks fixed by the Survey of India and temporary bench marks established by the Engineer In-charge which will serve as control points for these works. The Contractor shall establish sufficient number of reference benchmarks for facilitating setting out of work and taking levels for the purpose of measurements.

(b) Before starting any work, the Contractor shall erect reference benchmarks, reference lines and check profiles at convenient locations approved by the Engineer In-Charge. The benchmark shall be 200 mm x 200 mm x 600 mm with 400 mm embedded in the firm ground and 200 mm projecting above ground. The word ‘BM’ showing value of R. L. in ‘m’ shall be conspicuously carved and painted on the benchmark. The reference line shall comprise the base line properly dog belled on the ground with the numbered concrete / masonry pillar suitably spaced.

(c) The check profile shall be located 30 m apart or closer as directed by the Engineer In-Charge so as to ensure execution of all slopes, steps and
elevations to the profile or profiles indicated in the approved drawings. All important levels and all control points with respect to benchmarks and reference lines shall be fixed and correlated by the Contractor. The Contractor is fully responsible for maintaining all setting out work & Bench mark established by Engineer In-charge.

(d) All materials, labour and equipments (theodolites, levels, distometre, etc.) for setting out works including construction of benchmarks, reference lines, check profiles and surveys as may be required at the various stages of construction shall be supplied by the Contractor at his cost. The cost of such work shall be deemed to have been included in the cost of items in the Schedule-B. At each site minimum, following numbers of equipments shall be provided and maintained in good condition by the Contractor.

1. Total station and its accessories 1 set
2. Theodolites (Accuracy 1 second) 1 Nos.
3. Levels 2 Nos.
4. Staves 4 Nos.
5. Tapes, chains, ranging rods etc. As required

All equipments shall be of standard and approved make and precision, and shall be made available in advance of starting of the work. All equipment shall be maintained, repaired and got tested and certified as and when required for its accuracy from the standard test houses or from the manufactures and to the satisfaction of the Engineer In-Charge.

Cost of all above shall be deemed to have been included in the rates of the items included in the Schedule-B.

14.0 LAYING OF PIPES

14.1 HANDLING OF PIPES & SPECIALS

Coated pipes and specials that are to be stored on supports shall bear on the uncoated ends only. If bearing on coating is employed the supports shall be not
less than 20 cm (8 inches) wide and so arranged to prevent damage to the coating.

During handling of the pipes and fittings, coating shall be protected not less than 20 cm wide and placing strips of heavy belting or other approved sheet materials not less than, 20 cm wide under all ropes or fastening.

14.1.1 Excavation of Pipe Trenches – General

Trench Excavation means excavation of trenches into which pipes are to be laid and the term pipes shall mean pipes of all kinds and for whatever purpose.

The line and level of trenches shall be as shown on the Drawings or as may be required by the Engineer. Before commencing Trench Excavation, the route of the trench shall be pegged out accurately and the ground levels shall be agreed with the Engineer. Strong sight rails shall then be fixed and maintained at each change of gradient and at as many intermediate points as may be necessary. On these rails shall be marked the centre line and the level to which the excavation is to be carried out, such rails being not more than thirty five metres apart.

14.1.2 Trench Excavation

Trench excavation shall be carried out by such methods and to such lines, dimensions and depths as shall allow for the proper construction of the Works, provided always that, unless the Engineer permits otherwise, no Trench Excavation shall be less than 500 mm in width and no Trench Excavation for pipes larger than 200 mm diameter shall exceed the widths stated :-

- Excavation in firm ground or soft rock, no shoring required $D + 1000$ mm
- Excavation in soft ground or any conditions requiring shoring $D + 1400$ mm
- Excavation in Rock $D + 1000$ mm

Where “D” is the inside diameter of the pipe in mm.
Notwithstanding the foregoing, any Hard Rock in Trench Excavation shall be so excavated that the clearance between the pipe when laid and the Hard Rock sides and bottom of the trench is kept to the minimum limits necessary to provide for the specified thickness of bedding haunching and surround to the pipe. Any excavation outside these limits whether for working space or due to over break shall be held to be Excess Excavation.

The sides of Trench Excavation shall be vertical unless the Engineer permits otherwise.

Any widening or deepening of Trench Excavations necessary to accommodate curves, joints or bends in the pipe as shown on the drawings or when ordered by the Engineer shall be held to be `general excavation' but that required by the Contractor to provide extra working space for the construction thereof shall be held to be Excess Excavation.

No length of Trench Excavation shall be started until the pipes to be laid in that length are available on the Site.

The payment of excavation shall be made under different item in the same contract.

14.1.3 Trial Pits or Trenches

The Engineer may require trial pits or trenches be excavated well ahead of the trench excavation to such depths as he shall order to determine the alignment for the trench.

Any further trial pits or trenches required by the Contractor to determine the position of underground services, sub-soils, drains or for any other reason shall be excavated and reinstated at the Contractor's expense.

The Contractor shall arrange for the refilling and reinstatement of trial pits or trenches to be carried out immediately after the required information is obtained. The reinstatement of the surfaces of trial pits or trenches shall be carried out to the approval of the Engineer.

14.1.4 Trench Excavation in Roads and Footpaths

All Trench excavation and other work carried out within the limits of any road shall be completed as rapidly as possible and not more than half of the width of the
carriageway shall be obstructed at a time. Road drains and grips shall be kept free from obstruction. In a event the Contractor shall take special precautions, which shall include the continuous support of the sides of the excavation, from the time when excavation is begun until the refilling of the trench is placed, to ensure that there is no disturbance of the adjacent road or road foundation. Where excavated material has temporarily been deposited on grass margin or road pavement, the margin or road pavement shall on completion of refilling be restored entirely to its original condition and left free from loose stones.

14.1.5 Trench Excavation in Fields etc.

The term “fields” includes fields, moorlands, grass verges the like and all private lands, and no length of Trench Excavation located in fields shall be commenced until suitable temporary fencing has been erected around that length unless the Engineer permits otherwise.

Temporary fencing shall not be removed without the Engineer's permission which will not normally be given until the Trench Excavation has been refilled and reinstated to the original ground condition or as directed by the Engineer.

The Contractor shall have particular regard to the safety of livestock in fields or which may be introduced to the fields, and shall ensure that all open excavations, access routes and steep or loose slopes arising from the Contractor's operations in these fields are adequately fenced and protected.

After the erection of temporary fencing Contractor shall remove Topsoil to such depth and over such areas as may be necessary to provide sufficient material to ensure adequate surface reinstatement of the working areas occupied by the Contractor for construction of the pipeline.

14.1.6 Soft & Decomposed Rock and Hard Rock in Trench Excavation

Soft and Decomposed Rock means rock, boulders and other materials which in the opinion of the Engineer could normally be removed by picks, hammer, crow bars, wedges and pneumatic breaking equipment. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Excavation in macadam & tarred roads and pavements and dismantling masonry shall also be included under this item.
Hard Rock means rock occurring in large continuous masses which in the opinion of the Engineer could be loosened by blasting or by other rock quarrying methods. Rock boulders in sizes not classified under Ordinary / Hard Soils and Soft & Decomposed Rock shall be considered as hard rock.

Any material in Trench Excavation which the Contractor considers may be classified as Soft & Decomposed Rock or Hard Rock as defined above shall be notified to the Engineer before excavation of the material is begun. The quantities of this material excavated from within the nominal limits of Trench Excavation shall be recorded and the record signed by the Engineer and Contractor each day or at such shorter intervals as the Engineer may require. Only such proportion of material so notified and recorded as the Engineer classifies as Soft & Decomposed Rock or Hard Rock shall qualify for additional payment under respective items of BOQ. Over break shall be kept to a minimum and shall be held to be Excess Excavation.

14.1.7 Supporting Trench Excavations

The Contractor shall well and effectively support the sides of Trench Excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement of or damage to structures adjacent to the excavation. The Contractor shall be deemed to have made his own allowance for any extra excavation necessary to provide space for such support and for any other working space. If for any reason any portion of Trench Excavation shall give way, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed and such extra excavation shall be held to be Excess Excavation. Where the Contractor elects and is permitted by the Engineer to execute Trench Excavations with battered sides instead of providing support as aforesaid they shall be excavated to stable slopes and heights and the resulting extra excavation shall be held to be Excess Excavation.

14.1.8 Trimming Trench Excavations

When excavating to specified levels for Trench Excavation or to specified limits for the face of any structure therein required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing constructional work except where the Engineer permits otherwise. Should the Contractor have excavated to within 150 mm above these specified levels or to within 150 mm of these specified limits before he is ready to able to commence the constructional work he shall where required by the Engineer excavate further so as to remove not less than 150 mm of material immediately before commencing the constructional work and any such further excavation shall be held to be Excess Excavation.
Where no bedding material is specified to be laid beneath the pipe the bottom of Trench Excavations shall be carefully boned in and trimmed true to grade with the aid of a straight edge at least six metres long so as to ensure a continuous support for the pipes. The trench bottom shall then be pricked over with a fork and any stones or flints either likely to cause the pipe to bed unevenly or to damage the pipe and its coating or greater than 20 mm in size shall be picked out of the pipe bed and any holes so formed shall be filled in with soft material and trimmed to the correct level.

Where no bedding material is specified, all shattered and loose material shall be removed from the bottom of the Trench Excavation so that the bedding material rests on a solid and clean foundation.

14.1.9 Inspection by Engineer in charge

When the specified levels of Trench Excavation are reached the Engineer will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further and to refill the further excavation with such material as he may direct but such further excavations shall not be held to be Excess Excavation.

Should the bottom of any Trench Excavation while acceptable to the Engineer at the time of his inspection subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddle, soft or loose during the progress of the Works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. Such further excavation shall be held to be Excess Excavation.

14.1.10 Disposing Material from Trench Excavations

Subject to any specified requirements of the Contract, the Contractor shall make his own arrangements for the temporary storage of any excavated material which is required for use in refilling Trench Excavations, including any necessary double handling. In this connection the Contractor shall have regard to the working areas available to him for the construction of the pipeline particularly where this is located in roads or in other places to which the public has free access. Any temporary tips alongside the Trench Excavations shall be to stable slopes and heights.

Where the nature of the excavated material is suitable the Contractor's temporary storage as aforesaid shall include for the separate storage as the Engineer may direct of any of the various grades of material hereinafter specified for the refilling and surface reinstatement of Trench Excavation, namely, soft material, coarse material, hard material and topsoil.

Any excavated material not required for or not suitable for use as refilling as aforesaid or for use elsewhere in the Works shall become property of the Corporation and shall be dealt with as specified below.

Excavated material which is not required for or is unsuitable for re-use in the works shall be disposed off as directed to locations designated by the Engineer (Engineer's tip). Such material shall remain the property of the Corporation and shall be transported and deposited at places designated by the Engineer. Material so deposited shall be shaped up or spread and levelled as directed by the Engineer. Any necessary work to provide access to Engineer's tips or other preliminary work in connection therewith shall be carried out by the Contractor in consultation with the Engineer and the expenses thereof shall be included in the rate quoted for the item. If any dumping charge is paid by
contractor for dumping material at designated site, the amount will be reimbursed on production of receipt.

14.1.11 Trenches not to be left open

Trench Excavation shall be carried out expeditiously and, subject to any specific requirements of the Contract, the refilling and surface reinstatement of Trench Excavations shall be commenced and completed as soon as reasonable practicable after the pipes have been laid and jointed.

Pipelaying shall follow closely upon the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of Trench Excavation to remain open while awaiting testing of the pipeline. The Contractor shall take precautions to prevent flotation of pipes in locations where open Trench Excavations may become flooded, and these precautions may include the partial refilling of the trench leaving pipe joins exposed while awaiting tests of the joints.

If the Engineer considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further Trench Excavation until he is satisfied with the progress of laying and testing of pipes and refilling of Trench Excavations.

14.1.12 Measurement of Trench Excavation

Items for Trench Excavation shall apply to excavation in any material and shall include not only for all work in connection with excavation including timber shoring but also for refilling of trenches and for disposal of surplus material, for temporary fencing and, in fields, for the stripping and subsequent reinstatement of the top surface all as specified. Disposal of surplus excavated material shall be as specified.

The depth of Trench Excavation shall be measured vertically from the original ground level or, where appropriate, from the ground level remaining after the completion of any general excavation or filling down to the specified invert level of the pipe plus the thickness of the pipe plus, where appropriate, the specified thickness of bedding for the pipe.

For the purpose of measuring quantities of other items additional to Trench Excavation (such as Incidental Excavation, surface reinstatement, land drains and services) Trench Excavations shall be deemed to be of the nominal dimensions stated below:

(a) The nominal depth shall be depth as defined in the preceding paragraphs.
(b) The nominal width shall be as set out in Clause 2.7.1103

The sides of Trench Excavation shall be deemed to be vertical and the nominal widths shall apply to any depth of trench and whether or not bedding or surround to the pipe is specified. Shoring and dewatering shall be deemed to be included in the unit rates quoted for trench excavation unless separately provided for in the schedule of quantities.

Trench Excavation and all work in connection therewith as specified shall be valued by the measurement only of such items as are set forth in the Bill of Quantities except where expressly provided for otherwise by the inclusion in the Bill of Quantities of any of the following further items:
Incidental Excavation for trial pits and trenches ordered by the Engineer shall be measured as the volume excavated and shall include for supporting the excavation and for refilling the trial pits and trenches and, where in fields, for surface reinstatement.

Incidental Excavation for structures situated in the pipeline shall be measured only to the extent that the net excavation required to accommodate the structure falls outside the nominal dimensions of the Trench Excavation.

Incidental Excavation for removal of unsuitable material shall (unless it is held to be Excess Excavation) be measured as the volume ordered by the Engineer to be excavated beyond the nominal dimensions of Trench Excavation and shall include for the disposal of the excavated material.

Soft & Decomposed Rock or Hard Rock, measured E.O. Trench Excavation items, shall include for all additional work in connection with excavation in Soft & Decomposed Rock or Hard Rock and within the nominal limits of Trench Excavation in rock. Items for E.O. Incidental Excavation shall be measured similarly.

Excess Excavation and the backfilling thereof shall not be measured for payment.

Concrete refill (excluding bedding and surround) to such lengths of Trench Excavation as may be ordered by the Engineer shall be measured as the volume of concrete required to fill such lengths to the depth ordered and to the nominal width of the trench, a deduction having been made for the volume occupied by the pipe, and shall include for any shuttering required and for disposal of additional surplus material.

Concrete bedding and surround to pipes shall be measured as indicated under Pipelines. Imported or sieved bedding to pipes shall be measured as indicated under Pipelines. Granular bedding and surround to thin walled pipes shall be measured as under Pipelines.

Surface reinstatement of Trench Excavations in roads and in footpaths as specified shall be measured as the area calculated by multiplying the length of the Trench Excavation to be so reinstated by its nominal width. The stripping of the top surface and the surface reinstatement of Trench Excavation in fields shall be included in Trench Excavation and shall not be separately measured.

Crossing land drains shall include for all temporary and permanent measures for dealing with land drains and the like as specified and shall be measured as the length of land drains so dealt with within the nominal width of Trench Excavation.

Crossing services shall include for all temporary measures for dealing with service pipes and cables of any size as specified and shall be measured as the length of such services so dealt with within the nominal width of Trench Excavation. Any permanent measures required by the Engineer shall be ordered by him as additional work.

Crossing hedges, fences and walls shall include for all temporary measures for dealing with such barriers as specified and shall be measured as the length of such barriers so dealt with within the nominal width of Trench Excavation. Any permanent measures required by the Engineer shall be ordered by him as additional work.

Crossing rivers, culverts and other watercourses shall include for all additional measures necessary to make the crossings as specified. Only such crossings as may be itemised in the Bill of Quantities will be measured (E.O. Trench Excavation) for additional payment.
Overhaul of refill material (E.O. Trench Excavation or Excavation in borrow areas) shall apply in cases where the Engineer orders refill material to be transported from locations of excavation which are more than three hundred metres from the length of trench to be refilled, the "overhaul distance" being the distance in excess of three hundred metres.

Sieving of refill material where ordered by the Engineer shall include for transporting the refill material a distance of up to three hundred metres to the length of trench to be backfilled.

14.1.13 Sand Bedding

Where specified the sand bedding to required thickness, and level shall be provided below pipe, prior to laying the pipe in trenches. It shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming. For the purpose of the bedding under this item only screened fine sand of grain size not larger than 2 mm shall be used. The sand shall be clean, uncoated and free from clay lumps, injurious amounts of dust, soft particles, organic matter, loam or other deleterious, substances.

If the sand supplied is unclean it shall be washed. In no case shall sand containing more than 3.5 % by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt in sand and organic impurities as described in IS: 383 shall apply. Sieved and washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the Contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures. Also where necessary, trench shall be kept dry by pumping out seepage water continuously.

15.0 JOINTING OF PIPES

15.1 LOWERING AND JOINTING

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the gunite coating of pipe is not damaged in any way during the lowering and assembling. After the pipe is lowered into the trench, it shall be laid in correct line and level by using the levelling instruments, sight rails, theodolite, etc. care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4 mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends contact and alignment. It may also be necessary to for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this
stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work. For welding, refer to clause 2.7.1117
On completion of the pipe jointing and external protection, the trench and the welding pits shall be cleaned of guniting rebound.

15.2 PROVIDING STEEL PROPS INSIDE THE PIPELINE (Dia. 1200 MM AND ABOVE)

In order to effectively provide cement mortar lining to the inside of the pipes and to avoid difficulties during the work, it is necessary that the roundness of the pipes is maintained circular till the lining work is taken up. To achieve the same, steel adjustable screw type props of screw or similar approved make consisting of minimum six legs shall be fixed inside the pipe. The deflection of the Pipe should be limited to 2% of the average diameter. In no case shall the limit be exceeded, even under the full load, in case of pipes laid underground. The design and drawings of the props that the contractor intends to use should be got approved by the Engineer before starting the work. While laying the pipes underground, the Contractor shall provide this propping arrangement from inside to maintain circularity. These props shall be fixed vertically and at intervals of not more than 1.8 metres or as directed by the Engineer. In case the Engineer finds it necessary, they will have to be fixed in any position. The props should be kept in position at least for three days after the encasing of the pipe in that section is completed or till refilling is done to the full eight of fill over the pipe in case the pipes are not encased. The props shall be removed only after obtaining permission from the Engineer in charge. The height of earth fill over the pipe top shall normally be such as to avoid floatation under submerged condition and to have a minimum earth cushion of about 1.25 metres over the pipe whichever is greater. It is also necessary that, in case of buried pipe, adequate side supports from the backfilled materials is developed to keep the diametral deflection within the specified limits. Backfilling of the excavated trenches, particularly below the pipe and along the sides shall, therefore, have to be done with proper care and compaction as desired. No separate payment shall be made for the use of props.

15.3 WELDING JOINTS

As regards the welding work, the following points shall be borne in mind by the Contractor:

(a) The Contractor shall use approved make of standard electrodes depending on the thickness of plate and type of joint. He shall also use standard current and arc voltage required for the machine in use as per manufacturer’s directions. Welding electrodes shall conform to I.S. 814 - “Specifications for covered electrodes for metal arc welding of mild steel (Latest Revision).

(b) Welded joints (other than for closing lengths) shall be of the butt welded type with an internal circumferential weld. However, pipes 900 mm and below in diameter shall be internally and externally. All fillet welds shall have a throat thickness not less than 0.7 times the thickness of the pipe to be welded.
All parts to be welded shall have loose scale, slag, rust, paint and other foreign matter removed by means of a wire brush and shall be left clean and dry. All scale and slag shall be removed from each weld when it is completed.

(c) Gauging
Pipes larger in size, i.e. more than 900 mm diameter shall be welded internally and externally. At the time of internal welding, a `V' cut is made from inside of the pipes and after completing the internal welding with the required number of runs, the external welding (sealing run) is incumbent. Before starting the external welding (sealing run), the internally welded material in the joint will have to be cleaned by Gouging with Gas Flame. Gouging shall be done before starting the external welding (sealing run) and the rate of welding shall include the cost of gouging also. Gouging will also be carried out before rectifying the defective welding wherever necessary and as directed by the Engineer.

(d) Procedure

The welding of large pipes in the field shall comply with I.S. 816 and I.S. 823 (Latest Revisions). No field welding shall be permitted if there is rain or high wind. Openings in the laid pipeline in the form of manholes made at suitable distances, for access into the pipeline for the work of cleaning, painting and repairs to the welds, etc. shall be closed by welding a new patch on the opening. Such manholes should, as far as possible, be provided at the sides of pipelines; cutting at the crown of the pipe should be avoided. The following procedure should be strictly adopted while plugging the manholes by patch plating:

(i) The manholes shall be plugged by providing a patch plate cut from a separate strake of pipe of the same diameter. The old plate cut from the pipeline shall not be used for this purpose.
(ii) The edges of the new patch plate shall be properly shaped and the plate inserted in the opening by keeping a gap of 1.5 to 2.5 mm and tacked.
(iii) The welding of the patch should be done in segments with proper sequence conforming to I.S. 823.

(e) Testing of Welding Joints

(i) The welded joints shall be tested in accordance with the procedure laid down in I.S. 3600 "Code of Procedure for testing of fusion welded joints and weld metals in steel". One test specimen shall be taken from at least one field joint out of any ten and shall be subjected to test.

(ii) The test pieces shall be taken out from the positions pointed out by the Engineer without any delay. They shall be machined and tested in a week's time.

(iii) The shape of the test pieces removed from the pipes shall be such that it will give a specimen of the required dimensions and, at the same time, leave a hole in the pipe with rounded corners. This hole shall be patched up by inserting and welding suitable size plates. Great care should be taken in preparing these plates so as to get a good butt weld. Procedure given in Clause 2.7.1117 (d) shall be followed.

(iv) After the jointing is completed, all protruding portions shall be chipped off and ground smooth and the unpainted portion of the pipeline near the field joint shall be thoroughly scraped and cleaned. Internal and external surface treatment shall be done as per the instructions of the Engineer.

(v) The entire cost of the test, including taking out test samples, machining the test pieces, transport to and from the laboratory and testing them in a laboratory, the cost of patching up the test piece hole in the pipe, payment of all testing fees, cleaning and painting the same, shall be borne by the Contractor. The tests shall be carried out in
some Government or Semi-Government institute approved by the Engineer. This shall be arranged by the Engineer entirely at the Contractor's cost.

(vi) The following tests shall be made:

1. **Tensile Test:** The test specimen taken across the weld shall be shaped in accordance with I.S 823. The specimen shall be taken from the end of the pipe or at any field joint in the pipe as directed by the Engineer and shall be cut such that the weld lies approximately in the middle of the specimen length. The specimen shall be machined. The protruding welded portion from both inside and outside shall be removed by machining or grinding before the specimen is tested.

2. At least one field joint out of every ten shall be subjected to test by taking out a specimen. If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen substituted. The welding joint shall show strength not less than the minimum tensile strength specified for the plate.

3. **Bend Test:** The bend test specimen shall be prepared in the same way as that for tensile test and tested in the presence of the Engineer. The specimen shall withstand being bent cold through 180° around a pin, the diameter of which is equal to 4 & 1 / 2 times the thickness of the plate, without developing cracks. In making the bend test, the side of the specimen representing the inside of the pipe shall be placed touching the pin.

4. **Re-test:** If the results of the tensile or bend test of any lot do not conform to the requirements specified, retests of two additional specimens from the same section shall be made, each of which shall conform to the required specifications. In case of failure of one or both, extensive gouging (scooping out) and repairing shall be carried out as directed by the Engineer before the lot can be accepted.

(vii) The welder/operator shall be held responsible for any failure of the joint. Since factors such as current, arc voltage, quality of electrodes, etc. are already determined and controlled; the failure is due only to the carelessness and negligence of the welder. For the first failure, the welder/operator shall be warned and for the second failure, he shall be removed from the work and replaced by another approved welder/operator. The joints or a portion thereof shall be got and repaired to the satisfaction of the Engineer. In order to maintain a good standard in welding, all welders shall be tested before they are entrusted with any job. Further, they shall be periodically tested at intervals of six months.

(viii) A complete record shall be maintained by the Contractor showing the names of welders and operators working on each individual joint. The work shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or pair shall be as far as possible completed by them in all respects, including the sealing run. No helper or other unauthorized unqualified person shall be permitted to do any welding work whatsoever. In case of any infringement, the person concerned shall be penalised as directed by the Engineer.

**15.4 PRECAUTIONS AGAINST FLOATATION**

When the pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines, provision is made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc.

In the case of works extending over one or more monsoon seasons, however special care and precautions are necessary during the progress of work on this account. The
Contractor shall close down pipe laying operations well in time for the monsoon. The work of providing blocks, refilling the earth to the required level, compacting the same, etc. shall always be done as soon as the pipeline in the cutting has been laid.

The Contractor shall see that the water shall not be allowed to accumulate in open trenches. Where work is in an incomplete stage, precautionary work, such as blank flanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer.

Such works shall be to the Contractor's account and no separate payment shall be made for the same. The Contractor's rate for pipe laying shall be deemed to include such precautionary measures against floatation.

Protection of the pipeline against floatation during the Contract Period shall be the responsibility of the Contractor. Should any section of the pipeline float due to his negligence, etc. the entire cost of laying it again to the correct line and level shall be to his account.

15.5 REFILLING TRENCHES

Trench Excavations shall normally be refilled using suitable materials selected from excavations carried out within 300 metres of the length to be refilled. Special requirements for bedding and backfilling around thin walled pipes are as follows:-

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline (for field testing of pipeline refer Clause 2.7.8.5 of this Specification). If the Engineer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. Only soft earth and murrum of good quality free from stones larger than 75 mm in size and free from boulders, roots, vegetation etc., shall be utilised after the lumps are broken for filling in around the pipes for at least 30 cm all around for pipes less than 1200 mm diameter and D / 4 for pipes greater than 1200 mm diameter. Filling shall be in layers not exceeding 150 mm and compacted to 25 percent of the maximum dry density as per part VII of IS:2720. The excavated material nearest to the trench shall be used first. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to height of at least 30cm over the top of the pipe except as may for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150 mm in size if sufficient quantity of good earth and murrum are not available. Filling in shall be done in layers not exceeding 225 mm in thickness accompanied by adequate waterering, ramming etc., so as to be compacted to 95% of the maximum dry density as per part VII of IS:2720. Water contents of the soil shall be as near the optimum moisture content as possible. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.
To prevent buckling of pipe shell of diameters 1200 mm and above, pipes shall be strutted from inside while the work of refilling is in progress.

For pipelines of diameters below 1200 mm strutting shall be done from inside at either end of the stretch of the pipeline under refilling, by means of strong spiders which shall be sufficiently stiff to resist all deformation for which no extra payment will be made.

Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 2m.

The Engineer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.

If any material remains as surplus it shall be disposed of as directed by the Engineer. If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refining is not available for excavation the Contractor should bring earth, Murrum of approved quality as directed by the Engineer.

Regular measurement of the field dry density shall be taken by the Contractor at various levels in the backfilling as required by the Engineer.

No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Engineer has been obtained.

Subsidence in Filling in: Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract works, the contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

15.6 SOFT REFILL MATERIALS – SPECIAL MEASURES

Where in the opinion of the Engineer, sufficient supplies of the aforesaid soft material for trench refilling cannot reasonably be obtained from Trench Excavations within three hundred metres of the length of trench to be refilled without resorting to sieving or other special means, then the Engineer may order the Contractor.

(a) To carry out such work as may be necessary to sieve out stones, or
(b) To transport suitable soft material from Trench Excavations at distances greater than three hundred metres from the length to be refilled ("overhaul"), or
(c) To excavate soft materials from suitable borrow areas and transport it to the length of trench to be refilled.
The Contractor shall carry out any or all of these above mentioned items as directed by the Engineer.

15.7 SURFACE REINSTATEMENT IN FIELDS, ETC

After he has refilled Trench Excavations in fields and grass verges in the manner and to the level specified, the Contractor shall replace all Topsoil previously removed and it shall be evenly distributed and levelled over the full extent of the stripped area. Such of the working areas occupied by the Contractor as were originally down to grass shall be sown with grass seed of equivalent quality and maintained until the new grass is properly established.

Other areas not originally down to grass shall be dressed with suitable fertilizers harrowed in so as to restore the original level of fertility.

15.8 SURFACE REINSTATEMENT IN ROADS & FOOTPATHS

Surface reinstatement of refilled Trench excavations in roads and footpaths shall consist of approved backfill material which has been well compacted and brought up to the sub grade level of the adjacent road surface. The balance portion shall be made good with similar material as that of the adjacent road, and shall be so maintained (including topping up when necessary) until the end of the Defects Liability Period or until remain over for permanent reinstatement by the appropriate authority, whichever is sooner.

15.9 OTHER STRUCTURES ALONG THE PIPELINE

The contractors shall be held responsible for adopting every precaution which may be necessary for protecting any structure or mains or appurtenances which are likely to be damaged during the execution of work. If the Engineer requires the adoption of any special measures or precautions, the contractors shall do so forthwith. This however does not absolve the contractors of their responsibility or liability in this regard. No extra payment shall be made for any such measures taken by the contractors.

The Contractor shall carry out further excavation as may be necessary to accommodate structures such as anchor blocks and valve chambers. Such excavation shall include for disposal of surplus material and where appropriate, for backfilling round the structures.

15.10 LAND DRAINS

Where land drains, mole drains or field drains are severed by Trench Excavation they shall be kept in effective temporary operation during construction of the pipeline.

At the appropriate stage of refilling the Trench Excavation, the drains shall be permanently restored as follows:-

The drain on either side of the Trench Excavation shall be cut back for at least 300 mm and a suitable length and diameter of pitch fibre or other approved pipe shall be jointed to the existing drain and laid resting at the ends on solid ground with clay or other stopping to prevent the subsequent run of land drainage water into the pipe trench. During trench refilling, earth shall be carefully placed and thoroughly compacted under the drainpipes to give them adequate support.

15.11 EXISTING SERVICE

Where Trench Excavation is carried out close to or across the line of sewers, pipes, cables and other services, the Contractor shall, where necessary, provide temporary
supports or slings and where such sewer, pipe, cable or other service is temporarily disturbed it shall be replaced.

Where, in the opinion of the Engineer, construction of the pipeline cannot reasonably be carried out unless the sewer, pipe, cable or other service is permanently severed or permanently diverted or permanently supported by concrete he shall order the Contractor to undertake such work.

Notwithstanding any relevant information furnished by the Engineer, the Contractor shall be responsible for ascertaining from his own inspection of the site and from the respective supply authorities and other public bodies the positions of all mains, pipes and cables whether underground or overhead, within or near the Site.

15.12 HEDGES, FENCES & WALLS

Where the Trench Excavation crosses barriers such as hedges, fences and walls, the Contractor, as a temporary measure during construction of the pipeline, shall provide temporary fencing for any parts of such barriers as have had to be removed. After Trench Excavation has been reinstated, the Contractor shall carry out such work as the Engineer may order for permanent restoration of such barriers.

15.13 CROSSING WATERCOURSES ETC.

Where the pipeline crosses rivers, culverts and other watercourses, the Contractor shall be deemed to have allowed for all the additional measures necessary for the proper construction of the pipeline at these crossings including maintaining the full flow of water across the trench.

15.14 CLEANING, DISINFECTING & COMMISSING OF THE PIPELINE

Upon completion of a newly laid main, the main shall be disinfected as directed by the Engineer.

The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.

In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipe line is maintained at no less than 300 mg / l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'slug' of chlorinated water that will as it passes along the line expose all Interior surfaces to a concentration of at least 300 mg / l for at least 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for at least 24 hours.
After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg / l.

After final flushing and before the water main is placed in service, a sample or samples of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples are obtained before the main is placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.

15.15 MEASUREMENT

The measurement for pipes shall be on running metres of net length along the centre line of the pipe as laid excluding the length of specials and appurtenances. Specials shall be paid separately on the basis of net weight of fabricated specials without the weight of mortar lining and guniting. For the payment purpose, flanges shall be either included in or excluded from the weight of the specials as described in the Bill of Quantities. However weight of the jointing materials such as nuts, bolts and washers, etc. shall not be considered for the payment. The Bidder / Contractor shall include their cost in the item rates of specials and appurtenances. Appurtenances shall be paid per number basis. Painting shall be paid on area basis.

15.16 CLEARING SITE ON COMPLETION

In case of pipes, specials, etc become surplus in any section the contractor shall forthwith remove the same to the next section for use in the work. On the completion of the whole work, however, if any pipes and specials, etc become surplus and are stacked on the site, they should be removed from site immediately.

Similarly any mild steel scrap which may result during the process of pipe lying shall on completion of the whole work be collected by the contractors and shall be removed from site immediately.

Where any pavements, trees, shrubs, fencing poles or other property and surface structures have been damaged, removed or disturbed during the course of work, the same shall be replaced or repaired after completion of the work and restored to a condition equal to that before the commencement of the work.

On the completion of the whole of the work, the contractors shall clear the site of all rubbish, building materials, debris, excavated stuff, etc and restore the work site to its original condition, neat tidy, clean to the satisfaction of the Engineer, and handover the same to the Engineer. No Extra Payment shall be made to the Contractor for these works and the rates for laying the pipes shall cover the cost of loading, transporting, and unloading the surplus material on the site.

16.0 UNDERGROUND INSTALLATION OF SPECIALS (T-joints, Elbow joints)

16.1 SCOPE

This item included the fabrication of M.S. specials and other appurtenances as mentioned below, from the M.S. plates for the rising main as directed by the Engineer-in-charge.
16.2 SUPPLY
The specials and appurtenances or fixtures to be supplied under this contract agreement are generally include the following.

a) Bends and branches
b) Flanges
c) Blacks flanges
d) Straps
e) Saddle pieces
f) Wearing plates
g) Bearing plates
h) Flat Manhole covers
i) Plug plates
j) Tapers
k) Platform for scour valves
l) Ring girder, M.S. Rollers, stools etc.

The welding of special shall be done generally as per the specification in section X. Materials required such as washers, nuts, bolts etc. are to be procured by the contractor at his own cost.

16.3 BENDS AND BRANCHES

Fabrication of single or composite bends and T or ‘Y’ branches shall be done from M.S. plates of same specifications as used for the pipes of rising main. Fabrication may be done at site also as directed by the Engineer-in-charge.

16.4 FLANGES

Flanges to be provided at the cost of the pipes or specials where sluice valve, blank flanges, tapers are to be introduced. The contractor shall assemble the flanges in exact position, by marginal cutting if required so as to get the desired position of the other specials likes sluice valve etc., either vertically or horizontally and then shall be fully welded the flanges from both the sides, in such a manner that no part of welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if ordered by the Engineer-in-charge, the protrusions be removed, the contractor shall either file or chip these off. If required, and when directed the contractor shall provide gusset, stiffeners welded at site.

16.5 BLANK FLANGES

Blank flanges shall be provided at all end left unattended for the temporary closure of work and also for commissioning a section of pipe line laid or for testing of the pipe line. For temporary closures, non-pressure blank flanges. Consisting of mild steel plates, shall be tack welded at pipe ends. For pressure pipes. Flanges may be designed as directed by the engineer-in-charge.

16.5.1 Straps

When the pipe line laying is undertaken from both the ends or in stretches due any site difficulty, the final connection has to be made by introducing straps to cover gaps up to 30 cm length. Straps are also required to be provided as per procedure for fixing expansion joint. Such straps shall be fabricated from the pipes at field. Pipes shall be cut by slitting them longitudinally and slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have its inside diameter of pipe equal to the outside diameter of the pipes to be connected. A minimum lap of 8 cm, on either ends of the pipe shall be kept or fillet welds the joint. The longitudinal joints of the collar shall be butt welded. All fill welds shall have a throat thickness of not less than 0.7 times the width of welding.
16.6 SADDLE PIECES

Saddle pieces as required for scour valves and air valves of specified diameters shall be fabricated to fit properly on to the pipes and flanges. The width of the saddle pieces shall also be to suit to the pipes. The cutting and welding should be done suitably to project 1m beyond the edge of the valve manufactured without any extra cost.

16.6.1 Wearing Plates

Width of the plate shall be 40 cm and length shall be 1/3 rd. of circumference of the pipe. The wearing plate shall be welded where pipe rests on the R.C.C saddle. Welding shall be all round the edges of plates.

16.6.2 Bearing Plates

Bearing plates shall be of 40 cm. In width and length suitable to 1/3 rd circumference of pipe plus length of the side of top of saddle and shall be fixed on saddles with sufficient anchorage of M.S. bars as per the directions of Engineer-in-charge and drawing.

16.6.3 Flat or Dished Man Hole Covers

For the fabrication of flat or dished manhole covers special dyes with hydraulic press shall be used by the Contractor to obtain the required shape. The plate shall be cold pressed and no heating shall be permitted. Drilling of holes as required should be done and welding shall be tack welding.

16.6.4 Plug Plates

Plug plates shall be fabricated as directed in the drawing. The size of the plug may vary from 25 mm. to 40 mm. diameter. The hole for plug shall be cut drilled and threaded as directed to the exact size and a suitable. G.I. plug shall be provided by the contractor for every plug plate.

16.6.5 Tapers

Fabricating tapers from the steel plates includes cutting the plates rolling tack welding by machine to form ‘V’ edge to both ends of tapers, with longitudinal butt welding to form drums.

16.6.6 Platform for Scour Valves

These shall be fabricated as per the drawing. A hole of 600 mm. Diameter shall be cut in the centre of the platform for the water to flow down.

16.6.7 Ring Girders etc.

Rings girders shall be fabricated from the rolled steel channels or any other sections suitably as per direction and drawing. This may be required to be strengthened by welding flats. The M.S. sections shall be rolled in two halves to the exact curvature to fit in to pipes. To achieve exact curvature particularly at the ends of channels (rolled section) exact piece to channel may be welded before commencement of rolling, which can be removed after completion of rolling. The cost included fabrication, assembling on pipe and tack welding on both sides of the girder.
Rings girder supports or stools shall be fabricated from M.S. channels or flats as shown in the drawing. Special jack etc. shall be used during fabrication of ring girder supports so that not deformation takes place during fabrication. Rollers shall be fabricated with great care and they shall be straight machined and free from rust or stain or en-eruption.

16.6.8 Gas Cutting and Welding

Gas cutting (Square or v cut) of pipes plates, specials shall be done as specified with care in aligning, holding in position and for forming ‘V’ or any other cut as directed by the engineer-in-charge. Electric or gas welding of steel materials shall be done as per IS: 816-1969 with but joints or lap points or tack welding as directed by the engineer-in-charge.

17.0 HYDRAULIC TESTING OF PIPE LINE

After the work of laying pipe line is completed and before it is commissioned, the pipe line shall be tested in the field both for its strength and leakage in the following manner. Whether stated specifically elsewhere or not; the testing Shall have to be completed within 1 months of laying and jointing delay in testing shall be subject to a fine at 5% of the cost of the testing item for delay of every month or part thereof.

The pipe line laid length shall be divided into sections specified by Engineer-in-charge. The contractor shall recheck pipe and valves for cleanliness and shall recheck operations of the valve. The open ends of the pipe line for sections thereof shall normally be stopped off by blank flanges or cap ends additionally secured where necessary by temporary struts and wedges / all anchor and thrust blocks must have been completed and all pipe straps and other devices intended to prevent movement of pipe must have been securely fastened. The contractors shall clean out the whole pipe lie and flush it with water, so as to remove dust, dirt and any foreign matter lying in the pipeline. No separate payment for the work of cleaning shall be made and the rated under various items of work include the cost thereof.

Each valve section of the pipe line shall be subjected to hydraulic test in section. For this test, the pipe shall be slowly filled with clean water with the existing mains or otherwise by pumping water into the line (water and pumping arrangement is to be arranged by contractor) as directed, and all air shall be expelled from the pipe line through hydrants, air valve, and blow offs fixed on the pipe line. Once the pipe is full, pumping shall be closed. The pressure in the pipeline should then be raised in stages and build pressure and maintained by means of suitable approved pumps, to the specified test pressure based on the elevation of the lowest point on the line or section under test.

The test pressure shall be not less than the 10.0 Kg / cm² test pressure or 1.5 times the working pressure whichever is higher. Before starting the pressure test, the expansion joint shall be tightened. The test pressure shall be maintained for at least 24 hours. The drop in pressure shall not exceed 0.70 kg / cm² within a period of 2 hours after the full test pressure is built up under these pressure no leak or sweating shall be being the expenditure shall be recovered from the contractor’s retention money withheld in deposit without giving any prior intimation. The contractor shall not challenge or claim any extra for such action on the part of the Department. Generally the contractor shall be required to test the pipe line section of 2 km. using Necessary equipment. However if the Engineer-in-charge directs to test full pipe line length. In future suitable sections in the interest of the work, the tender shall have to carry out the test. In such sections as directed by engineer –in-charge.

18.0 OBSERVATIONS, CHECKING TESTING FOR LEAKAGE
The level of water surface shall be measured after 48 hours of initial filling and thereafter at an interval of 24 hours for at-least 5 (Five) days. During the testing the joints of pipe line shall be observed and checked, if any leakage found, the pipe shall be emptied out by the Contractor at his cost and shall be rectified at his cost. The testing procedure shall be repeated, till the rectification of the damages / defects / leakages is of the acceptable engineering standard. During the testing after initial filling the level of water surface in the outlets under consideration shall be measured. The difference in the levels of the water surface after duration of 24 hours shall not be more than 50 mm for a length up-to 1.0 Km. For more / less length the tolerance limit of difference shall be arrived proportionately.

19.0 REJECTION OF SYSTEM OR SYSTEM COMPONENTS

If any leakage found during testing of pipe line, Contractor will have to attend immediately and rectify at his cost within 5 (Five) days. If Contractor fails to rectify the defect the entire length of pipe line between two adjacent outlets shall be rejected and not accepted. The payment shall not be made for the rejected work. The difference in water level during testing shall be within the tolerance limit as specified above, otherwise the work shall not be accepted and paid. If any intermediate payment made to the Contractor for portion under rejection, the same shall be recovered from the outstanding dues of the Contractor.

20.0 BACK FILLING

20.1 GENERAL

Back-filling generally means excavation re-fill up to the ground level by embankment material which is required to be placed in excavation after the structure is built up above the normal ground level. All the back-fill shall be carefully graded to the lines and grades as shown on the drawings or as directed. The item includes the quarrying, transporting servicing and such other processing operations to produce the materials of desired quality, laying watering and compacting as directed. The materials obtained from the excavation work in this contract will be allowed to be used for back-filling, if of approved quality, free of cost.

20.2 PREPARING SURFACE FOR BACK-FILLING

All loose material and surface debris shall be removed. The bed and sides shall be drenched with water sufficiently so as to prevent absorption of water from back-fill material. Before placing the back-fill material, the surface shall be tamped or otherwise consolidated sufficiently.

20.3 BACK-FILLING WITH IMPERVIOUS MATERIAL

The impervious material may be obtained from excavation stuff free of cost or borrowed from outside from contractor's own sources if required without any limitation of lead or lift. The quality of the impervious material should be got approved from the Engineer-in-charge in advance. Water shall be added to the embankment and mixed by suitable means to assure uniform distribution of
moisture and the desired standard of compaction.

20.4 COMPACTION

The average bulk density of soil should be maintained with 10% deviation. Laboratory methods will be used to determine the optimum moisture content, dry and wet density and permeability and the construction will be controlled by field tests and made to determine whether adequate degree of compaction is being attained.

The measurement of widths for payment will be taken as between the accepted payment lines of the excavation under the respective excavation items and will be paid separately under the same contract.

21.0 PERMANENT MARKINGS ON GROUND ALONG THE ALIGNMENT OF PIPES

21.1 The contractor shall establish the sufficient number of reference blocks on the alignment of PDN preferably at the interval of 30m or as suitable on the field boundaries so as they will not be disturbed during the agricultural activities of the farmers.

21.2 The marking shall be constructed in prefabricated concrete block of size (15x15x45)cm embeded in concrete block of size (30x30x30)cm. The base of this block shall be burried in ground projecting only 15cm above the ground and the base concrete block.

21.3 These blocks shall be able to locate the pipeline as and where it is laid all over the work under this agreement. The contractor shall mark each block with specific distinct identification mark.

21.4 The contractor shall show all this blocks jointly to the Engineer in charge or his representative, representative of WUA, concern farmers sharing the boundaries, TPI, any other stake holders in the command.

21.5 Contractor shall maintain these blocks in proper order during operation & maintenance period of this contract. Any damage done to these blocks for any the reasons shall be made good at the cost of contractor.

21.6 The contractor shall submit the location of such blocks with specific identification marks with schedule on a special command area map along with the final bill.

21.7 The map of marking of the block shall be handed over to WUA while handing over the command area.

22.0 THIRD PARTY INSPECTION

Work of PDN shall be inspected, tested and certified by PMC / TPI / QC. Modalities of PMC / TPI / QC Inspection shall be separately decided and given by GOM. All the testing charges will be borne by the Contractor.

22.1 TESTING OF MATERIALS
22.1(a) All materials before being utilized in works shall be inspected and tested, if found necessary, by the Engineer In-charge or his representative / QC. The nature of testing and periodical intervals at which such testing is to be done etc. shall be as per the latest editions of relevant IS Codes and determined by the Engineer In-charge. The day-to-day and periodical tests to be carried out on materials mixes and placed concrete, mortar etc. shall be specified by the Engineer In-charge from time to time and the Contractor shall provide free of cost all facilities towards collections of samples etc. unless otherwise specified. Labours for collecting samples and transportation of the samples to quality control authorities for test shall be provided free cost of by the contractor. Also electricity, fuel, water curing tank and stores etc shall be provided free of cost by the contractors.

22.1(b) The materials shall be tested in QC laboratory or at any other place directed by the Engineer In-charge. The Contractor shall obtain the test results from the concern authority and the results given by such authorities shall be considered to determine whether all materials, workmanship are of respective standard described in contract and in accordance with the instructions of the Engineer In-charge. The Contractor’s representatives shall, however, be given access to all operations and tests that may be carried out as aforesaid so that he may satisfy himself regarding the procedure and methods adopted. It shall then be the Contractor’s responsibility to produce on the work, materials and finished item to the standard as determined by the laboratory tests or to take follow up action to rectify the quality. All Testing charges shall, however, be borne by the Contractor.

(i) When the supply of the samples and the carrying out of such test at Contractor’s cost is provided for or clearly intended in the Contract and is carried out either at the site of work or at place of manufacture specified in the contract document.

(ii) When the supply of the samples and the carrying out of such tests is not provided for or clearly intended in the contract, but on testing the material is found defective and has to be rejected.

22.2 The Contractor shall, however, supply all materials, required for tests and also make good at his cost, materials, mixes and bore / core hole with similar or other materials as may be directed by and to the satisfaction of the Engineer incharge.

22.3 The Contractor shall make suitable arrangements to see that one of his representatives remains present at the time of taking samples and shall authenticate the facts. If the Contractor, fails to keep his representative present at site at the time of taking samples or fail to provide required labours and other equipment to collect the samples, the same shall be taken by the Engineer In-charge, and the samples selected shall be considered as authentic. The cost incurred by the Engineer In-charge when the Contractor fails to provide required men and materials for collecting samples and or their transport shall be recovered from the Contractor.

23.0 QUALITY CONTROL AND QUALITY ASSURANCE

23.1 It is the responsibility of the contractor to assure the desired quality of work. Whenever the testing of construction materials are required as per the detailed specifications or otherwise required by the Engineer In-Charge, the same shall be carried out at the laboratory, selected by the Engineer In-
Charge at Contractor's cost. The other tests of mortar, concrete, sand, coarse aggregates etc. shall be carried out in field laboratory set up by the contractor in presence of quality control representative at contractors cost. Contractor shall through this procedure assure the quality of work.

23.2 The materials, mixes and any other arrangements, including labourers, shall be supplied by the contractor to the Corporation at contractor's cost. The samples for testing shall be taken in the presence of Engineer-in-Charge or his representative / QC present on site. The contractor or his authorized representative shall have a free access in these laboratories, to get himself satisfied about procedures of testing etc. Even if the contractor or his representative fails to remain present while collecting samples or testing the results will be considered as authentic and binding on the contractor.

23.3 On award of contract, the Contractors will have to provide adequate quality assurance setup including Quality Assurance Engineer backed with suitable laboratory assistants, labours and well equipped laboratory for taking necessary field test required as per specifications and as per instructions of Engineer in charge.

23.4 Contractor shall provide all test reports of material used in the work as desired from the NABL (National Accreditation Board for Testing & Calibration Laboratories) approved laboratories and from Quality Control, MERI laboratories of the WRD,CIPET, Aurangabad. Contractor shall provide periodical quality assurance report (Weekly / fortnightly / monthly) to Engineer In-charge along with proofs in support of quality of material brought for the work the process / execution of work is as per specification.

23.5 Contractor shall submit the account of all materials brought for the work, which are necessary for execution of work and any other data necessary to assess the quality of work.

23.6 If he fails to fulfill the requirement, the required manpower for testing and field laboratory with required equipments will be deployed by the Engineer In-charge and the charges will be recovered from the contractor (Provisions of Clause 4 will be applicable) or the agreement will be revoked.

23.7 PERSONAL FOR QUALITY ASSURANCE

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Personnel with Qualification</th>
<th>Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quality Assurance Engineer</td>
<td>One</td>
</tr>
<tr>
<td></td>
<td>(Civil Engineering Graduate with 2 Year experience in QA testing and report generation work)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Laboratory Assistants</td>
<td>Two to Four</td>
</tr>
<tr>
<td></td>
<td>(Twelth Pass with Science subject with 2 year experience in testing of material)</td>
<td>(As per work)</td>
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<tr>
<td>3</td>
<td>Laboratory Attendants</td>
<td>Two to Four</td>
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<tr>
<td></td>
<td></td>
<td>(One for each L.A.)</td>
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23.8 EQUIPMENTS
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Equipments</th>
<th>Apparatus for Tests</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth Work –</td>
<td>Field density, Moisture Content, Sieves for Sand &amp; Metal.</td>
</tr>
<tr>
<td></td>
<td>Field testing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipments</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Concrete Work -</td>
<td>Silt, Gradation, Moisture Content, Slump, &amp; Cube Modules.</td>
</tr>
</tbody>
</table>

The tender rates are inclusive of quality control testing charges.

24.0 HANDING OVER TO WUA

The contractor shall operate and maintain the complete pipe distribution network for the period of 5 (five) years. On completion of O & M period, the system shall be handed over to WUA.

24.1 During rotation period, once in every year, The Contractor shall perform hydraulic test to the satisfaction of Engineer In-charge to verify the flow of designed discharge, detect or confirm any leakage in the system and rectify at his own cost. The testing shall preferably be conducted jointly with members of WUA / representative of Engineer In-charge, technical representative of contractor and any other stake holder.

24.2 On completion of every Irrigation season the contractor shall flush the pipe line from its tail flush valve so that any siltation, vegetation or obstruction is cleaned and pipe is able to flow designed discharge for next season.

24.3 During the O & M period contractor shall give training to the members of WUA about O & M of PDN work and its efficient use and protection of the system from any damages.

24.4 The contractor shall prepare a detail map of the permanent marking along the alignment of pipe and submit with to Engineer In-charge. The Engineer In-charge shall verify and endorsed the location of the marking and handover these signed maps as a permanent record to WUA.

24.5 In association of the members of WUA, the Engineer In-charge shall confirm the release of designed discharge through every outlet before handing over. In case of any short fall or defect it should be made good from the contractor at his own cost.
SPECIFICATIONS FOR DI, CI PIPES FOR PDN

1.0 DUCTILE IRON AND CAST IRON PIPES

1. Scope of work:

This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of DI / CI Pipes used for water supply for irrigation. Use of DI / CI Pipes shall be confirming to IS 8329 / 9523 or relevant Indian code of practice & its revisions.

1.1 Training

The Contractor shall provide on-site training on DI / CI pipe laying, jointing, testing and maintenance etc., to the personnel authorized by Corporation.

1.2 Manuals

Technical Manual on DI / CI pipes including precautions to be taken during operation of the pipeline.

2. Applicable IS Codes, ISO Codes:

The manufacturing testing, supplying, at work sites of Ductile Iron pipes shall comply with all currently applicable statutes, regulations, standards and codes.

In particular, the following standards, specified herein shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of
specifications conflict with the requirements of the codes and standards, this specification shall govern.

<table>
<thead>
<tr>
<th>sr. no</th>
<th>Code Title</th>
<th>IS Code</th>
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<tr>
<td>1</td>
<td>Centrifugally cast(spun) ductile iron pressure pipes for water, gas and sewage- specification</td>
<td>IS8329</td>
</tr>
<tr>
<td>2</td>
<td>Ductile iron fittings for pressure pipes for water, gas and sewage Specification</td>
<td>IS9523</td>
</tr>
<tr>
<td>3</td>
<td>Rubber sealing rings for gas mains, water mains and sewers</td>
<td>IS5382</td>
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<tr>
<td>4</td>
<td>Specification for Sheet Rubber Jointing and Rubber Insertion Jointing</td>
<td>IS638</td>
</tr>
<tr>
<td>5</td>
<td>Code of practice for use and laying of Ductile Iron pipes</td>
<td>IS12288</td>
</tr>
<tr>
<td>6</td>
<td>Methods for sampling of Cast Iron pipes and fittings</td>
<td>IS11606</td>
</tr>
<tr>
<td>7</td>
<td>Portland slag cement</td>
<td>IS455</td>
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<tr>
<td>8</td>
<td>Sulphate resisting Portland cement</td>
<td>IS12330</td>
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<tr>
<td>9</td>
<td>Specification for high alumina cement for structural use</td>
<td>IS6452</td>
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<tr>
<td>10</td>
<td>Specification for super-sulphate cement</td>
<td>IS6909</td>
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<tr>
<td>11</td>
<td>43 grade ordinary Portland cement</td>
<td>IS8112</td>
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<tr>
<td>12</td>
<td>General requirements for supply of metallurgical materials</td>
<td>IS1387</td>
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<tr>
<td>13</td>
<td>Methods for Brunel hardness test for metallic materials</td>
<td>IS1500</td>
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<tr>
<td>14</td>
<td>Mechanical testing of metals - tensile testing</td>
<td>IS1608</td>
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<td>15</td>
<td>Ductile iron pipes, fittings, accessories and their joints for water applications</td>
<td>ISO2531</td>
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<tr>
<td>16</td>
<td>Ductile iron pipes and fittings for pressure and non-pressure pipelines-- Cement mortar lining</td>
<td>ISO04179</td>
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<td>17</td>
<td>Rubber seals-- Joint rings for water supply, drainage and sewerage pipelines- Specification for materials</td>
<td>ISO04633</td>
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<td>18</td>
<td>Ductile iron pipes-- External zinc-based coating- Part 1: Metallic zinc with finishing layer</td>
<td>ISO08179</td>
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<tr>
<td>19</td>
<td>Ductile iron pipes-- External zinc coating-- Part 2: Zinc rich paint with finishing layer</td>
<td>ISO08179</td>
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<tr>
<td>20</td>
<td>Ductile iron pipelines-- Polyethylene sleeving for site Application</td>
<td>ISO08180</td>
</tr>
<tr>
<td>21</td>
<td>Ductile iron pipelines-- Hydrostatic testing after installation</td>
<td>ISO10802</td>
</tr>
</tbody>
</table>
3. Specifications and Requirements of Pipe

3.1 Materials

The general requirements relating to the supply of material shall be as per IS:1387. and IS 8329

3.2 Dimensions:

The internal diameter, thickness and length of barrel, dimensions of pipes shall be as per the relevant tables of IS.8329 / IS: 9523 for different class of pipes.

The tolerances for pipes regarding dimensions and deviations from straight line shall be as per relevant IS codes.

The standard weight of uncoated pipes and the permissible tolerances shall be as per relevant IS codes.

3.3 Coating

All D.I. pipes shall be delivered with internal lining and external coating.

Coating shall not be applied to any pipe unless its surface is clean dry and free from rust.

All DI pipes shall be mortar lined on internal surface as specified in ISO: 4179 and externally coated with bituminous paint as specified in IS: 8329.
3.4 Workmanship and Finish

The pipes shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes shall be free from defects, other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the use of the pipes in the opinion of Engineer-in-charge

The pipes shall be such that they could be cut, drilled or machined. The hardness of the external unmachined surface shall not exceed 230 HBS.

In the case of spigot and socket pipes and fittings for lead joints, the socket shall be without the centering ring.

In the case of flanged pipes the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the center line. The bolt hole circle shall be eccentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipes shall be correctly aligned.

4 Manufacturing of pipes

Pipes supplied shall be centrifugally cast (spun) Ductile Iron pipes conforming to IS 8329 or equivalent international standard. The pipes shall be stripped with all precautions to avoid warping or shrinkage defects, detrimental to their good quality. The pipes shall be sound and free from surface or other defects. The pipes are subjected to designed pressure and carbon content and types of steel etc. will be as per IS 8329

5. Marking of Pipes

Each pipe shall be indelibly marked in English at the ends of the pipe. The marking shall show the following.

1. Manufactures name or trade mark
2. Grade of raw material
3. class of pipe & pressure rating
4. outside diameter
5. Lot / batch No.of manufacturer
6. ISI certification mark
7. Name of Department / Project under which is to be executed: GoM with symbol of QC testing as per design
8. Any other important matter that the manufacturer or purchaser deems fit to be inscribed.
9. white ring line showing spigot length is to be marked

6.0 Pre-Delivery Testing of pipes in Factory

These Test will be governed by IS 10802:1992 and as per clause 10 of IS 8329

6.1 Ring bend test
Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

6.2 Cement Lining Smoothness Type Test

The contractor / manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished to the WRD.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the Engineer-in-Charge at the cost of contractor within the scope of this contract.

6.3 Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500.

6.4 Hydrostatic Test

For hydrostatic test at works, the pipes shall be kept under test pressure as specified in relevant IS codes for 15 seconds, shall be struck moderately with a 700 g hammer for confirmation of satisfactory sound. They shall withstand the pressure test without showing any leakage sweating, or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes.

6.5 Re-test

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

7. Dimensions of spigot and sockets
Dimensions of spigot and socket pipes are governed by provisions of IS 8329 clause no.13.1,13.2,13.3 of IS:8329 which are as follows

7.1 Length

The standard working length of socket and spigot pipes shall be 4 m, 5 m, 5.5 m and for flanged pipes shall be 4 m, 5 m and 5.5 m other lengths are available by agreement between the manufacturer and the purchaser.

7.2 Internal Diameter

The nominal values of the internal diameters of centrifugally cast pipes, expressed in millimetres are approximately equal to the numbers indicating their nominal sizes DN.

7.3 Wall Thickness

The nominal wall thickness of pipes shall be calculated as a function of the nominal size. DN, as given in the formula (1) in 4.3. The different nominal wall thickness are given in Table 2. Other thickness and class are possible for pipes by agreement between the manufacturer and the purchaser.

<table>
<thead>
<tr>
<th>Nominal Diameter (DN)</th>
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<th>K-7</th>
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<td>6.6</td>
<td>7.6</td>
<td>8.6</td>
<td>9.5</td>
</tr>
</tbody>
</table>
8. Transportation of Pipes

All pipes manufactured in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The transportation of pipes shall be done in confirmation to Clause 7.2d IS-12288:1987. The item of transport covers the cost of loading in the factory, transporting to the site of laying or to stacking yard selected by the Engineer-in-Charge its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. The pipe should be loaded in such a way that they are secured and that no movements should take place on vehicle during transit. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer-in-Charge shall be adopted.

<table>
<thead>
<tr>
<th>Contractor</th>
<th>No. of corrections</th>
<th>SDE</th>
<th>Ex. Er.</th>
</tr>
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<tr>
<td>2000</td>
<td>2082</td>
<td>22.5</td>
<td>22.5</td>
</tr>
</tbody>
</table>
The damages / defect or damage noticed shall be repaired to the satisfaction of the Engineer-in-Charge before payment is admitted.

9 Handling and Stacking of pipes

It is essential to avoid damage to the pipes, or their coatings at all stages during handling. Pipes shall be stacked as per provision of clause 7.4 of IS 12288:1987. The pipes shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating. Great care shall be taken in handling the pipe right from the first operation of manufacture until they are delivered to the store. No defective or damaged pipe shall be allowed in the work without rectification / replacement to the satisfaction of the Engineer-in-charge. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer-in-charge.

The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth. As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer-in-charge. IS 12288 shall govern in this case.

10. Post Delivery testing of Pipes

10.1. Pipes produced are subject to following checks;
   a. Visual Inspection for workmanship, marking, visual defect etc.
   b. Mechanical Properties as per relevant governing Standard
   c. Dimension
      • Inside Diameter
      • Outside Diameter
      • Wall Thickness
      • Ovality of Pipes
- Length of Pipes
- Straightness

d. Hydrostatic Leak Tightness to be carried out as per provisions of clause 8 of IS 12288:1987.
e. Zinc coating & bituminous painting on external layer DI pipes shall be carried out as per relevant standard Technical Specifications.
f. Identification- Manufacturer Logo, Nominal Diameter, Class, length indication for cutting of pipe at site, ISI certification mark, pipe no. Internal lining of suitable cement mortar shall be done as per relevant standard / Technical Specifications.

2. Rubber gaskets shall confirm to the requirement if relevant standard / Technical Specifications.

3. Joints for pipe, DI Fittings & specials shall be as per relevant standard / Technical Specifications.

11. **Demarcation of site**

   Before the pipes and specials are lowered and laid in trenches, the contractor shall see that the bedding is plane or the surface is brought to uniform grade and leveled with the help of cross sight rails and boning staff and approved in advance by the last 3 days by the Engineer-in-charge. The contractor shall provide, fix and maintain cross sight rails and boning staff when ever required until the time of completion without any extra claim for cost etc. and which shall be considered inclusive of the rates for excavation and lowering and laying. The contractor shall provide temporary benchmarks if called upon at a minimum distance every 150 M without any claim for extra cost. These benchmarks shall be either of stonemasonry or mass concrete not less than 0.03 Cum.

   The contractor shall provide ladder for inspection of works at least 2 Nos. at the time of inspection for all the trenches of depth greater than 1.2 M.

   The pipes, specials and valves shall be lowered by means of ropes, rackles or pulley as ordered evenly and uniformly and shall be brought level with well consolidated hard murum or wooden sleeper as ordered.
All the S & S pipes and specials shall be laid with sockets facing direction of flow, as per manual.

Materials to be used for jointing such as spun yarn, etc. shall be first get approved in advance from the Engineer-in-charge.

No jointing operations shall be started unless the Engineer-in-charge approved the grade and levels.

12 Preparation of site-

The item pertains to the provision of site clearing including cutting small shrubs, vegetation, bushes and clearing stumps and molehills during the survey work. The land width required for component of pump house & its subcomponent, all pipeline distribution network, various crossings and other components of entire scheme, etc., shall be cleared for all trees having a girth of 30 cm. and less brushwood. Vegetation, bushes, stumps and other objectionable material. The roots of trees shall be removed to a depth of 30 cm. Below the surface of the foundation land and side slopes and the excavation filled up with excavated material in 15 cm to 20 layers and the compacted. Brushwood, vegetation, bushes, stumps, etc. shall be cut flush with the ground. All the material cleared shall be the property of WRD. Usefull material shall be arranged in convenient stacks as directed at convenient place of disposal and handed over to the WRD for disposal. Unsuitable material shall be burned or otherwise disposed off by the contractor at his own cost as directed by the Engineer-in-charge without causing any nuisance, inconvenience or damage to the property of the people in neighbourhood in all cases, the material shall be disposed off in a neat manner. All necessary labour, materials and use of tools for carrying out the item shall be arranged by the contractor at his own cost. Payment for this item shall be per Hectare of area & shall be paid after completion of survey and based on approved estimate.

13. Fixing permanant bench marks in concrete block

13.1 The Contractor shall carry out the Topographical Survey in the command area for preparation of contour plan, locating all topographical features like river / streams, villages, road, railway line, important monuments, forest boundary, contours and administrative boundaries, if any, etc. The Contractor shall carry out
the Bench Mark (Preferably GTS bench mark approved by Engineer-in-charge) from nearest place to the specified location (At proposed pump house location and various locations in command) of the survey area by double tertiary (D.T.) levelling using two auto levels / Total station, establishing and construction of Permanent bench mark / TBMs and reference pillars in the field.

13.2. **Construction Of Permanent Bench Mark (PBM):** The required number of PBM of size as per drawing given by the department with following details of construction-

13.2.1 **Details of Construction of PBM**

1) Carry out excavation in any type of strata / soil for PCC Bench Mark & Reference pillar.

2) PCC Bench Mark

- Use C.C 1:4:8 & 1:2:4 as shown in drawing available with Engineer-in-Charge.
- M.S. Plate of size 200 X 200 & 6 mm thickness of approved quality shall be used.
- Marking of P.B.M. value on steel plate as per instruction of Eng-in-charge.
- 4 Nos of 16 mm dia Anchor Bolt welded to MS Plate shall be used (As shown in Drawing)
- Good quality dressed stone of size 300 X 300 X 600 mm approved by Eng-in-charge shall be used.
- Fencing around PBM.

This should be located preferably at one corner of the field, which shall not hamper the agriculture operations or as instructed by the Engineer-in-Charge. The level of PBM shall be established on top of pillar. Adequate care shall be taken by the Contractor for curing the concrete laid for the PBMs. Payment shall be made as per approved estimate.

**Note:** - Latitude and longitude values of each PBM & TBM shall be submitted to department in register after or during survey work for future references.
13.3 Construction of Temporary Bench Mark (TBM):
RCC precast block of size 900 x 175 x 100 mm shall be used as TBM. The required number of TBM shall be establish in entire command area of Irrigation from established PBM required for execution of work. The numbers of TBM shall be decide by Engineer-In-Charge.

13.4 Details of RCC Precast Block
- Excavation & necessary refilling as per specification given & instruction by Eng-in-charge.
- Use of PCC 1:4:8 for fixing of RCC Precast Pillar (size-600 x 450 x 450 mm)
- RCC Precast stone of size 900 x 175 x 100 mm in CC 1:2:4 with reinforcement 0.75 kg / each Block and as per instruction of by Eng-in-charge shall be used.
- Rates inclusive of necessary paintings of B.M value and other Details.

14. Laying Of Pipes
Zinc coating & bituminous painting on external layer DI pipes shall be carried out as per relevant standard Technical Specifications.

Code of practice for laying DI / CI pipes as per IS 12288 of clause no.5.

14.1 Laying underground
Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 250 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes, either a well designed set of shear legs or mobile crane should be used. When lifting gear is used, the positioning of the sling to ensure a proper balance, should be checked when the pipe is just clear of the ground. If sheathed pipes are being laid, suitable wide slings or scissor dogs should be used. All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing apull-through in the
pipe, or by hand, depending on the size of the pipe. When laying is not in progress, a temporary end closure should be securely fitted to the open end of the pipeline. This may make the pipe buoyant in the event of the trench becoming flooded, in which case the pipes should be held down either partial re-filling of the trench or by temporary strutting. All persons should vacate any section of trench into which the pipe is being lowered.

14.2 Laying above ground

The ground should be dressed to match the curvature of the pipe shell for an arc length subtending an angle of 1200 at the centre of the pipes. Alternatively, the pipeline should be laid either on saddle, roller or rocker supports as specified by authority. The pipes may be allowed to rest on ground if the soil is non-aggressive.

14.3 Supporting pipes above ground

The following recommendations assume that no additional bending moments above those due to the self weight of the pipe and its contents are present.

13.3.1 With Spigot and Socket Pipes - It is recommended that above ground installations of spigot and socket pipes be provided with one support per pipe, the supports being positioned behind the socket of each pipe. This results in a normal distance between supports of 4 m as shown in Fig. 2A. and 6 m may be obtained by positioning the supports relative to the pipe joints as shown in fig. 2 A.

13.3.2 With Flanged Pipes - The recommended maximum unsupported span is 8 m. The supports shall be located at the centre of every second pipe as shown in Fig. 3A. The recommended maximum unsupported span at water course is 8 The relative positions of pipe joints and pipe supports should be as shown in Fig. The supports of all flanged pipework spans should be stable and unyielding due to movements in the pipeline. The straps should prevent any lateral movement or lifting of the pipelines but not restrict expansions and constructions caused by temperature fluctuations.

14.4 Cutting of pipes
The cutting of pipe for inserting valves, fittings, etc, shall be done in a neat and workman like manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe. Methods of cutting ductile iron pipes are given in to clause 5.4.1 To 5.4.3 of IS 12288. 

**By Hacksaw** - Hand or power operated hacksaw should be used with blades having teeth at a pitch of 1 mm.

**5.4.2 By Manually Operated Wheel Cutter** – The type of cutting wheel used for cast iron pipes is not suitable for ductile iron pipe. Special wheels,

**5.4.3 By Pipe Cutting Machine** – Machines with cutter heads or abrasive wheels shall be used. Cutter head should have a front rake angle of 70 as used for steel pipes.

### 14.5 End preparation of cut pipes for jointing

End Preparation of Cut Pipes for Jointing the burr left after cutting should be trimmed off by light grinding or by filling.

### 14.6 Wrapping

- When ductile iron pipes are to wrapped externally with protective coatings, such as bitumen or coaltar sheathing protective tapes or by loose polythene sleeving, or in certain circumstances, concrete before laying. At joints, bends and valves, precautions should be taken to provide sufficient overlap of the wrapping sleeve so that no pipe line is exposed to the aggressive soil.

### 14.7 Pipeline Anchorage

All pipelines having unanchored flexible joints require anchorage at changes of direction and at dead ends to resist the static thrusts developed by internal pressure. Dynamic thrusts caused by flowing water act in the same direction as static thrusts. This thrust is of sufficient magnitude at high velocities to warrant safety consideration.

Anchorages to resist the thrust should be designed taking into account the maximum pressure the main is to carry in service or on test and the safe bearing pressure of the surrounding soil.

Where possible concrete anchor blocks should be of such a shape as to allow sufficient space for the remaking of the joints. Figure 4 shows typical anchorages using concrete anchor blocks.
15. Joining of Pipes-

As per clause no. 6 of IS 12288 the joining will be. Two main types of joints are used with ductile iron pipes and fittings

a) Socket and spigot flexible joints:

1) push on joints and
2) Mechanical joints;

b) Rigid flanged joint.

15.1 Flexible Joint - The spigot and socket flexible joint should be designed to permit angular deflection in direction and axial movement to compensate for ground movement and thermal expansion and contraction. They incorporate gasket of elastomeric materials and the joints may be of the simple push-on-type or the type mechanical joints. Both push-in (Fig. 5A) and require to be externally anchored at all changes in direction such as at bends, etc., and at blank end to resist the thrust created by internal pressure and to prevent the withdrawal of spigots.

15.2 Flanged Joint - Flanged joints are made on pipes having a machined flange at each end of the pipe. The seal is usually effected by means of a flat rubber gasket compressed between two flanges by means of bolts which also serve to connect the pipe rigidly (see Fig. 5B). Gaskets of other materials, both metallic and non-metallic, are used for special applications.

15.3 Jointing Procedure - Procedure for jointing will vary according to the type of joint being used. Basic requirements for all types are:

a) Cleanliness of all parts,
b) Strict compliance with manufacturer's jointing instructions.

The inside of sockets and the outside of spigots should be cleaned and wire brushed for. The use of slings passed around bundles of pipes is not recommended because bundles become unstable as the sling is drawn tight or released. However, when it is necessary to use the central slinging method for lifting single pipe. a broad webbing sling is recommended which minimizes the risk of the pipe slipping. Chain slings may slip and are dangerous.
16. Underground installation of specials (T-Joints, Elbow Joints)

The class of Fittings to be provided shall be as specified in the design requirement. The external diameter and wall thickness of fittings for Push-on-joints for the specified Class shall be as per IS 9523 or equivalent.

The Pressure class of flanged fittings shall be as specified in the design requirement and shall conform to the requirements of IS 9523 or equivalent.

17. Hydraulic Testing of Pipes

The pipeline and valves should be tested hydraulically up to the required pressure as per IS satisfactorily and all the leakages if any should be repaired at the time of hydraulic testing. Contractor should make his own arrangements at his own cost for water for hydraulic testing of pipeline. He should not rely upon completion of any other sub-works for such testing. Note:- Contractor should maintain Gravity Main for a period of 5 Years governed by ISO 10802, IS 12288

17.1 HYDRAULIC TESTING OF PIPELINES

After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. As per provision of table no.1 under clause 8 of IS 12288:1987 & procedure laid down as per ISO-10802:1992. The pipeline may be tested in sections. Water and other facilities as required for such hydro testing shall be arranged by the Contractor. Each section shall be properly sealed-off with special stop ends secured by adequate temporary anchors. The thrust on the stop ends shall be calculated and the anchors designed to resist it. All permanent anchors shall be in position and, if of concrete, shall have developed adequate strength before testing begins.

17.2 Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere. After filling, the pipe line shall be
adequately pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as stipulated in the table no 1 under clause 8 of IS-12288:1987 and the section under test completely shall be closed off. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

17.3 Hydraulic Testing of Complete pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in clause 8 of IS 12288:1987

17.4 Joint Leak Tightness Test

Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.

Tests for Leak tightness and mechanical resistance of flanged joints shall be conducted as per ISO 2531.

17.5 Acceptance Criteria

The acceptance of the complete pipeline after hydraulic testing shall be in confirmation of Clause 6 of ISO 10802

17.5.1 In case of Pressure Pipelines
The water loss shall not exceed 0.001 litre / hour / kilometre of pipeline / millimetre of nominal size / bar of static pressure (average head applied to the test section).

This corresponds to an acceptable loss of 1 l / h per kilometre of DN 100 pipeline tested at 10 bar.

In cases where the elevation of the pipeline varies considerably throughout its length the acceptable loss shall be determined from an weighted average pressure.

17.5.2 In case of Non-pressure pipelines

The water loss shall not exceed 0.1 litre / kilometre of pipeline / millimetre of nominal size.

However, when a test pressure in excess of 1 bar is specified the acceptance criterion is that of pressure pipelines.

18. OBSERVATION / CHECKING / TESTING FOR LEAKAGE:

The level of water surface shall be measured after 48 hours of initial filling and thereafter at an interval of 24 hours for at least 5 (Five) days. During the testing of joints of pipe line shall be observed and checked, if any leakage found the pipe line shall be emptied out by contractor at his cost and shall be rectified at his cost. The testing procedure shall be repeated till the rectification of the damage / defects / leakage of the acceptable engineering standard. The mains intended for irrigation purpose shall be flushed before commissioning for use. The procedure described in clause 9 of IS 12288:1987 shall be adopted to the satisfaction of Engineer-in-Charge.

19. REJECTION OF SYSTEM OR SYSTEM COMPONENTS

If any leakage found during testing of pipe line, Contractor will have to attend immediately and rectify at his cost within 5 (Five) days. If Contractor fails to rectify the defect the entire length of pipe line between two adjacent outlets shall be rejected and not accepted. The payment shall not be made for the rejected work. If any intermediate payment made to the Contractor for portion under rejection, the same shall be recovered from the outstanding dues of the Contractor.
20 BACK FILLING OF TRENCHES

Back filling the foundation trenches around the structures etc with selected excavated stuff including watering, ramming, compacting, etc. complete.

20.1 General:

(a) For the purpose of backfilling the depth of trench shall be considered as divided into three zones as zone A, zone B & zone C as per provisions of clause 4.11 of IS 12288:1987 & the backfilling shall be done as per procedure laid down in IS 12288:1987. The type of material used for backfilling and the manner of depositing the material, shall be subject to approval by Engineer-in-Charge. As far as practicable, backfill material shall be obtained from the excavation for structures or from adjacent PDN excavation.

(b) Backfill material shall contain no stone larger than 7.5 cm size.

(c) The backfill material shall be placed to the line and grades as shown on drawings or as prescribed in this paragraph or as directed by the Engineer-in-Charge.

(d) Backfill shall not be placed against retaining walls until the retaining wall is cured adequately and is strong enough to take lateral pressure of the backfill. Trimming of the sides of excavation against which the backfill is to be laid shall be delayed until immediately prior to backfilling and any excessive drying of the surface shall be conditioned properly and made adequately moist to avoid potential desiccation for the rock or partly compacted consolidated materials.

(e) The backfill material shall be placed carefully and spread in uniform layers of not more than 15cm thickness. The backfill shall be brought up as uniformly as practicable on both sides of walls and all sides of structures to prevent unequal loading. The backfill material shall be placed at about the same elevation of both sides of the pipe portions of the structures and culverts and difference in elevation shall be responsible for providing adequate earth cover over pipe to prevent damage due to loads of construction equipment’s.
(f) If a haul road is built over a pipe, all backfill around and over the pipe shall be placed to a uniform surface and no humps or depressions shall be permitted at the pipe crossings.

(g) Backfill placement and compaction around structures shall be restricted until the structure is complete.

(h) Compaction around the structure shall be done by pneumatic rammers in thin layers.

21.0 PERMANENT MARKINGS ON GROUND ALONG THE ALIGNMENT OF PIPES

21.1 The contractor shall establish the sufficient number of reference blocks on the alignment of PDN preferably at the interval of 30m or as suitable on the field boundaries so as they will not be disturbed during the agricultural activities of the farmers.

21.2 The marking shall be constructed in prefabricated concrete block of size (15x15x45)cm embedded in concrete block of size (30x30x30)cm. The base of this block shall be buried in ground projecting only 15cm above the ground and the base concrete block.

21.3 These blocks shall be able to locate the pipeline as and where it is laid all over the work under this agreement. The contractor shall mark each block with specific distinct identification mark.

21.4 The contractor shall show all this blocks jointly to the Engineer-in-charge or his representative, representative of WUA, concern farmers sharing the boundaries, TPI, any other stake holders in the command.

21.5 Contractor shall maintained these blocks in proper order during operation & maintenance period of this contract. Any damage done to these blocks for the reasons whatsoever shall be made good at the cost of contractor.
21.6 The contractor shall submit the location of such blocks with specific identification marks with schedule on a special command area map along with the final bill.

21.7 The map of marking of the block shall be handed over to WUA while handing over the command area.

22.0 THIRD PARTY INSPECTION

Work of PDN shall be inspected, tested and certified by PMC / TPI. Modalities of PMC / TPI Inspection shall be separately decided and given by WRD. All the testing charges will be borne by the Contractor.

23.0 Quality Control and Quality Assurance

23.1 It is the responsibility of the contractor to assure the desired quality of work. Whenever the testing of construction materials are required as per the detailed specifications or otherwise required by the Engineer-in-Charge, the same shall be carried out at the laboratory, selected by the Engineer-in-Charge at Contractor’s cost. The other tests of mortar, concrete, sand, coarse aggregates etc. shall be carried out in field laboratory set up by the contractor in presence of quality control representative at contractors cost. Contractor shall through this procedure assure the quality of work.

23.2 The materials, mixes and any other arrangements, including labours, shall be supplied by the contractor to the Corporation at contractor’s cost. The samples for testing shall be taken in the presence of Engineer-in-Charge or his representative / QC present on site. The contractor or his authorized representative shall have a free access in these laboratories, to get himself satisfied about procedures of testing etc. Even if the contractor or his representative fails to remain present while collecting samples or testing the results will be considered as authentic and binding on the contractor.
23.3 On award of contract, the Contractors will have to provide adequate quality assurance setup including Quality Assurance Engineer backed with suitable laboratory assistants, labours and well equipped laboratory for taking necessary field test required as per specifications and as per instructions of Engineer in charge.

23.4 Contractor shall provide all test reports of material used in the work as desired from the NABL (National Accreditation Board for Testing & Calibration Laboratories) approved laboratories and from Quality Control, MERI laboratories of the WRD. Contractor shall provide periodical quality assurance report (Weekly / fortnightly / monthly) to Engineer in Charge along with proofs in support of quality of material brought for the work the process/execution of work is as per specification.

23.5 Contractor shall submit the account of all materials brought for the work, which are necessary for execution of work and any other data necessary to assess the quality of work.

23.6 If he fails to fulfill the requirement, the required manpower for testing and field laboratory with required equipments will be deployed by the Engineer in charge and the charges will be recovered from the contractor.

23.7 PERSONNEL FOR QUALITY ASSURANCE

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Personnel with Qualification</th>
<th>Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quality Assurance Engineer (Civil Engineering Graduate with 2 Year experience in QA testing and report generation work)</td>
<td>One</td>
</tr>
<tr>
<td>2</td>
<td>Laboratory Assistants (Twelth Pass with Science subject with 2 year experience in testing of material)</td>
<td>Two to Four (As per work)</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory Attendants</td>
<td>Two to Four (One for each L.A.)</td>
</tr>
</tbody>
</table>

23.8 EQUIPMENTS
### Sr. No. Equipments | Apparatus for Tests
--- | ---
1 | Earth Work – Field testing Equipments | Field density, Moisture Content, Sieves for Sand & Metal.
2 | Concrete Work - | Silt, Gradation, Moisture Content, Slump, & Cube Modules.

#### 23.9 The tender rates are inclusive of quality control testing charges.

#### 24. Handing over to WUA

The contractor shall operate and maintain the complete pipe distribution network for the period of 5 (five) years. On completion of O & M period, the system shall be handed over to WUA.

**24.1** During rotation period, once in every year, The Contractor shall perform hydraulic test to the satisfaction of Engineer In-charge to verify the flow of designed discharge, detect or confirm any leakage in the system and rectify at his own cost. The testing shall preferably be conducted jointly with members of WUA / representative of Engineer In-charge, technical representative of contractor and any other stake holder.

**24.2** On completion of every Irrigation season the contractor shall flush the pipe line from its tail flush valve so that any siltation, vegetation or obstruction is cleaned and pipe is able to flow designed discharge for next season.

**24.3** During the O & M period contractor shall give training to the members of WUA about O & M of PDN work and its efficient use and protection of the system from any damages.

**24.4** The contractor shall prepare a detail map of the permanent marking along the alignment of pipe and submit with to Engineer In-charge. The Engineer In-charge shall verify and endorsed the location of the marking and handover these signed maps as a permanent record to WUA.

**24.5** In association of the members of WUA, the Engineer In-charge shall confirm the release of designed discharge through every outlet before handing over. In case of any short fall or defect it should be made good from the contractor at his own cost.
SPECIFICATIONS OF HIGH DENSITY POLYETHYLENE PIPES (HDPE) AND FITTINGS

1.0 Scope of work

This specification covers the requirements for manufacturing, pre-delivery testing, supplying, laying, jointing and testing at works and site of High Density Polyethylene Pipes used for water supply. Use of HDPE Pipes shall be Pressure class of minimum PN 6 or above and confirming to IS 4984 / 14151 / 12786 / 13488 or relevant Indian code of practice & its revisions.

1.1 Training

The Contractor shall provide on-site training on PE pipe laying, jointing, testing and maintenance etc., to the personnel authorized by Corporation.

1.2 Manuals

The contractor should provide technical Manual on PE pipes including precautions to be taken during operation of the pipeline.

2.0 Applicable IS codes, ISO codes

The manufacturing, testing, supplying, laying, jointing and testing at work sites of HDPE pipes shall comply with all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern. Others Codes not specifically mentioned here but pertaining to the use of HDPE Pipes form part of these Specifications.

<table>
<thead>
<tr>
<th>IS 4984</th>
<th>High Density Polyethylene Pipes for Water Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 5382</td>
<td>Rubber sealing rings for gas mains, water mains and sewers.</td>
</tr>
<tr>
<td>IS 4905</td>
<td>Methods for random sampling</td>
</tr>
<tr>
<td>IS 7328</td>
<td>High density polyethylene materials for molding and extrusion</td>
</tr>
<tr>
<td>IS 7634</td>
<td>Laying &amp; Jointing of Polyethylene (PE) Pipes</td>
</tr>
<tr>
<td>IS 9845</td>
<td>Method of analysis for the determination of specific and / or overall migration of constituents of plastics material and articles intended to come into contact with food stuffs</td>
</tr>
<tr>
<td>IS 10141</td>
<td>positive lists of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water.</td>
</tr>
<tr>
<td>IS 10146</td>
<td>Polyethylene for its safe use in contact with food stuff, Pharmaceuticals and drinking water.</td>
</tr>
<tr>
<td>IS 12235</td>
<td>Thermoplastics pipes &amp; fitting methods of test.</td>
</tr>
</tbody>
</table>
3.0 Specification & requirements of pipes

3.1 Labelling on pipes

Pipes shall be designated as per IS 4984, according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 100 PN 10 DN 200 indicates a pipe pertaining to material grade 100 having a pressure rating 1.0 MPa and outside nominal diameter 200 mm.

All IS specifications shall apply to HDPE pipes and they shall be tested by CIPET for the standards required for HDPE pipes

3.2 Colour

The colour of the pipe shall be black.

3.3 Materials

The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odour, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any internationally reputed organization as per the satisfaction of the Engineer-in-Charge in charge.

3.3.1 Raw Material

(a) Raw material used to manufacture the HDPE pipes shall be 100% virgin PE100, compounded or Natural black PE resin confirming to IS: 4984, IS: 7328 and ISO: 4427. For this a certification has to be given by the resin manufacturer as per clause 3.2.3 of IS: 4984. The resin proposed to be used for manufacturing of water supply pipes.

The pipes should also comply with the following norms as per ISO 9080

(b) The resin should have been certified by an independent laboratory of international repute for having passed 10,000 hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10MPa. Internal certificate of any resin manufacturer shall not be acceptable.

(c) Certificate from reputed organization OR Raw material supplier for having passed the full scale rapid crack propagation test as per ISO 13478. High density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-50-T-003 of IS 7328. HDPE conforming to designation PEEWA-50- T-003 of IS 7328 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g / 10 min. In addition the material shall also conform to clause 5.6.2 of IS 7328.
(d) The specified base density shall be between 940 kg / m³ and 958 kg / m³ (both inclusive) when determined at 27°C according to procedure prescribed in IS 7328

The value of the density shall also not differ from the nominal value by more than 3 kg / m³ as per 5.2.1.1 of IS 7328. The MFR of the material shall be between 0.20 and 1.10 (both inclusive) when tested at 190°C with nominal load of 5 kgf as determined by method prescribed in IS 2530. The MFR of the material shall also be within ±20 percent of the value declared by the manufacturer.

(e) The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 ±0.5% and the dispersion of carbon black shall be satisfactory when tested as per IS 2530.

3.3.2 Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harm less and shall be selected from the list given in IS 10141

3.3.3 Reworked Material

No addition of Reworked / Recycled Material from the manufacturer’s own rework material resulting from the manufacture of pipes is permissible and the vendor is required to use only 100% virgin resin compound.

3.4 Maximum Ovality of Pipe

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in table 2 of IS 4984. Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

3.5 Detectability

HDPE Pipes should be detectable when buried underground, by providing a copper wire of 1.20mm + / - 0.2 mm Ø, co-extruded along the entire length of pipe.

3.6 Length of Straight Pipe

The length of straight pipe used shall be more than 6 m or as agreed by Engineer-in-Charge in charge. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.
3.7 Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. Pipe beyond 110mm dia shall be supplied in straight length not less than 6m.

3.8 Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe. IS 4984:1995 shall be followed for visual appearance.

4.0 Manufacturing of pipes

The General requirement relating to the manufacture of HDPE pipes shall be confirming to IS: 4984 -1995 and its latest revision / amendments.

(a) The dimension, material composition, tests etc shall be as per IS:12235 - 2004 and its latest revision / amendments.

(b) HDPE pipes shall be marked with ISI certification mark.

(c) The pipe dimensions and tolerances shall be as per latest revisions and amendments of IS 12235 -2004. (Part1)& IS: 4984 -1995

5.0 Marking of pipes

Each pipe shall be indelibly marked in English language at the end of each pipe. The marking shall show the following.

1. Manufactures name or trade mark.
2. Grade of raw material
3. Class of pipe & pressure rating.
4. Outside diameter
5. Lot / batch No. of manufacturer.
6. ISI certification mark.
7. CIPET certification mark for each lot
8. Name of Department / Project under which work is to be executed: WRD with symbol of QC testing as per design.

9. Any other important matter that the manufacturer or purchaser deems fit to be

inscribed.

6.0 Pre-delivery testing of pipes in factory

6.1 Tests

The following tests as per IS:12235-2004 and its latest revision / amendments will be carried out by the agency in the presence of representative of Engineer In-charge / WRD / QC / TPI. Laboratory tests to be carried out at manufacturing unit of pipes by CIPET and if required additional tests shall be conducted as suggested by Engineer In-Charge after supply of pipes at site such random sample of pipes collected from site shall be tested in CIPET Laboratory. The testing charges shall be borne by the Contractor.

a. Dimensions (Inside and outside diameter, Wall thickness and Length of pipe) as per Clause No. 6.0 of IS:4984-1995 & its revision.

b. Visual appearance as per Clause No.7of IS:4984-1995

c. Hydraulic Characteristics as per Clause No. 8.1 of IS:4984-1995

d. Reversion test as per Clause No. 8.2 of IS:4984-1995

e. Density test as per Clause No. 8.4 of IS:4984-1995

f. Melt flow rate (MFR) at 190°C with nominal load of 5kg shall be between 0.4 to 1.1 g / 10minutes as per Cl.no.8.5 of IS-4984:1995.Carbon black content shall be within 2.5%( ±0.5%)and dispersion carbon black shall be satisfactory as per cl8.6% IS 4984:1995.

g. Internal hydrostatic pressure, creep rupture test in accordance with procedure given in annexure B & table 6 of IS 4984:1995 pipe shall not burst during the prescribed test duration.

h. Acceptance test shall be in confirmation with Cl.9.2 of IS-4984:1995. The HDPE pipe shall not contain vinyl chloride monomer (VCM) exceeding 1ppm when determined by means of gas phase chromatography using the headspace method according to IS: 10151-1982.

i. The wall of the plain pipe shall not transmit more than 0.2% of visible light falling on them when tested in accordance with IS:12235-2004 (part -3).

Sampling and Criteria for Conformity

The sampling procedure and the criteria for conformity shall be as per Cl.9 of IS :4984 - 1995.
The scale of sampling for visual and dimensional requirement shall be as per Cl.no.9 Table No.7 of IS-4984:1995 or as directed by Engineer In-charge. The sampling shall be made on random basis, from a lot manufactured. The samples required for testing shall be taken as directed by Engineer In-charge or his representative / QC / PMC / TPI.

When subjected to internal hydrostatic pressure test in accordance with the procedure given in IS:12235-2004 (Part 8) the pipe shall not fail during the prescribed test duration. The temperatures and duration of test shall confirm to the requirements given in the table mentioned below. The tests shall be carried out not earlier than 24 hr after the pipes have been manufactured.

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Temp. (Min.) °C</th>
<th>Test Duration (Min. holding time)</th>
<th>Test Pressure (Min.) MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Quality</td>
<td>60</td>
<td>1000</td>
<td>1.16xPN(MPa)</td>
</tr>
<tr>
<td>Acceptanc</td>
<td>27</td>
<td>1</td>
<td>4.19xPN(MPa)</td>
</tr>
</tbody>
</table>

The pipes under test shall show no signs of localized swelling, seepage cracking, leakage or weeping and shall not burst during the prescribed test period.

During execution if required the sampling of pipes shall be made from the procured, tested and delivered lot of pipes at site randomly. The Contractor shall have to borne all the cost of testing in such a case over and above the cost of regular testing.

7.0 Transportation of pipes

- The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded – especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the Pipe.

- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly on contractors yard along the alignment / road side / elsewhere near by the work site or as directed by the Engineer In-Charge.

- Damages during transit, handling, storage shall be to the Contractors account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer In-Charge.

8.0 Stacking of pipes
During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole.

The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain maximum safety during unloading, lifting and lowering.

- Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60°C.
- Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials.
- Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.
- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.
- Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks are used on PE pipes.
- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.
- During coiling care should be taken to maintain the coil diameter at or above the specified minimum to prevent kinks. Coiling shall be done when the pipe attains the ambient temperature from the extruder. In uncoiling or recoiling care should be taken that sharp objects do not scour the pipe.
- When releasing coils, it must be remembered that the coil is under tension and must be released in a controlled manner. The end of the coil should be retained at all times, then the straps released steadily, one at a time. If the coil has bands at different layers of the coil, then they should be released sequentially starting from the outer layers. The amount of the energy locked up in the coil shall depend on the size of the pipe, the SDR of the pipe, and the size of the coil.
- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.
- Bare coils shall be wrapped with hessian cloth for long distance (>300Kms)
- Stacking of pipes must be done at contractor’s own cost.

9.0 Post-delivery testing of pipes
9.1 Inspection and test after erection
In addition to the progressive supervision and inspection by the Engineer in charge or his representative / TPI, the Contractor shall offer for inspection to Engineer-in-Charge or his representative / QC / TPI, the complete erected or its parts on which tests are to be carried out in the laboratory of CIPET. After such inspection by Engineer-in-charge or his representative / QC / TPI, the Contractor shall have to carry out the testing for leakage / seepage from pipe line / structures in the presence of Engineer In-Charge or his representative / QC / TPI. All the structures shall be observed, checked and tested for leakage and constructional defects.

9.2 Testing

(1) The length of pipeline to be tested shall be the length between outlet to outlet well or as directed by Engineer In-Charge. Generally for sub-minor the testing shall be carried out for full length at a time, if length of sub-minor is less than 1.0 km and for more length of sub-minor the testing shall be carried out in two stages as directed / decided by Engineer In-Charge. The Contractor shall have to make all the arrangement of water for testing, labours, supervisory staff, etc. for the period of testing. The necessary arrangement for plugging of opening in the wells / outlets / (end well of reach under testing) shall be made by the Contractor at his cost. After testing, Contractor shall have to remove the plugging at his cost, but care should be taken that no damage will occur to the work executed. If any damage will occur to any parts of work executed the same shall be required to be repaired by the Contractor at his cost to the satisfaction of Engineer In-Charge.

(2) Backfilling of pipeline trenches can be done before the testing of pipe line.

Initial Filling: The water shall be filled in the portion under testing up to predetermined level and shall be continuously maintained at predetermined level at predetermined locations (outlets) for 48 hours. The purpose of initial filling shall be to provide sufficient time / water for absorption in the concrete structures.

10 DEMARCATION OF SITE

10.1 INSPECTION & DEMARCATION
All materials such as pegs, bamboo’s and strings and temples for marking out slopes, and labour required for line out should be provided by the Contractor at his own cost. The centerline of excavation shall be clearly marked by pegs or by stones at each chain or change of direction or at shorter intervals on curves, in the beginning. The final line out will be done by fixing reference stone at suitable distances on either side of the centerline, beyond the canal edges so that they are not disturbed the construction period. The position of these stones will be marked on the cross section.

10.2 Contractor shall provide and maintain the quarry roads and temporary roads required for conveying and transport of material at his cost.
10.3 The material available from all excavation and remaining surplus after use on the work from adjacent reaches / canal works etc. can be used by the Contractor free of cost provided these materials are used solely or the specific contract work and prior approval of the Engineer In-charge is taken.

11.0 PREPARATION OF SITE

11.1 Clearing the Site

The Contractor shall clear the entire area required for setting out. All tree stumps, roots, brushwood, rubbish of all kinds, loose stones and all other objectionable materials shall be removed by the Contractor. All buried irrigation pipeline, and other structure shall remove by Contractor. The ownership of all the usable material, so removed from clearing site and / or excavation shall rest with the Engineer In-charge. Useful material shall stack as directed. Cutting of all trees up to 0.50 m girth shall be covered in this item. The Contractor shall have to remove all the stumps and roots of trees for which no additional payment shall be made. The roots of trees shall be grubbed below the ground. The Contractor shall dispose off all such materials outside the canal land width as directed by the Engineer In-charge.

11.2 Excavation for trenches and structure and its classification

Except or otherwise provided in these specifications, excavation of structure / Canal trenches shall be carried out as per excavation line shown in the drawing or as directed by Engineer In-charge. Excavation in all sorts of soil includes the dry, wet & slushy condition. Contractor must assume all responsibility for deductions and conclusion as to the nature of the materials to be excavated and the difficulties of making and maintaining the required excavation.

11.2.1 Classification of the soil

Excavation for foundation in overburden, soil and murram includes all excavation to be done in strata including hard rock which covers excavation in all kinds of soil such as brown soil, reddish soil, black soil, clay, sand, gravel and murram or mixtures of any of these soils. It shall also include removal of boulders / pebbles up to 70 kg and which are embedded in soil and can be removed by pick bar and shovel without blasting.

11.2.2 Conveyance and disposal of excavated materials

(a) The usable excavated material available from the excavated trenches (PDN) shall be used in back filling. If such usable material is in excess of the requirement of back filling, the same shall be deposited in the spoils as and where directed by the Engineer In-charge.

(b) All suitable materials removed from excavation and in excess of the requirement of trenches (PDN), back filling shall be used in the construction of
approaches to the road bridges and backfill around structures up to 1 km. lead for which no extra payment will be made. The remaining material from excavation shall be used to be deposited in low areas to eliminate tripped drainage or otherwise stacked in spoil banks in regular shape with suitable slopes or spread in other approved locations as directed by the Engineer In-Charge, within a lead of 1 Km. Spoil banks shall not be constructed continuous.

A gap of 10 m shall be provided at 150 m interval. The maximum height of spoil bank shall be restricted to 3.0 m with side slope 1.5:1.

(c) When the excavated material is required to be used for adjacent spoil bank, the lead involved shall be measured along the center line of PDN considering 15 m block as a unit and when the excavated material is required to be used for other than approach road and spoil banks, the lead involved shall be measured from the block of 15 m to the place of dumping as a straight-line distance, i.e. shortest possible distance.

11.2.3 Dewatering in PDN trenches and wet excavation

Surface or sub-soil water met with during excavated trench (PDN) and structure excavation shall be diverted to nearby drain / nalla by cutting an open channel from trench. When the drain / nalla bed is higher than the sub-soil water level met with, the bailing out by suitable means of pumping shall be resorted to for dewatering sub-soil water below the drain / nalla bed level. In case where topography of area is such that surface water is not possible to be drained off by excavating the channel, the bailing out by suitable means of pumping shall be resorted to and no separate payment shall be made for the dewatering. No distinction shall be made as to whether the material being excavated is dry, moist wet or slushy. The Contractor shall have to excavate the PDN pipe trench and structure in under water level conditions also i.e. under wet / slushy condition after providing sufficient arrangement of dewatering. The material excavated under water level condition which requires intermediate stacking for drying shall have to rehandle. No extra payment for efforts for drying out of soil, re-handling of dry soil, etc. shall be given. The Contractor shall have to excavate the wet and saturated soils met with above subsoil water level. (Including capillary fringe) No payment for extra efforts for excavation under this condition shall be made.

11.2.4 Over Excavation

(c) Over excavation performed by the Contractor for any purpose or reason, except for additional excavation as stated herein above or as may be directed by the Engineer In-charge shall be rectified at the cost of the Contractor Filling and compaction for such over excavation using the material as directed by the Engineer In-Charge shall also be at the cost of the Contractor.

(d) In the PDN and structure section where expansive type of soil such as CH type of soil encountered and over which PDN cannot be directly laid, the PDN trench and structure shall be over excavated to the extent as directed by the
Engineer In-Charge and such over excavated section shall be filled with suitable murrum type soil to be placed in uniformly compacted layers as directed by the Engineer In-Charge. The over excavation made in such strata, filling by suitable soil, and watering and compacting such soil will not be paid additionally. Above provision for over excavating and filling with suitable murrum type or good soil available material shall be applicable in case such treatment is found essential.

12.0 FIXING PERMANENT BENCH MARK IN CONCRETE BLOCKS

(a) In the vicinity of PDN, there are M or B type bench marks fixed by the Survey of India and temporary bench marks established by the Engineer In-charge which will serve as control points for these works. The Contractor shall establish sufficient number of reference benchmarks for facilitating setting out of work and taking levels for the purpose of measurements.

(b) Before starting any work, the Contractor shall erect reference benchmarks, reference lines and check profiles at convenient locations approved by the Engineer In-Charge. The benchmark shall be 200 mm x 200 mm x 600 mm with 400 mm embedded in the firm ground and 200 mm projecting above ground. The word ‘BM’ showing value of R. L. in ‘m’ shall be conspicuously carved and painted on the benchmark. The reference line shall comprise the base line properly dog belled on the ground with the numbered concrete / masonry pillar suitably spaced.

(c) The check profile shall be located 30 m apart or closer as directed by the Engineer In-Charge so as to ensure execution of all slopes, steps and elevations to the profile or profiles indicated in the approved drawings. All important levels and all control points with respect to benchmarks and reference lines shall be fixed and correlated by the Contractor. The Contractor is fully responsible for maintaining all setting out work & Bench mark established by Engineer In-charge.

(d) All materials, labour and equipments (theodolites, levels, distometre, etc.) for setting out works including construction of benchmarks, reference lines, check profiles and surveys as may be required at the various stages of construction shall be supplied by the Contractor at his cost. The cost of such work shall be deemed to have been included in the cost of items in the Schedule-B. At each site minimum, following numbers of equipments shall be provided and maintained in good condition by the Contractor.

1. Total station and its accessories   1 set
2. Theodolites (Accuracy 1 second)  1 Nos.
3. Levels                        2 Nos.
4. Staves                       4 Nos.
5. Tapes, chains, ranging rods etc. As required
All equipments shall be of standard and approved make and precision, and shall be made available in advance of starting of the work. All equipment shall be maintained, repaired and got tested and certified as and when required for its accuracy from the standard test houses or from the manufactures and to the satisfaction of the Engineer In-Charge.

Cost of all above shall be deemed to have been included in the rates of the items included in the Schedule-B.

13.0 Laying of Pipes

- Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer In-Charge shall be laid.

- While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same a backfill material. While laying in rocky areas suitable bed of sand or gravel should be provided. The fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete M15, 15 cm or 20cm thick sand bed as approved by the Engineer In-Charge may be provided.

- In case of sandy strata no separate bedding is required. However the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. The pipe bedding should be placed so as to give complete contact between the bottom of the trench and the pipe. The minimum cover over buried pipe should be 1 m.

- As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.

- During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion / contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc.) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day.)

- For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

- The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.

- The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total
system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.

- The Installation of flanged fittings such as connections to sluice / air / gate valves and hydrant tees etc., requires the use of stub ends (collars / flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balance torque.
- Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.
- PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done.
- When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.
- However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.

14.0 Jointing of Pipes
The pipe shall have heat butt-fusion jointing system that shall provide for fluid tightness for the intended service conditions.

Jointing of pipes should be done as per IS 7634-2 (2012). The principle of fusion welding is to heat the two pipe surfaces to a designated temperature and then fuse them together by application of sufficient force. This force causes the melted materials to flow and mix, there by resulting in fusion. Fusion welding of PE pipes must be carried out with welding equipment having temperature and pressure (where applicable) display arrangements.

The Contractor shall have to make sufficient room for making the joints leak proof at the bottom of joint by excavating the earth as per requirement. But due care shall be required during the backfilling in that portion. No extra payment shall be made for making sufficient room for the jointing of pipes at bottom of joint.

Connections through walls of outlets
Pipe may have to go through masonry walls of outlets. In such a case, the pipe should have a puddle flange welded around the pipe to ensure a leak proof joint between the pipe and the masonry outlet wall. The cost of connection is included in this item.
Thrust Block

RCC thrust block should be suitably designed & provided at bends and at places of reduction in cross section to take care of trust.

15.0 Underground installation of specials (T-joints, Elbow joints).

All HDPE fittings / specials shall be of minimum PN 6 or above Pressure class, fabricated in accordance with IS: 8360 (Part me & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings / specials shall be moulded at factory only. No fabrication or moulding shall be allowed at site, unless specifically permitted by the Engineer-In-Charge. Fittings shall be welded on to the pipes or other fittings by use of Electro- fusion process. Recommended makes for PE / PP fittings / specials are Georg-Fischer, Glynwed, Astore, Magnum and GPS or equivalent as directed by Engineer In-Charge.

15.1 Bends

HDPE bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends shall be moulded.

15.2 Tees

HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees shall be moulded.

15.3 Reducers

HDPE Reducers shall be plain square ended conforming to IS: 8008 Part I & VII Specifications. Reducer must be moulded.

15.4 Flanged HDPE Pipe Ends

HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & VI Specifications. Stub ends shall be welded on the pipe. Flange shall be of slip on flange type as described below.

15.5 Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges shall be PN10.

15.6 Welding Procedure
Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with Electro-fusion welding using automatic or semi-automatic, hydraulically operated, superior quality Electro-fusion machines which shall ensure good quality fusion welding of HDPE pipes.

16.0 Hydraulic Testing before commissioning

Pipes shall be tested for hydraulic test pressure for ensuring quality of manufacturing as per Standard Specification before commissioning.

a. The Sectional Hydraulic Test shall be carried out after the pipeline section to be tested has been laid jointed and backfilled to a depth sufficient to prevent floatation.

b. Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the forces which will be exerted when the test pressure is applied.

c. Proposals for testing where thrusts on structures are involved, even where thrust flanges on the piping are installed, shall be with the prior approval of the Engineer.

d. The proper method of filling the pipeline with water shall be used. The length under test shall be filled making certain that all air is displaced through an air valve or any other appropriate mechanism. The test length shall then remain under constant moderate pressure as per testing method given in the IS 7634.

e. As per IS code water required to built up allowable drop in pressure during test will be treated as a make up water.

f. The maximum allowable test pressure shall be 1.5 times the system design pressure or pipe rating which ever is higher.

g. Not withstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint, the Contractor shall, at his own cost, replace the pipe, repair the pipe or re-make the joint and repeat the hydraulic test with cost including the cost of water.

h. Test pressures are to be measured in kg / cm2 at the center of the blank flange situated at the lowest end of the pipeline under test. Unless otherwise specified...
the test pressure shall be as stated below.

e. Potable water should be used by the contractor for carrying hydraulic testing.

17.0 Observations, checking, testing for leakage

The level of water surface shall be measured after 48 hours of initial filling and thereafter at an interval of 24 hours for at-least 5(Five) days. During the testing the joints of pipe line shall be observed and checked, if any leakage found, the pipe shall be emptied out by the Contractor at his cost and shall be rectified at his cost. The testing procedure shall be repeated, till the rectification of the damages / defects / leakages is of the acceptable engineering standard. During the testing after initial filling the level of water surface in the outlets under consideration shall be measured. The difference in the levels of the water surface after duration of 24 hours shall not be more than 50 mm for a length up-to 1.0 Km. For more / less length the tolerance limit of difference shall be arrived proportionately.

18.0 Rejection of the system or system components

If any leakage found during testing of pipe line, Contractor will have to attend immediately and rectify at his cost within 5 (Five) days. If Contractor fails to rectify the defect the entire length of pipe line between two adjacent outlets shall be rejected and not accepted. The payment shall not be made for the rejected work. The difference in water level during testing shall be within the tolerance limit as specified above, otherwise the work shall not be accepted and paid. If any intermediate payment made to the Contractor for portion under rejection, the same shall be recovered from the outstanding dues of the Contractor.

19.0 Back Filling

19.0 BACK FILLING OF TRENCHES

Back filling the foundation trenches around the structures etc with selected excavated stuff including watering, ramming, compacting, etc. complete.

19.1 General:

(a) The type of material used for backfilling and the manner of depositing the material, shall be subject to approval. As far as practicable, backfill material shall be obtained from the excavation for structures or from adjacent PDN excavation.

(b) Backfill material shall contain no stone larger than 7.5 cm size.
(c) The backfill material shall be placed to the line and grades as shown on drawings or as prescribed in this paragraph or as directed by the Engineer-in-Charge.

(d) Backfill shall not be placed against retaining walls until the retaining wall is cured adequately and is strong enough to take lateral pressure of the backfill. Trimming of the sides of excavation against which the backfill is to be laid shall be delayed until immediately prior to backfilling and any excessive drying of the surface shall be conditioned properly and made adequately moist to avoid potential desiccation for the rock or partly compacted consolidated materials.

(e) The backfill material shall be placed carefully and spread in uniform layers of not more than 15cm thickness. The backfill shall be brought up as uniformly as practicable on both sides of walls and all sides of structures to prevent unequal loading. The backfill material shall be placed at about the same elevation of both sides of the pipe portions of the structures and culverts and difference in elevation shall be responsible for providing adequate earth cover over pipe to prevent damage due to loads of construction equipment’s.

(f) If a haul road is built over a pipe, all backfill around and over the pipe shall be placed to a uniform surface and no humps or depressions shall be permitted at the pipe crossings.

(g) Backfill placement and compaction around structures shall be restricted unit the structure is complete.

(h) Compaction around the structure shall be done by pneumatic rammers in thin layers.

19.2 Compaction of Backfill

When compacting the soil against steep rock, abutment walls of concrete structures, construction surface of embankment shall be sloped away from the rock or concrete structure leaving a minimum distance of 0.6 m and at an inclination of 3:1. Rollers shall not be used close to structures as structural damage is very likely more particularly when structures have not been fully cured. The size and weight of equipment will depend on nature of material, the height and load assumed in design of structure. The backfill close to the structure up to the rolled layer shall be compacted in suitable uniform layers, using pneumatic / hand tampers as appropriate for dry density at average bulk density (+/- 10%). The moisture content of the earth fill placed against the rock or the structure shall be on higher / lower side of OMC by about 2% or so, to allow it to be compacted. Profuse watering shall be done to pervious materials (sand) before compaction as per instruction of the Engineer-in-Charge. Compaction at junction of earthwork and backfill around the structure shall be carried out with special care without claiming any extra cost.
20.0 Permanent markings on ground along the alignments of pipes

20.1 The contractor shall establish the sufficient number of reference blocks on the alignment of PDN preferably at the interval of 30m or as suitable on the field boundaries so as they will not be disturbed during the agricultural activities of the farmers.

20.2 The marking shall be constructed in prefabricated concrete block of size (15x15x45)CM embeded in concrete block of size (30x30x30)CM. The base of this block shall be buried in ground projecting only 15cm above the ground and the base concrete block.

20.3 These blocks shall be able to locate the pipeline as and where it is laid all over the work under this agreement. The contractor shall mark each block with specific distinct identification mark.

20.4 The contractor shall show all this blocks jointly to the Engineer incharge or his representative, representative of WUA, concern farmers sharing the boundaries, TPI, any other stake holders in the command.

20.5 Contractor shall maintained these blocks in proper order during operation & maintenance period of this contract. Any damage done to these blocks for the reasons whatsoever shall be made good at the cost of contractor.

20.6 The contractor shall submit the location of such blocks with specific identification marks with schedule on a special command area map along with the final bill.

20.7 The map of marking of the block shall be handed over to WUA while handing over the command area.

21.0 Third Party Inspection

Work of PDN shall be inspected, tested and certified by PMC / TPI / QC. Modalities of PMC / TPI / QC Inspection shall be separately decided and given by Engineer In-charge. All the testing charges will be borne by the Contractor.

21.1 Testing of materials

21.1(a) All materials before being utilized in works shall be inspected and tested, if found necessary, by the Engineer In-charge or his representative / QC. The nature of testing and periodical intervals at which such testing is to be done etc. shall be as per the latest editions of relevant IS Codes and determined by the Engineer In-charge. The day-to-day and periodical tests to be carried out on materials mixes and placed concrete, mortar etc. shall be specified by the Engineer In-charge from time to time and the Contractor shall provide free of cost all facilities towards collections of samples etc. unless otherwise specified. Labours for collecting samples and transportation of the samples to quality control authorities for test shall be
provided free cost of by the contractor. Also electricity, fuel, water curing tank and stores etc shall be provided free of cost by the contractors.

21.1(b) The materials shall be tested in QC laboratory or at any other place directed by the Engineer In-charge. The Contractor shall obtain the test results from the concern authority and the results given by such authorities shall be considered to determine whether all materials, workmanship are of respective standard described in contract and in accordance with the instructions of the Engineer In-charge. The Contractor’s representatives shall, however, be given access to all operations and tests that may be carried out as aforesaid so that he may satisfy himself regarding the procedure and methods adopted. It shall then be the Contractor’s responsibility to produce on the work, materials and finished item to the standard as determined by the laboratory tests or to take follow up action to rectify the quality. All Testing charges shall, however, be borne by the Contractor.

(i) When the supply of the samples and the carrying out of such test at Contractor’s cost is provided for or clearly intended in the Contract and is carried out either at the site of work or at place of manufacture specified in the contract document.

(ii) When the supply of the samples and the carrying out of such tests is not provided for or clearly intended in the contract, but on testing the material is found defective and has to be rejected.

(iii) Testing charges for testing of Cement, TMT bars, PVC water stops, PVC strips, GRP water stops, GRP strips RCC pipes, M.S. pipes and all materials to be used in the works including cost of samples and its collection shall be borne by the Contractor.

21.2 The Contractor shall, however, supply all materials, required for tests and also make good at his cost, materials, mixes and bore / core hole with similar or other materials as may be directed by and to the satisfaction of the Engineer in-charge.

21.3 The Contractor shall make suitable arrangements to see that one of his representatives remains present at the time of taking samples and shall authenticate the facts. If the Contractor, fails to keep his representative present at site at the time of taking samples or fail to provide required labours and other equipment to collect the samples, the same shall be taken by the Engineer In-charge, and the samples selected shall be considered as authentic. The cost incurred by the Engineer In-charge when the Contractor fails to provide required men and materials for collecting samples and or their transport shall be recovered from the Contractor.

22.0 Quality Control and Quality assurance
22.1 It is the responsibility of the contractor to assure the desired quality of work. Whenever the testing of construction materials are required as per the detailed specifications or otherwise required by the Engineer In-Charge, the same shall be carried out at the laboratory, selected by the Engineer In-Charge at Contractor's cost. The other tests of mortar, concrete, sand, coarse aggregates etc. shall be carried out in field laboratory set up by the contractor in presence of quality control representative at contractors cost. Contractor shall through this procedure assure the quality of work.

22.2 The materials, mixes and any other arrangements, including labourers, shall be supplied by the contractor to the Corporation at contractor's cost. The samples for testing shall be taken in the presence of Engineer-in-Charge or his representative / QC present on site. The contractor or his authorized representative shall have a free access in these laboratories, to get himself satisfied about procedures of testing etc. Even if the contractor or his representative fails to remain present while collecting samples or testing the results will be considered as authentic and binding on the contractor.

22.3 On award of contract, the Contractors will have to provide adequate quality assurance setup including Quality Assurance Engineer backed with suitable laboratory assistants, labours and well equipped laboratory for taking necessary field test required as per specifications and as per instructions of Engineer in charge.

22.4 Contractor shall provide all test reports of material used in the work as desired from the NABL (National Accreditation Board for Testing & Calibration Laboratories) approved laboratories and from Quality Control, MERI laboratories of the WRD,CIPET, Aurangabad . Contractor shall provide periodical quality assurance report (Weekly / fortnightly / monthly) to Engineer In-charge along with proofs in support of quality of material brought for the work the process / execution of work is as per specification.

22.5 Contractor shall submit the account of all materials brought for the work, which are necessary for execution of work and any other data necessary to assess the quality of work.

22.6 If he fails to fulfill the requirement, the required manpower for testing and field laboratory with required equipments will be deployed by the Engineer In-charge and the charges will be recovered from the contractor (Provisions of Clause 4 will be applicable) or the agreement will be revoked.

22.7 Personel for Quality Assurance

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Personel with Qualification</th>
<th>Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quality Assurance Engineer</td>
<td>One</td>
</tr>
<tr>
<td></td>
<td>(Civil Engineering Graduate with 2 Year experience in)</td>
<td></td>
</tr>
</tbody>
</table>
22.8 Equipments

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Equipments</th>
<th>Apparatus for Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth Work – Field testing Equipments</td>
<td>Field density, Moisture Content, Sieves for Sand &amp; Metal.</td>
</tr>
<tr>
<td>2</td>
<td>Concrete Work -</td>
<td>Silt, Gradation, Moisture Content, Slump, &amp; Cube Modules.</td>
</tr>
</tbody>
</table>

The tender rates are inclusive of quality control testing charges.

23. Handing over to WUA

The contractor shall operate and maintain the complete pipe distribution network for the period of 5 (five) years. On completion of O & M period, the system shall be handed over to WUA

23.1 During rotation period, once in every year, The Contractor shall perform hydraulic test to the satisfaction of Engineer In-charge to verify the flow of designed discharge, detect or confirm any leakage in the system and rectify at his own cost. The testing shall preferably be conducted jointly with members of WUA / representative of Engineer In-charge, technical representative of contractor and any other stake holder.

23.2 On completion of every Irrigation season the contractor shall flush the pipe line from its tail flush valve so that any siltation, vegetation or obstruction is cleaned and pipe is able to flow designed discharge for next season.
23.3 During the O & M period contractor shall give training to the members of WUA about O & M of PDN work and its efficient use and protection of the system from any damages.

23.4 The contractor shall prepare a detail map of the permanent marking along the alignment of pipe and submit with to Engineer In-charge. The Engineer In-charge shall verify and endorsed the location of the marking and handover these signed maps as a permanent record to WUA.

23.5 In association of the members of WUA, the Engineer In-charge shall confirm the release of designed discharge through every outlet before handing over. In case of any short fall or defect it should be made good from the contractor at his own cost.

SPECIFICATIONS OF PVC PIPES

1.0 SCOPE OF WORK

This specification covers the requirements for manufacturing, pre-delivery testing, supplying, laying, jointing and testing at works and site of PVC pipes used for water supply. PVC Pipes shall be confirming to IS 4985-2000 or relevant Indian code of practice & its revisions.

1.1 Training

The Contractor shall provide on-site training on PE pipe laying, jointing, testing and maintenance etc., to the personnel authorized by Corporation.

1.2 Manuals

The contractor should provide technical Manual on PE pipes including precautions to be taken during operation of the pipeline.

2.0 APPLICABLE IS CODES, ISO CODES

<table>
<thead>
<tr>
<th>IS CODE No.</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS - 4985:2000</td>
<td>Unplastized PVC pipes for potable water supplies – specification</td>
</tr>
<tr>
<td>IS- 458:2003</td>
<td>Precast concrete pipes (with or without Reinforcement.</td>
</tr>
<tr>
<td>IS- 4669:1968</td>
<td>Methods of test for polyvinyl chloride resins</td>
</tr>
</tbody>
</table>
3.0 Specification & requirements of pipes

3.1 Labelling on pipes

The designs of distribution network are carried out considering PVC pipes of Class-2 (Test pressure 4kg / cm² or as per the design required having following outer and inner diameters as per IS-4985:2000 & its revision.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Nominal Outside diameter</th>
<th>Average Thickness</th>
<th>Min Thickness</th>
<th>Max Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>110 mm</td>
<td>3.00mm</td>
<td>2.50mm</td>
<td>3.00mm</td>
</tr>
<tr>
<td>2</td>
<td>160 mm</td>
<td>4.30 mm</td>
<td>3.70 mm</td>
<td>4.30 mm</td>
</tr>
<tr>
<td>3</td>
<td>180 mm</td>
<td>4.90 mm</td>
<td>4.20 mm</td>
<td>4.90 mm</td>
</tr>
<tr>
<td>4</td>
<td>200 mm</td>
<td>5.30 mm</td>
<td>4.60 mm</td>
<td>5.30 mm</td>
</tr>
<tr>
<td>5</td>
<td>225 mm</td>
<td>6.00 mm</td>
<td>5.20 mm</td>
<td>6.00 mm</td>
</tr>
<tr>
<td>6</td>
<td>250 mm</td>
<td>6.50 mm</td>
<td>5.70 mm</td>
<td>6.50 mm</td>
</tr>
<tr>
<td>7</td>
<td>280 mm</td>
<td>7.30 mm</td>
<td>6.40 mm</td>
<td>7.40 mm</td>
</tr>
<tr>
<td>8</td>
<td>315 mm</td>
<td>8.20 mm</td>
<td>7.20 mm</td>
<td>8.30 mm</td>
</tr>
<tr>
<td>9</td>
<td>355 mm</td>
<td>9.20 mm</td>
<td>8.10 mm</td>
<td>9.40 mm</td>
</tr>
</tbody>
</table>

3.2 Raw material:-

Raw material used to manufacture PVC Pipes shall be virgin compound (polyvinyl chloride resin) conforming to IS: 4985-2000 and its testing shall conform to IS: 4669-1968. The bulk density of the PVC compound
shall be 0.50 to 0.53. The density of PVC pipe shall be 1.40 to 1.46 g / cm³.

3.3 Temperature variation: -

All the pipes to be manufactured, supplied and erected shall be resistant to whether conditions like sun, dust, rain, wind etc as per the environmental conditions under the project area of State Maharashtra. They shall also be subject to carry and convey raw water under variable temperature conditions ranging from 4 to 50 deg. Centigrade.

3.4 Material and workmanship

(a) General requirements of material and workmanship shall mean any material or article either raw material or additives or finished are required to be used in the manufacturing process of pipes.

(b) The material used for manufacturing of pipes should not constitute any toxic hazards, should not support micro biological growth and should not give rise to unpleasant test or odor, discolorations of water. The Contractor shall have to produce a certificate fulfilling these effects from the pipe manufacturer. Pipe manufacturer shall obtain certificate to this effect from the manufacturer of raw material. Also a certification from raw material manufacturer that the raw material meets the poly vinyl chloride confirming to ISO 4435-1991 & IS:4985-2000 and its latest revision amendments.

(c) The material from which the pipes are made shall consists substantially of poly vinyl Chloride confirming to IS :10151-1982 to which may be added only those additives that are absolutely needed to facilitate the manufacture of the polymer and the production of sound durable pipe of good surface finish, mechanical strength and opacity. All other quality parameters like density, MFR, Carbon black contents and anti-oxidant used for manufacturing of pipes shall be strictly as per IS :12235-2004 and its latest revision / amendments.

4.0 MANUFACTURE OF PVC PIPES.

The General requirement relating to the manufacture of PVC pipes shall be confirming to IS: 4985 - 2000 and its latest revision / amendments.

(a) The dimension, material composition, tests etc shall be as per IS:12235 - 2004 and its latest revision / amendments.

(b) PVC pipes shall be marked with ISI certification mark.
6.0 PRE DELIVERY TESTING OF PIPE IN FACTORY BY CIPET

6.1 Tests

The following tests as per IS : 12235-2004 and its latest revision / amendments will be carried out by the agency in the presence of representative of Engineer incharge / WRD / QC / TPI. Laboratory tests to be carried out at manufacturing unit of pipes by CIPET (Central Institute of Plastics Engineering & Technology) and if required additional tests shall be conducted as suggested by Engineer In Charge after supply of pipes at site such random sample of pipes collected from site shall be tested in CIPET Laboratory. The testing charges shall be borne by the Contractor.

j. Dimensions (Inside and outside diameter, Wall thickness and Length of pipe) as per Clause No. 7.0 of IS-4985:2000

k. Visual appearance as per Clause No. 10.1 of IS-4985:2000

l. Hydraulic Characteristics as per Clause No. 11.1 of IS-4985:2000
m. Reversion test as per Clause No. 10.4 of IS-4985:2000
n. Density test as per Clause No. 10.6 of IS-4985:2000
o. Sulphate Ash Content 11% Max. as per Clause no.10.7of IS-4985:2000.
p. Internal hydrostatic pressure in accordance with IS-12235:2004 (part-8), pipe shall not burst during the prescribed test duration.
q. The PVC pipe shall not contain vinyl chloride monomer (VCM) exceeding 1ppm when determined by means of gas phase chromatography using the headspace method according to IS-10151:1982.
r. The wall of the wall of the plain pipe shall not transmit more than 0.2% of visible light falling on them when tested in accordance with IS-12235:2004 (part -3).

Sampling and Criteria for Conformity

The sampling procedure and the criteria for conformity shall be as per Annex D of IS -4985: 2000.

The scale of sampling for visual and dimensional requirement shall be as per Table No.13 of IS-4985:2000 or as directed by Engineer-in-charge. The sampling shall be made on random basis, from a lot manufactured. The samples required for testing shall be taken as directed by Engineer in charge or his representative / QC / PMC / TPI.

When subjected to internal hydrostatic pressure test in accordance with the procedure given in IS:12235-2004 (Part 8) the pipe shall not fail during the prescribed test duration. The temperatures and duration of test shall confirm to the requirements given in the table mentioned below. The tests shall be carried out not earlier than 24 hr after the pipes have been manufactured.

<table>
<thead>
<tr>
<th>Requirements of Pipes for Internal Hydrostatic Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Quality</td>
</tr>
<tr>
<td>Acceptanc</td>
</tr>
</tbody>
</table>
The pipes under test shall show no signs of localized swelling, seepage cracking, leakage or weeping and shall not burst during the prescribed test period.

During execution if required the sampling of pipes shall be made from the procured, tested and delivered lot of pipes at site randomly. The Contractor shall have to borne all the cost of testing in such a case over and above the cost of regular testing.

**7.0 DIMENSIONS OF SPECIALS & FITTINGS**

Spigot & socket dimensions shall confirm I.S. 458-2003 amendments No.2 April-1991 or its latest revision.

**8.0 TRANSPORTATION OF PIPES**

The pipes manufactured at factory are to be carried to the site of work either directly or stacked suitably along the road or elsewhere near the site. On the contractors land. Extreme care shall be taken while handling the pipes, damage during the transit and handling shall be at Contractor’s account and shall not be payable. Damage pipes shall be rejected outright. The discretion of the Engineer-in-charge in this behalf shall be final and binding on the Contractor. The payment of the entry tax, octroi tax and all other taxes shall be the responsibility of the Contractor.

**9.0 STACKING OF PIPES**

Stacking of PVC pipe shall confirm IS 7634(part 3):2003 or its latest revision Damages due to rain or flood either in cutting in foundation of structure shall have to be made good by the Contractor till the final section is handed over.

The responsibility of desilting and making good the damages due to rain or flood rests with the Contractor, throughout the construction period of work and not only limited to earthwork. No extra cost is payable for such operations to protect the work done during the construction and the Contractor shall therefore have to take all necessary precautions to protect the work done during the construction period. The provision made in this para shall be applicable to all the components of the work under this contract up to construction period of the work.

The Contractor shall take all precautionary measures well prior to onset of monsoon to prevent entry of flood waters of drains, nallas and other area. However, any damage done to the work or silting or slush caused shall have to be attended by the Contractor without any extra cost to and no time limit sanction shall be entertained for the work.
During monsoon, the Contractor shall make available the machinery such as pumps, excavators, dozers, rollers, etc. and skilled and unskilled manpower to attend the emergency conditions of flood inundation caused due to construction of PDN in surrounding fields, roads, etc. so that the public traffic can be maintained with least possible damage to public and natural drain / nallas / GOM property. Stacking of pipes must be done at contractors cost.

10.0 POST DELIVERY TESTING OFPIPES.

10.1 Inspection and test before erection

After delivery of pipe from the factory to the field, five sample of the pipe to be collected randomly from each lot for testing in the presence of engineer- in - charge or his representative / QC / TPI representative. These samples to be tested at CIPET laboratory.

10.2 Inspection and test after erection

In addition to the progressive supervision and inspection by the Engineer-in charge or his representative / TPI, the Contractor shall offer for inspection to Engineer-in-Charge or his representative / QC / TPI, the complete erected or its parts on which tests are to be carried out. After such inspection by Engineer-in-charge or his representative / QC / TPI, the Contractor shall have to carry out the testing for leakage / seepage from pipe line / structures in the presence of Engineer-In-Charge or his representative / QC / TPI. All the structures shall be observed, checked and tested for leakage and constructional defects.

10.3 Testing

(1) The length of pipeline to be tested shall be the length between outlet to outlet well or as directed by Engineer - In - Charge. Generally for sub-minor the testing shall be carried out for full length at a time, if length of sub-minor is less than 1.0 km and for more length of sub-minor the testing shall be carried out in two stages as directed / decided by Engineer - In - Charge. The Contractor shall have to make all the arrangement of water for testing, labours, supervisory staff, etc. for the period of testing. The necessary arrangement for plugging of opening in the wells / outlets / (end well of reach under testing) shall be made by the Contractor at his cost. After testing, Contractor shall have to remove the plugging at his cost, but care should be taken that no damage will occur to the work executed. If any damage will occur to any parts of work executed the same shall be required to be repaired by the Contractor at his cost to the satisfaction of Engineer - In - Charge.
(2) Backfilling of pipeline trenches can be done before the testing of pipe line.

(a) Initial Filling: The water shall be filled in the portion under testing up to predetermined level and shall be continuously maintained at predetermined level at predetermined locations (outlets) for 48 hours. The purpose of initial filling shall be to provide sufficient time / water for absorption in the concrete structures.

11. DEMARCATION OF SITE

11.1 All materials such as pegs, bamboo’s and strings and temples for marking out slopes, and labour required for line out should be provided by the Contractor at his own cost. The centerline of excavation shall be clearly marked by pegs or by stones at each chain or change of direction or at shorter intervals on curves, in the beginning. The final line out will be done by fixing reference stone at suitable distances on either side of the centerline, beyond the canal edges so that they are not disturbed the construction period. The position of these stones will be marked on the cross section.

11.2 Contractor shall provide and maintain the quarry roads and temporary roads required for conveying and transport of material at his cost.

11.3 The material available from all excavation and remaining surplus after use on the work from adjacent reaches / canal works etc. can be used by the Contractor free of cost provided these materials are used solely or the specific contract work and prior approval of the Engineer incharge is taken.

12.0 PREPARATION OF SITE

12.1 Clearing the Site

The Contractor shall clear the entire area required for setting out. All tree stumps, roots, brushwood, rubbish of all kinds, loose stones and all other objectionable materials shall be removed by the Contractor. All buried irrigation pipeline, and other structure shall remove by Contractor. The ownership of all the usable material, so removed from clearing site and / or excavation shall rest with the Engineer incharge. Useful material shall stack as directed. Cutting of all trees up to 0.50 m girth shall be covered in this item. The Contractor shall have to remove all the stumps and roots of trees for which no additional payment shall be made. The roots of trees shall be grubbed below the ground. The Contractor shall dispose off all such materials outside the canal land width as directed by the Engineer incharge.
12.2 Excavation for trenches and structure and its classification

Except or otherwise provided in these specifications, excavation of structure / Canal trenches shall be carried out as per excavation line shown in the drawing or as directed by Engineer in charge. Excavation in all sorts of soil includes the dry, wet & slushy condition. Contractor must assume all responsibility for deductions and conclusion as to the nature of the materials to be excavated and the difficulties of making and maintaining the required excavation.

12.2.1 Classification of the soil

Excavation for foundation in overburden, soil and murum includes all excavation to be done in strata including hard rock which coverings excavation in all kinds of soil such as brown soil, reddish soil, black soil, clay, sand, gravel and murum or mixtures of any of these soils. It shall also include removal of boulders / pebbles up to 0.028 m³ (upto 70 kg) in size and which are embedded in soil and can be removed by pick bar and shovel without blasting.

12.2.2 Conveyance and disposal of excavated materials

(a) The usable excavated material available from the excavated trenches (PDN) shall be used in back filling. If such usable material is in excess of the requirement of back filling, the same shall be deposited in the spoils as and where directed by the Engineer in charge.

(b) All suitable materials removed from excavation and in excess of the requirement of trenches (PDN), back filling shall be used in the construction of approaches to the road bridges and backfill around structures up to 1 km. lead for which no extra payment will be made. The remaining material from excavation shall be used to be deposited in low areas to eliminate tripped drainage or otherwise stacked in spoil banks in regular shape with suitable slopes or spread in other approved locations as directed by the Engineer-In-Charge, within a lead of 1 Km. Spoil banks shall not be constructed continuous. A gap of 10 m shall be provided at 150 m interval. The maximum height of spoil bank shall be restricted to 3.0 m with side slope 1.5:1.

(c) When the excavated material is required to be used for adjacent spoil bank, the lead involved shall be measured along the center line of PDN considering 15 m block as a unit and when the excavated material is required to be used for other than approach road and spoil banks, the lead involved shall be measured from the block of 15 m to the place of dumping as a straight-line distance, i.e. shortest possible distance.
12.2.3 Dewatering in PDN trenches and wet excavation

Surface or sub-soil water met with during excavated trench (PDN) and structure excavation shall be diverted to nearby drain / nalla by cutting an open channel from trench. When the drain / nalla bed is higher than the sub-soil water level met with, the bailing out by suitable means of pumping shall be resorted to for dewatering sub-soil water below the drain / nalla bed level. In case where topography of area is such that surface water is not possible to be drained off by excavating the channel, the bailing out by suitable means of pumping shall be resorted to and no separate payment shall be made for the dewatering. No distinction shall be made as to whether the material being excavated is dry, moist wet or slushy. The Contractor shall have to excavate the PDN pipe trench and structure in under water level conditions also i.e. under wet / slushy condition after providing sufficient arrangement of dewatering. The material excavated under water level condition which requires intermediate stacking for drying shall have to rehandle. No extra payment for efforts for drying out of soil, re-handling of dry soil, etc. shall be given. The Contractor shall have to excavate the wet and saturated soils met with above subsoil water level. (Including capillary fringe) No payment for extra efforts for excavation under this condition shall be made.

12.2.4 Over Excavation

(e) Over excavation performed by the Contractor for any purpose or reason, except for additional excavation as stated herein above or as may be directed by the Engineer Incharge shall be rectified at the cost of the Contractor Filling and compaction for such over excavation using the material as directed by the Engineer-In-Charge shall also be at the cost of the Contractor.

(f) In the PDN and structure section where expansive type of soil such as CH type of soil encountered and over which PDN cannot be directly laid, the PDN trench and structure shall be over excavated to the extent as directed by the Engineer-In-Charge and such over excavated section shall be filled with the suitable murum type soil as describe in clause 19 back filling of trenches to be placed in uniformly compacted layers as directed by the Engineer-In-Charge. The over excavation made in such strata, filling by suitable soil, and watering and compacting such soil will not be paid additionally. Above provision for over excavating and filling with suitable murrum type or good soil available material shall be applicable in case such treatment is found essential.

13.0 FIXING PERMANENT BENCH MARK IN CONCRETE BLOCKS
(a) In the vicinity of PDN, there are M or B type bench marks fixed by the Survey of India and temporary bench marks established by the Engineer incharge which will serve as control points for these works. The Contractor shall establish sufficient number of reference benchmarks for facilitating setting out of work and taking levels for the purpose of measurements.

(b) Before starting any work, the Contractor shall erect reference benchmarks, reference lines and check profiles at convenient locations approved by the Engineer-In-Charge. The benchmark shall be 200 mm x 200 mm x 600 mm with 400 mm embedded in the firm ground and 200 mm projecting above ground. The word ‘BM’ showing value of R. L. in ‘m’ shall be conspicuously carved and painted on the benchmark. The reference line shall comprise the base line properly dog belled on the ground with the numbered concrete / masonry pillar suitably spaced.

(c) The check profile shall be located 30 m apart or closer as directed by the Engineer-In-Charge so as to ensure execution of all slopes, steps and elevations to the profile or profiles indicated in the approved drawings. All important levels and all control points with respect to benchmarks and reference lines shall be fixed and correlated by the Contractor The Contractor is fully responsible for maintaining all setting out work & Bench mark established by Engineer incharge.

(d) All materials, labour and equipments (theodolites, levels, distometre, etc.) for setting out works including construction of benchmarks, reference lines, check profiles and surveys as may be required at the various stages of construction shall be supplied by the Contractor at his cost. The cost of such work shall be deemed to have been included in the cost of items in the Schedule-B. At each site minimum, following numbers of equipments shall be provided and maintained in good condition by the Contractor.

1. Total station and its accessories 1 set
2. Theodolites (Accuracy 1 second) 1 Nos.
3. Levels 2 Nos.
4. Staves 4 Nos.
5. Tapes, chains, ranging rods etc. As required

All equipments shall be of standard and approved make and precision, and shall be made available in advance of starting of the work. All equipment shall be maintained, repaired and got tested and certified as and when required for its accuracy from the standard
test houses or from the manufactures and to the satisfaction of the Engineer-In-Charge.

Cost of all above shall be deemed to have been included in the rates of the items included in the Schedule-B.

14.0 LAYING OF PIPE

14.1 Preparation for pipe laying.

Pipes shall be joined to form a single long length above ground prior to staking into the trench as per site situation or as directed by Engineer-In-Charge. To prevent scratches on surface of pipe / damage to pipe of the road surface, pipe rollers should be used.

Before commencing of pipe laying into the trench a check should be made for deep cuts, scratches or other damages in the pipe and the fusion joint system is sufficiently cooled.

14.2 Pipe Laying

The pipes shall be laid in proper line and level as per drawing or as directed by Engineer-In-Charge. Gradual changes in direction of polyethylene can be accommodated by pipe deflection but every effort should be made to keep the pipe as central as possible within the trench to enable correct side fill compaction. Similar care should be taken when any distortion of the coiled pipe has occurred.

15.0 JOINING OF PIPES:

15.1 Jointing of pipes.

The pipes shall be jointed by flush joint as instructed by the Engineer-In-Charge. Caulking space shall be as per relevant IS code according to the diameter of the pipes. The next pipe shall then to be pressed against the first so that the recess between the end of first pipe and that of the second properly fills with Synthetic ring and both pipe shall have pressed against each other properly. The joints shall be smooth finished. The Contractor shall have to make sufficient room for making the joints leak proof at the bottom of joint by excavating the earth as per requirement. But due care shall be required during the backfilling in that portion. No extra payment shall be made for making sufficient room for the jointing of pipes at bottom of joint.

15.2 Connections through walls of outlets:

Pipe may have to go through masonry walls of outlets. In such a case, the pipe should have a puddle flange welded around the pipe
to ensure a leak proof joint between the pipe and the masonry outlet wall. The cost of connection is included in this item.

**16.0 UNDERGROUND INSTALLATION OF SPECIALS (T-JOINT, ELBOW JOINT etc)**

All specials shall be moulded in factory as per relevant IS codes. The special shall not be fabricated at all on sites. PVC Tee & PVC Bend shall be as per IS:4985-2000 and PVC Reducer, PVC Tee & PVC 0-179 degree Bend shall be from IS:4985-2000 conforming PVC material and shall be as per test pressure of 4 kg / cm² or as per IS.

Rate shall be including loading, unloading, carting, insurance and labour charge for installation, etc. complete.

All the Tee, Elbow, Bend and Reducer shall be true in line & level as per IS code. The joint shall be water tight & no leakage shall be noticed during testing.

**16.1) Specials Made from I.S.I. approved PVC material (Test Pressure as per IS Code)**

**A) Tee**

<table>
<thead>
<tr>
<th>(i) size (110 x 110 mm)</th>
<th>(vi) size (250 x 250 mm)</th>
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<tbody>
<tr>
<td>(ii) size (160 x 160 mm)</td>
<td>(vii) size (280 x 280 mm)</td>
</tr>
<tr>
<td>(iii) size (180 x 180 mm)</td>
<td>(viii) size (315 x 315 mm)</td>
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<tr>
<td>(iv) size (200 x 200 mm)</td>
<td>(ix) size (355 x 355 mm)</td>
</tr>
<tr>
<td>(v) size (225 x 225 mm)</td>
<td>(x) size (400 x 400 mm)</td>
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</tbody>
</table>

**B) Elbow**

<table>
<thead>
<tr>
<th>(i) size (110 x 110 mm)</th>
<th>(vi) size (250 x 250 mm)</th>
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</thead>
<tbody>
<tr>
<td>(ii) size (160 x 160 mm)</td>
<td>(vii) size (280 x 280 mm)</td>
</tr>
<tr>
<td>(iii) size (180 x 180 mm)</td>
<td>(viii) size (315 x 315 mm)</td>
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<tr>
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<td>(ix) size (355 x 355 mm)</td>
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<tr>
<td>(v) size (225 x 225 mm)</td>
<td>(x) size (400 x 400 mm)</td>
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</table>
16.2) Made from I.S.I. approved PVC material (Test Pressure as per IS Code)

<table>
<thead>
<tr>
<th>A) Reducer</th>
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<tbody>
<tr>
<td>(i) size 110 x 63 mm</td>
<td>xi) size 250 x 225 mm</td>
<td></td>
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<tr>
<td>ii) size 160 x 110 mm</td>
<td>xii) size 280 x 250 mm</td>
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<tr>
<td>iii) size 180 x 110 mm</td>
<td>xiii) size 315 x 280 mm</td>
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<td>iv) size 200 x 110 mm</td>
<td>xiv) size 355 x 315 mm</td>
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<tr>
<td>v) size 225 x 110 mm</td>
<td>xv) size 400 x 355 mm</td>
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<tr>
<td>vi) size 250 x 110 mm</td>
<td>xvi) size 225 x 160 mm</td>
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<td>vii) size 180 x 160 mm</td>
<td>xvii) size 250 x 160 mm</td>
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<td>viii) size 200 x 160 mm</td>
<td>xviii) size 280 x 160 mm</td>
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<td>ix) size 200 x 180 mm</td>
<td>xix) size 315 x 160 mm</td>
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<tr>
<td>x) size 225 x 200 mm</td>
<td>xx) size 355 x 160 mm</td>
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<table>
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<tr>
<th>B) Tee</th>
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<tbody>
<tr>
<td>(i) size 180x160 mm</td>
<td>ix) size 200 x 180mm</td>
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<tr>
<td>ii) size 200x160 mm</td>
<td>x) size 225x200 mm</td>
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<td>iii) size 225x160 mm</td>
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<td>iv) size 250 x 160 mm</td>
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<td>v) size 280 x 160 mm</td>
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<td>vi) size 315 x 160 mm</td>
<td>xiv) size 355x315 mm</td>
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<tr>
<td>vii) size 355 x 160 mm</td>
<td>xv) size 400x355 mm</td>
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<tr>
<td>viii) size 400 x 160 mm</td>
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<table>
<thead>
<tr>
<th>C) P.V.C. Bend (0 to 179 degree)</th>
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</thead>
<tbody>
<tr>
<td>i) 160 mm dia. (PVC)</td>
<td>vi) 280 mm dia. (PVC)</td>
<td></td>
</tr>
<tr>
<td>ii) 180 mm dia. (PVC)</td>
<td>vii) 315 mm dia. (PVC)</td>
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<tr>
<td>iii) 200 mm dia. (PVC)</td>
<td>viii) 355 mm dia. (PVC)</td>
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<tr>
<td>iv) 225 mm dia. (PVC)</td>
<td>ix) 400 mm dia. (PVC)</td>
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</tr>
</tbody>
</table>
The rate includes all clearing of site, excavation of pipe trench providing & fixing PVC pipe with jointing material like rings, Tee, Elbow, reducers, bends etc. clearing of site, excavation of pipe trench providing & fixing PVC pipe with jointing material like rings, Tee, Elbow, reducers, bends etc. equipment & ancillary work required to complete the item as per specifications & drawing.

17.0 HYDRAULIC TESTING OF PIPE

The test of the pipeline in the field shall be carried out after the stretch of suitable length of line is laid. Testing shall be carried out in the following manner. The pipeline shall be subjected to hydraulic test in full length or in part as may be found necessary. The pipes shall be subjected to a test pressure of 1.5 times the actual working pressure expected in the pipeline as per hydraulic design in the strip under observation. There should not be a drop of more than 0.5 Kg / Cm2 within a period of two hours after the pressure has been built up by the use of suitable pumps. In case of leak anywhere in the field joints same shall be repaired entirely at the cost of the contractor which shall include cost of excavation repairs etc. The rate of pipe is inclusive of this cost. The contractor shall provide skilled and unskilled labour free of cost for departmental check of the work and portable water shall be procured by contractor for hydraulic testing.

Special Note:

1. No pipe shall be laid when, in the opinion of the Engineer-in-charge, trench conditions are unsuitable.
2. Pipes shall be laid in reasonably dry trenches and under no circumstances on slushy murum bedding.
3. The contractor shall use the pipes after checking and testing and he shall be held responsible for replacement of such pipes if already inadvertently fixed or jointed.
4. Before the pipes are lowered and laid in position the contractor shall see that the invert at the support is correct and pipe is brought to uniform grade and level. This should be checked with the help of dumpy level and should be got approved in advance from Engineer-in-charge.
5. Temporary bench marks shall be provided by the contractor at a minimum distance of every 100 m without any claim for extra cost. The bench marks shall be either of stone masonry or mass concrete.
6. The pipes shall be laid in conformity with the profile, level, curvature, straightness etc. as per the drawings. No variation, unless previously approved by Engineer-in-charge will be allowed.
7. The contractor shall bear the cost of wastage, breakage in pipes and specials. The length of pipes and specials will be paid as per exact length in laid condition, for both fabrication and laying job.
8. All temporary supports made to the pipe line during laying and jointing shall be removed before pipeline is filled with water for hydraulic testing.
9. Flanged caps-or plugs, casting of thrust block, the hydraulic test pump with the required piping etc. shall be arranged to testing purpose by the contractor at his own cost.
10. The hydraulic test shall be made in the presence of Engineer-in-charge.
11. When any section of a main is provided with concrete thrust blocks or anchorage, the pressure test shall not be made within 28 days of casting of the RCC blocks.
12. At the Time of Hydraulic Testing of pipe line any Damage to any structure, chamber etc rectification is made by contractor from his own cost.

18.0 OBSERVATION / CHECKING / TESTING FOR LEAKAGE:

The level of water surface shall be measured after 48 hours of initial filling and thereafter at an interval of 24 hours for at-least 5(Five) days. During the testing the joints of pipe line shall be observed and checked, if any leakage found, the pipe shall be emptied out by the Contractor at his cost and shall be rectified at his cost. The testing procedure shall be repeated, till the rectification of the damages / defects / leakages is of the acceptable engineering standard. During the testing after initial filling the level of water surface in the outlets under consideration shall be measured. The difference in the levels of the water surface after duration of 24 hours shall not be more than 50 mm for a length up-to 1.0 Km. For more / less length the tolerance limit of difference shall be arrived proportionately.

Work of PDN shall be inspected by Engineer incharge and payments shall be done after getting approval of Engineer incharge.

19.0 REJECTION OF SYSTEM OR SYSTEM COMPONENTS

If any leakage found during testing of pipe line, Contractor will have to attend immediately and rectify at his cost within 5 (Five) days. If Contractor fails to rectify the defect the entire length of pipe line between two adjacent outlets shall be rejected and not accepted. The payment shall not be made for the rejected work. The difference in water level
during testing shall be within the tolerance limit as specified above, otherwise the work shall not be accepted and paid. If any intermediate payment made to the Contractor for portion under rejection, the same shall be recovered from the outstanding dues of the Contractor.

20.0 BACK FILLING OF TRENCHES

Back filling the foundation trenches around the structures etc with selected excavated stuff including watering, ramming, compacting, etc. complete.

20.1 General:

(a) The type of material used for backfilling and the manner of depositing the material, shall be subject to approval. As far as practicable, backfill material shall be obtained from the excavation for structures or from adjacent PDN excavation.

(b) Backfill material shall contain no stone larger than 7.5 cm size.

(c) The backfill material shall be placed to the line and grades as shown on drawings or as prescribed in this paragraph or as directed by the Engineer-in-Charge.

(d) Backfill shall not be placed against retaining walls until the retaining wall is cured adequately and is strong enough to take lateral pressure of the backfill. Trimming of the sides of excavation against which the backfill is to be laid shall be delayed until immediately prior to backfilling and any excessive drying of the surface shall be conditioned properly and made adequately moist to avoid potential desiccation for the rock or partly compacted consolidated materials.

(e) The backfill material shall be placed carefully and spread in uniform layers of not more than 15cm thickness. The backfill shall be brought up as uniformly as practicable on both sides of walls and all sides of structures to prevent unequal loading. The backfill material shall be placed at about the same elevation of both sides of the pipe portions of the structures and culverts and difference in elevation shall be responsible for providing adequate earth cover over pipe to prevent damage due to loads of construction equipment’s.

(f) If a haul road is built over a pipe, all backfill around and over the pipe shall be placed to a uniform surface and no humps or depressions shall be permitted at the pipe crossings.
20.2 Compaction of Backfill

When compacting the soil against steep rock, abutment walls of concrete structures, construction surface of embankment shall be sloped away from the rock or concrete structure leaving a minimum distance of 0.6 m and at an inclination of 3:1. Rollers shall not be used close to structures as structural damage is very likely more particularly when structures have not been fully cured. The size and weight of equipment will depend on nature of material, the height and load assumed in design of structure. The backfill close to the structure up to the rolled layer shall be compacted in suitable uniform layers, using pneumatic / hand tampers as appropriate for dry density at average bulk density (+ / - 10%). The moisture content of the earth fill placed against the rock or the structure shall be on higher / lower side of OMC by about 2% or so, to allow it to be compacted. Profuse watering shall be done to pervious materials (sand) before compaction as per instruction of the Engineer-in-Charge. Compaction at junction of earthwork and backfill around the structure shall be carried out with special care without claiming any extra cost.

21.0 Permanent Markings On Ground Along The Alignment Of Pipes

21.1 The contractor shall establish the sufficient number of reference blocks on the alignment of PDN preferably at the interval of 30m or as suitable on the field boundaries so as they will not be disturbed during the agricultural activities of the farmers.

21.2 The marking shall be constructed in prefabricated concrete block of size (15x15x45)cm embeded in concrete block of size (30x30x30)cm. The base of this block shall be burried in ground projecting only 15cm above the ground and the base concrete block.

21.3 These blocks shall be able to locate the pipeline as and where it is laid all over the work under this agreement. The contractor shall mark each block with specific distinct identification mark.
21.4 The contractor shall show all this blocks jointly to the Engineer incharge or his representative, representative of WUA, concern farmers sharing the boundaries, TPI, any other stake holders in the command.

21.5 Contractor shall maintained these blocks in proper order during operation & maintance period of this contract. Any damage done to these blocks for the reasons whatsoever shall be made good at the cost of contractor.

21.6 The contractor shall submit the location of such blocks with specific identification marks with schedule on a special command area map along with the final bill.

21.7 The map of marking of the block shall be handed over to WUA while handing over the command area.

22.0 THIRD PARTY INSPECTION

Work of PDN shall be inspected, tested and certified by PMC / TPI / QC. Modalities of PMC / TPI / QC Inspection shall be separately decided and given by Engineer In-charge. All the testing charges will be borne by the Contractor.

22.1 TESTING OF MATERIALS

22.1(a) All materials before being utilized in works shall be inspected and tested, if found necessary, by the Engineer incharge or his representative / QC. The nature of testing and periodical intervals at which such testing is to be done etc. shall be as per the latest editions of relevant IS Codes and determined by the Engineer incharge. The day-to-day and periodical tests to be carried out on materials mixes and placed concrete, mortar etc. shall be specified by the Engineer incharge from time to time and the Contractor shall provide free of cost all facilities towards collections of samples etc. unless otherwise specified. Labours for collecting samples and transportation of the samples to quality control authorities for test shall be provided free cost of by the contractor. Also electricity, fuel, water curing tank and stores etc shall be provided free of cost by the contractors.

22.1(b) The materials shall be tested in QC laboratory or at any other place directed by the Engineer incharge. The Contractor shall obtain the
test results from the concern authority and the results given by such authorities shall be considered to determine whether all materials, workmanship are of respective standard described in contract and in accordance with the instructions of the Engineer incharge. The Contractor’s representatives shall, however, be given access to all operations and tests that may be carried out as aforesaid so that he may satisfy himself regarding the procedure and methods adopted. It shall then be the Contractor’s responsibility to produce on the work, materials and finished item to the standard as determined by the laboratory tests or to take follow up action to rectify the quality. All Testing charges shall, however, be borne by the Contractor.

(i) When the supply of the samples and the carrying out of such test at Contractor’s cost is provided for or clearly intended in the Contract and is carried out either at the site of work or at place of manufacture specified in the contract document.

(ii) When the supply of the samples and the carrying out of such tests is not provided for or clearly intended in the contract, but on testing the material is found defective and has to be rejected.

(iii) Testing charges for testing of Cement, TMT bars, PVC water stops, PVC strips, GRP water stops, GRP strips RCC pipes, M.S. pipes and all materials to be used in the works including cost of samples and its collection shall be borne by the Contractor.

22.2 The Contractor shall, however, supply all materials, required for tests and also make good at his cost, materials, mixes and bore / core hole with similar or other materials as may be directed by and to the satisfaction of the Engineer incharge.

22.3 The Contractor shall make suitable arrangements to see that one of his representatives remains present at the time of taking samples and shall authenticate the facts. If the Contractor, fails to keep his representative present at site at the time of taking samples or fail to provide required labours and other equipment to collect the samples, the same shall be taken by the Engineer incharge, and the samples selected shall be considered as authentic. The cost incurred by the Engineer incharge when the Contractor fails to provide required men and materials for collecting samples and or their transport shall be recovered from the Contractor.

23.0 Quality Control and Quality assurance.

23.1 It is the responsibility of the contractor to assure the desired quality of work. Whenever the testing of construction materials are required as per the detailed specifications or otherwise required by
the Engineer-in-Charge, the same shall be carried out at the laboratory, selected by the Engineer-in-Charge at Contractor’s cost. The other tests of mortar, concrete, sand, coarse aggregates etc. shall be carried out in field laboratory set up by the contractor in presence of quality control representative at contractors cost. Contractor shall through this procedure assure the quality of work.

23.2 The materials, mixes and any other arrangements, including labourers, shall be supplied by the contractor to the Corporation at contractor’s cost. The samples for testing shall be taken in the presence of Engineer-in-Charge or his representative / QC present on site. The contractor or his authorized representative shall have a free access in these laboratories, to get himself satisfied about procedures of testing etc. Even if the contractor or his representative fails to remain present while collecting samples or testing the results will be considered as authentic and binding on the contractor.

23.3 On award of contract, the Contractors will have to provide adequate quality assurance setup including Quality Assurance Engineer backed with suitable laboratory assistants, labour and well equipped laboratory for taking necessary field test required as per specifications and as per instructions of Engineer in charge.

23.4 Contractor shall provide all test reports of material used in the work as desired from the NABL(National Accreditation Board for Testing & Calibration Laboratories) approved laboratories and from Quality Control, MERI laboratories of the WRD,CIPET, Aurangabad. Contractor shall provide periodical quality assurance report (Weekly / fortnightly / monthly) to Engineer in Charge along with proofs in support of quality of material brought for the work the process / execution of work is as per specification.

23.5 Contractor shall submit the account of all materials brought for the work, which are necessary for execution of work and any other data necessary to assess the quality of work.

23.6 If he fails to fulfill the requirement, the required manpower for testing and field laboratory with required equipments will be deployed by the Engineer in charge and the charges will be recovered from the contractor (Provisions of Clause 4 will be applicable) or the agreement will be revoked.

23.7 PERSONEL FOR QUALITY ASSURENCE

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Personnel with Qualification</th>
<th>Nos.</th>
</tr>
</thead>
</table>
23.8 EQUIPMENTS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Equipments</th>
<th>Apparatus for Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth Work – Field testing Equipments</td>
<td>Field density, Moisture Content, Sieves for Sand &amp; Metal.</td>
</tr>
<tr>
<td>2</td>
<td>Concrete Work -</td>
<td>Silt, Gradation, Moisture Content, Slump, &amp; Cube Modules.</td>
</tr>
</tbody>
</table>

23.9 The tender rates are inclusive of quality control testing charges.

24. Handing over to WUA

The contractor shall operate and maintain the complete pipe distribution network for the period of 5 (five) years. On completion of O & M period, the system shall be handed over to WUA

24.1 During rotation period, once in every year, The Contractor shall perform hydraulic test to the satisfaction of Engineer In-charge to verify the flow of designed discharge, detect or confirm any leakage in the system and rectify at his own cost. The testing shall preferably be conducted jointly with members of WUA / representative of Engineer In-charge, technical representative of contractor and any other stake holder.

24.2 On completion of every Irrigation season the contractor shall flush the pipe line from its tail flush valve so that any siltation, vegetation or obstruction is cleaned and pipe is able to flow designed discharge for next season.

24.3 During the O & M period contractor shall give training to the members of WUA about O & M of PDN work and its efficient use and protection of the system from any damages.
24.4 The contractor shall prepare a detail map of the permanent marking along the alignment of pipe and submit with to Engineer In-charge. The Engineer In-charge shall verify and endorsed the location of the marking and handover these signed maps as a permanent record to WUA.

24.5 In association of the members of WUA, the Engineer In-charge shall confirm the release of designed discharge through every outlet before handing over. In case of any short fall or defect it should be made good from the contractor at his own cost.
SECTION- VIII

AUTOMATION SYSTEMS,
SURGE PROTECTION
DEVICES, FILTRATION
UNITS
CHAPTER XX

SPECIFICATIONS FOR AUTOMATION SYSTEMS, SURGE PROTECTION DEVICES, FILTRATION UNITS.

1. SPECIFICATION FOR INSTRUMENTATION, AUTOMATION AND LOCAL HSCADA SYSTEM

A. AUTOMATION SYSTEM

For Automated Radio Control of Irrigation System in each zone, one irrigation controller shall be provided for every zone or suitable controllers. The irrigation controller shall be placed at suitable locations. Along with irrigation controller, other components like Remote Terminal Unit (RTU), automation antenna, solar panel, etc. shall also be provided at suitable location. Each Chak is designed with minimum 18 solenoid valves (or required numbers) which are placed in groups of 2 / 3 valves at 3 or 4 locations. All the solenoid valves shall be protected by providing enclosures made up of reinforced polyester / any other approved material with door and vandalism alert to be managed by WUA. All solenoid valves shall be operated in different shifts (number of shifts depend on number of solenoid valves). Each group of solenoid valve shall be equipped with one RTU. Each RTU & solenoid shall be activated with Lithium Battery or Solar Battery. Each solenoid valve is designed for an average area of up to chak 3 Ha. As suggested in operational plan, during kharif 100 % area is proposed for irrigation.

Note- No of solenoid valves, number of shifts changes as per up to chak 3 Ha., 1 solenoid valve shall be provided.

B. PUMP STATION

There is water inflow to jack well / sump cum pump house and pumps are designed to transfer water from jack well cum pump house to suitable Chak outlets and further to 3 Ha outlet. There shall be one number of Pumping Station with number of working pumps and 25% standby pumps all are connected to VFD motors and shall be delivering 12400 m$^3$ / hr. water to total command of 12230 Ha under Lower Pedhi Project. The complete distribution network shall be closed conduit network in the form of suitable pipelines delivering up to 3 Ha. sub chak.
In this project depending on the no. of outlets open / closed, Water Demand, the flow shall vary and accordingly no. of operating pumps shall vary so it is the need of project to have reliable and effective Automation System for Pumping Stations and Synchronization between Pumping Station and Distribution.

The Communication System with Wireless Communication shall be operating as this requires not only the pump operation but also the synchronization between the Pumping Station, Consumption in Distribution Network, Distribution Management Systems, Distribution Control Unit Management System and Air Management Systems. This Complete System shall be based on external Energy less and Wireless Communication.

C. DISTRIBUTION NETWORK

Water Suitable for farming shall be delivered at chak outlet i.e. at Distribution Management System. On a peak demand day, it is very highly likely that all Distribution Management System in distributaries are fully open and deliver peak flows to Chak.

On the other hand (for example the days of unexpected heavy rains during a peak demand period) all Distribution Management System may not need to be turned off to prevent excess watering and consequent damage to crops.

In between these two extremes, the number of Distribution Management Systems operating at any given time may vary from total number of Distribution Management Systems in the distributaries. In addition, the Distribution Management Systems may be operated only for certain number of hours in a day depending on the demand etc. so it is required to control and monitor the Distribution Management Systems with effective automation system as depending on the no. of Distribution Management Systems open / close, Water Demand, the flow shall vary and accordingly no. of operating pumps shall vary.

Also Operation of the system during on peak demand months is the most critical to implement as Outflow to Chak from an Distribution Management System depends on the available residual pressure at that Distribution Management System and Higher residual pressure at Distribution Management System means higher flow to chak unless there is a control to restrict the flow to the maximum allowable value. Therefore, it is essential to have control at all chak Distribution Management Systems and more importantly these controls should be set to
maximum flow limits so the Distribution Management Systems cannot draw more water even when there is higher residual pressure at that location and so sufficient flow shall be available at the Distribution Management Systems where pressure is low compare to other Distribution Management Systems or at the higher elevation. Contractor shall provide the Distribution Management System which shall control the Maximum Flow at the Chak Outlets. It shall have the feature of Anti-Drain to enable to keep the network always full of water which shall avoid the Air Entry in the pipe and shall keep the Network full of water. This shall enable to start the flow from the Distribution Management Systems immediately when the Demand shall be given. The System has many more advantages such as

1. Distribution Management System shall enable to operate only when there is demand.

2. Distribution Management System shall prevent the draining of water from the Network.

3. Distribution Management System avoid the Air Entry in pipeline and so reduces the problems associated with air lock such as less / Partial Flow, Leakages, etc.

4. Distribution Management System enables the uniform & equitable distribution of water irrespective of its elevation and distance from the supply source otherwise outlets at lower elevation and near to supply source shall get the more water and other shall get may be less or NIL water.

5. In Distribution Management System the water shall be immediately available at Distribution Management System once the supply shall start.

6. Distribution Management System also consists of Secondary Filtration System of 130 Micron by online self-cleaning screen filter. The Filter is provided to remove the dirt load from the water for long run of Drip, pipelines and smooth working of complete irrigation pipe network.

7. In Distribution Management System as water always remains in pipe network it shall increase the life and efficiency of pipeline.

Entire Distribution Network System shall cover through Distribution Management System, Air Management System, and Outlet Management System.
Typical Distribution Management System

The System shall be capable to record the Instantaneous and Cumulative flow through the Distribution Management System at Remote Control Centre placed at Pumping station. This shall sum up the flow through each Distribution Management System and subsequently through each Mains / Sub mains / Bulk feeders and shall able to operate the No. of Pumps as per the requirements. This system shall not only maintain the equitable distribution in the complete network but shall also increase the efficiency of the project in totality.

- Leads to efficient and reliable long-term trouble free operation
- No guess work
- Precise delivery of specified quantities of water
- Complete control on time and quantities of water to be delivered
- Complete control on Isolation of part of Network whenever needed

Working of Distribution Management System

- Corporation reading water in volume i.e.in m3, Distribution Management Open / Close status, panel door switch open / close status.
- HSCADA (Supervised Control and Data Acquisition) shall display next one week water quota, System open / close timings.
- HSCADA shall also display previous one week quota and actual water quantity passed.
- For every Distribution Management System user can able to view one year calendar with daily quota, valve Opening and closing time.
- Following methods shall be used to know System ON / OFF scheduling, Farmer complaints registration & to know Status of credit and balance water quantity
  - By SMS from registered mobile
  - Using web site
  - IVRS – Voice recorded system on toll free no or any no provide by service provider (optional)
  - Using Mobile App (optional)
Outlet (Distribution Control Unit) Management System

Every section (upto chak 3 Ha.) shall be controlled with Outlet Distribution Control Unit System. The Distribution Control Unit also enables to record the quantity of water delivered in each section at any time automatically. We can operate this Outlet Distribution Control Unit Remotely and Time can be varied as per our requirement. These operations are done without electric energy and Communication is wireless.

Radio / GPRS communication Network

The Radio / GPRS communication network shall be able to make the communication link between the remote control Centre and outlets / Reservoir with suitable frequency (free band) or using GPRS network. The communication protocol shall be able to support multiple logical channels per physical port, enabling simultaneous Central-to-Field Control Unit and Field Control Unit-to-Field Control Unit sessions. The communication protocol shall be able to support the following messaging methods:

- Burst (also known as Contention) – this is transmission upon change of state.
- Polling (also known as Interrogation) – automatically or manually request for data updating.

D. OBJECT OF AUTOMATION

The objectives of providing Instrumentation, Automation and HSCADAsystem for reach pumping station and the entire irrigations system networking general as follows:

- Hydraulic parameters and monitoring and control.
- Electrical Energy monitoring.
- Equipment monitoring .e.pump,motorsetc.
- Optimization of pumping station.
- Monitoring and measurements in Distribution network up to chak 3 Ha.
- Pumping system efficiency monitoring.
- Minimization of human errors & Aid to manpower.
- Logging, reporting preventive maintenance, safety etc.
- Vandalized alerts and all type of type alarms for all automation components / Units.
- Data Collection from established weather station and control of system based on collected weather data.
- Data storage, analysis, backup facility.
- Various alert to all farmers / users using SMS and website.

E. GENERAL REQUIREMENTS OF INSTRUMENTATION SYSTEM

The entire Instrumentation system shall be such that, it can receive and store the information from the following system and do desired computerized actions including alarm and automations. The design details and standards of the HSCADA system shall be approved by the Chief Engineer, Special Project Water Resources Department, Amravati. The HSCADA system shall include automation up to up tochak 3 Ha, Flow and pressure control up to suitable Chak outlet and only on off control at show in concept as to how 15 meter head at up tochak 3 Ha.

1. Electrical System

The required below readings shall be display on panel mounted Graphical Users Interface (GUI) at each location as well as the same shall be displayed on HSCADA system installed at MCS (Main Control Station).

a) Power consumption (kWh), and power factor of 3.3 or 11 kV and 433VOR 6.6 kV system, auxiliary transformers and all HT / LT motors.

b) Status of breakers.

c) Status of all HT motors and all LT motors (On / Off / Trip / Local / Remote) & all parameters.

d) Winding temperatures and bearing temperature of HT / LT motors.

e) Any modification required in Electrical MCC to facilitate SCADA System.

2. Mechanical equipments

a) Status of pumps, dewatering pumps and pumps used for collation / cooling pumps, etc., all discharges up tochak 3 Ha.
b) Status (Open / Close, Local / Remote) of all Butterfly / pump control Valve, on individual pumps (delivery) etc.

c) Temperature of HT motors / pump, Thrust / shaft bearing.

3. **Instrumentation Equipments**

**Following instruments shall be installed by the contractor—**

a) Flowdata (instantaneous flow rate and total flow) from the pump house (through flow meter installed discharge header main), in let channel of reservoirs / pumphouse, distribution line up to up tochak 3 Ha, etc.

b) Level of water in the pump of jack well and intake. (With level sensors)

c) Pressures gauges at delivery of each main pump.

d) Flow switch at inlet cooling water line / lubricating water line.

e) Differential pressures switch across the pressure filters at the discharge of lubricating water pumps.

f) Portable vibration meter.

g) Portablespeed meter

h) Weather Station of required numbers including Rain sensor (Tipping bucket type) with digital output, temperature sensor, humidity sensor, wind speed and direction (digit), solar radiation etc., shall be able to communicate with MCS (Main Control Station).

4. **HSCADA for Disnet Network:**

Automations System of Distribution / Outlet Management System (DMS / OMS) shall able to control and monitor the Outlet OPEN / CLOSE, Flow Measurement from remote control room. Automation consists of remote control room. Wireless Radio Communication Infrastructure and Outlet field units also known as Field Controller Units (FCU) Based on crop water requirement, control centre shall decide the quantity of water requirement at each Distribution / outlet management system (DMS / OMS). Accordingly outlet valve OPEN / CLOSE schedule shall be sent to individual FCU. FCU shall issue command to OPEN /
CLOSE outlet valve. Same time FCU shall read the water flow / volume pulse and transmit to control centre at regular interval.

The HSCADA system includes automation up to up tochak 3 Ha. Flow and pressure control up to SuitableChak outlet and only on / off control at up tochak 3 Ha outlet, with operational details. Contractor / ‘C’ contractor shall be required to show in concept as to how shall he achieve 15meter head at up tochak 3 Ha.

Remote control centre server shall also poll the data from FCU at regular interval. Also status (communication healthiness) of each FCU. If FCU is failed to communicate to central server then shall be reported on central screen as an alert message.

Valve operating time schedule and total volume and flow shall be recorded in the central for historical trending and reporting.

3. MATERIALS AND SPECIFICATION:

All materials, Electrical / Mechanical / Electronic Instruments / Equipment shall be as per relevant Indian / International standard and specifications.

SPECIFICATIONS OF DISTRIBUTION MANAGEMENT SYSTEM (DMS) AT SUITABLE HECTER CHAK

Scope:

1. Supply, Erection and Commissioning of DMS System which should be able to control measure, monitor the flow as per demand to facilitate Uniform distribution of water to the outlets irrespective of its location, elevation and distance from the water source from remote without electrical energy and with wireless communication system complete with Enclosure Cabinet having Vandadalized Alert.

2. The system should be able to record, monitor and control the cumulative quantity delivered to the outlets without any external electric energy and with minimum recurring cost for communication with GSM / GPRS / RADIO etc. (License free band of 865 to 867 frequency in India).

General specifications:
• The System shall be able to Operate, Monitor, Control and Manage the Water to Outlets in Complete Distribution Network without any External Electric supply. (Preferably solar power panel of suitable capacity with 12 V battery having minimum 3 days back up capacity for communication.)
• The System should be capable to achieve the Uniform Distribution of Water to all the Outlets in the Network irrespective of its Elevation and Distance from the source of supply
• The system should be able to record and generate the report of the cumulative quantity delivered to every outlet in the network.
• The system should be able to allow the quantity to outlet as per the demand / quota.
• The System should have minimum recurring cost for Communication by using GSM / GPRS / RADIO etc. (License free band of 865 to 867 frequency in India). The system should be kept in protective enclosure capable of giving vandalism alert.
• DMS should consist of PFCMD, Air valves, inlet ant outlet isolation valves, pressure transmitter, solar power panel of suitable capacity with 12 V battery having 3 days back up capacity for communication, protective enclosure of IP 65 standard.

2. TECHNICAL SPECIFICATIONS FOR PRESSURE FLOW CONTROL & MONITORING DEVICE (PFCMD)

1. Pressure Flow Control Monitoring Device (PFCMD)

The Pressure Flow Control Monitoring Device (PFCMD) shall automatically performs one, two or more independent functions as per requirements, such as Anti-Draining of System, Reducing higher upstream pressure to a constant maximal downstream pressure or sustaining maximum set Flow. All functions are performed irrespective of change in upstream pressure and / or demand. Functions can easily be added or removed in a modular way. The meter accuracy is independent and not affected by the action of the valve.

The valve shall be compatible with Automation System. Valve should be with Rapid-action piston for Fast Opening / Closing action to facilitate stable and accurate control of pressure flow and level. Valve should have High KV factor
e.g. 4” valve should have KV value of 475 m3/hr., Valve should have Low head loss at high flow rates, Valve should have Precision moulded composite construction (Nylon12 + 50% glass fibre reinforced) Valve should be strong, lightweight and corrosion proof surfaces, which resist cavitation damage, thus increasing service life and reducing operation & maintenance cost. Valve should have linear flow, Low turbulence to minimize cavitation, and allow high flow velocities with low noise and vibration. **Valve should have Drip-tight closure, even when command pressure is lower than line pressure. Valve should have “Soft closure feature to prevent water hammer.** Multi-Valve modular configuration Full redundancy or replacement which reduces downtime and maintenance costs & allows maintenance work to be done without halting water flow.

**Material of Construction:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve Body</td>
<td>Reinforced fiberglass nylon or Polypropylene or Cast iron</td>
</tr>
<tr>
<td>Pistons, Bushing, Front and Rear Cups</td>
<td>Reinforced fiberglass nylon or Polypropylene</td>
</tr>
<tr>
<td>Main seal</td>
<td>NBR, VITON or EPDM rubber, Shore index: 80</td>
</tr>
<tr>
<td>O-rings</td>
<td>NBR or EPDM rubber, Shore index: 70</td>
</tr>
<tr>
<td>Inlets, outlets</td>
<td>Stainless steel / Reinforced fiberglass nylon</td>
</tr>
<tr>
<td>Clamps, bolts</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Multi-Valve manifolds</td>
<td>Spheroid iron with polyester or epoxy coating</td>
</tr>
<tr>
<td>Pressure Rating</td>
<td>PN16</td>
</tr>
</tbody>
</table>

2. **Special Combination Air Valves (For OMS)**

- Working pressure range: 0.1 to 10 bar
- Testing pressure: 16 bar
- Working temperature: 60°C maximum
- Shall be suitable to prevent premature closing.
- Shall be suitable for low pressure sealing.
- Kinetic components: Valve shall discharge air at high velocity during filling of system and admit air during draining of water.
- Automatic Components: Vacuum orifice making it less prone to obstruction by debris.
- Body material: Reinforced Nylon.
- **Installation:** It shall be installed before the PFCMD in the DMS System and has the features of an Air-release valve and Air / vacuum valve.
3. Technical specifications of automation system for remote Control and monitoring

The proposed Automation System for DMS shall be able to control and monitor the required parameters from Control Centre with help of license free band radio frequency and GPRS system.

A: REMOTE CONTROL CENTRE

The remote Control Centre shall provide a management tool for controlling all the outlets in the water network. Remote control station shall be web based application so that authorized user can monitor and control each Outlet from any place with the help of internet connection.

System Configuration:

- The Remote Control Centre shall be able to configure system’s parameters for optimal operation.
- The user shall be able to define all fields Units and their associated configurations,
- The user shall be able to define all software application functionality and download (send) the data to the field units, in order for them to perform the on-site function.
- The user shall be able to upload the existing data from the field units in order to monitor the entire system.
- The Control Centre shall provide the ability for user to “zoom in” to level of single element characteristics (i.e. Input / Sensor, Output / Pump etc.) at each site.
- The user can be able to monitor site condition like inside panel temperature, Battery Voltages, GSM / Radio signal strength.
- The user can able to monitor the Panel door status at central.

Management tools:

- Accumulation reporting, historical trends views and Events / Alarms logging.
- Interface to third party database and communication systems such as SMS, paging alarms and weather stations.
• Time based and / or Volume based Weekly Auto schedule shall be stored into the controllers
• Onsite Critical alarms and events are sent by email / SMS to user given email ID or mobile nos.

**Edit Mode:** The same Remote Control Centre software package shall provide both functionality of what is known as Runtime Mode and Edit Mode (when changes to the runtime screen are needed.)

**Part of the Remote Control Centre**

**A) Zonal Field Control Unit (ZFCU).**

• The ZFCU shall provide communication capabilities and interface between the remote Control Centre and Filed Control unit which is on the site.
• The ZFCU shall have the ability to perform "regular" Field Control Unit's functionalities, such as monitoring sensors or activating pumps, in addition to its ZFCU functionalities.
• As part of the Control Centre a front end (FEP) is requested (HW and / or SW) enabling the communication between the Control Centre a front end (FEP) is requested (HW and / or SW) enabling the communication between the Control Centre and the Field Control Units.
• The Control Centre shall be able to interface with various software applications (third party), such as weather stations, and other management SW packages.

**The Remote Control Centre shall be able to execute and support the following features:**

• Displaying the entire data of Field Control Units such as, flowrate / accumulated flow, and total time of operation, balance time in the form of tables and graphical screens
• Displaying Field Control Unit’s events and alarms and ability to report them utilizing SMS technology.
• Display the communication healthiness of field units.
• The user shall be able to change valve operation timings, from the graphical screens
• The user shall be able to operate valve from the graphical screens
• Shall be able to call the Downloading and Uploading data from the Field ControlUnits
• Shall allow the quantity of water as per the Demand set by the operator
• Shall have a program to design and display an event report for each outlet in the water network
• Shall have a program to calculate the predicted flow load over the hydraulics system
• Shall have a program for displaying sensors data, historical trends and alarms
• Shall have an Off-Line program for the Field Units in addition to the current run-time unit's program.

B: FIELD CONTROL UNITS:

• Shall have Logic board incorporating microcontroller / microprocessor and data storage components.
• Shall run on solar or power or long life lithium battery.
• Shall be with I / O port required for on-site sensor connection. I / O boards may be expanded / replaced on-site. These may be inputs such as water meters, reservoir level, pressure meters or general digital inputs, or outputs such as valves, pump starts, general relay etc.
• Communication Ports - enabling the Field Unit to communicate with the Remote Control Centre, and each other, and on-site programming / diagnostic tool (such as laptop)
• Shall be able to operate not only the local I / O (onboard I / O connections, but remote I / Os as well.
• Shall be able to update the Remote Control Centre database upon request (by the remote Control Centre) or by exception. The Field Unit shall be able to report to the Remote Control Centre every defined alarm which occurs in the field.
• Shall be capable of functioning in a stand-alone mode (no Remote Control Centre), as well as a part of a system with a Remote Control Centre.
• Shall be able to perform Store & Forward functionality - receive information from other sites, store it in memory, and then transmit (forward) the data to another site.
• Shall be able to support both local I/Os and Remote I/Os modules. The modules shall be equipped with radiotechnology, allowing the Field Unit full access and control, as if they are locally connected.

• Shall be able to report by exception (known as burst) to the Control Centre upon any Change-Of-State (COS)

• Shall be equipped with a multi-basking Operating System, specially designed for a meal-time environment

C: RADIO / GPRS COMMUNICATION NETWORK

• The Radio / GPRS communication network shall be able to make the communication link between the remote control Centre and DMS / Outlet with conventional (Suitable free band) frequency or using GPRS network.

• The communication protocol shall be able to support multiple logical channels per physical port enabling simultaneous Central-to-Field Control Unit and Field Control Unit-to-Field Control Unit sessions

The communication protocol shall be able to support the following messaging methods:

• Burst (also known as Contention)—this is transmission upon change of state.

• Polling (also known as Interrogation) —automatically or manually request for data updating. Report by Exception— the unit shall only report data that have changed since the last poll.

4. ISOLATION WAFER TYPE BUTTERFLY VALVE (BFV)

Wafer Type BFV should be provided to Inlet of PFCMD and for outlet, if required as per design. Chief Engineer, Special Project Water Resources Department, Amravati, decision will be final in this regard.

Material of Construction

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Ductile Iron GGG40</td>
</tr>
<tr>
<td>Disc</td>
<td>Ductile Iron GGG50</td>
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<tr>
<td>Shaft</td>
<td>Stainless Steel 410</td>
</tr>
<tr>
<td>O-Ring</td>
<td>NBR</td>
</tr>
<tr>
<td>Plug</td>
<td>Stainless Steel 410</td>
</tr>
<tr>
<td>Bushing</td>
<td>Bronze</td>
</tr>
<tr>
<td>Washer</td>
<td>Stainless Steel 410</td>
</tr>
<tr>
<td>Half Washer</td>
<td>Stainless Steel 410</td>
</tr>
</tbody>
</table>
Bolts | Stainless Steel
--- | ---
**TEST PRESSURE**
Seat test | 16 Kg / cm²
Body test | 24 Kg / cm²

5. ENCLOSURE

Enclosure to be made up of Reinforced Polyester / MS with Door having vandalism alert.

OUTLET MANAGEMENT SYSTEM (OMS)
Outlet management system (OMS) consist On / off valve, Enclosure cabinet made up of Reinforced polyester with door having vandalism alert and shall be installed with remote on / off feature for the water supply to 3 Hectare area and should be able to operate without any external electric supply and communication should be wireless.

MATERIALS & SPECIFICATION
All materials used for DMS / OMS like Electrical / Mechanical / Electronics Instruments equipment shall be as per relevant Indian / International standards as specifications.

4. SPECIFICATION FOR SURGE PROTECTION DEVICES

Surge Analysis
The contractor shall undertake surge analyses to determine the extent of surge pressures or other adverse hydraulic conditions that may occur during the operation of rising mains. The contractor shall undertake the following tasks as an integral part of the surge analysis for each system:

1. Construct a mathematical model of the system using internationally recognized transient simulation computer software. The network model should be as detailed as possible incorporating high and low elevation points along the pipeline and detailed piping manifold in pump station area.
2. List all the steady state scenarios under which the system shall operate;
3. List, with reasons, the most adverse surge conditions under which the system shall operate;
4. Determine maximum and minimum surge pressures along the system that can occur due to system operation with and without cavitation.
conditions. The case with cavitation conditions must capture high and low surge pressures by simultaneously limiting low pressures to vapour pressure at all nodes considered in the mathematical model.

5. Add surge protection system to the network model and determine the maximum and minimum surge pressures for the most adverse surge protection system should also include all air entring valves, though they are not normally considered as part of the surge protection system.

6. Verify the adequacy of the surge protection system for other important operating scenarios such as new pipe roughness condition, power failure during single pump operations, and pump start up conditions.

7. The surge simulations must be carried out for at least 10 times \(2L/c\) value where \(L\) is the total length (m) of the pipeline and \(C\) is the average celerity (wave speed) in m/s. Results presented should indicate the total simulation time e.g., pressure variation graph w.r.t. time at some specific locations along the pipeline.

8. Computational time should be at a minimum of 0.005 seconds to capture all the pressure spikes arising from air valve slam conditions, NRV Slam conditions and any other rapidly varying slam pressures. The report generated by the surge analysis Software should be attached to demonstrate the use of all small computational steps.

9. Surge Protection System should be suitable for the Thickness of Pipeline used for the Project. Thickness of the pipeline must be capable of withstanding both highest and lowest negative pressures in accordance with the appropriate Indian or AWWA standards.

10. Prepare a Surge Analysis Report providing full details of tasks (1) to (6). Including sufficient data sheets, figures, and analysis output etc. from the transient simulation computer software to allow the vetting authority to undertake a detailed review of the Surge Analysis Report. The Report should be vetted by Competent Authority such as CDO Nashik / VNIT / VJTI / COEP / IIT / IISCBangalore and if they suggests additional simulations and / or changes to the protection methods, the contractor shall incorporate all the necessary changes as agreed mutually by client and contractor and resubmit the report. Surge protection system should comprises of bladder vessels or along with any or all of the following equipment depending on the recommendation of surge analysis to prevent the positive and negative
surges in the pipeline.
Surge protection system shall comprises of bladder vessel and surge suppression valves.
Surge Monitoring System comprises of Data Logger, Pressure Transmitter to be supplied to enable to study the surge effect.

5. TECHNICAL SPECIFICATIONS OF SURGE PROTECTION EQUIPMENT

Supplying, erecting, commissioning of Three Stage Surge Suppression Valve.

(1) For Right Flank – Flow 3956 LPS and head 55m. 
(2) For Left Flank – Flow 1794 LPS and head 52m.

OPERATION

The valve should be able to take high air intake capacity and Discharge the Air in Controlled Way by predesigned Small Orifice to allow the re-joining of columns slowly.

SPECIFICATION:

Air Intake: The valves should offer very high air intake capacity with nominal orifice size for ex. G‖ valve should have a large orifice of 6‖ along with better aerodynamic design to reduce the obstruction of air flow through the valve.

Sealing: The models should be equipped with a two stage sealing, a soft EPDM seal and Bronze seal. As float approaches the orifice it meets first the rubber seal and as pressure increases the seal is pushed and the float seats on the Bronze seat, this ensures low minimum sealing pressure of 2 meters and long life maintenance and leakage free operation.

Float design: Floats should be made of polycarbonate, and should be tested for 100 bar bursting pressure for all pressure ratings of the valves. The float design should offers long term maintenance free operation and resistance against drowning effect of float against orifice. The float design and the air valve body design should offer better protection against pre-mature closing of the valve. The spherical hollow design of the float shall offer less resistance which leads to high flow capacities and also avoids accumulation of debris.
**Air discharge and surge suppression:** The Surge Suppression Disc should be used in Surge Suppression Air Valve the following parameters are emphasized for the purpose of simulation:

1. **Air Intake Orifice:** Both the methods offer nominal size of orifice for ex. 6” valve has as large orifice of 6” offering high intake capacity due to less frictional losses.

2. **Air Outlet Orifice (Surge Suppression orifice):** Manufacturer should develop standard Surge Suppression orifice sizes for each size for Customization of specific requirement as per the hydraulic analysis.

**Switching pressure:** This denotes differential pressure required to switch from large orifice to Surge Suppression orifice during air release. The valve should have Surge Suppression Disc operating from a differential pressure less than 2 KPA (20cm) of water column.

**Technical Specification for API surge suppression High Flow Combination Air Release valve Material of Construction**

<table>
<thead>
<tr>
<th>Body &amp; Cover</th>
<th>Ductile Iron ASTM A 536 / EN 1563</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float(Kinetic)</td>
<td>Polycarbonate / Polypropylene</td>
</tr>
<tr>
<td>Float(Automatic)</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>Seal</td>
<td>Rubber E.P.D.M</td>
</tr>
<tr>
<td>O-Ring</td>
<td>Buna-N</td>
</tr>
<tr>
<td>Bolt and Nut</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Working Pressure</td>
<td>16 kg / cm2</td>
</tr>
</tbody>
</table>

**6. DESIGN, MANUFACTURE, SUPPLY, ERECTION, COMMISSIONING & TESTING AT SITE AND SUPPLY OF BLADDER TYPE AIR VESSELS**

The surge tank shall be vertical, Bladder type vessel suitable for use of with water. The tank, supports & anchor bolts shall be designed & with stand confirm to Indian / International standards.

**Surge Tank**

The surge tank shall be vertical; bladder type vessel suitable for use with raw Water Nitrogen should be used to avoid the corrosion.

**Tank Sizing.**
Surge Tank Design and Materials

1. Materials for the tank, design, and shop fabrication and inspection shall comply with pressure equipment standards (IS / ASME / BS 5500 / CODAP)
2. Minimum design pressure shall be as started in this section of the Specifications. Perform hydrostatic testing in shop. Test pressure shall be 150% of the design pressure of the tank.
3. Provide a ½ inch threaded connection at the top of the tank to contain a gas charging valve and pressure gauge. Tank shell shall be constructed of deep drawn shall be equipped with a heavy duty rubber bladder. The Precharge pressure shall be located between the shell of the tank and the bladder. The side manhole shall be sized to conform to the inner shape of the vessel. Bladder Surge tank shall be of the vertical configuration.

Bladder tank shall be equipped with a Hydro control level Gauge Equipment with Output 4 / 20 MA.

Bladder ManufacturingService Conditions

Surge Tank hydraulic performance conditions shall be as per approved surge analysis by Chief Engineer, Special Project Water Resources Department. Amravati,

Tank Installation

The Surge tank shall be installed in accordance with the manufacturers / Suppliers suggested procedures. All supports, piping, valves, and related appurtenances shall be provided and installed by the Contractor at no additional cost to the Owner.

Painting and Coating

All painting and coating shall be completed at the factory. Field painting and coating shall not be accepted. The tank interior shall be painted with anti-corrosion epoxy paint with a uniform layer thickness of no less than 130 microns; the tank exterior shall be painted with 3 coat zinc based epoxy to a minimum thickness of 110 microns.

MATERIAL SPECIFICATIONS FOR BLADDER TYPE SURGE VESSEL
7. SPECIFICATION OF PRIMARY FILTRATION AT PUMPING STATION

General
Providing and Supplying, installation & testing of Online Automatic screen Filter with self-cleaning mechanism of 130 micron suitable for maximum flow rate of 3956 LPS and 1794 LPS along with isolation butterfly valve and manifold etc. completed (Primary Filter) as per relevant Indian or International standard and as directed by Engineer-in-Charge.

1) Minimum Flow Rate: 3956 LPS and 1794 LPS (Total Capacity)

2) Filtration Degree: 200 Micron

3) Self Cleaning Mechanism: Activated by Differential Pressure in the System.

4) No of Units- equals to number of Pumps or as per design requirement.

The automated filter unit should consist of heavy duty automatic filters with self-cleaning mechanism and should be capable to a filter design discharge of pump. It should have capability to work for 22 hours continuously per day without any obstruction due to cleaning operation. It should be installed on the delivery side of Pump after the Pump Control Valve.

TECHNICAL SPECIFICATION FOR ONLINE SELF CLEAING FILTERS

The filter shall be designed for following parameters:

- Maximum flow rate
- Minimum Inlet Pressure
- Filtration Degree absolute
- Inlet TSS in mg / l or ppm
- Minimum water used for draining / flushing
- Cleaning Mechanism
- Mechanical Life: Filter shall be designed considering mechanical life of self-cleaning mechanism and housing.

Maximum flow rate:

The filter shall be designed based on the Maximum flow rate.

Minimum Inlet Pressure:

The minimum inlet pressure provided for the filter shall be 2.0 Bars. No back wash pumps shall be used for cleaning purpose.

Filtration Degree absolute:

The filter element design shall be based on revolving Brush cleaning mechanism to achieve absolute i.e. removal of 99.99% suspended solid based on the 220 micron rating or filtration degree.

Inlet TSS in mg / l or ppm:

Based on the inlet TSS load the filter selection shall be done accordingly with minimum flushing cycles.

Minimum water flushing:

The Water used for flushing shall not exceed to 1% of the rated flow and the filter shall always deliver at the outlet of 98% of the rated flow. No standby filters are envisaged for this application.

Cleaning Mechanism:

The Cleaning mechanism shall be self-cleaning mechanism to ensure uniform cleaning of the screen. The cleaning mechanism shall be suitable for number of flushing cycle online basis with no downtime and should be activated either by pressure differential or time.
Mechanical life of screens / filter housing:

As no standby filters are envisaged for this application the functionality of the system and mechanical parameters shall be of high quality. The screens shall be in SS316L material for surface water (rivers, lakes etc.). Housing shall be in high grade carbon steel with suitable sandblasting and epoxy or polyester coating.

The filter shall have Electric controller for online self-cleaning based on the differential head in the system. As soon as the system reaches to 0.5 bar differential head, the rinse controller activates the online self-cleaning and the dirt load shall be removed with the help of revolving brush. Filter Housing should comprise of Single or Double Filters together to meet the project requirement.

Material of Construction:

<table>
<thead>
<tr>
<th>Filter Housing and Lid</th>
<th>Epoxy or Polyester Coated Carbon Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning Mechanism</td>
<td>Stainless Steel 316L, PVC, Acetyl</td>
</tr>
<tr>
<td>Control</td>
<td>Brass, Stainless Steel, Nylon</td>
</tr>
<tr>
<td>Seals</td>
<td>Synthetic Rubber, Teflon</td>
</tr>
</tbody>
</table>

OPERATING PHILOSOPHY:

Raw water enters the inside of the screen-cylinder from the filter's Inlet and flows through the screen to the filter Outlet. The dirt particles are trapped on the inner screen surface and forming a "filtration cake" that causes a pressure differential across the screen.

During the self-cleaning process, filtered process water continues to flow. The Exhaust Valve open and the Drive Unit rotates self-cleaning mechanism which cleans the inner surface of the cylinder screen. The particles trapped on the screen are sucked out by the suction nozzle and flushed out the exhaust valve.

The control system comprises of a Pressure Differential Switch that senses the pressure differential across the screen and sends a signal to the control board when it reaches a predefined value. The control board initiates the self-cleaning process.
The filter begins a self-cleaning cycle under any one of the following conditions:

1. Receiving a signal from the Pressure Differential Switch
2. Time interval parameter set at the control board
3. Manual Start

**Testing:** Filter should be tested for the Hydrostatic of 15 Kg/cm².

### 8. TECHNICAL SPECIFICATIONS FOR SECONDARY FILTARATION

#### General

Providing and Supplying, installation & testing of Online Hydraulically operated Automatic screen Filter with self-cleaning mechanism of 130 micron suitable for minimum flow rate of 11.28 LPS along with isolation butterfly valve and manifold etc. completed as per relevant Indian or International standard and as directed by Engineer-in-Charge.

**(Secondary Filter Specification)**

1) Minimum Flow Rate: 11.28 LPS (This flow rating for 24 Ha chak. If chak size changes, flow rate of secondary filter changes accordingly)

2) Filtration Degree: 130 Micron

3) Self Cleaning Mechanism: Activated by Differential Pressure in the System

4) No of units- Equals to number of chak.

The Filter to be an Automatic filter, The mid-range automatic filters, ideal for remote installation sites, with a water-driven self -cleaning mechanism that doesn't require external power source to operate with a capacity up to 30 m³/h and with 130 micron filtration degree to be installed in the Distribution Network.

#### The Filtering Process

The Filtration process begins when raw water flows through the filter inlet into the coarse screen. Here, the water is pre-filtered in order to protect the cleaning mechanism from large debris. The water then passes through the inner surface of the fine screen; dirt particles are trapped and accumulated inside the filter while
clean water flows through the filter outlet. The gradual dirt build-up on the inner screen surface causes a filter cake to develop, with a corresponding increases in the pressure differential across the screen.

**The Self-Cleaning Process**

When the pressure differential across the screen reaches a pre-set level of 0.5 bar, the filter's rinse controller starts the cleaning process by opening the internal flush valve. This result in the releases of a back-flush stream, flowing through the nozzles out of the hollow Suction Scanner Shaft and the Turbine to the Drainage pipe.

**MATERIAL OF CONSTRUCTION:**

<table>
<thead>
<tr>
<th>Filter housing and Lid</th>
<th>Epoxy-coated carbon steel 37-2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>Moulded weave wire SS 316 L</td>
</tr>
<tr>
<td>Cleaning mechanism</td>
<td>PVC and Stainless Steel 316 L</td>
</tr>
<tr>
<td>Seals</td>
<td>BUNA-N</td>
</tr>
<tr>
<td>Controls</td>
<td>Aluminium, Brass Stainless steel 316, PVC, Acetyl</td>
</tr>
</tbody>
</table>

**9. SPECIFICATIONS FOR WIRELESS AUTOMATIC IRRIGATION SYSTEM:**

**1.1 Radio Remote Terminal Unit (RRTU) 8DO / 4AI / 4DI**

- Radio Frequency: Preferably 865 to 867 MHz (License free band in India)
- No. of outputs: 8 digital Output, 12 V DC latching
- No. of analogInputs: up to 4 Analog input 4-20 mA or 0-5V
- No. of Digital Inputs: 4 digital input.
- Shall be low power consumption i.e. <80 mA.
- RRTU shall have LCD indicators to show status or error and signal strength.
- RRTU shall be programmable.
- Shall be operated in mesh topology.
- Shall be solar powered, battery operated.
- Shall have IP65 protection.

**1.2 Radio Remote Terminal Unit (RRTU) 8 DO**
• Radio Frequency: Preferably 865 to 867 MHz (License free band in India)
• No. of outputs: 8 digital Output, 12 V DC latching
• Shall be low power consumption i.e. <80 mA.
• RRTU shall have LCD indicators to show status or error and signal strength.
• RRTU shall be programmable.
• Shall be operated in mesh topology.
• Shall be solar powered, battery operated with 3 days autonomy.
• Shall have IP65 protection

1.3 Master Base Station
• Shall act as interface between server based software and RRTU.
• Shall have GSM communication facility for communication with server based software.
• Shall able to send and receive information and alarms to server based software.
• Radio Frequency: Preferably 865 to 867 MHz (License free band in India) for communication with RRTU.
• GSM / GPRS Communication: any available mobile operator within the operating area.
• Shall be able to control up to 100 RRTU.
• RRTU unit shall be approved by WPC (Wireless Planning Commission, India)
• RRTU shall have LCD indicators to show status or error and signal strength.
• Shall be solar powered, battery operated
• Shall have IP65 protection.
• Shall have 3 days power Backup.

1.4 Server Based Software for Automation Control
• Software with Supervisory Control and Data Acquisition System (HSCADA)
• Shall have authorized user interface for review and monitoring the project.
- Shall have authorized user interface for programming and scheduling irrigation cycles.
- Shall be deployed on cloud (internet platform) to allow authorized user to access the software for project monitoring.
- Shall have facility to see and print graphs and reports.
- Shall be able to communicate with Master Base Station.
- Shall have backup up facility for one year.
- Shall be able to provide utilization of total volume of water, water use efficiency.
- Shall be able to generate alarms.

1.5 Micro-Irrigation Network Management Information System (MINMIS)

- Proposed Micro-Irrigation Network Management Information System (MINMS) should be open-source and can be able to scale up to whole state.
- It should have facility to get demand from farmers and supply water as per crop water requirement to each field.
- It should have a facility to track online information regarding water availability, water requirement as per crop water requirement, Irrigation schedule and any notification from department.
- It should have facility for online information about actual water consumption, water bill, crop details etc.
- It should be able to integrate with HSCADA application.
- Functionality for MINMIS
- Proposed MINMIS application must able to capture all farmer details like
  - Farmer Name
  - Photograph
  - UIDAI no / Voter ID no
  - Mobile No
  - Land Holding
  - Land under MI scheme
  - Crop taken in each seasons
  - Administrative Details
- Water User Co-operative Society Details (if Any)
- Proposed MINMIS application must able to acquire water demand on basis of Area & Crop.
- MINMIS application should be able to calculate Crop Water Requirement & should be able to export it to HSCADA software.
- MINMIS application must able to integrate with smart phone application, Information kiosk or website which can be capable to take water requirements from farmers
- Smart Phone application must be Multilingual i.e. Local Language, Hindi & in English and must be able to take water demands from farmer.
- System should capable to prepare Irrigation schedule depending upon water demand, crop pattern & availability of water.
- System should be able to communicate stake holders through SMS / emails about the Irrigation schedule.
- MINMIS application must be able to generate bills to the farmers.

1.6 PLC with HMI
- PLC shall have facility to control Pump Station including VFDs.
- Shall have minimum programming memory of 100 kb
- It shall have Human Machine Interface (HMI) minimum 4 inch screen.
- Shall have inputs and outputs required to control entire pump station having multiple pumps.
- Shall be able to take inputs from pressure or inflow sensor to control VFD panels for all pumps and then intern shall also be also to operate the Non VFD pumps of the pumping station have 24VDC input and outputs.
- Shall have 24VDC input and outputs
- Programming and software requirement shall be done by the supplier (Contractor)
- Shall be able to generate user defined alarms.

1.7 Pressure Transmitter
- Shall be IP 66 rating
- Shall be 2 wires, analogue 4-20 ma or 0-05 V output.
• Sensor shall be piezo-resistive with SS316 diaphragm
• Pressure rating 0 to 10 Kg / cm²
• Accuracy, + / - 0.25% of full scale including linearity
• Mounting shall be direct on line with ¼" or ½" threaded inlet
• Temperature Limits, 0 to 60°C

1.8 VFD Panel at main Pump house
• VFD panels as per design requirement and suitable for motor shall be provided for all pumps.
• Shall be able to communicate through any of the RS484, Modbus, Profile bus, TCP / IP, Device Net, GPRS wireless transmission.
• Shall be able to set frequency through user interface or via analogue input
• It shall have display and keypad to set the parameters.
• Shall be supplied with necessary panel and wiring complete

1.9 Level Transmitter
• Ultrasonic Level sensor shall be suitable to monitor water level minimum up to 8 m
• Output signal shall be analogue with 4-20 mA or 0-5 V signal.
• Output body of the transmitter shall be weather proof with IP66 / 67 enclosure
• Shall be supplied with proper mounting arrangements
• Resolution shall be 1mm
• Accuracy shall be 0.25% FS

1.10 Level Switch
• Level switch shall be suitable to maintain pre-set water level
• Output shall be discrete type NO / NC signal
• Level switch can be float or magnetic or any other suitable mechanism
• Minimum range shall be 5m. It shall be supplied with suitable mounting arrangements

1.11 Pressure Switch
• Pressure Switch shall be spring opposed bellows supplied weather proven closure
• Range shall be up to 10 Kg / cm²
• Repeatability shall be + / -0.1% or below of full scale range
• Switch rating shall be 15A, 230VAC

1.12 Flow Sensor
• Flow sensor shall be transit time multi cross path
• Output shall be analogue 4-20 mA or 0-5V
• Operating range shall be 0.05 to 10 m / s
• Accuracy shall be better than 1%
• Shall be suitable to pipe sizing from DN15 to DN900
• Shall have proper mounting arrangement
• Shall have IP65 protection

1.13 Control Valves
• Control valves can be disc control valve or diaphragm control valve
• Control Valves can be disc control valve or diaphragm control valve.
• It shall be actuated through electrical actuator or solenoid to throttle or control the valve.
• Valve actuator / solenoid shall be compatible with the output of RTU and / or PLC.
• Valve shall have suitable end connections.
• It shall have leak proof sealing.
• Material of construction can be metal / plastic or both.
• Metal part exposed to atmosphere shall be properly powder coated with coating thickness more than 80 micron.
• Maximum pressure rating for valve shall be 10 kg / cm2.

1.14 Water Meter
• Shall be able to multipath transit time design with advanced digital signal processing.
• Accuracy shall be better than 1%
• Repeatability shall be better than 0.2 % of span
• Shall have ultrasonic type.
• Shall have suitable end connection.
• Maximum pressure rating shall be 10 kg / cm2.

1.15 Establishment of Automatic Weather Stations consisting of :-
• Air Temperature sensor
• Relative Humidity sensor
- Barometric Pressure sensor
- Wind speed & direction sensor
- Rain fall sensor
- Solar Radiation sensor
- Data logger with Water proof enclosure.
- Inbuilt GSM / GPRS modem for data communications
- Solar power, battery and cabling

1.15.1 **Air Temperature and Relative Humidity sensor with Radiation Shield**

**Temperature:**
- Range: -40º C to +60º C
- Accuracy: + / - 0.30 C or better (with radiation shield)
- Resolution: + / - 0.10 C
- Response time: 10 sec or better

**Humidity:**
- Range: 0 to 100% RH
- Accuracy: + / - 3% or better
- Resolution: 0.5%
- Stability: Better than 1 % RH per year
- Response time: 10 sec. or better

1.15.2 **Wind Speed**
- Sensor type: Ultrasonic
- Range (Operation): 0 to 60 m / s or better
- Accuracy: + / - 3%@12m / s or better
- Resolution: 0.1 m / s
- Threshold: 0.5 m / s or less

1.15.3 **Wind Direction**
- Sensor type: Ultrasonic
- Range: 0 to 360 Degrees
- Accuracy: + / - 3 degrees 0 to 35 m / s and + / - 5 degrees 35 to 60 m / s
- Resolution: 1 deg.
- Threshold: 0.5 m / s or better
1.15.4 Rainfall Sensor

- Sensor Type: Tipping bucket / Optical / Impact Type Sensors
- Range: 0-200 mm/h
- Accuracy: 5% maximum depending upon the variation of Precipitation type and intensity
- Resolution: 0.2 mm or better

1.15.5 Barometric Pressure Sensor

- Range: 600 – 1100 mbar
- Accuracy: 0.5 mbar or better (at 25 deg C)
- Operating temperature: -40 to +60 deg C
- Resolution: 0.1 hPa

1.15.6 Solar Radiation / Sunshine Recorder Sensor:
Silicon photo voltaic detector type Global Solar Radiation sensor is required to measure the global solar radiation. The output from the sensor is fed to an intelligent data logger, which calculates the sunshine duration from the measurement of solar radiation during day. The Sunshine duration as calculated by the data logger is also communicated to the central station.

Technical specifications:

- Sensor type: Silicon Photo voltaic detector type Pyranometer
- Spectral Range: 400 to 1100 nm
- Measurement Range: 0 to 1500 Watt/m²
- Sensitivity: Better than 10 micro V per 1000 Watt/m²
- Accuracy: Less than 5% including the stability, temperature dependence and any other error
- Temperature Dependence: +0.15% / 0C (typical) Max
- Stability: Less than 2% per year
- Resolution: 1 Watt/m²
- Response time: Better than 20 micro Sec
- Cosine Error: Cosine error compensated up to 80 deg angle of incidence
- Tilt Error: No error is induced from orientation
- Operating Temperature: -40 to +60 deg C
- Humidity: 0 to 100%
- Sensor Housing: Water Proof, Aluminized case with acrylic diffuser with levelling screws
- Calibration: Sensor must have calibration against WMO-WRC secondary standard Pyranometer

1.15.7 **Data Logger Specifications:**

- Processor: 32 Bit.
- ADC Resolution: 24 bit or better
- Conversion Accuracy: ± 1 LSB
- System clock
- Stability Long-term: 1 ppm / year or better
- Stability (Temperature): 3 ppm or better from -10°C to 55°C
- Operating Temperature range: -10°C to +55°C
- Internal Memory: For 6 months data storage with 1 sec sampling and 10 minutes averaging. Vendor must provide the adequacy of memory calculation.
- Battery Backup (internal): Lithium Battery, storage: 2 years
- Watchdog Timer: System Reset upon microprocessor failure
- Sample Intervals: 1 sec. to 24 hr. in 1 second increments (user selectable)
- Visual display: 2*16 Character or more, alphanumeric LED / LCD to operate in temp. range -10°C to +55°C
- Charge controller: Internal or External
- Protection: Data logger must have IP67 compliant enclosure

1.16 **Water Quality Multi parameter SONDE.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Power</td>
<td>8-36 VDC</td>
</tr>
<tr>
<td>Operating temp.</td>
<td>-5 to 50 Degree C.</td>
</tr>
<tr>
<td>Storage temp</td>
<td>-40 to 65 Degree C.</td>
</tr>
<tr>
<td>Data logging</td>
<td>50 logs</td>
</tr>
<tr>
<td>Logging rate</td>
<td>1 minute to 99 hours</td>
</tr>
<tr>
<td>Max Pressure Rating</td>
<td>Up to 350 PSI</td>
</tr>
<tr>
<td>Output Options</td>
<td>Rs-485 / MODBUS,SDI-12,Bluetooth</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Internal Memory</td>
<td>16 MB, 8GB micro SD Card.</td>
</tr>
<tr>
<td>Interface</td>
<td>Android 4.4, required Bluetooth2.0</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>+ / -0.1°C</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>-5 to 50°C</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.01°C</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>Celsius or Fahrenheit</td>
</tr>
<tr>
<td><strong>Barometric Pressure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>+ / - 1.0 mbars</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>300 to 1100 mbar</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.1 mbar</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>Psi, Lpa, bar, mbar, inHg, mmHg</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>+ / 10.1 pH</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0 to 14 pH units</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.01 pH</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>pH</td>
</tr>
<tr>
<td><strong>Conductivity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>+ / - 0.5 % of reading</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0 to 250000 uS/cm</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.1 uS/cm</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>uS/cm</td>
</tr>
<tr>
<td><strong>TDS</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0 to 350 ppt</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.1 ppt</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>ppt, ppm</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0 to 350 PSU</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.1 PSU</td>
</tr>
<tr>
<td><strong>Response Time</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>PSU</td>
</tr>
<tr>
<td><strong>Turbidity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>+ / - 2% of reading</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0 to 4000 NTU</td>
</tr>
<tr>
<td><strong>Resolution / Precision</strong></td>
<td>0.01 NTU</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>NTU, FNU</td>
</tr>
</tbody>
</table>

### 1.17 Solenoid Pilot Valve

- Shall be a latching type solenoid.
- Operating voltage, 12 VDC
- Shall have manual override option.
• Shall have threaded connection of 1/8"

1.18 Hydraulic Relay

• Hydraulic relay shall be used to boost pressure required to operate the valve wherever, it is located at farther distance (more than 100m) and/or valve is located at elevation difference.

CHAPTER XXI
OPERATION & MAINTENANCE,
TRAINING & CAPACITY BUILDING
OF FARMERS
CHAPTER XXI

SPECIFICATIONS FOR OPERATION & MAINTENANCE, TRAINING & CAPACITY BUILDING OF FARMERS

Scope of Work

Operation & maintenance for period for entire scheme shall be 60 months (5Years) including all types of repairs, replacements of electrical, mechanical, civil, automation equipment or components required for successful running of commissioned scheme for all seasons i.e. for complete 12 months of year. Training for WUA / Farmers, capacity building of farmers for successful running of WUA. O&M also consist of training of every stakeholder for implementation of microirrigation and adaptation of new farming methodologies and techniques for success of the scheme with contractors own cost. Detailed schedule of training along with the bid document shall be submitted to Engineer-in-Charge. Detailed schedule of training shall be got approved from competent authority. Training regarding entire scheme operation including automation shall be given to WUA members and employees appointed by them during the O&M period so that after
completion of O&M period, trained persons can easily operate and maintain the schemes successfully.

In addition to above scope of work, following task required for operation & maintenance of scheme-

1. Most Efficient, optimum and effective use of water and Electricity.
2. Regular operation, maintenance and servicing of all mechanical, electrical, electronic equipments including all primary & secondary filtration units.
4. Preventive maintenance and schedule maintenance.
5. Co-ordination with department officials for all maintenance & operation related work and giving feedback to Engineer-in-Charge shall be the responsibility of Contractor.
7. Maximum service to consumer for maintaining uninterrupted water supply.
8. Maintenance of proper record of operation, maintenance and training given to stockholders / Farmers. (Log Book, Registers, check lists which should be approved by Project Engineer and Engineer-in-Charge)
10. Collection of water charges including Electricity Charges from WUA / farmers. Crop area measurement, water demand collection, etc.
12. Provision of Agronomical services for farmers in the command of Lower Pedhi Project.
13. Establishment, operation & maintenance of Complaint Cell (Call centre Type) for recording & attending complaints from user. Same data shall be immediately submitted to department including complaint attendance register and resolve of complaint.

Note: Complaint shall be attended within 24 Hours of complaint. If contractor fails to attained complaint within 24 Hours, fine of Minimum Rs. 1000 / per complaint shall be charged from Running Bill of contractor. (All major faults and problems shall be reported to Engineer-in-Charge or his office within 12 hours through a memo only).
14. Any damage or loss due to failure to carry out prescheduled maintenance work shall be the responsibility of Contractor.

15. During last Two years out of Five years of maintenance period, activity of handing over of distribution scheme to WUA’s shall be completed.

16. Management of Entire command area as declared by Water Resources Department.

17. Preparation of Annual Operation Plan and submit to the Engineer-in-Charge for approval.

18. Preparation of demo plots for on farm demonstration of farmer at the start of work, with contractor’s own cost. (minimum 10 ha area of each WUA within command)

**Training Programme & Capacity Building of Farmers / WUA**

Class room training, field training to every stake holder on subjects like Soil testing, Cropping pattern, contract farming, Fertigation, Marketing, Crop water Requirements, etc.

**Minimum 1 training programme in every month (During 5 Years of O&M)** including guest lecture facility, food, field visits including all misc. items etc.

Training related to formation and functioning of WUA before starting of O&M period. Proper co-ordination with department for arrangement of training shall be done. Expenditure on training shall be borne by the contractor.

**1.0 Materials & Manpower**

Defect liability of entire project is 5 Years after receiving of completion certificate. All materials, Spares & tools, vehicles, consumable, manpower required for successful maintenance and operation of Entire scheme shall be the responsibility of contractor including all costs.

The Contractor shall deploy experienced personnel for maintenance & operation of the project. The deployment schedule indicating the name of the persons, responsibility assigned to each of them and their bio-data shall be provided to Engineer-in-Charge.

Following (Minimum) manpower shall be appointed for Operation & Maintenance of the scheme-

<table>
<thead>
<tr>
<th>Description</th>
<th>Nos</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project Engineer</td>
<td>1</td>
<td>Nos</td>
</tr>
</tbody>
</table>
2. Engineer
   Instrumentation Engineer-01 Nos
   Mechanical Engineer-01 Nos
   Electrical Engineer-01 Nos
   Civil Engineer-01 Nos
   Agronomist-01 Nos

3. Accountant / Office Clerk / Complaint cell
   1. Nos

3. Electricians
   4. Nos

4. Technicians / Mechanic
   4. Nos

5. Foreman Equivalent to Supervisor
   1. Nos

6. Supervisor
   4. Nos

7. Security Guard
   4. Nos

8. Office Assistant / Store Keeper
   2. Nos

9. Skilled Labour
   20. Nos

Vehicles Required
1. Utility vehicle - 4 wheeler including fuel
   2. Nos
2. Two wheelers including fuel
   4. Nos

5.0 Other Specifications for O&M

1. General

The commissioning shall mean the release of water in entire pipe line Distribution Network systems up to tail of all distribution network system up to up tochak 3 Hawith micro irrigation network.

After completion of the entire work stipulated in the Contract work Contractor shall commission and provide trial run for 24 hours for 13 days for pipe line Distribution Network system under the Contract.

After completion of the work, the Contractor shall take care of the maintenance & operation of entire scheme for 5 years from the date of completion certificate of total work. The Contractor shall be responsible for the maintenance of all components of the project including associated works in accordance with prudent utility practice.
1. **Government Rules**

The Contractor shall perform the work in accordance with Indian and other applicable laws (including environmental protection, sanitary, employment, industrial safety and labour laws) regulations, codes, permits, licenses, court orders and standards binding and enforceable on the Corporation.

3. **Right To Perform Upon Contractor's Default**

If anytime, the Contractor fails to perform and such failure is likely to cause injury to any person or damage to the project, the Engineer-in-Charge may, but shall have no obligation to, perform any such obligation. The cost to the Corporation of affecting such performance would be deducted from the payment due to the Contractor.

4. No separate payment shall be made for above and needed any of the maintenance services during the maintenance & operation period of 5 years and shall be deemed to be included in the quoted contract price.

5. **Acceptance on Completion of Defect Liability Period:**

On completion of defect liability period, there shall be joint inspection by contractor and Engineer-in-Charge. WUA authority shall be verified that the all components of the scheme including pressurized pipe distribution network is constructed as per design and drawing and running with design discharge right up to tail along with all the structures constructed in the pressurized pipe distribution network and performing their function as per their design requirement without any defects and the certificate shall be accorded to this effect by both the parties.
CHAPTER XXII

MISCELLANEOUS WORKS
CHAPTER XXII

SPECIFICATIONS FOR MISCELLANEOUS WORKS

1.0 CLEARING SITE

SCOPE
The item pertains to the provision of site clearing including cutting small shrubs, vegetation, bushes and clearing stumps and molehills in the works.

CLEARING SITE
The land width required for component of work shall be cleared for all trees having a girth of 30 cm and less brushwood, vegetation, bushed, stumps and other objectionable material. The roots of trees shall be removed to a depth of 30 cm below the surface of the foundation land and side slopes and the excavation filled up with excavated material in 15 cm. To 20 cm. Layers and the compacted. Brushwood, vegetation, bushes, stumps etc. shall be cut flush with the ground. All the material cleared shall be the property of Corporation. Useful material shall be arranged in convenient stacks as directed, at convenient place of disposal and handed over the Corporation for disposal. Unsuitable material shall be burned or otherwise disposed off by the Contractor at his own cost as directed by the Engineer-in-charge without causing any nuisance, inconvenience or damage to the property of the people in neighbourhood in cases, the material shall be disposed off in a neat manner.

DISPOSAL OF STUFF REMOVED
All materials removed; as a result of clearance shall be a property of Corporation. Useful material shall be arranged in convenient stacks as directed by the Engineer-in-charge. Useless material shall be disposed off by the Contractor as directed by the Engineer-in-charge without causing any nuisance, inconvenience.

ITEM TO INCLUDE
Clearing for works including cutting trees having a girth of 30 cm removing vegetation roots and molehills and disposal of material removed. All necessary labour, materials and use of tools for carrying out the item shall be arranged by the Contractor.
BORROW PITS
No borrow pits shall be allowed in the Corporation land acquired for the canal, branches, minors, and sub-minors or pump house, approach channel and forebays.

DEPOSITION OF MATERIAL.
All materials obtained from excavation or Contractors own materials shall be laid in regular layers not exceeding 23 cm. Thickness loose. The layers of earth shall have a slight slope towards centre of bund, which shall be formed by dumping earth from the sides towards the centre. During monsoon, a small crown shall be maintained at the middle of the bank work to facilitate easy drainage of rainwater. The material shall be laid to the section inclusive of pride. The profiles shall show the total heights and slopes including allowances for settlement. The bank is to be constructed evenly to the full section of the set out. The finished bank work shall be dressed neatly to the sections and slopes shown by the profile.

4.0 CONSTRUCTING MURUM FILLING OVER HAUNCHES AND PIPES Etc.
CONSTRUCTION
Murum of selected and approved quality shall be spread, levelled, watered and rolled or consolidated in layers not more than 15 cm. In thickness and as per the direction of Engineer-in-charge.

Rolling shall be done in layers by roller of approved design in the parts of the structure which is in accessible for the rolling equipment; the compaction shall be done by hand tamping or by any other method approved by the Engineer-in-charge.

5.0 providing and fixing R.C.C. 1:2:4, precast  200 m .stone and kilo meter stones of standard size and shape including fixing in block of c: c 1:4:8 including painting and lettering etc. Complete.

GENERAL
The item provides for supply of precast R.C.C. 1:2:4 kilometre half kilometre stones of specified dimensions at site and fixing them in a block of C.C. 1:4:8 as shown in drawing including painting and lettering etc. complete.
CONSTRUCTION / MANUFACTURE

The stones shall be of the dimensions as specified on the drawing. Wooden or steel shuttering shall be used to cast the stones of required dimensions. The reinforcement as specified in the stones shall be fabricated, assembled and placed in the form by keeping the specified cover. The side form shall be removed after 24 hours and the sides finished smoothly and neatly with 1:2 cement mortars immediately. The stones shall be properly cured for 3 days by immersing them in pond.

FIXING

The half kilometre stones and kilometre stones shall be fixed in position as indicated on the drawing or as directed by the Engineer-in-charge. It shall be fixed in ground in a block of C.C. 1:4:8 of size as specified. Any excavation necessary for fixing of the stone and laying of the C.C. bedding shall be done by the Contractor at his cost.

ITEM TO INCLUDE

Supply of half kilometre / kilometre stones, necessary excavation, fixing in cement concrete and painting and lettering. All labours, material and tools and plant required for completion of the item satisfactorily.

6.0 RAILWAY / ROAD CROSSING

1. IS 15663 (Part-2):2006 Design and Installation of Natural Gas Pipelines Part2 Laying of Pipelines in Crossing shall be applicable for crossing work.

2. Material required for the same shall be as per relevant Indian standard code of practice.

7.0 INFORMATORY SIGN BOARDS

Providing and fixing informatory sign boards in square or rectangular shape of any size made out 16 gauge (1.6mm) thick mild steel sheet painted with one coat of zinc chromate-stoveing primer and two coats green stove enamel paint on front side and grey stove enamel on back side and border / message / symbols etc. with cut out of Type - IV (High intensity micro prismatic grade sheeting) / Type - XI (Prismatic grade sheeting) vide clause no 801 as per ASTM D 4956.
specifications, fixed over 2.00 mm thick aluminium sheeting / 3mm to 4.00 mm thick ACP Sheeting Supported including M.S. angle frame of 35 mm x 35 mm x 3 mm and two M.S. angle iron post of size 65 mm x 65 mm x 6mm, 3.65 m long properly cross braced with angle iron of size 50 mm x 50 mm x 5 mm duly painted with alternate black and white bands of 25 cm width including G.I. fixtures etc. and fixing the board in 1:4:8 concrete block of size 60 cm x 60 cm x 75 cm including transportation etc. complete. The nut bolts of board with angle iron post / supporting structure after fixing at site has to be electrically welded. Sqm. Retroreflective sheeting should be written warranty of five years for Type IV / seven years for Type XI from the manufacture & authorized distributor / convertor, for satisfactory field retro reflectance of retro reflective sheeting. Performance, durability & stipulated this certificate in original should be submitted to the Engineer in charge by the contractor / supplier.

All as per Spec. No. : As per IRC-67, & M.O.R.T. & H .Circular No. RW / NH-33023 / 31 / 88 D.O.III Dated 2-5-1994Type- IV (High intensity micro prismatic grade sheeting)

<table>
<thead>
<tr>
<th>Information boards at pump house, TRG Centre</th>
<th>Total Quantity minimum 200 Sqm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welcome board at pumphouse, TRG centre</td>
<td></td>
</tr>
<tr>
<td>Display boards inside pump house</td>
<td></td>
</tr>
<tr>
<td>Display boards for each chak</td>
<td></td>
</tr>
<tr>
<td>Display boards for Main lines, branches, various crossings</td>
<td></td>
</tr>
</tbody>
</table>

8.0 ROAD WORK

All work related to construction of permanent / temporary road shall be as per latest PWD Maharashtra Standard Specifications for Roads and as per latest provisions of IRC Publications and as directed by Engineer-in-Charge.
CHAPTER XXIII

OTHER SPECIFICATIONS
CHAPTER XXIII

OTHER SPECIFICATIONS & REQUIREMENTS

1.0 The contractor shall review all the information/data available with the department and assess the scope of additional surveys, investigation etc., that are to be carried out to fulfil the obligations under the contract.

2.0 The contractors shall take this into consideration while quoting for the bid. No claims whatsoever on this issue shall be entertained during execution.

The Contractor shall quote the bid price keeping the above aspects into consideration and no claims whatsoever on this issue shall be entertained.

3.0 The contractor may use the excavated useful soils, stone, and other construction material from Lower Pedhi Project free of cost for construction purpose on this project only and rates quoted shall include such utilization.

4.0 Wherever the rising main requires shifting of H.T. / L.T. power lines, towers, Electrical poles, Telephone lines water supply lines and any other facility in way of work etc. either permanently or temporarily the contractor shall arrange for such shifting of power lines towers, electrical poles etc., through concerned authorities at his own cost. The Engineer-in-Charge shall process the proposals submitted by the contractor to the authorities concerned. The price bid quoted by the Contractor is deemed to be inclusive of such cost and no claims for separate payment shall be entertained.

5.0 Wherever the pipe line system is crossing Railway line, the contractor has to prepare necessary proposals for seeking permissions of Railway authorities. The Engineer-in-Charge shall process such proposals to the Railway authorities concerned for taking up the work by them as a deposit work duly
paying the Amount demanded by the railway authorities by the Dept. and shall be recovered from the next running bill of the Contractor. The Contractor shall include such cost in the bid price or the contractor may execute himself by obtaining permission from Railway Authorities.

6.0 In order to check the accuracy of the investigation work the equipment, labour required transport and other materials etc., at site of work have to be supplied to the Engineer’s Representative without extra cost.

7.0 Cultivator wise register for outlets with hydraulic particulars shall be prepared.

8.0 No extra payment shall be made to the Contractor if there is any change in type of structure, specifications, variation in quantities as per actual site conditions.

9.0 Overhead Retro reflective information / Welcome board, Display Boards shall be displayed on main piped Distribution Network, on branch piped Distribution Network, on Disnet pipes at change of reaches, off-take structures, road crossing in every chak or where ever necessary. Boards / direction boards should also be displayed to facilitate for inspection both at investigation and execution stages.

10.0 During soil exploration by drilling boreholes for foundations, the contractor shall take required no. of Un-disturbed Samples and normal samples and obtain soil classification soil properties and bearing capacity by getting them tested in the soil testing laboratories of Government Labs / Engineering Colleges or other reputed institutes. The contractor shall provide certain U.D. Samples and normal samples to the Engineer-in-Charge also so as to get them tested parallel at any other lab to be selected by the Engineer-in-Charge, if required. The cost of such testing shall be borne by the Contractor.

11.0 The contractor shall fix enamel-coated metallic measuring gauges both on U / s and D / s side of all the structures and at suitable locations as suggested by the Engineer-in-Charge.

12.0 In respect of pipe Distribution Network measuring structure shall be provided with gauges / devices fixed in the structure by the contractor and
the cost there of is deemed to be included in the quoted contract price.

13.0 The co-efficient of discharge (Cd) of all structures cross regulators, Escapes, Head Sluices, Off-take Sluices etc., shall be calibrated and furnished to the department. Further Gate operation schedules for each of the above structure are to be Prepared and got approved by the Engineer-in-Charge by the contractor and cost towards these items is deemed to be included in the contract price quoted.

14.0 The Contractor shall provide 0.2 km and Kilometre stones of standard design on the main piped Distribution Networks, piped distribution system and cost thereof is deemed to be included in the quoted contract price. The contractor has to make his own arrangement for diversion of flow and dewatering of foundation etc. wherever necessary within the quoted contract price.

15.0 Construction of Asphalt / WBM service roads and / or inspection paths on pressurized pipe distribution network as specified. The concrete mixes to be adopted for all the structures shall be design mixes only and these design mixes shall be conducted in the reputed laboratories and got approved by the Engineer-in-Charge before adoption.

16.0 Catch drains are to be provided wherever necessary to facilitate drainage all along the piped Distribution Networks within the scope of the contract at no extra cost. In case of cross drainage works the contractor shall excavate necessary approach / Tail channels to these structures to have smooth drainage through the structure. The cost of excavation of such channels shall be borne by the Contractor within quoted contract price. The cost of Land Acquisition for such channels shall be borne by the department.

17.0 All the crossings of pressurized pipe distribution network of National Highways, State Highways, District Roads, Village roads and all other roads / Cart tracks shall be provided with suitable bridges as per standards of the respective departments and as per the permissions granted by them. The approaches to these bridges shall be provided as per the standard of their respective departments. The cost of these bridges shall be deemed to have been included in the contract price quoted.
18.0 If the proposed pressurized pipe distribution network is crossing any existing irrigation Distribution Networks or channels, supply channels or Sources / Streams to Minor Irrigation tanks, suitable structures are to be provided within the quoted contract price by the contractor.

19.0 If the pressurized pipe distribution network is crossing oil pipe lines, gas pipe lines, water supply pipeline, or any other pipe lines, the contractor shall provide suitable crossing in consultation with the authorities concerned after obtaining the approval either by himself or getting them executed by the concerned authorities as a deposit work duly depositing the requisite amount to them. The Engineer-in-Charge shall help in processing the proposals to the authorities concerned to obtain their permission. The cost of such crossings shall be deemed to be included in the contract price.

20.0 Diversion of streams that are crossing the proposed pressurized pipe distribution network into nearby stream(s) is not permitted in general. However in exceptional cases, the Engineer-in-Charge may consider such proposals depending upon their feasibility, if the distance between them is not much (i.e., less than 200 m) and also if such diversion shall not affect the riparian rights of existing or contemplated sources on D / s side.

21.0 The off takes shall not be placed either in heavy embankments or in deep cuts. Surplus escape regulators shall not be provided in deep cut reaches.

22.0 R.R. Masonry / CR Masonry Structures shall not be permitted.

23.0 For all the sluices, Regulators, escapes etc., Structural steel structures with suitable hoisting arrangement and required E / M. Parts shall be provided as per approved designs of the competent authority. The hoisting arrangement must be such that the steel gates can be operated by single person. Further all the gates shall be provided with fool-proof locking arrangement to avoid meddling of gates by miscreants.

24.0 The contractor has to make his own arrangement for diversion of flow and dewatering of foundation etc., wherever necessary within the quoted contract price.

25.0 The concrete mixes to be adopted for all the structures shall be design
mixes only and these design mixes shall be conducted in the reputed laboratories and got approved by the Engineer-in-Charge before adoption.

26.0 In case of cross drainage works the contractor shall excavate necessary approach / Tail channels to these structures to have smooth drainage through the structure. The cost of excavation of such channels shall be borne by the Contractor within quoted contract price. The cost of Land Acquisition for such channels shall be borne by the department.

27.0 The Contractor shall plant shade giving trees at locations as directed by Engineer-in-Charge. The Contractor shall arrange cattle guard to all these plants, provide necessary manure, water them daily and sustain them. If any trees are damaged or lost, he shall replace with new plants and shall maintain these plants. The Contract price quoted by the Contractor shall include all these items.
ANNEXURE

IS CODES
Annexure-I

The various IS codes for different components of the system are tabulated as under:

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>COMPONENT DESCRIPTION</th>
<th>IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dimensional requirements for rubber gaskets for mechanical joints and push on joint for use with cast iron pipes and fittings for carrying water, gas and sewage.</td>
<td>IS:12820</td>
</tr>
<tr>
<td>2</td>
<td>Sluice valve for water works purposes</td>
<td>IS:14846</td>
</tr>
<tr>
<td>3</td>
<td>Pressure and vacuum gauges</td>
<td>IS:3624</td>
</tr>
<tr>
<td>4</td>
<td>Ready mixed paint, brushing, bituminous, and black ,lead free, acid, alkali ,water and chlorine resisting</td>
<td>IS:9862</td>
</tr>
<tr>
<td>5</td>
<td>Mild Steel tubes, tubular and other wrought steel fittings</td>
<td>IS:1239</td>
</tr>
<tr>
<td>6</td>
<td>Specifications for copper alloy gate, globe and check valves for water works purposes.</td>
<td>IS:778</td>
</tr>
<tr>
<td>7</td>
<td>Specification for steel for general structural purposes</td>
<td>IS:2062</td>
</tr>
<tr>
<td>8</td>
<td>Specification for dimensions for hot rolled steel beam, column, channel and angle sections</td>
<td>IS:808</td>
</tr>
<tr>
<td>9</td>
<td>Specification for covered Electrodes form annual metal arc welding of Carbon and carbon manganese steel.</td>
<td>IS:814</td>
</tr>
<tr>
<td>10</td>
<td>Acceptance tests for wire flux combination for submerged arc welding.</td>
<td>IS:3613</td>
</tr>
<tr>
<td>11</td>
<td>Specification for dimensions for hot rolled steel beam, column, channel and angle sections</td>
<td>IS:808</td>
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<tr>
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<td>IS:3613</td>
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<tr>
<td>No.</td>
<td>Description</td>
<td>IS Code</td>
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<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>14</td>
<td>Specification for bare wire electrodes for submerged arc welding of structural steel</td>
<td>IS:7280</td>
</tr>
<tr>
<td>15</td>
<td>Technical supply conditions for threaded steel fasteners</td>
<td>IS:1367</td>
</tr>
<tr>
<td>16</td>
<td>Specification for plain washers.</td>
<td>IS:2016</td>
</tr>
<tr>
<td>17</td>
<td>Specification for ready mixed Paint hair drying, red oxide zinc chrome and priming</td>
<td>IS:2074</td>
</tr>
<tr>
<td>18</td>
<td>Ready mixed paint, brushing, red lead, non-setting, Priming</td>
<td>IS:102</td>
</tr>
<tr>
<td>19</td>
<td>Specification for high strength deformed steel bars and wires for concrete reinforcement</td>
<td>IS:1786</td>
</tr>
<tr>
<td>20</td>
<td>Specification for mild steel and medium tensile bars and hard drawn steel wire for(Part-I) Concrete reinforcement: Mild steel and medium tensile steel bars</td>
<td>IS:432</td>
</tr>
<tr>
<td>21</td>
<td>Specification for 33 grade ordinary Portland cement</td>
<td>IS:269</td>
</tr>
<tr>
<td>22</td>
<td>Specification for rapid hardening Portland cement</td>
<td>IS:8041</td>
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<tr>
<td>23</td>
<td>Specification for coarse and fine aggregates from natural sources for concrete</td>
<td>IS:383</td>
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<tr>
<td>24</td>
<td>Specification for sulphate resisting Portland cement</td>
<td>IS:12330</td>
</tr>
<tr>
<td>26</td>
<td>Code of practice for general construction in steel</td>
<td>IS:800</td>
</tr>
<tr>
<td>27</td>
<td>Code of practice for use of metal arc welding for general construction in mild steel</td>
<td>IS:816</td>
</tr>
<tr>
<td>28</td>
<td>Recommendation for submerged arc welding of mild steel &amp;low alloy steels</td>
<td>IS:4353</td>
</tr>
<tr>
<td>29</td>
<td>Code of practice for training and testing of metal arc welders</td>
<td>IS:817</td>
</tr>
<tr>
<td>30</td>
<td>Recommended practice for radiographic examination of fusion- welded Butt joints in steel plates.</td>
<td>IS:1182</td>
</tr>
<tr>
<td>31</td>
<td>Code of practice for radiographic testing</td>
<td>IS:2595</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Code</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>32</td>
<td>Code of practice for liquid penetrant flaw detection.</td>
<td>IS:3658</td>
</tr>
<tr>
<td>33</td>
<td>Code of practice for magnetic particle flaw detection of welds.</td>
<td>IS:5334</td>
</tr>
<tr>
<td>34</td>
<td>Code of procedure for testing of fusion welded joints and weld metal in steel</td>
<td>IS:3600</td>
</tr>
<tr>
<td>35</td>
<td>Recommended practice for radiographic examination of fusion welded circumferential joints in steel pipes.</td>
<td>IS:4853</td>
</tr>
<tr>
<td>36</td>
<td>Specification for seamless or electrically welded steel pipes for water gas and sewage (168.3 to 2032 mm outside diameter).</td>
<td>IS:359</td>
</tr>
<tr>
<td>37</td>
<td>Steel pipes for hydraulic purposes</td>
<td>IS:6631</td>
</tr>
<tr>
<td>38</td>
<td>Code of practice for ultrasonic testing of ferrous welded pipes and tubular products.</td>
<td>IS:7343</td>
</tr>
<tr>
<td>39</td>
<td>Safety code for industrial radiographic practice</td>
<td>IS:2598</td>
</tr>
<tr>
<td>40</td>
<td>Code of practice for laying of welded steel pipes for water supply</td>
<td>IS:5822</td>
</tr>
<tr>
<td>41</td>
<td>High Density Polyethylene Pipes for Water Supply</td>
<td>IS:4984</td>
</tr>
<tr>
<td>42</td>
<td>Rubber sealing rings for gas mains, water mains and sewers.</td>
<td>IS:5382</td>
</tr>
<tr>
<td>43</td>
<td>Methods for random sampling</td>
<td>IS:4905</td>
</tr>
<tr>
<td>44</td>
<td>High density polyethylene materials for moulding and extrusion</td>
<td>IS:7328</td>
</tr>
<tr>
<td>45</td>
<td>Laying &amp; Jointing of Polyethylene (PE) Pipes</td>
<td>IS:7634</td>
</tr>
<tr>
<td>46</td>
<td>Method of analysis for the determination of specific and/or overall Migration of constituents of plastics material and articles intended to Come into contact with food stuffs</td>
<td>IS:9845</td>
</tr>
<tr>
<td>47</td>
<td>Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water.</td>
<td>IS:10141</td>
</tr>
<tr>
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