INDRADHANUSH GAS GRID LIMITED
(Joint Venture of IOCL, ONGC, GAIL, OIL and NRL)
GUWAHATI, ASSAM

BID DOCUMENT

FOR

NATURAL GAS COMPRESSOR STATIONFOR NORTH EAST GAS GRID PIPELINE PROJET OF M/s IGGL

OPEN INTERNATIONAL COMPETITIVE BIDDING

Tender no.: 05/51/23UU/IGGL/001-i-5

VOLUME – II OF II

Visit: www.tenderwizard.com/MECON
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PREPARED AND ISSUED BY

MECON LIMITED
(A Govt. of India Undertaking)
Delhi, India

INDRADHANUSH GAS GRID LIMITED

NORTH EAST GAS GRID PIPELINE PROJECT
(PHASE - I)

TECHNICAL SPECIFICATION FOR
NATURAL GAS COMPRESSOR STATION

VOLUME-II

PART-I (CHAPTERS)

MECON LIMITED

TS NO.: MEC/S/23UU/05/28/0001 (Rev. 00) **MAY, 2022**

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01.00 INTENT OF SPECIFICATION

01.01 Introduction

A network of natural gas pipeline is being laid under the Hydro-carbon vision 2030 of Ministry of Petroleum & Natural Gas (MoPNG), connecting all states of the North East and Sikkim. This grid is called North East Gas Grid (NEGG) and it would be connected to the upcoming Barauni-Guwahati natural gas pipeline which is a part of Urja Ganga scheme. Indradhanush Gas Grid Limited (IGGL) has been constituted as a joint venture company (JVC) to develop and operate the grid. MECON has been appointed as consultant to the project for rendering PMC services for execution of the project (Phase - I & Phase – II). Under Phase – I, M/s IGGL is planning to install a Natural Gas Compressor Station at Dispatch Terminal Guwahati (Barpalaha) in order to maintain the required natural gas pressure in the downstream network.

01.02 Natural Gas Compressor Station

Dispatch terminal cum Compressor Station for NEGG (Phase-1) pipeline has been considered at Guwahati (Barpalaha). Natural gas shall be metered by necessary metering facility (at check metering skid) before compression. Compressor units have been envisaged to achieve desired downstream pressure for various consumers.

This natural gas compressor station shall house the compressors, all auxiliary equipment & facilities, control room, administration building, electrical system facilities and all other related units as mentioned below:

1. Main & Exit Gate / Wicket Gate
2. Administrative Building
3. HT/ LT Sub-Station Building cum Control Room Building
4. Gas Compressor (motor driven with VFD) along with shed
5. After Cooler
6. Fire Water Pump House
7. Fire Water Tanks
8. Fire Tender House
9. Emergency Assembly Point
10. MRS & Switchyard area including Power Transformer
11. Diesel Generator Sets with Day Oil Tanks
12. Rest room for workers
13. Canteen
14. Lube Oil and HSD Storage Shed
15. Bore well

16. Circulating type Cooling water system
17. Mechanical Work Shop
18. Central Store
19. Nitrogen facility
20. Instrument Air Compressor along with shed
21. Parking Shed
22. Sewage Disposal system
23. Security Guard Cabin
24. High Mast
25. Watch Tower
26. Air Conditioning & Ventilation Facilities
27. Street Lighting and Building/ Shed illumination
28. Security Office
29. Central Monitoring Basin
30. Flare Stack with header and control system
31. Greenbelt within the boundary

Equipment Details for Main Compressor

Sl. No.	Description	Remarks
1	Products to be transported	Natural Gas (Dry / RLNG)
2	Design code	API-618/ISO-13631/ PNGRB/OISD
3	Total Flow	3.75 MMSCMD (max)
4	No. of Units	Four (04) nos. (3 W + 1 S)
5	Capacity of each Compressor	1.25 MMSCMD
6	Compressor Suction Pressure	30 kg / cm²g
7	Compressor Discharge pressure	55 kg / cm²g
8	Operating Temperature before compression	5 – 50 °C
9	Max. gas temperature after aftercooler	55 deg. C
10	Type of aftercooler	Air cooled
11	Design Pressure & class of pipeline downstream	92 kg/cm²g / 600#
12	Compressor type	Lubricated, Air Cooled, Reciprocating
13	Type of Drive	Induction Motor (VFD)
14	Voltage Level	6.6 kV

01.03 Meteorological Data

Altitude above MSL	50 m
Ambient Temperature	40 °C (max) & 5 °C (min)
Relative Humidity	100% (max) & 25% (min)
Seismic Zone	Zone - V

01.04 Following gas composition is considered at the inlet battery limit of the compressor package:

S. No.	**Operating case**	**Mole %**
01.	CO2	0.02
02.	Nitrogen	0.12
03.	Methane	98.34
04.	Ethane	1.50
05.	Propane	0.02
06.	i-Butane	0
07.	N-Butane	0
08.	i-pentane	0
09.	n-pentane	0
10.	n-Hexane	0
	Total	100

02.00 TECHNICAL INSTRUCTION TO TENDERER

02.01 The Tenderer shall furnish all the drawings, documents, load data and other information/ data like fault diagnosis, operation and maintenance manuals, general details and layout drawings, design calculations, equipment specification of plant and equipment, together with `as built' drawings for all mechanical, electrical and instrumentation & control.

All civil and structural works shall be carried out by the Tenderer including equipment foundation, buildings, structure, shed, etc.

02.02 The Tenderer shall include the spare parts and specialities required for the operation and maintenance of the plant and equipment for a period of 24 months to be reckoned from the date of taking over of the plant and equipment. The Tenderer shall be required to replenish at their own expense the stock of spares used, if any, from these normal operation spares for any reason during the performance guarantee test and guarantee period. Commissioning spares shall be supplied by the Tenderer separately.

02.03 The Tenderer shall include in their scope the requirement of all resins, lubricants and all other consumables for testing, commissioning and performance guarantee tests of the plant and equipment.

02.04 The Tenderer shall include in their scope a complete new and unused set of all special tools and tackles required for operation and maintenance of the equipment/installation supplied.

02.05 Any work/ equipment and material which may not have been specifically mentioned in this specification but are required to make the plant complete in every respect in accordance with technical specification and necessary for safe operation and guaranteed performance of the plant shall be deemed to have been covered under the scope of this specification and shall be provided by the Tenderer within the quoted price.

02.06 Any loss of plant and equipment due to imprudence, negligence and/or unsuitable treatment and handling shall be replaced by the Tenderer at his own cost.

02.07 The Tenderer shall satisfy the Purchaser that they possess the necessary technical experience and have at their disposal, suitable facilities and staff to ensure that the contract shall be executed with the best quality material and workmanship within the stipulated time. Necessary particulars in this regard shall be furnished with the Tender.

02.08 The Tenderer shall not off-load the contract or part thereof to any Sub-Vendor without written permission of the Purchaser. In the event of subletting of any part of the work is permitted by the Purchaser, the fact that such permission has been accorded shall not

establish any contractual relationship between approved Sub-Vendor from any of his obligations and liabilities under the contract.

02.09 The Tenderer shall have to furnish drawings, documents etc. as per chapter 12.00 and general and technical particulars of plant & equipment in the Performa given in chapter-15.00 of this specification.

02.10 Stainless steel name plates with letters engraved in English language shall be provided by the Tenderer for each equipment. The name plate shall indicate make, identification number, capacity, rating & weight of equipment. The name plate shall be fitted at a prominent place in the body of each equipment with the help of stainless-steel screws.

02.11 All documents, instruction, catalogues, brochures, pamphlets, design, data, norms & calculations, drawings, operation & maintenance manuals, reports, labels, correspondence and any other data shall be in English language and metric system.

02.12 **Workmanship and Quality Control**

a) The plant and equipment supplied shall be new and best of their kind and of latest technology on the date. All materials and equipment shall comply with the latest Indian Standards, statutory requirements of the concerned State Governments. In absence of relevant Indian Standards/practices, other standards which are internationally accepted, acceptable to the Purchaser, could be followed but the same shall be clearly indicated in the offer. Necessary certificates from the competent authorities, as applicable, shall be furnished for different equipment as supporting documents. Materials for all pressure parts and other important components shall be exhaustively listed in the tender along with chemical composition, physical properties and code reference.

b) The plant and equipment shall be designed to have maximum reliability and ease of operation and maintenance as primary consideration. The plant offered shall be of a family having basic design as per which other plants have already been supplied and which have operated efficiently and reliably elsewhere.

c) The Tenderer shall avoid offering sophisticated and complicated equipment where simple and proven equipment shall achieve the specified requirements. The Tenderer shall offer the best and proven design of plant and the equipment which can be capable of delivering its guaranteed output continuously. Latest trends, philosophies, state of the art technology, proven, efficient and reliable equipment shall be given preference.

02.13 **Inspection & Works Testing**

a) The plant and equipment shall be subjected to inspection and witnessing of shop tests by the Purchaser/ Consultant or the agency mutually agreed between Purchaser and the Tenderer/ Supplier. The Tenderer/ Supplier shall inform the Purchaser/his Consultants at least fifteen days in advance of the date when the plant and equipment shall be made available for inspection and testing. The Purchaser and/or his Consultant shall be given full access to the tests and testing premises and can inspect the factories and offices of the supplier or sub-vendor, if so required. After inspection and testing the Tenderer shall submit all the certificates/ documents as required by the Purchaser /Consultant for approval before obtaining clearance for despatch of equipment.

b) For plant and equipment for which tests at works may not have been witnessed by Purchaser/ Consultant, the tests and quality certificates duly signed by appropriate authority acceptable to Purchaser shall be submitted to the Purchaser for approval, within one month of conducting the test and 6 weeks in advance of the despatch.

c) Inspection by the Purchaser or his representative shall not relieve the Tenderer of his liability for rectifying any defects which may subsequently appear or be detected during or after erection and during guarantee test. After rectification, the testing of equipment shall be repeated to the satisfaction of the Purchaser.

02.14 **Drawings/ Data to be submitted with the Tender**

In order to enable the Purchaser/ Consultant to properly evaluate the tenders, the drawings/ documents as indicated in chapter - 12.00 of this specification shall be submitted along with the tender.

02.15 **Approval of Drawings and Documents**

a) The successful Tenderer shall supply the following details/drawings for Purchaser's/ Consultant's approval and/or for use, to detail out the other connected systems/facilities not forming part of this tender, within the period of placement of order as mutually agreed and shall fit in the total implementation schedule of the project. The drawings and documents submitted for approval shall be as indicated in chapter-13.00 and include the following :-

i) General arrangement and detailed drawings of all equipment, plant layout showing disposition of equipment, pipelines, trenches(pipes & cables) etc. with dimensions.

ii) Electrical schematic drawings, P&I diagrams, elementary power and control circuit drawings and wiring and connection diagram with all relevant terminal marking cable layout and schedules.

iii) Piping drawings upto plant battery limit.

iv) Performance, test certificates and characteristic curves of the plant and equipment.

b) All drawings supplied by the successful Tenderer shall have name plate and drawings nos. of the Purchaser / Consultants. The name plate sample and drawings nos. shall be provided to the Tenderer after placement of order.

c) All drawings and data shall be submitted in soft copy or as agreed otherwise. After scrutiny of drawings, the Purchaser/ Consultant shall return one copy / set of drawings to the Tenderer marked with stamp of approval as given in the following article.

d) The following monograms shall be used by the Purchaser / Consultant and shall be stamped on each drawing and data sheet which shall be sent by the successful Tenderer for approval.

1. Approved
2. Approved As Noted
3. Not Approved
4. Retained for Reference

The Tenderer shall confirm their compliance with the above stamps of approval.

e) Drawings under category - 2&3 above shall be revised to incorporate the comments and resubmitted for final approval. All revisions shall be marked on the drawings, together with date, reference, location / area, and details of changes made. Reasons for not incorporating any of the comments made by the Purchaser / Consultant shall be clearly brought out to the attention of the Purchaser / Consultant while submitting the revised drawings.

f) The Tenderer shall also submit to the Purchaser/ Consultant any other / further details / drawings of plant and equipment that may be required, in order to fully assess the design and its compliance with the specifications.

g) As built drawings for the items /systems under scope of supply of the Tenderer shall be prepared and furnished by the Tenderer.

h) Final copies of drawings in ten (10) sets along with one reproducible tracing print (RTP) and soft copy shall be submitted by the successful Tenderer for Purchaser's reference and records.

i) Approval of any drawing / document by the Purchaser or his representative shall not

relieve the Tenderer of his liability for supply of all the plant & equipment / system complete in all respect and performance of all the plant & equipment and systems to the satisfaction of the Purchaser.

02.16 **Painting & Finishing**

a) The surface of plant & equipment shall be suitably cleaned and coated with anti - rust primer to protect against corrosion and damage during transit and transportation to the site.

b) Painting shall be done as per details indicated in chapter-08.00 of this specification.

02.17 **Packing, Despatch, Handling & Transportation**

a) All equipment, pipes, valves, instruments etc. shall be suitably packed for protection against mechanical damages and climatic conditions during transit and storage. Packing and weather proofing shall be subject to approval of the Purchaser/ Consultant. This approval shall be general and may not be required every time for an article to be despatched. However, the Purchaser reserves the right to examine the packing for any particular consignment at supplier's/manufacturer's works before despatch.

b) The Supplier shall be entirely responsible for the insurance, shipment, handling and transportation of all plant & equipment, construction tools, labourers and materials including unloading at destination, transportation to site, off-loading, storing and procurement at site till erection.

c) The equipment shall not be dispatched by the Tenderer from the place of manufacture to the site until the equipment is inspected by the Purchaser or his representative and the despatch instructions are issued by the Purchaser.

02.18 **Erection, Testing & Commissioning and demonstration of Performance Guarantee**

a) All the plant and equipment, units / sub units supplied shall be erected, tested and commissioned individually as well as in integrated manner. It is the responsibility of the Successful Tenderer to ensure proper installation and satisfactory performance of the plant and equipment supplied by them.

b) During site testing and commissioning, the Supplier/Tenderer shall be required to formulate and operate a safety clearance system. The details of these systems are to be approved by the Purchaser / Consultant.

c) The performance guarantee parameters of the plant shall be demonstrated by the Tenderer

within 12 months from the date of taking over.

02.19 **Guarantee and Penalties**

All the plant and equipment supplied shall be guaranteed for quality workmanship and compliance with the specified requirements for integrated performance to deliver rated outputs. Non-compliance and non-performance shall be subjected to penalty to be paid by the successful Tenderer to the Purchaser. The details of guarantee and penalty stipulation shall be as described in Chapter-11.00 of this specification.

02.20 **Drawings & Documents for Purchaser's use and archives**

The Tenderer shall submit ten (10) sets of all the final approved drawings and documents/ manuals for Purchaser's use and reference/record required during course of operation and maintenance of the plant.

02.21 **Codes and Standards**

a) All plant and equipment supplied shall be in conformity with codes and standards as applicable and nationally/internationally acceptable for the type of equipment/system supplied. The different codes to be followed in design & manufacture and a consolidated list of codes and standard to be followed shall be submitted with the offer by the Tenderer. Copies of all such codes shall be submitted with the offer as may be different from those mentioned in this specification. All codes and standards used/referred to shall be to their latest edition/version as on the date of the acceptance of the tender.

b) All equipment as may be necessary shall conform to the provision of statutory and other regulations in force, such as Indian Explosive Act, Indian Factories Act, Indian Petroleum Act and also those of State Government.

c) All electrical equipment supplied shall comply with the latest revision of Indian Electricity Rules and within the statutory requirement of the Government of India and State Government as regards safety, earthing and other provisions specified therein for installation and operation of electrical equipment.

02.22 **Clarifications, Assumptions**

a) Any clarifications required w.r.t. the specification shall be clearly defined and indicated in a consolidated manner by the Tenderer at one place in their offer. Clarifications given in other places shall not be entertained.

b) While in general the design, manufacture and supply of the plant and equipment shall be complied with requirement and conditions stipulated in this specification, any assumption made, to arrive at different solution/calculation, working out details as indicated in the offer, shall be clearly spelt out and brought out in the tender by the Tenderer.

02.23 **Exclusions, Battery Limit**

Tenderer shall clearly mention exclusions, if any and battery limit to further design by the Purchaser to make the system complete in all respect.

03.00 SCOPE OF WORK AND BATTERY LIMITS

03.01 Scope of Work

Tenderer's scope of work shall include design, engineering, manufacture, procurement, shop painting, assembly, testing at manufacturer's works, inspection, packing, transportation to site, unloading and storage, preservation, handling at site, insurance, complete installation of mechanical, electrical, instrumentation and other associated works, pre-commissioning, commissioning, testing and performance guarantee testing and handing over all plant and equipment to purchaser. All civil and structural works including foundation of equipment, building, shed, etc. shall be done by the Tenderer based on the approved equipment layout drawings. The plant and equipment shall be designed for safe and trouble free continuous operation and with adequate maintenance facility as per latest modern engineering practices. All buildings including civil and structural works shall be in the scope of Tenderer.

The scope shall also include obtaining of all necessary approval / statutory clearances from the concerned authority / agencies. Necessary fees for the same shall also be paid by the successful tenderer till commissioning and handing over of the plant.

The design, manufacture and performance of the equipment shall comply to the latest codes / standards.

This package covers mainly the units including civil and structural buildings and all types of work on lump sum turnkey basis as mentioned below. The detailed specification of the facilities is mentioned in the subsequent chapters of this specification.

03.02 The scope of work shall include the following:

1. Four (04) Nos. (3W+1S) lubricated, air cooled, reciprocating type natural gas compressors each of capacity 1.25 MMSCMD along with accessories as indicated in the table below (for each compressor):

Sl. No.	Description
1.	Reciprocating Compressor (Horizontal type) assembly complete with frame, cross head, distance piece and cylinder
2.	Drive motor
3.	Frame lubrication System complete with piping and oil cooler
4.	Cylinder packaging lubrication system including lubricator &

Sl. No.	Description
	interconnecting piping.
5.	Capacity control system
6.	Suction KOD for compressor as per process needs.
7.	Suction separator for each stage (skid mounted) **If recommended by Tenderer**
8.	Suction volume Bottle, Discharge Volume Bottle for each stage.
9.	After Cooler separator
10.	Discharge KOD for compressor as per process needs
11.	Drain Pot for suction pulsation dampeners
12.	Vibration and temperature monitoring system as per applicable design codes.
13.	Suction strainer with spool piece on each process gas inlet line.
14.	Skid or base plate for compressor & Driver (as applicable) and auxiliaries **(Refer Note-i).**
15.	Flywheel (if applicable)
16.	Coupling
17.	Coupling guards (Non Sparking)
18.	Pulsation study as per applicable codes.
19.	Supply of Piping support and bracket (for vendor supplied piping) as per Pulsation study report)
20.	Heat Exchanger (Wherever specified comprising): • Gas Inter cooler • Gas after cooler • Cooling system for Lube oil, as applicable.
21.	Interconnected piping between compressor and various consoles/heat exchangers.
22.	Utility piping/other auxiliary piping.
23.	Discharge check valve (similar to compressor valve design) on process gas outlet line (at final discharge)
24.	Relief Valve (for process gas)
25.	Crank case explosion device
26.	All foundation bolts, fixing bolts, anchor bolts for compressor driver, auxiliary skids, and all equipment in compressor vendor's scope.
27.	Local control panel with PLC
28.	Testing and inspection as specified.
29.	Painting
30.	Set of spares for commissioning and start-up
31.	Special tools and tackles
32.	Spares for five years operation and maintenance not limited to the minimum

Sl. No.	Description
	following items: **<u>Compressors:</u>** 1) Crank Shaft – 1 no 2) Connecting rod – 1 no 3) Main Bearing – 1 Set 4) Thrust bearing – 1 Set 5) Crank shaft big end bearings – 1 Set 6) Crank shaft small end bearings – 1 Set 7) Cross head – 1 Set 8) Cross head guide – 1 Set 9) Stuffing box seal – 1 Set 10) Oil Seal – 2 Sets **<u>Drive Motor:</u>** 1) Bearing – 1 Set 2) Oil Seal – 2 Sets **<u>PLC:</u>** 1) IO power supply – 1 Set 2) CPU PLC system – 1 no 3) Communication Module/ Modbus serial module – 1 no 4) Barrier modules
33.	Initial fill and subsequent requirement of lubricants for start-up, commissioning as per commercial documents enclosed elsewhere.
35.	Closed Blow Down Vessel

Note:

i. In case due to transportation reason, single skid is not feasible, the skid shall be supplied in two numbers of skids suitable for bolting and dowelling at site.

2. Main & Exit Gate / Wicket Gate
3. Administrative Building
4. HT/ LT Sub-Station Building cum Control Room Building
5. Gas Compressor Shed
6. After Cooler
7. Fire Water Pump House
8. Fire Water Tanks
9. Fire Tender House

10. Emergency Assembly Point
11. MRS & Switchyard area including Power Transformer
12. Diesel Generator Sets with Day Oil Tanks
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15. Lube Oil and HSD Storage Shed
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17. Circulating type Cooling water system
18. Mechanical Work Shop
19. Central Store
20. Nitrogen Generating Unit
21. Instrument Air Compressor along with shed
22. Parking Shed
23. Sewage Disposal system
24. Security Guard Cabin
25. High Mast
26. Watch Tower
27. Air Conditioning & Ventilation Facilities
28. Street Lighting and Building/ Shed illumination
29. Security Office
30. Central Monitoring Basin
31. Flare Stack with header and control system
32. Greenbelt within the boundary
33. Telecom and internet facilities

Besides the above, the following facilities/system are included in the scope of work of the tenderer :

- Water system including the following facilities:-
  Drinking water system
  Firefighting system
  Make-up / Service water system
  Interplant pipelines

- Air compressor of suitable capacity and all its accessories & auxiliaries along with pipes, fitting, valves, to meet the requirement of service/ instrument quality air.

- All buildings, structures and facilities for all production, auxiliary units, foundations for all buildings, structures and equipment, paving's, roads, water supply and sanitary system and all other miscellaneous civil engineering work.

- Electrical works including Illumination, Earthing, Fire Fighting, Fire Detection Alarm, Communication System etc.

- Control and Instrumentation work including PLC for complete plant operation & control, Primary , Secondary Instruments, Panels, Modular control Desks, mosaic grid mounting Alarm Annunciation System, Maintenance and Calibration Equipment, Control Valves and Actuators, Instrumentation Cables and Process Connection and impulse Piping and Electrical Actuators/MOV, etc.

- Central-store and mechanical workshop with equipment for undertaking various repair works etc.

- Fire Protection system including fire Water Pumps, Fire Water Tanks, MVWS System, Fire water piping network, Hydrants & monitors, Clean Agent system, Fire Detection & Alarm System, Portable Fire Extinguishers, First Aid & Safety Equipment.

- Air Conditioning and Ventilation facilities for various buildings and rooms like in administration building, control building, control rooms, MCC Rooms, pump houses, hydraulic rooms, cable cellars, Switch gear rooms etc.

- Handling/Hoisting facilities for the various units like Gas compressor shed, Air compressor shed, mechanical workshop, Central store, Fire water pump house, Lube oil storage shed etc.

- Nitrogen facility to meet various nitrogen needs of the equipment as well as for occasional purging.

- Solar system with solar array, charge controllers, battery banks, 3 Ph chargers, DC-DC converters, Distribution boxes, interconnecting cables etc

- Elevators for control building and administration building.

- Achieving minimum 3 STAR GRIHA Rating for Admin Building and control building.

- Training at manufacturer's works for eight (08) persons of client. Duration of training shall be fifteen (15) days.

- Comprehensive Annual Maintenance Contract (CAMC) for Natural Gas Compressors and Auxiliaries for a period of five years.

The above mentioned scope is not exhaustive, and respective chapters shall be referred for detailed scope of work.

The topographical survey and geotechnical investigation are not included in scope of work, as these are being done through a separate package.

03.03 In addition to the above scope, following studies/ analysis shall be carried out by the Tenderer:

1. Safety Studies

The Safety Studies including SIL Study as required shall be developed by the Tenderer during the detailed design phase and continued into the installation and commissioning phases and Tenderer shall ensure that risk mitigation is introduced at the earliest possible time. The Tenderer shall develop a schedule for the completion of the Safety Studies.

2. HAZID Workshops

Major Accident Events (MAEs) and their associated hazards shall be documented through Hazard Identification (HAZID) Workshops. The Tenderer shall be responsible for organizing, running and documenting the HAZID process.

The key objectives of the HAZID Workshops shall be the following:

Identify MAEs that are capable of posing a serious and immediate risk to health and safety including flammable releases, toxic releases, non-process incidents, etc.

Identify the hazards that shall cause those MAEs (e.g. Process upset, equipment failure, maintenance).

Identify existing engineering or operational (e.g. Procedural) controls and measures that are included in the design for prevention or mitigation.

Identify those controls that are safety critical to the identified MAE.

The results of HAZID Workshops shall be recorded in the project Hazard Register. The Hazard Register shall be maintained throughout the project by the Tenderer and shall provide a primary input to the Safety Studies as well as recording their outputs.

3. HAZOP Studies

Hazard and Operability (HAZOP) studies are valuable as a design tool and in a role of supplementing the Safety Studies. The Tenderer shall be responsible for the completion of the HAZOPs and ensuring the identification of MAEs and other issues are carried from the HAZOPs to other Safety Studies. The HAZOPs shall be completed in a manner that is consistent with industry standard approach. The Tenderer shall, as part of the Safety Studies Methodology, describe the HAZOP process.

Based upon review and approval of documents / calculations / drawings etc., P&IDs, Safe Charts & Equipment Layouts shall be issued for HAZOP study. The Tenderer shall engage a reputed third party agency for carrying out HAZOP study.

In the HAZOP workshop, HAZOP observations / recommendations shall be deliberated in presence of Company's representative / Engineering Consultant. The firmed-up HAZOP recommendations shall be incorporated in relevant documents/ drawings and after their approval; P&IDs shall be issued for "Approved for Construction (AFC)". Tenderer to note that all changes/ recommendations arising due to HAZOP study shall be considered and incorporated within the scope of this project without any cost/ schedule impact.

Adequate care shall be exercised when developing the modification requirement of existing installations, with special emphasis towards safety, operability and hook up with the existing system with minimum shutdown time requirements.

4. Consequence Studies

The assessment of applicable MAEs shall be completed by undertaking the following:

Fire and Explosion Analysis for ignited hydrocarbon and non-hydrocarbon scenarios.

Gas and Smoke Dispersion Analysis including un-ignited and toxic gas scenarios and combustion products.

Non Process Hazards Analysis associated with all non-process type hazards. The outcome from these studies shall be taken forward to the Emergency Systems Review, Escape and Rescue Analysis and Quantitative Risk Assessment.

For the non process hazards identified in the HAZID, assess the potential for impact on personnel and the potential for escalation to a hydrocarbon release, emergency systems and evacuation and rescue systems.

5. Emergency System Reviews

Based on the consequence analysis and the criteria developed as part of the Safety Studies Methodology, the effectiveness of systems and features for preventing or mitigating consequences shall be assessed. Systems and features to be considered include (but are not limited to):

i) Fire and gas detection systems
ii) Emergency Shutdown (ESD) and blow down systems
iii) Active fire protection system (e.g. deluge valve, ring main, monitors, fire hydrants and foam facilities)
iv) Plant layout and separation distances
v) Equipment design
vi) Emergency response

6. Escape and Rescue Analysis

The Tenderer shall examine the potential for impacts on the designated escape, safe muster, evacuation and rescue facilities and systems provided. In the event of an MAE, those personnel surviving the initial incident shall be able to escape from the facilities in a safe and controlled manner and where appropriate be promptly rescued and taken to a place of safety. The assessment shall include but not be limited to:

i) Estimation of evacuation times
ii) The vulnerability and frequency of impairment of the facility escape routes
iii) The vulnerability and frequency of impairment of the muster areas.
iv) The vulnerability and suitability of the evacuation systems.
v) The effectiveness of Emergency Response systems.

7. Quantitative Risk Assessment

The objective of the QRA is to assist the overall process in determining the following:

i) Relative ranking of the identified MAEs and their contribution to the facility risk profiles.
ii) Facility worker Individual Risk Per Annum (IRPA).
iii) Risk posed by the facility on all worker groups through PLL.
iv) Based on the above results, discuss the implications and major contributors to the facilities risk profile and where applicable identify potential risk reduction measures.
v) The risk quantification process shall be based on accepted methodology (such as the development of event and fault trees).

03.04 Codes and standards

All equipment, systems and works offered shall comply with applicable latest statutes, regulations and safety codes as applicable in India / Assam state. All systems and equipment shall comply in all respects with the requirements of the latest editions of codes and standards applicable for proposed type of equipment and system.

It shall be the responsibility of the Tenderer to obtain the necessary approval of the concerned Inspecting Authority for the design and design calculations, manufacturing and erection procedure as called for under any statutes. The necessary statutory fees for the same has to be paid by the tenderer.

Design not meeting the stipulations of the codes and standards shall not be acceptable.

All statutory clearances like Chief Controller of Explosives, Electrical inspectorate, Tariff Advisory Committee etc. as required and applicable shall be obtained by Tenderer. However, Purchaser shall provide necessary documents, as available with them for further fulfilling the obligation by Tenderer.

Apart from various codes and standards mentioned below, Tenderer shall comply with other requirements of codes and standards and requirements mentioned in the technical specifications for detailed design, manufacture, shop & site testing, etc.

The applicable Codes & Standards (latest editions unless mentioned otherwise) are of organizations, institutions etc. listed hereunder (but not limited to the same) in alphabetical order and whether mentioned in the specifications or not:

1) American Petroleum Institute (API)
2) American National Standards Institute (ANSI)
3) American Society of Mechanical Engineers (ASME)
4) Bureau of Indian Standards (BIS)
5) British Standards (BS)
6) Central Pollution Control Board, India
7) Deutsches Institut für Normung eV (DIN)
8) Directorate General of Mines Safety (DGMS), India
9) Institute of Electrical and Electronics Engineers (IEEE)
10) International Electro technical Commission (IEC)
11) International Organization for Standardization(ISO)
12) Instrument Society of America (ISA) Page 13 of 33
13) National Association of Corrosion Engineers (NACE)

14) National Electrical Code (NEC)
15) National Electrical Manufacturers Association
16) National Environmental Policy Act (NEPA)
17) Oil Industry Safety Directorate (OISD), India
18) Oil Mines Regulations

The detailed list of Applicable Codes and Standards for various disciplines are also placed at respective places in the bid. Due care shall be exercised such that overall design provides conformity to process requirements, ease of construction, installation, commissioning, start-up operation and maintenance and shall be safe to operate under all conditions.

03.05 Battery Limits

1. Natural Gas Pipeline - The battery limit of the contractor for the natural gas pipeline shall start after the flange of the gas metering system from where the natural gas pipeline's inlet header for the compressor station shall start. The battery limit of the contractor for the natural gas pipeline shall end at the flange of the gas metering station where the natural gas pipeline's return header from the compressor shall be connected. The same has been shown in the layout drawing and P&ID drawing also.

2. Electrics – as per clause no. 05.00

3. Road and Drain - All the roads inside the natural gas compressor station complex shall be under the scope of the successful tenderer. The civil portion shown in the process area near the metering skid facility shall be in the scope of the tenderer.

   All the drains in the natural gas compressor station complex shall be in the scope of the tenderer.

04.00 TECHNICAL SPECIFICATION – TECHNOLOGICAL EQUIPMENT

04.01 RECIPROCATING TYPE NATURAL GAS COMPRESSOR AND AUXILIARIES

04.01.01 This specification constitutes the minimum requirement for reciprocating compressors including their drivers and drive mechanisms, gearbox if any, lubricating systems, controls, safety systems, instrumentation and other auxiliary systems as required.

04.01.02 Tenderer shall make all possible efforts to comply strictly with the requirements of this specification and other aforesaid specifications/ attachments to inquiry/ order. In case any deviations are considered essential by the Tenderer, same shall be separately listed (with cross reference to Page No. / Section / Clause No. / Para etc. of the respective document) in offer duly supported with proper reasons for the deviation for Purchaser's considerations. No cognizance shall be given to any deviation indicated elsewhere, but not listed in the deviation list. All such issues shall be conveyed to Purchaser in writing by the Tenderer prior / during the pre-bid conference, if any, before submitting the final offer. No deviation and exception from this specification shall be permitted without written approval of Purchaser/Consultant.

04.01.03 Tenderer shall seek Purchaser's/Consultant's approval regarding such features which are not specified in this specification but job requirements call for purchaser's decision on these matters. Compliance with this specification shall not relieve Tenderer of the responsibilities of furnishing equipment and accessories / auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case Tenderer considers requirement of additional instrumentation, controls, safety devices and any other accessories / auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with his offer and include the same in his scope of supply.

04.01.04 The compressor shall be designed, manufactured and tested in accordance with ISO 13631 (Latest Edition) or API 618 (Latest Edition).

04.01.05 Codes, Standards and Regulations

The compressors covered by this specification shall be designed, manufactured and tested in accordance with the requirements of this Project Specifications, Company approved data sheets and the latest editions of applicable National / International codes and standards (not limited to those listed hereunder) and Statutory Regulations (where applicable).

ISO 13631 (Latest edition)	Petroleum and natural gas industries —Packaged reciprocating gas compressors
API 618 (Latest Edition)	Reciprocating Compressors for Petroleum Chemical and Gas Industry Services.
API 661 (Latest Edition)	Air-cooled Heat Exchanger
API RP 520	Sizing Selection and Installation of Pressure-Relieving (Part-I, II). Devices in Refineries (Sizing and Selection & Installation)
ASME Boiler and Pressure vessel code	
Section VIII Div. I	Unfired Pressure Vessels
Section IX	Welding Qualifications
AGMA 420.03	Practice for helical and herringbone Gear Speed Reducers and Increasers.
TEMA Standards, code& specifications	
IS: 210	Grey Cast Iron Castings.
IS: 1865	Iron Castings with Spheroidal or Nodular graphite
IS: 5456	Code of practice for testing of Positive displacement type air compressors and exhausters.
BS: 1571(Part I)	Specification for testing of Positive displacement Compressors and exhausters (Methods for acceptance tests)
ISO: 1217	Displacement Compressors – Acceptance Tests.
OISD 113	Standard on classification of area for electrical installations at hydrocarbon and handling facilities
DGMS	Latest notification

04.01.06 Units used on all documentation, drawings and name plates shall be metric SI units, except for pressure units that shall be kg/cm²g.

04.01.07 The stipulations of this chapter are the design criteria for the equipment in association with relevant codes and standards. Compressor, driver and associated equipment shall be designed to minimize the generation of noise and vibration. The maximum

permissible noise/sound level shall not exceed 88 dbA measured at 1m from edge of the equipment for the recommended range of operation.

04.01.08 Safety

It is the intent of Purchaser that operational hazards be reduced to a minimum. The Tenderer shall use sound engineering judgment to complete an installation that will perform the required process function without compromising this aim.

All couplings, gears and exposed rotating parts shall be provided with adequate guards of non- sparking type. Drive belts, if used shall be antistatic type. All emergency shutdown system shall have manual operating mode.

04.01.09 Compressors and drivers (including V-belt drive, gear units and coupling, as required) shall be designed to perform satisfactorily under start up conditions, part load / full load operation, maximum differential pressure operation and cylinder relief valve setting pressure and up to trip speed. Unless otherwise specified compressor vendor shall also assume full responsibility to undertake:-

i) Torsional analysis of the complete compressor train including the driver except in case of belt driven compressors.

ii) Selection, sizing and rating of the transmission equipment between the compressor and the driver and also of the base plates, sole plates and slide rails.

iii) Checking the conformity of the motors coupling flange with compressor coupling flange and supplying to motor manufacturer, in due course of time, the drilling jig for the motor coupling flange, in case of rigid coupling drive.

iv) Stress analysis of the piping and appurtenances from the intake filter / suction strainer upto the outlet flange of the final compression stage pulsation suppression devices / separators / aftercoolers /receivers as the case maybe.

v) Furnishing the design, type and location of the supports for the piping and appurtenances as defined above in (iv).

vi) Compressor Pulsation and Vibration Control.

vii) Coordination of the work and resolution of any technical problems with the driver vendor/manufacturer whether or not the driver forms part of the scope of supply.

04.01.10 Vendor shall ensure that life of Piston rings, rider rings, cylinder packings shall be guaranteed for a minimum duration of 8000 hours. Vendor shall select the compressor speed considering this criteria.

For a variable speed drive, vendor shall state in his offer, the minimum speed at which the unit may be operated continuously with the proposed lubrication system.

04.01.11 Allowable discharge temperatures

Maximum allowable discharge temperature shall be as per ISO 13631 (Latest Edition) or API 618 (Latest Edition).

To achieve the same, the ratio of compression, no. of cylinders, the surface area of the cooling passages and velocity of the coolant shall be considered accordingly.

04.01.12 Rod Loading

The actual rod loading, calculated considering the cylinder gas relieving pressures, maximum differential pressure possible during operation under all operating conditions, and inertial forces of reciprocating masses, shall not exceed maximum allowable rod load.

The actual rod loading due to inertia forces of reciprocating masses alone, shall not exceed the maximum allowable rod load.

04.01.13 Critical speeds

The critical speed of the compressor shall be atleast 20% away from the rated operating speed as per API 618(Latest Edition).

04.01.14 Compressor Cylinders

i) The maximum allowable working pressure shall exceed the rated discharge pressure by at least 10%.

ii) Cylinder shall be spaced and arranged to permit access to all openings and components without removing the cylinder, the cylinder head, air piping.

iii) Single acting, step piston or tandem cylinders arrangements may be furnished with purchaser's approval. For such cylinder arrangements adequate design considerations must be given to achieve rod reversals. In case of tandem cylinder arrangements, compressor vendor shall furnish along with the offer, a line schematic of the cylinder assemblies indicating location of cylinder packings, piston / piston rod diameters and operating pressures.

iv) Cylinder liner: It is preferred to have cylinder liners. If the same is not possible in vendor's design, vendor shall provide re-boring allowance in the cylinder without

encroaching upon either the maximum allowable working pressure or the maximum allowable rod loads. Tenderer shall ensure that life of Piston rings, rider rings, cylinder packing shall be guaranteed for a minimum duration of 8000 hours. Tenderer shall select the compressor speed considering this criteria.

v) Cylinders may be non-liquid-cooled (i.e. no provision for coolant jackets) or liquid-cooled (coolant jacket around the cylinder bore and cylinder head). Tenderer shall also consider maximum ambient temperature as given in the bid package and discharge temperature shall not exceed the permissible limits as mentioned in this document elsewhere.

vi) Cylinder supports shall be designed to avoid misalignment or excessive rod run out during warm- up period and at actual operating temperature. The supports shall not be attached to the outboard cylinder head.

vii) Lubricated Cylinders and Packing:

All compressors cylinders along with cylinder packing shall be lubricated type.

04.01.15 Cylinder Valves

i) The design of the suction / discharge valves shall be such that valve assemblies cannot be inadvertently reversed nor a suction valve assembly be fitted into a discharge port.

ii) Valves shall be fitted in the cylinder either with a lapped joint or through a solid metal gasket. Non-metallic or filled gasket shall not be used.

iii) The valve / valve port design shall be such that no part of the valve assembly or mounting can fall into the cylinder even if the valve bolting unfastens /breaks.

iv) Valve plates / rings shall be lapped on both faces and shall be suitable for installation with either face sealing.

v) The valve hold downs shall bear at not less than 3 points on the valve cage. Bearing points shall be arranged as symmetrically as possible.

vi) Valve and Suction Valve Unloader:

Valves shall be suitable for operation with normal process gas. Unloader shall be reverse action type (Air to Load). Unloader cylinders, piston, and shafts shall be of

stainless steel. Unloader shall be shop tested for proper operation.

04.01.16 Piston, Piston Rods and Piston Rings

i) When pistons are removable from the rod, they shall be attached to the rod by a shoulder and lock nut design. The nuts on the ends shall be positively locked in place. The rod shall be positively locked to the cross-head to prevent rotation. Pre-stressing shall be done to ensure that nuts remain stressed under all service conditions.

ii) Wear-bands when provided shall be of single piece with or without end gap construction. Wear-bands with end gaps shall be designed to prevent pressurization. Wear-bands shall not overrun valve port or liner counter bore by more than half the wear-band width. The bearing load of fluorocarbon wear-bands shall not exceed 5 psi based on the weight of the entire piston assembly plus one half the weight of the rod divided by the area of a 120 arc of the wear-bands. In case of end-less wear bands vendor shall provide the necessary tools, and the wear band installation mandrels etc.

iii) The rod surface finish in the packing area shall be 16 micro inches (rms) or better.

iv) Mechanical Packing shall be used for cylinder sealing. Surface hardness of piston rod shall exceed 50 RC.

v) Glands shall be bolted to the cylinder head or to cylinder with no less than four bolts.

04.01.17 Crank shafts & Bearings

i) Crank shaft shall be forged steel but may have provision for removable counter weights.

ii) Crankshafts shall be dynamically balanced for compressors running at speed equal to or higher than 800rpm.

iii) Replaceable precision type crankpin bearings and main bearings shall be used.

04.01.18 Distance Piece

Access openings of adequate size shall be provided on all distance pieces to permit removal of the assembled packing case. The surfaces of the openings shall be

machined and provided with either solid covers or louvers.

04.01.19 Compressor frame lubrication

Compressor frame lubrication shall be pressurized system, for compressor and motor (if required) with main oil pump driven directly by the compressor shaft and an "off mounted" full size, motor driven rotary pump instrumented for automatic start. twin oil cooler, twin filters with one separate continuous flow transfer valve shall be easily accessible for maintenance. Lube oil cooling system should be air cooled.

Where a motor driven auxiliary oil pump is specified for the frame oil system, a suitable interlock shall be provided to ensure that the main motor shall not start until after the auxiliary oil pump has built up the requisite oil pressure. The auxiliary oil pump shall automatically start in the case of failure of main oil pump at the same time actuating alarm. Visual indication at panel shall be provided to indicate whether the main or the auxiliary pump is operating.

04.01.20 Tenderer shall design, size and manufacture the lube oil console sufficiently spread out from the point of view of easy accessibility and maintainability of the major pieces of equipment such as pumps drivers, filters and valves.

04.01.21 Cylinder and packing lubrication

i) For lubricated cylinders, lubrication to cylinders and packings (except when packing is lubricated from the crank end) shall be provided by a forced feed mechanical lubricator separate from the frame lubrication pump. The cylinder lubrication shall be single plunger per feed and shall have a sight flow indicator and check valve for each lubrication point. The reservoir capacity of the lubricator shall be sufficient for at least 30 hrs running. The lubricator shall have a provision for permitting pre-lubrication at the time of compressor starting.

ii) Lubricating oil injection to the cylinder bore shall 'be through continuous hole drilled in metal provided in the cylinder,

04.01.24 Material

i) The selection of suitable materials of construction shall be the responsibility of the Tenderer, unless specific materials are indicated on the data sheet by Purchaser.

ii) Unless otherwise specified gray iron castings for pressure containing parts shall be in accordance with IS: 210. The grade shall be selected and specified by Tenderer

but as a minimum grade 25 shall be used.

iii) Nodular / spheroidal iron castings shall be produced in accordance with IS: 1865, with a minimum 2% Nickel. Micro-structure examination and non-destructive testing shall be conducted where specified.

iv) Welding of piping and fabricated pressure containing parts shall be in accordance with written and qualified procedures and shall be performed by welders qualified in accordance with ASME Boiler & Pressure Vessel Code Section IX. Welding procedures and qualification records shall be submitted to purchaser for review.

v) All repair welding shall be carried out in accordance with procedures submitted to and approved by purchaser prior to commencement of such welding. Weld repairs shall be inspected by a suitable method after each layer of weld deposit to ensure that the weld metal is sound and free from defects. Castings subjected to major weld repairs shall be stress relieved. Only weld-able grades of steel can be repaired by welding. Pressure containing parts of cast iron shall not be repaired by welding.

xiii) Crankshaft – Forged Steel

xiv) Connecting Rod – Forged Steel.

xv) Piston rod – AISI 4140 / Equivalent

Material of construction shall be as per specification. Tenderer shall however assume responsibility for suitability of selected material for specified service. If necessary, vendor should furnish superior materials than specified.

Tenderer shall provide material certificates giving chemical composition and mechanical data for pressure-containing parts and all main components of the compressor.

04.01.25 Name plates & Rotating arrows

i) A nameplate shall be securely attached at an easily accessible point on the compressor frame and to any other major piece of equipment.

ii) Rotation arrows shall be cast in or attached to each major item of rotating equipment. Nameplates and rotation arrows (if attached) shall be of Series 300 Stainless Steel or Nickel- Copper alloy (Monel or equivalent). Attachment pins shall be of the same material.

iii) Company item number, vendor's name, machine serial number, compressor size & type, maximum allowable design limits and rating data (including pressure, temperatures, speeds and power), cylinder rated pressures, maximum allowable working pressures and temperatures, hydrostatic test pressures, total end clearance, and cold clearance setting for each end shall appear on each compressor nameplate.

04.01.26 Weather Protection & Climatization

Compressor units and auxiliaries shall be climatized for the particular site conditions and suitable for outdoor installation without a roof.

04.01.27 Accessories

a) Drivers

The compressor driver shall be capable to start the compressor under unloaded condition with maximum suction pressure as specified for compressor without any gas venting.

For all electrical motors, motors shall have rating as a minimum 110% of the maximum brake power (including transmission losses) required under any of the compressor operating conditions.

b) Couplings and Guards

i) Compressor couplings shall be supplied by Tenderer.

ii) Couplings shall be suitable for continuously transmitting the maximum torque and the maximum torque fluctuations without distress or undue wear. They shall be suitable for emergency shutdown of the unit under full load.

iii) Coupling shall be adequate for expansion and other end-movements of shafts without overstressing themselves or any other thrust absorbing components in the system.

iv) Rigid couplings shall not be used when either the driver or the driven equipment uses anti- friction bearings.

v) Normal or non-sparking guards shall be provided on all otherwise exposed moving parts.

vi) Guards shall be easily removable and shall be sufficiently rigid to withstand deflection and to prevent rubbing as a result of bodily contact of 100kgs.

vii) Guards shall be weather-proof and ventilated.

c) Gear Units

Gear units, when used, shall be designed in accordance with AGMA 420 or an equivalent standard and shall have an AGMA services factor of not less than 2, based on the driver nameplates rating when the driver is electric motor.

d) Mounting Plates

Sole plates and rails as required shall be provided by Tenderer.

e) Lubricants for Compressors

Tenderer shall recommend ISO grades of various oils / grease / other lubricants during post order stage. Equivalent Indian Grades shall also be recommended by Tenderer.

04.01.28 Tachometer

A tachometer shall be provided on units equipped with variable speed drives. The range of the tachometer shall be from lowest speed control point to 115% of the trip speed.

04.01.29 Relief Valves

i) Relief valves for all operating equipment shall meet the limiting requirements specified in API RP 520 Part-I and II.

ii) Relief valves shall be set not higher than max. allowable pressure. However, the setting shall be 110 % of the rated discharge pressure.

04.01.30 Starting Unloading

i) Where automatic capacity control is achieved by unloading suction valves through

pressure switches and solenoid valves, the automatic unloading at the time of start shall also be achieved. On power supply cutoff or failure, the compressor shall be unloaded automatically.

ii) The driver starting system shall be interlocked with the control circuit to protect against loaded start.

04.01.31 Piping

The selection, fabrication and installation of piping works shall meet the minimum requirements defined in the attached piping specifications.

a) General

i) All auxiliary piping with its mounted appurtenances located within the confines of the main unit base area and the confines of any assembly (console) base or any packaged accessory shall be furnished by Tenderer.

ii) Unless otherwise specified elsewhere, all interconnecting piping between the main unit and the auxiliaries, instruments and instrument panels shall also be furnished by Tenderer.

iii) Piping furnished by Tenderer shall be prefabricated and designed to provide proper flexibility and normal accessibility for operation, maintenance and cleaning. Small piping shall be fastened to eliminate vibration and damage.

iv) Regardless of the scope of supply, Tenderer shall be responsible for assessing the design and layout of the piping and appurtenances for excessive pulsation and harmful vibration. Based on the findings, Tenderer shall be responsible for undertaking any modifications necessary to ensure trouble- free operation.

v) Vent lines from cylinder pickings shall be routed to flare.

vi) Vents shall be protected against rain etc. and shall be fitted with a bird screen and mesh / filter as required.

vii) Drain lines – Shall be terminated with isolation valves which shall be routed to CBD by Tenderer.

viii) Local vent lines – All atmospheric vent lines shall be routed outside the compressor shed by Tenderer at an elevation of 3 m above the roof of the compressor shed.

ix) Interconnecting piping from battery limit to compressor and from compressor to various consoles shall be in Tenderer's scope.

x) For all piping, approved piping schedule shall be followed.

xi) Design and supply of pipe supports, springs for supplied piping shall be in Tenderer's scope.

b) Piping and Connection

i) The materials and construction of piping and its connections to the equipment shall conform to ANSI Standards and shall be compatible with the site conditions specified in the inquiry / order. Cylinder suction and discharge connections shall be flanged.

ii) Piping shall be of minimum 25 mm (1 inch) size except for lubrication, instrumentation and control line. When the required openings cannot be realized, Tenderer shall furnish adapters to meet the requirements.

iii) Cast iron or malleable iron pipe fittings shall not be used.

iv) Carbon steel piping shall be seamless in accordance with ASTM A 106 or A 192 or equivalent.

v) Oil piping wherever threaded shall be seal welded without thread lubricants compound. Piping material downstream of oil filter shall be of S.S. Other C.S. piping in lube oil system shall be pickled and passivated.

04.01.32 After coolers

i) Each compressor unit shall be complete with air cooled, finned tube type aftercoolers (including fan and fan guard). The finned tube exchangers for all the streams shall be mounted in one compact cooler assembly with cooler fans. Cooler design shall be on the basis of 20% extra design margin on thermal duty, and maximum ambient air temp shall be taken for cooler design.

ii) Fin-fan-air cooled heat exchangers shall be designed, fabricated, inspected and tested in accordance with API 661. Pressure-retaining components (headers) shall comply with ASME VIII Appendix 13. Pressure piping within package shall be designed and fabricated to ASME B31.3.

iii) For heat exchanger handling process hydrocarbon (Design pressure is greater than 3.5 kg/cm² g), ASME Code stamping is required.

iv) Latest computer programs will be used to establish & check thermal design of heat exchangers.

v) Thermal data sheets of all the air-cooled heat exchangers shall be developed / prepared by Tenderer.

vi) All tubes shall be cold drawn & seamless.

vii) Air-cooled heat exchangers are to be plug type.

viii) Air seal shall be provided to minimize bypassing. In general gap exceeding 3 mm shall be sealed.

ix) The fan & driver shall be designed for continuous service operation.

x) Piping, Instrumentation & Electrical drives within equipment package should be as per given relevant specs.

xi) Equipment shall meet the noise level limits as per relevant standards

xii) For compressors which are driven by Electric motors, fans in the air exchangers shall be driven by separate electric motor.

xiv) For Motor driven Compressor the following design criteria should be followed:

The fans of air exchangers shall operate with the following sparing philosophy.

- Where one fan is required to meet the cooling requirement -

One working and one standby (1+1). Cooling area shall be 200 % of the required surface area. Each fan shall be designed for 110% of the heat load required to be removed.

- Where two fans are required to meet the cooling requirement

Two working and one standby (2+1). Cooling area shall be 150% of the required area. However, if the sufficient space is not available to accommodate the above

sparing philosophy, the air exchangers and fans will be designed after due approval of the purchaser.

xv) Equipment furnished for Air-cooled exchangers shall include, but not limited to:

- Coolers with fans and guards, electrical motor drivers and gear-reducer (Service factor as per AGMA).
- Vibration cut out switches.
- Fan running /tripping Status
- ASME Code stamp is required on all coolers.
- Access platform and ladders.

xvi) Fans shall be fitted with vibration monitoring accelerometers which shall be cabled down to a readily accessible junction box to enable connection of vibration measuring equipment. Access ways, platform and ladders shall be provided to enable operational and maintenance activities to be carried out safely. Particular consideration shall be given to provide permanent access to permit the rodding of tubes (from either end), accessing motor drives, gear drives, fan bearings, upper fan enclosure, fan hubs, instruments etc. Size and thickness of tubes, maximum number of fins per inch shall be as per relevant applicable functional specification and API code.

xvii) Motors shall be in accordance with functional specification of electrical motors, suitable for area classification.

xviii) Provisions shall be made in the cooler design to facilitate ease of cleaning of the cooler. Working platform shall be provided for air exchangers with ladders to have access for Air Cooler Bundles. Suitable material handling needs to be provided for removal of motor for air exchanger.

xix) Suitable arrangement shall be provided to avoid discharge temperature should go below the acceptable limit.

04.01.33 Pulsations and vibration control requirements

a) Vibration

i) For compressor driver rating ≥ 500kW vibration monitoring system comprising frame vibration transducer with alarm (with measurement of vibration level) shall be provided for the safety of equipment. Any additional vibration instrument as per applicable code and Tenderer's recommendation shall also be provided.

ii) For compressor driver rating < 500kW frame vibration switch shall be provided. Any additional vibration instrument as per applicable code and Tenderer's recommendation shall also be provided.

iii) Alarm (alert) and shutdown (danger) annunciation shall be provided for each of the monitored variable as applicable.

iv) Rod drop monitoring (if applicable) shall be as per vendor standard practice.

b) Pulsation Suppression Devices:

i) Threaded connections on pulsation suppression devices are not permitted.

ii) Pulsation design approach shall be as per ISO 13631 or API 618. The pulsation suppression devices/supports outcome of the pulsation study shall be in Tenderer scope.

iii) Tenderer shall also comply with pulsation requirements specified in Piping Engineering Design Basis, attached elsewhere in the Bid Package

iv) Unless otherwise specified volume bottles shall be provided at the inlet and the outlet of each cylinder to limit the residual peak to peak pulsations to 6% at the line side nozzle of the volume bottle. These volume bottles shall be designed and fabricated in accordance with ASME Sec. VIII Div.-I.

v) The use of volume bottles as cylinder supports shall not be permitted.

vi) Mechanical natural frequencies and acoustic (organ-pipe) frequencies should not be coincident with pulsation frequencies generated by the compressor.

vii) Pulsation study has to be got carried out by the Tenderer by reputed agencies and the report has to be vetted by the compressor manufacturer.

04.01.34 Gas Intake filters /strainers

Compressor should be provided with a combination of filter / silencer and a weather hood as per manufacturer's standards or strainer for gas service. It shall be suitable for outdoor installation.

04.01.35 Flywheel

Flywheel shall be statically balanced within such limits so as not to compromise with the life of the compressor main bearings. Nor must be residual imbalance result in vibratory stresses and deflections of magnitudes that compromise the operation of the machine. It shall be dynamically balanced if compressor running speed is equal or higher than 800 rpm.

04.01.36 Special Tools

Special tools, tackles and gauges required either for installation / erection or operation and maintenance of each compressor unit along with complete instruction for their use shall be included in Tenderer's scope of supply.

04.01.37 Painting and Insulation

Painting of Natural Gas Compressor and its auxiliaries shall be in accordance with ISO 13631 or API 618.

All equipment shall be final painted at vendor's shop, except Stainless steel components; which shall not be painted.

The hot process piping from compressor discharge to coolers including discharge pulsation dampeners shall be insulated with Aluminium cladding, wherever the surface temperature exceeds 60 deg C.

04.01.38 The minimum acceptable vibration levels for equipment shall be as per applicable / governing codes.

04.01.39 Central Monitoring Basin

One no. Central Monitoring Basin of RCC construction shall be provided by Tenderer. The basin shall be located underground and covered with RCC grade slab. Effluents consisting of oils, grease, lubricants, gas condensate, etc. shall be routed from respective locations of natural gas compressor station to the Central Monitoring

Basin for necessary treatment by Tenderer meeting the environmental regulations before discharging from the plant.

04.01.40 Flaring System

Flaring arrangement consisting of flare stack, control valves, etc. shall be considered by the Tenderer. All vents from KODs, Compressors, gas pipeline shall be routed through common flare header up to the flare stack.

04.01.41 Inspection, Testing & Certification

a) Testing For Assembled Equipment

The assembled equipment shall be subjected to tests in Tenderer shop in accordance with the following table. The requirements of Tenderer's certificates and of witnessing by the third-party inspection agency/ purchaser's authorized representative shall be as stated in this table. However, third party inspection agency / purchaser's authorized representative shall have the option to witness any/ all the tests at his discretion.

Sl. No	Test	Certificate Required From Tenderer	Test to be Witnessed by third party inspection agency / Purchaser's Representative
1	Mechanical Run test	Yes	Yes
2	Package unit Test	Yes	Yes
3	Test for instruments controls and safety devices	Yes	Yes
4	Post Test Inspection	Yes	Yes
5	Testing of pressure vessels and heat exchangers	Yes	Yes

b) Hydrostatic and Leakage Tests

i) Hydrostatic Tests for all pressure containing parts, shall be carried out at pressure of 1.5 times the maximum allowable working pressure. The test shall be maintained for a period of time sufficient to permit a thorough examination of the parts, with a minimum period of 30 minutes.

ii) The frame and the distance piece shall be tested for leaks using kerosene for a minimum period of 24hours.

c) Mechanical Running Test

i) Test shall be as per ISO 13631 or API 618.

ii) The major components including compressor and driver separately shall be tested at respective manufacturer's shop in accordance with the specifications. The compressor shall be operated for 4 hours at rated speed.

iii) The following requirements shall be met before the test is performed at manufacturer's shop:

- The contract rod packing, piston rings / bands, and bearings shall be used in the machine.
- All oil pressures, viscosities, and temperatures shall be within the operating range of values recommended by manufacturer for the specific unit being tested.
- All casing and oil system joints and connections shall be checked for tightness, and any leaks shall be corrected prior to test.

iv) Control systems shall be demonstrated with extent practicable.

v) If replacement or modification of bearings, valves, or packing or dismantling of the machine to replace or modify other parts is required to correct mechanical or performance deficiencies, the initial test will not be acceptable, and the final shop tests shall be run after these replacements or corrections are made.

vi) Post-Test inspection shall include the following as a minimum:

- Visual examination of the cylinder bores and crosshead guides for scoring.
- The power frame for presence of foreign material.

d) Packaged unit test:

Packaged Unit Test / String Test for compressors:

i) Each compressor shall be string tested at shop.

ii) The duration of Packaged Unit Test / String Test shall be 4hours.

iii) Test shall be broadly followed as per ISO 13631 or API 618.

Note: Job air cooler is not mandatory for string test.

04.02 WATER SYSTEM

04.02.01 Scope of work

The scope of work of the bidder covers site visit, design, engineering, manufacture/ fabrication, assembly, testing, shop painting, packing and sequential delivery FOR site, transportation of materials to site, unloading, unpacking and storage at site, watch and ward, handling at site, complete civil & structural works, road approach to plants / units, erection of the structures, mechanical equipment, pipelines, electrical equipment, instruments and other accessories, final painting, testing, commissioning and performance guarantee tests, etc. of plant & equipment and piping, etc, of complete water supply facilities required for complete water system of the proposed project of Compressor station for North Gas Grid Pipeline as specified in this chapter as well as various chapters of this Technical Specification and subject to Employer's approval, complete in all respect on **turnkey basis.**

The scope of work of bidder shall include the following activities.

i) Design, engineering, manufacture / fabrication, assembly, shop testing, painting, packing sequential delivery for site, unloading, unpacking, storage at site, preparation & submission of all drawings for civil, mechanical, structural, piping, construction & erection drawings, construction & erection as per approved drawings, site-testing, painting, commissioning and fulfillment of guarantee performance of all plant & equipment of water supply facilities for the proposed units of the entire project including drinking water system, industrial service/make-up water system, cooling water system, water conditioning system, & fire water system in accordance with the water system requirement of the proposed plant.

ii) Supply of pipeline supports, thrust blocks/ anchor blocks, RCC pedestals etc. for overhead / on-ground /underground pipelines.

iii) Supply of all technical literature, drawings & documents, general arrangement drawings, assembly & sub-assembly drawings of all the plant & equipment, construction & erection drawings, as-built drawings, operation & maintenance manuals, manufacturing drawings, etc.

iv) Submission of all drawings at (iii) above, design calculations, data sheets for various equipment, pipeline sizing calculation and for approval of Employer/ Consultant and finalizing the same as per approval of Employer/ Consultant. The approval of the same, however, does not absolve the contractor from his responsibilities.

v) Supply of commissioning spares & consumables; a list there of shall be submitted by the bidder.

vi) Bidder shall submit an item wise price-list of two years operation and maintenance

spares.

vii) Supply of special tools & tackles for construction, erection operation and repair & maintenance of the plant and equipment.

viii) All necessary connections for hook-up with Employer's system at battery limits.

ix) Supply of erection, testing & commissioning equipment and material.

x) Piping network flushing fluids, chemicals & consumables.

xi) First fill of oils, lubricants, filter media, resins, chemicals reagents and other consumables as applicable.

xii) Inspection and performance testing of individual equipment and system as a whole.

xiii) Participation in design conference with the Employer & Consultant as and when called for.

The bidder's scope covers providing cooling water system, fire water system, drinking water system, make-up system / service water, chemical conditioning system to various consumer points of the proposed units in line with the technical specification.

Water supply system/ sub-systems shall be complete in all respects and any equipment or material not specifically mentioned herein, but required for safe, efficient & smooth operation and guaranteed performance of the plant shall be deemed to be included under the scope of work of the bidder.

04.02.02 Battery limit

Cooling water, Drinking water, make-up water/service , water conditioning & fire water shall be provided by the bidder to various consumers within the plant boundary.

Broad Description of Proposed Water Supply facilities

Water system shall generally include the following facilities:-

a) Cooling water system
b) Drinking water system,
c) Firefighting system,
d) Make-up/Service water system,
e) Chemical conditioning System
f) Interplant pipelines.

a) Cooling Water System:

i) For cooling of the compressor units, there shall be a separate cooling water

recirculation system. The cooling water recirculation system shall consist of pumps, cooling tower, pipes and fittings, valves, rubber expansion joints, necessary electrics and instrumentation along with chemical conditioning system etc. Hot water from the compressor unit shall be taken to the cooling tower. The system shall be designed with adequate head that water shall reach cooling tower top without any intermediate boosting. Make-up water connection shall be provided to compensate for the losses on account of evaporation and drift losses. The re circulating pumps for compressor cooling water may be housed in the compressor house or a separate pump house may be provided of RCC construction.

The scope of work broadly includes:

ii) Supply, installation and commissioning of compressor recirculation water pumps, valves, rubber expansion joints, pipes and fittings, cooling tower, necessary electrics, instruments along with all appurtenances.

iii) Supply, installation and commissioning of chemical conditioning system to prevent the circulation water system from corrosion and scale formation and to bring the water suitable for cooling water requirement. The conditioning system shall consist of dosing tanks, pumps, valves, pipe, fittings along with necessary appurtenances etc. The bidder shall furnish the details of chemical dosing proposed for the system.

iv) Bidder shall consider three months supply of chemicals from the date of successful commissioning under their scope of work.

v) Chemicals for Pre-cleaning, passivation and Conditioning chemicals required during trial, testing and commissioning shall also be included under bidder's scope of work.

vi) Operation of the pumps shall be from centralized control room.

b) Drinking water system

. Bore well water shall be used for the drinking purpose .Under the proposed scheme (Refer Drg No. MEC/05/28/23UU/NGCS/TD/025, Sheet 1 of 1, Rev. 0), it has been planned to draw water by installation of two numbers of bore well (minimum 200m apart).The water from the bore well shall be pumped and collected in an RCC sump (Capacity – 250 Cum approx.) The water from the sump shall be pumped by means of 04 pumps (2W+2R) to the overhead tanks installed at the various consumer units. The scope of work broadly includes:

i) Supply, installation, testing and commissioning of two numbers of bore well , valves, rubber expansion joints, fittings, instruments along with all appurtenances. Supply, installation and commissioning of pipelines from bore well up to the sump as indicated in the enclosed (Refer Drg No . MEC/05/28/23UU/NGCS/TD/025, Sheet 1 of 1, Rev. 0).

ii) Supply, installation, testing and commissioning of bore well water transfer pumps, valves, rubber expansion joints, fittings, instruments and pipeline along with all appurtenances. Supply, fabrication, laying and commissioning of pipelines from sump up to the over head tanks installed at the respective consumer units. (Refer Drg No. MEC/05/28/23UU/NGCS/TD/025, Sheet 1 of 1, Rev. 0).

iii) Supply, installation and commissioning of RO filters (10 liter per hour approx.) along with water coolers (capacity 40 liters) at each consumer unit.

iv) Construction of Bore well Water pump house with complete structural and civil work etc.

The list of consumers for drinking water is as under: (The levels of the buildings are indicated for design purpose).

a) Administration building - G+2 building.

b) Control building - G+2 building.

c) Canteen building - G+2 building.

d) Fire tender house building - Ground floor building.

e) Gate complex - Ground floor building.

f) Guard room - Ground floor building.

g) Worker's rest room building - G+1 building.

h) MRS switchyard building - Ground floor building.

i) Mechanical workshop - Ground floor building.

j) Store - Ground floor building.

k) Misc drinking water tapings – 03 Nos.

v) The actual drinking water requirement shall be finalized during engineering duly corroborated by back-up calculation to be submitted by the bidder and approved by the Employer / Consultant.

vi) Coverage of drinking water facilities shall be subject to approval by technological group of Employer / Consultant.

vii) The bore well work shall be carried out in accordance with IS-2800-1991 (part-1) “Code of practice for Construction and Testing of Tube wells” and as directed by the Employer / Consultant on site. In case of conflict between these, the direction of the Employer shall be final. Two (02) nos. of Deep bore wells 200m apart each of suitable capacity shall be installed and commissioned by the bidder. Capacity and head of bore well submersible pump shall be finalized on establishment of yield test

for bore wells. Conducting yield test shall be included under the scope of bidder. Provision of column pipes, fittings, cable and cable clamps, wire rope, electric cables, junction boxes, control panel, piping network along with valves and necessary appurtenances from bore well up to the sump /water storage tanks, etc. along with all necessary civil, electrical and mechanical works planned under installation of bore well shall be included in the scope of bidder.

viii) The location of the bore wells shall be decided based on the hydro-potential study to be carried out by the successful bidder. Bidder to optimize the yield which will be available within each of the locations delimited

c) Water based fire-fighting system

To cater to the needs of water based fire-fighting system, a fire water pump house, static water tanks (structural) & piping network, valves, fittings along with necessary electrics and instrumentation has been planned. Bore well water shall be used for the purpose of filling the static water tank of the Fire Water Pump house.

The scope of work broadly includes the following. However the same shall be finalized during engineering as per the stipulation of OISD 226.:

a) Fire water pump house and static water tank

b) Supply, installation testing and commissioning of Diesel engine driven pumps along with associated accessories, Jockey pumps, valves, rubber expansion joints, fittings, instruments and pipeline along with all appurtenances.

c) Supply, fabrication, laying, testing and commissioning of fire water network pipelines from fie fighting pump house up to all units in line with OISD guidelines.

d) Supply, fabrication, erection of two (02) nos static water tanks (steel tanks, Diameter 24 meter X 16 meter height) along with complete civil work.

The water based firefighting system shall be designed, supplied & erected in line with the stipulations under OISD.

d) Make-up /Service water system

Make-up water requirement for various usages for the proposed project shall be met through the drinking water network. Bidder shall make necessary tapping from the DW network and shall extend up to the respective consumer units. The actual make-up water requirement shall be finalized during engineering duly corroborated by back-up calculation to be submitted by the bidder and approved by the Employer /

Consultant.

The scope of work broadly includes.

i) Supply, laying, testing and commissioning of make up water pipelines from drinking water network up to respective consumers.

ii) Supply, laying, testing and commissioning of service water pipeline from drinking water network up to consumers as listed below.

Sl.	Units
1.	Administration building - G+2 building.
2	Control building - G+2 building.
3	Canteen building - G+2 building.
4	Mechanical workshop - Ground floor building
5	Compressor building
6	Store - Ground floor building
7	MRS switchyard building

e) Water Conditioning Chemicals

To prevent the circulation water system from corrosion and scale formation and to bring the make up water to the condition suitable for the cooling water requirement for Compressor house there shall be a water conditioning facility as per system requirement.
The scope of work broadly includes.

i) Supply, installation testing and commissioning of chemical conditioning system comprising of Dosing tanks, pumps, valves, pipes, fitting, pipe supports and associated technological structures, electrical, instrumentation, material handling, air-conditioning & ventilation etc.

ii) Chemical dosing pumps may also be housed in the same pump-house for cooling water system or separately.

iii) The Bidder shall furnish the details of chemical dosing proposed for the system. Bidder shall provide covered shed for storage of chemical for a minimum of 90 days consumptions of chemicals. The shed shall be preferably installed near the pump house.

f) Interplant pipelines

Cooling water, drinking water, make-up water, service water, fire water and general plant usage will be met through the proposed interplant pipelines to be supplied &

laid by the bidder.

04.02.03 Pump House Design Criteria

a. The layout of the various equipment inside the pump house shall be designed keeping in view the safety of the personnel, accessibility of equipment and space for maintenance.

b. The Pump house shall be of structural construction/RCC covered by all sides and shall be provided with minimum two entries. One of the entries shall be provided with rolling shutters having space provision for maintenance of equipments and loading/unloading into truck parked outside the rolling shutter of PH. Each pump house shall be provided with modern office room with standard furniture of reputed make, and toilet facilities, water purification, water cooler with drinking water points. Office room shall comprises of at least two tables, two reclining chairs, four meeting chairs, two file cabinets, one set of computer with printer facility, necessary illumination and air conditioner. Each technological shop, offices, ECR, and other manned / unmanned buildings shall be provided with drinking water platform with water purification and water coolers. One HDPE OHT of capacity minimum 1500 litre & one water cooler with water purifier 40ltr capacity shall be provided. OHT (PVC/HDPE) shall be provided with drinking water connection, drain pipe and overflow pipe along with suitable valves. Overflow and drain shall be connected to nearest storm water drain. Equipment layout including design load data, equipment foundation size, layout of pump house, details of electrics, cable layout etc shall be furnished. The pump houses shall in general be above ground unless specified otherwise.

c. Each pump shall have independent suction. The delivery line of each pump shall be connected to the main header.

d. Minimum clear gap between equipment to equipment, pipe to wall equipment to wall and valves to wall should be kept as per ease of maintenance and operation and shall be decided during detailed engineering but shall not be less than 500mm.

e. In each pump houses maintenance space of agreed length and width shall be provided.

f. Clear walkway of width 2.0 m shall be provided on one side of the pump house with clear marked approach to all the pump set, motors, valves, filters etc. All operating platforms/ maintenance platforms shall be of minimum width 1.0 m.

g. Structural platform with ladder shall be provided so that the valves can be easily accessible for operation and maintenance.

h. The electrics of the pump house shall be designed as per the specification given in the relevant chapter.

i. The pump house shall be provided with necessary illumination facilities along with portable lamps. The details of illuminations have been given in the relevant chapter.

j. The capacity of the hoisting and handling equipment shall be selected in such a manner that it is able to handle the single heaviest load. Cranes/monorails with electric hoist shall be provided as indicated in the relevant chapter.

k. The pump house shall be provided with proper ventilation, electrics, illumination, instrumentation, telecommunication, office room, control room (if required), with furniture wall clock and hoisting and handling equipment. The control room and office room shall be air-conditioned.

l. The pump house shall be provided with adequate drainage facilities with necessary side slope, channels, etc. leading to drainage sump of suitable capacity.

m. Minimum two drainage pumps (one working and one standby) type - submersible / vertical non-clog type centrifugal pumps, of suitable capacity shall be provided to drain out the leakage/seepage water in pump houses, technological shops and electrical buildings. However in substation / cable tunnels only submersible pump shall be provided. The drainage pumps shall operate automatically based on water levels in the sump. In case of drainage pumps and other special type of vertical pumps, the pumps shall include the electric motor suitable or vertical mounting, motor stool, base plate with accessories and fixing bolts, flexible coupling, shaft enclosing pipe column assembly, bearings, lubrication gaskets and washers pressure gauges, strainer at suction side etc. The characteristics of the prime mover shall be same as described under the main pumps. If the length of the pump house is more, then drainage pumps shall be installed at an interval of approx. 50m

n. All RCC pump houses and sump shall be provided with RCC staircase from both sides upto terrace/roof. All sumps shall be provided with hand railings and pump houses with parapet of 1.2 m height.

o. Sump

The sump/suction chamber shall be designed as per the standard of Hydraulic Institute. The sump shall be epoxy painted from inside. The sump/suction chamber

shall have two compartments for each group of pump with provisions to divert the entire flow from the cooling tower/ settling tank to either of the compartments when one of the compartments is under repair/maintenance. Sluice gates shall be provided for isolation of the compartments. The sluice gates shall be selected for velocity less than 0.5 m/s. The suction chambers / sump shall be provided with drain and overflow connections leading to the nearest storm water drain. The minimum capacity of the sump shall be of 10 minutes of the pumping capacity. However single compartment may be accepted in case of single group of pump (single water circuit) is envisaged.

p. The makeup water shall be drawn into the sump through motorized valve, which shall open/close depending upon the level in the sump. The scheme of make-up water supply shall ensure maintenance of normal water level in the sump and prevent wastage through overflow. Level switch shall be provided in the sump, which will actuate motor/solenoid operated Gate valve on make-up water line to the sump in order to maintain water level within a desired range. A bypass make-up water line with float valve shall also be provided into the sump. The motorised isolation valve on the make-up water line shall be provided with 2 Nos. of manual isolation valves on upstream side. The bypass line shall be provided from centre of manual isolation valves.

The pump house sump shall be provided with low level / very low level / high level / very high alarm and the pumps shall be provided with dry running protection.

q. Pump & Piping inside Pump house

Total no. of pumps for a particular group shall be selected in the following manners.

Total no. of working pumps for a particular group	Minimum no. of reserve pumps for each group
1 pump	1
2 to 3	2
More than 3 but less than 6	3

r. Final arrangement shall be decided by the Purchaser / Consultant during detailed engineering stage on case-to-case basis. In case of drainage pumps, there will be one reserve pump for one working pump.

s. All the cold water and hot water pumps shall be of horizontal, centrifugal type side suction & side delivery type (HSC) and shall have flooded suction. If HSC/ SSSD pump model is not available with preferred vendors, ESTD pumps/vertical

centrifugal pumps may be accepted (case to case). The design criteria of pump house and sump mentioned in this specification are also applicable for vertical centrifugal pumps.

In pump suction: Triple eccentric butterfly valve followed by REJ shall be provided.

In Pump delivery line: REJ followed by Dual Plate check valve (DPCV) followed by motorised triple eccentric butterfly valve followed by manual butterfly valve (gear operated beyond DN 300).

In case of double header system with ring main concept each header shall be designed for 70% of total flow.

Each pump shall be provided with local indication of pressure on suction side and local indication and signaling of pressure on delivery side

Each header shall be provided with local indication, recording and signaling of flow, pressure and temperature, which shall be depicted on the panel of the control room.

t. All the valves of diameter 450 mm (except for firefighting application which will be manual gear operated) and above and the valves requiring remote control operation shall be electrically / pneumatically operated. Electrically operated valves shall be provided with limit switches as a safety measure. Electrically operated valves shall have provision for manual operation also. All Manual valves of sizes of 250 and above shall be gear operated.

u. Rubber Expansion joints near the pumps on both suction and delivery lines before reducers (i.e. size same as suction/delivery valve size).

The pipe network and valves within the pump house shall be adequately supported so as to avoid undue stress on the pumps.

v. Suitable chemical and chloride / biocide dosing facilities shall be provided in the suction chambers of the pump houses so as to prevent biological growth, scale/ corrosion in any of the circulating water system. The facilities shall consist of chemical storage tanks of suitable storage time, dosing pumps (metering type) one working and one reserve. The dosing system shall be complete in all respects with tanks, pumps, valves, supports, agitators and necessary pipe-work. 90 days chemical storage space shall be provided / near the pump house in separate building

04.02.04 Pump House Operation Philosophy

All the controls for the recirculation system and cooling tower shall be provided and the control panel shall depict the working condition of various units.

The following interlocks shall be provided, as applicable, in the operation of all the pumps, such that for the starting of any of the pumps:

- The level of the liquid in the pump house basin is higher than the low level,
- All the pumps shall be tripped when the low-low level is reached.

Wherever gravity drainage of premises is not feasible, suitable drainage pit shall be provided for collection of drain and stray effluents. Minimum two Vertical / submersible non clog type drainage pumps of adequate capacity shall be provided in the drainage pit for automatic operation based on the drainage pit water level. The level control equipment for automatic operation shall consist of the following:

a) level indication,
b) low level to stop the pump(s),
c) high level to start the first pump,
d) high-high level to start the second pump,
e) high-high-high level for alarm annunciation.

04.02.05 Velocity in Pipes

The following flow velocities shall be maintained for the pump suction and delivery branches and water pipeline headers / branch headers and distribution network.

Pipe Diameter	Suction side	Delivery side
Upto DN 150 mm	0.6 to 1.0	1 to 1.5 m/s
DN 200 mm to 450 mm	0.8 to 1.2 m/s	1 to 1.5 m/s
DN 500 mm to 1200	1.0 to 1.2 m/s	1 to 2.2 m/s
Above DN 1200 mm	Upto 1.5 m/s	1 to 2.5 m/s

04.02.06 HOISTING & HANDLING EQUIPMENT:

The hoists shall be designed in accordance with the latest edition of IS-3938-1983 standard subject to any modifications and requirements specified hereinafter. Hoist will be operated by pendant push button station.

Hoisting and handling equipment shall be provided for lifting individual loads weighing 50 kg and over.

The type of lifting device shall be selected based on amount of load to be lifted, height of lift and frequency of operation and the layout of the equipment to be lifted. In general if the load to be lifted is 500kg or more and /or height of lift is 6 m and more, electrically operated handling equipment shall be provided.

1	Manual hoist with chain pulley block of capacity 1 t	for load less than 200 kg
2	Electric hoist of capacity 2 t	for load more than 200 kg to less than 1.5 t
3	U/S Crane/ Single Girder EOT Crane above of capacity 3t to 5t	for load more than 1.5 t to 3.5t
4	U/S crane or DG EOT Crane above 5t	for load more than 3.5 t

All the Underslung cranes shall be provided with C type maintenance platform at one end of pump house. Regular RCC/ Structural Staircase shall be provided to reach the C type platform.

For detail specification of hoisting facilities, please refer the relevant clauses Material Handling & hoisting.

04.02.07 DESIGN CRITERIA FOR PIPE WORK

a. The term pipe work referred herein generally cover pipes, fittings (such as bends, tees, reducers, plugs, nipples, sockets, unions, flanges, crosses etc.), valves of various types and functions (such as gate, globe butterfly, plug, ball check, diaphragm, electrically operated, pressure reducing valves, etc.) strainers, filters, hoses, hose couplings hose clamps, hose nozzles, fire hydrant assemblies, and pipe supports, corrosion protection etc.

Pipe work is intended to convey fluids such as different qualities of water and industrial effluents.

b. The pipe work shall be designed, manufactured, assembled and tested as per the latest standards, codes and recommendations of the Bureau of Indian Standards, ANSI, ASTM, AWWA, or other equivalent international standards. Pipe work shall be complete in all respects including all accessories essential for proper installation, operation and maintenance, even though such items are not specifically mentioned in the specification.

Piping system shall be designed with high degree of reliability so that the systems perform the duty of fluid handling without any failure under all conditions of plant operation.

Piping layout must follow good engineering practice. Proper attention shall be given to obtain full functional requirement of the piping system with a layout, which provides sufficient clearance for other equipment and operating personnel, easy access for operation and maintenance, convenient supporting points and neat appearance.

c. Complete design of piping system shall be subject to approval by the Owner/ Consultant. The design shall take into account the effect of internal/external pressure, thermal expansion, self weight of piping, support reactions, surge and water hammer, earthquake and wind effects at site, corrosion and erosion etc. and any other effects dictated by good engineering practices.

d. MOC of pipe lines to be used for various services shall be as listed below:

1. Cooling / Circulation water (Industrial Quality) –Carbon steel (CS)
2. Waste water / Industrial effluent (with Chloride & hardness levels less than 100 ppm) –CS
3. Waste water / Industrial effluent (with Chloride& hardness levels more than 100 ppm and TDS level more than 1000 ppm) – CPVC/HDPE
4. Chemical pipe lines – CPVC
5. Soft water pipe lines – Inside soft water plant – MSRL & In other area – MS/CS pipes
6. DM water pipe lines – SS pipes
7. Cross country piping – CMDI pipes/CS/GRP(based on application and pressure rating)
8. Make-up water distribution piping – CS pipes.
9. Drinking water piping (interplant) – GI pipes upto DN 65 & CS above DN 65.
10. Slurry piping (abrasive) – CS pipes inner lined with abrasive resistant material.
11. Slurry piping (non-abrasive) – CS pipes with higher thickness.
12. Slurry launder – MS launder lined with 30 mm thick basalt tiles
13. Scale flume – RCC flume lined with 30 mm thick Basalt tiles.
14. Fire water (hydrant system) – CS

e. The pipe network shall be provided with air release valves at high points and drain valves at the lower points.

f. Pipeline passing under or through equipment foundations or walls of buildings or any other inaccessible structure shall be provided with steel encasing pipes for easy insertion and removal.

All the pressure pipes shall be laid with a nominal slope and the gravity network with slope of self-cleaning velocities.

g. Continuous welding MS pipes shall be used and pipe flanged at regular intervals & at bends shall be used for slurry (cast basalt pipe) and other corrosive fluid services.

Except where otherwise specified, all piping shall have butt-welded connections with a minimum of flanged joints for connections to equipment. Branches shall in general, be formed by welding.

Provision shall be made for branches for cleaning and flushing of pipelines wherever necessary.

Manholes shall be provided in the gravity pipe networks and the distance between two manholes shall be 30-50 m depending upon the pipe size.

h. Wherever over-ground pipelines are crossing roads and railway tracks, they shall be laid on pipe bridges (clear gap of 8.0 m from rail / road top) to provide the necessary clearance for the traffic movement. This should take in to account the various types of vehicles likely to move in the plant.

i. Valves provided on the over-ground pipe network shall be provided with steel structural platforms and access ladders.

j. Walkable platforms of min. width 1.0 m with necessary handrails shall be provided by the side of overhead pipe trestles, overhead slime troughs and open gravity network.

Provision shall be made for support of piping which may be disconnected during maintenance work. All large pipes and all long pipes shall have at least two supports each arranged in such a way that any length of piping or valve may be removed without any additional supports being required.

Pipe supports shall be capable of supporting the pipelines under all conditions of operation.

All the buried pipelines shall be laid with a nominal slope towards the drain

point.

All the buried pipelines shall be laid as far as possible at a depth of about 1200 mm, below finished ground level (i.e. the top of the pipelines shall be 1.2 m below the finished ground level).

k. Isolation /control valves, drain valves, air release valve provided on the buried pipe network shall be housed in suitably sized covered valve pit and the valve pits shall be of self-draining type, means the water accumulation in the valve pit shall not occur. The pit shall be drained either through gravity or by means of pumping.

l. Wherever the buried pipelines are crossing the roads and tracks, they shall be suitably encased with mild steel pipes or reinforced concrete casing pipes (NP4 grade) and the different sizes of the encasing pipes shall be as appended:

Encased pip	Encasing pipe (For Flanged pipe) size	Encasing pipe (for welded
Upto 100	300	250
150	400	300
200	500	400
300	600	400
350	600	500
400	700	600
500	800	700
600	900	800
700	1000	900
800	1100	1000
900	1200	1100
1000	1400	1200

In case a number of pipes are crossing road or track, these pipes shall be laid in a reinforced concrete culvert having easy access.

m. Coal tar based anticorrosion tape as per IS: 15337 – 2003 shall be provided for protection of underground mild steel pipelines. The thickness of tape shall be 4 mm for all pipes.

04.02.08 LAYING BURIED PIPELINES

a. All buried pipelines shall be laid with earth cover sufficient to avoid damage from pressure of vibration caused by the surface traffic. Minimum earth covering over the

pipe shall be 1200 mm from the finished ground levels. For laying of buried pipelines earth work in excavation, back filling and acceptance of trenches etc. shall be as per IS: 5822- 1994 and IS: 3114-1994 and IS: 12288-1987.

b. The trench shall be so dug that the pipeline can be laid to the required alignment and at the required depth; proper levelling of the excavated surfaces is an essential requirement.

c. In case stones, boulders etc. are found at the bottom of the trench which cannot be removed completely, the bottom shall be levelled by sand layer for a minimum thickness of 150 mm.

d. If the depth of excavation is more, proper protection for sidewalls shall be provided till the pipe levelling is completed.

e. The entire pipe trenches bottom shall be covered with local sand bed of 50 mm thick layer.After laying the pipelines, 150 mm thick layer of local sand shall be provided over the sand bed.

f. Precautions shall be taken at all the times to prevent damage to the coating and wrapping in the pipe lines and appurtenances as applicable by workmen or trespassers during laying or at any other time. Pipe handling slung and any blocking used in handling or storing the pipes must be well padded to avoid damage to pipe and its coating.

g. After laying a pipeline on skids it shall be thoroughly cleaned, inspected and for any damage to the protective coating, satisfactory repair work shall be performed while the pipe is suspended above the trench.

h. Before laying the pipelines, the Owner shall examine the trenches and after his approval only the pipes can be laid.

i. After the pipes are erected and tested, the back filling of the trenches shall be done with loose soil free from stones, bricks and metallic pieces, in layers and shall be well rammed and compacted.

j. Where the pipelines cannot be laid overhead on stockades and are crossing roads and tracks at too many points in a given area, the pipeline may be laid in walk-able tunnels.

k. Pipelines in tunnels shall be provided with isolating valves, air release valves and drain valves, which are easily accessible for operation and maintenance. Gland type

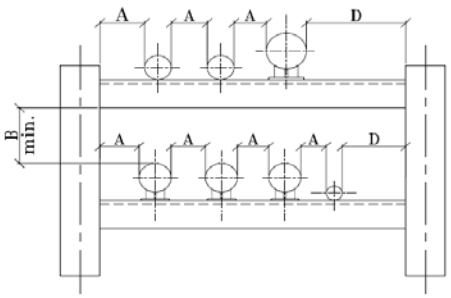
of Compensators shall be provided on these pipelines wherever necessary.

l. Pipelines in tunnels shall be suitably ventilated and illuminated. There shall be minimum two entries for the tunnel. Each tunnel shall be provided with at-least two vertical centrifugal, non-clog type drainage pumps (one working and one standby) in a drainage pit and these pumps shall operate automatically based on the liquid levels. Tunnel shall be provided with saucer drain at one side with slope towards the drainage pit. Each tunnel shall be provided with at least a monorail and hoist for erection and maintenance purposes. Minimum height of the tunnel shall be of 3.0 m and suitable walkway of 1.2m minimum width shall be provided for each tunnel.

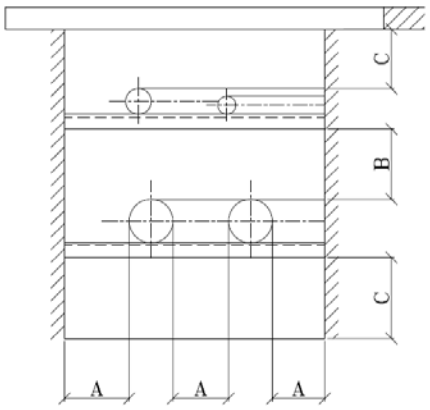
m. Spacing of Pipes in U/G Tunnels & Trenches/ OH Structural Trestles

n. Pipes on O/H structural trestle.

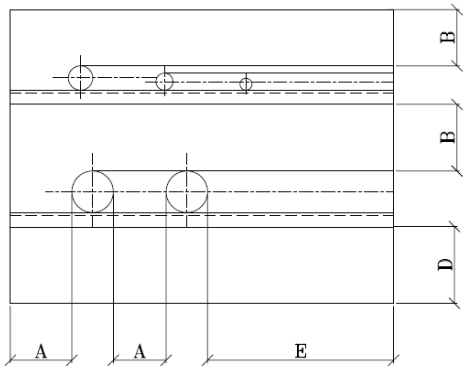
o. For O/H trestle, 1m clear walkway with hand railings to be provided. If the width of the trestle is more than 6m, 1m walkway to be provided on both sides of the trestle. For pipe DN 350 & above, Saddle support to be provided. Cleat support can be provided inside pump house. For pipe less than DN 350 U-clamp support to be provided.



The typical cross-section of tunnel/trench showing pipe arrangement is as indicated below:



PIPE IN TRENCH



PIPE IN TUNNEL

	Nomi	Spacing (mm)				
		A	B	C	D	E
	50	150	300	100	150	800
	65	150	300	100	150	800
	80	150	300	100	150	800
	100	150	300	100	150	800
	125	150	300	100	150	800
	150	150	300	100	150	800
	200	300	300	100	300	800
	250	300	350	100	300	800
	300	300	400	100	300	800
	350	300	450	100	300	900
	400	350	500	100	300	900
	450	350	550	100	300	100
	500	350	600	100	300	100
	600	350	700	100	300	120
	700	350	800	100	300	120
	800	400	900	100	500	150
	900	400	1000	100	500	150
	1000	400	1100	100	500	150

Pipelines within the shop buildings shall be laid overhead supported form the building columns/side walls/cranes girder etc. wherever this is not possible, the pipelines shall be laid either in tunnel or in pipe trenches (covered with removable slabs or chequered plates).

Wherever pipelines are crossing form one bay to another parallel bay, they shall be laid in tunnel or supported form the gable end.

04.02.09 PIPE SPECIFICATION

A). Pipe Specification (Carbon Steel)

Type	Dia. (mm)	Standard	Material	Thickness	Manufacture
Black pipe	15-50	B36.10	A106	Sch 80	Seamless
Black pipe	65-150	IS1239:2004	Fe410	Heavy class	ERW
Black pipe	200-250	IS3589:2001	Fe410	6.35mm	ERW
Black pipe	300-350	IS3589:2001	Fe410	7.14mm	ERW
Black pipe	400-450	IS3589:2001	Fe410	7.14mm	ERW
SW	500-1000	IS3589:2001	Fe410	7.92mm	Spiral Welded.

SW	1000-1200	IS3589:2001	Fe410	8.74mm	Spiral Welded.

CS Fittings (Class 3000)	**Applicable standards**.
Pipe butt welded fittings	ANS B16.9 ANS B16.28 Material: ASTM A234 WP8
Forged fittings: - (Socket / Screwed fittings)	ANSI B16.11, thread to ASA B2.1 Material: ASTM A105
Mitre Bend: -	To be fabricated from parent pipe

B). <u>Pipe Specification (Stainless steel)</u>

	Applicable standards.
Upto Dia. 50mm.	Dimensions as per ANSI B36.19, Schedule 40, Conforming ASTM A312 TP304
Beyond 65mm and above	Dimensions as per ANSI B36.19, Schedule 20, Conforming ASTM A312 TP304

SS Fittings (Minimum class 3000)	**Applicable standards**.
Butt welding fittings	As per ANSI – 16.9, ASTM A304 WP304
Socket welding fittings	As per ANSI B16.11– A182 F-304
Screwed fittings	As per ANSI B16.11– A182 F-304

C) **HDPE Pipes**

1. From sizes OD 20 to OD 50 – IS 7328- PE100, PN 16, Plain End, Dimensional Standard IS 4984
2. From Sizes OF 63 to OD 630 - IS 7328- PE100, PN 10, Plain End, Dimensional Standard IS 4984
3. HDPE fitting shall generally confirm to IS 7328 PE-100, PN 16/PN 10 based on the pipe rating.

D) **CPVC pipe & fittings**

1. Pipes of size DN 15 to DN 350 – ASTM D1784 – CPVC (23447-B), Sch. 40, Plain end, Dimensional standard – ASTM F441
2. Fittings - ASTM D1784 – CPVC (23447-B), Sch. 80, Socket cemented, Dimensional

standard – ASTM F438

TABLE FOR MAXIMUM SPAN OF SUPPORTS

Sl. No.	Nominal pipe size (mm)	Maximum span for liquid services (m)
1	25	2.1
2	40	2.7
3	50	3.0
4	65	3.4
41	80	4.0
5	100	4.3
6	150	5.2
7	200	5.8
8	250	6.7
9	300	7.0
10	350	7.6
11	400	8.2
12	450	8.5
13	500	9.2
14	600	9.8
15	900	12.0
16	1000	15.0

Note: Vertical pipe work shall be clamped at intervals of 3.5m (approx.) and at the base of each riser. Maximum span at the place of turning shall be 0.7 times of normal span.

Dimensional Performance and End Finishes

Tolerance on outside diameter of the pipe and specified thickness shall conform to the limits laid down in IS: 3589-2001. Finish pipe shall not deviate from straightness by more than 0.2% of the total length.

Pipes to be butt-welded shall be supplied with ends bevelled to an angle of 30

degrees (+ 5 degree – 0 degree) measured from a line drawn perpendicular to the axis of the pipe. The root face shall be 1.6 ± 0.8 mm.

Method of Quality Control in Welded Joints

Following steps shall be taken by the Contractor, besides controlling quality in general, to make effective control in carrying out welded joints.

a) Welding procedures shall be prepared in line with IS: 7307 (Part – I) – 1974, reaffirmed in 1991 and tests shall be carried out to quality procedures. Number of procedures will depend on variables like positions of welding, thickness range etc. Once a welding procedure is qualified, strict adherence to it shall be made during actual welding.

b) Welders employed shall be qualified as per IS: 7310 (Part – I) – 1974, reaffirmed in 1987 after passing necessary tests.

c) Welding consumables shall be of approved type. Such consumables are, however, subject to qualifying initial check tests as per IS: 814-1991.

d) The Contractor shall strictly follow approved welding procedures during actual welding. Besides, the following stages of inspection shall also be carried out:

i) Weld edge preparation before welding, proper fit up, position of welding, cleaning of slag between the passes, proper weld profile etc., shall be checked visually amongst others.

ii) Non-destructive tests of weld of welded joints shall be carried out as per approved procedures/ drawings.

Preparation of Joints

The Contractor shall prepare the edge correctly to the shape, size and dimensions of the vee-grooves as per ANSI B-16.25 unless otherwise specified in drawings/ documents.

The welding surfaces shall be smooth, uniform and free from fins, tears, notches or any other defect which may adversely affect welding and shall be free from loose scale, slag, rust, grease, paint, moisture or any other foreign material. The clean surface shall extend to about 10 mm beyond the welding faces to avoid contamination of the weld metal with foreign material and to avoid unsound weld

deposit.

Assembly, Alignment & Welding

The sequence of welding shall be so planned and followed that there shall be a balance of welding about the neutral axis of the fabrication. The Contractor shall employ sufficient number of welders working at the same time in diagonal quadrants of the shell using back-step method of welding. The rate of progress of each welder shall be more or less equal and quality uniform.

The general direction of welding shall be towards the free end of the joint, but in a long joint as in shell fabrication, back-step technique shall be used to reduce distortion.

To minimize internal locked up stresses due to welding, the vertical joints for the shell shall be welded and completed to a circular course and then the horizontal circumferential seam welded. However, before the welding of horizontal seam started, the complete circular course shall be aligned and adjusted for their correct axes.

Alternatively, the Contractor shall complete each course in all respect on ground and then the pre-assembled course shall be listed and placed in position. In such a sequence and planning, the same principle of balancing of weld about the neutral axis shall be followed and the method of fabrication of each course shall be similar to fabrication of penstock pipes of transmission/ industrial pipelines of bigger diameter.

Pipe and attachment shall be aligned properly by accurate and permanent methods prior to welding. If tack welds are used, the tack shall be either fused into the first layer or weld or else chipped out.

Tests on welded joints

(a) Visual examination

The Contractor shall conduct visual examination and measurement of external dimensions of the weld for all joints. Before examining the welded joints, areas close to it on both sides of the weld for a width not less that of 20 mm shall be cleared of slag and other impurities. Examination shall be done by magnifying glass which has a magnification power of ten (10) and measuring instrument which has an accuracy of ± 0.1 mm of by weld gauges. Welded joints shall be examined from both sides. After leak test of the pipeline the coating of the joints shall be

done. The Contractor shall examine the following during the Visual examination: -

i) Check the correctness of shape and size of the welded joints
ii) Incomplete penetration of weld metal
iii) Influx
iv) Burns
v) Under cuts
vi) Un-welded crates
vii) Cracks in welded spots and heat affected zones
viii) Porosity in welds and spot welds
ix) Compression in welded joints as a result of electrode impact while carrying out contact welding
x) Displacement of welded element.

To carry out any or all tests as specified hereinafter to satisfy the Purchaser about the acceptability of the welded joints, as directed by the Purchaser.

(b) Liquid Dye-penetrant Test

Liquid dye-penetrant tests shall be carried out in accordance with IS: 3658-1981, reaffirmed in 1991 for surface/ sub-surface defects.

(c) Test by Blowing

The surface of the weld shall be covered with soap solution consisting of one (1) litre of water and hundred (100) grams of soap. Compressed air shall be blown from the opposite side at pressure of 4 to 5 kg/cm^2. The distance between the tip of base and the weld shall not be more than 50 mm. Any formation of soap bubble will indicate welding defects. Portable compressor shall be arranged by the Contractor, if necessary, for this purpose.

(d) Hydro-testing

The pipes shall be tested with water for correctness of pressure withstanding. The hydro test pressure for all welded/flanged water carrying pipes shall be 1.5 times of working pressure or 10 kg/cm2, whichever is higher.

Tolerance

Deviations for assembly of welded joints may be permitted to the following extent:

Sl. No.		Tolerance	
		Manual arc	Automatic
a)	Source butt-Joints		
	i) Gap between the ends of plates	+ 2.00 mm - 1.00 mm	± 1.00 mm
	ii) Stepping of one plate over the other	1.00 mm	2.00 mm
b)	Single Vee-groove Joints		
	i) Bevel angle	± 5 deg.	± 5 deg.
	ii) Gap between two	+ 2.00 mm - 1.00 mm	+ 1.00 mm
		Manual arc	Automatic
	iii) Stepping of one plate over other	2.00 mm	2.00 mm
c)	Lap Joint		
	i) Overlap	5.00 mm	5.00 mm
	ii) Gap between the surface	2.00 mm	1.00 mm
d)	Tee-filler Joints		
	i) Gap between the edges of the web and the surface of the flange	2.00 mm	2.00 mm

Note: After hydro testing of the pipeline all the joints shall be coated / painted only after rectification of defects if any.

04.02.10 DESIGN CRITERIA FOR PUMPS

HORIZONTAL & VERTICAL CENTRIFUGAL PUMPS

a. All the pumps provided in the pump house shall be horizontal centrifugal type with flooded suction. Drainage pumps installed in sump pits shall be horizontal, centrifugal type with priming tank arrangement. In the event of space constraints, the use of vertical centrifugal, non-clog submersible pumps may be permitted. As far as practicable, pumps of reputed indigenous makes shall be preferred. Pump type shall be HSC SSSD type only. In case the HSC SSSD pump of required duty parameter are not in the manufacturing range, ESTD pump can be accepted subject to submission of details.

b. The horizontal pumps shall be mounted on a common base plate with the motor and shall be directly coupled to the motor thorough a flexible coupling without any gear

reducer. In case of slurry pumps V-belt driven to be provided. Fluid coupling for slurry pumps to be provided as per system requirement.

c. The pumps (horizontal as well as vertical centrifugal) will be designed, manufactured and tested as per IS:1520-1980, IS:5120-1977 R.A.1991, IS:9137-1978 R.A.1993 or as per international standards acceptable to the Purchaser and will be suitable for the required duty conditions and capacities.

d. The pumps and their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty at full load.

e. The centrifugal pumps shall be suitable for a capacity range of 25% to 125% of duty point capacity. However Pumps having low flow & high head may be suitably reviewed during detailed engg regarding above.

f. In case of pumps are to be operated in parallel, the motors are to be suitable for parallel operation depending upon the end of the power curve.

g. Based on the full range curve, Motor rating selected should be suitable considering end of the range power.

Motor Eff required shall be min 96%
Motor rotation should be bidirectional

h. The motor capacity shall have a margin over its BHP absorbed at the pump shaft at duty point and the margin shall be 25% for motors of rating upto 15kW, 20% for motors of rating 18.5kW to 160kW and 15% for motors of rating 200kW and above. The above margin shall be in addition to temperature derating.

i. All the pump shall be selected keeping margin of 10% on flow and 5% on calculated head. Pump set with motor of 300 kW and above shall be of nominal 1000 rpm or less.

j. The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantable without disturbing the suction and delivery pipe connections.

k. The equipment design shall incorporate provisions for reduction in noise level of Max 85 dB from 1m distance.

l. The rotating elements of the pumps shall be checked for critical speed in bending as

well as in torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating speed in case of stiff shafts.

m. All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

n. The direction of rotation shall be clearly marked either by incorporating it on the casing or by separate metal plate arrow securely fitted to the casing.

- The head – Vs – discharge characteristics of the pump shall be continuously rising form the duty point to the shut off point without any zone of instability. The required duty range for a pump shall be on the stable portion of its head capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge. The power-Vs- discharge characteristics shall be non-overloading type.

- The pump shall be so selected and installed that the available NPSH is not lower than the required NPSH even in the most adverse operating conditions. Required NPSH of the selected pump shall be less than 6.5 m (except diesel engine driven wherein the max NPSHR shall be limited to 8. Impeller diameter shall be selected preferably with in 25%-75% range of the respective family curve.

- The pump shall be of proven make and design having material of construction which is the best of its kind for the particular application and shall be manufactured using best engineering practices under strict quality control. Each pump shall be tested as per the standards stipulated elsewhere in this document. The test shall include hydrostatic test, static and dynamic balancing tests, performance tests material tests and motor routine tests.

- The pump shaft and bearing shall be adequately sized to take the unbalanced forced due to mal-operation. The pump gland shall ensure proper sealing without excessive tightening of the packing. Proper cooling and flushing arrangement for the gland shall be provided wherever required.

- All moving parts of the pump shall be adequately guarded to prevent any injury to operating personnel.

- Pumps shall be designed and installed keeping in view the easy accessibility of its parts for maintenance. All end suction pumps shall be of back-pull-out design and shall be provided with spacer coupling of adequate length.

- Minimum no. of standby pump shall be provided for each group of clear water pumps and drainage pumps as specified in the design criteria for pump house. The group of Pumps for scale water or other abrasive slurries shall be provided with at least two standby units. Special abrasion resistant material shall be used for these pumps and the design shall allow easy replacement of parts subject to wear and tear.

- The suction pipeline shall be laid at a constant down ward slope from pump centre line to the suction chamber. Reducers used in the line shall be eccentric type to keep the top of the suction line straight.

- Each pump shall be provided with adequate safety interlocks including overload and dry running protection.

- All pumps shall be provided with suitable lifting attachments and each pump installation shall have suitable handling facilities.

- The details of pumps should match with the drive motors throughout the working life of these equipments and to meet operational requirement. High-speed motors of 3000 rpm shall not be used, as for as practicable. However for low flow and high head rpm of 2900 will be accepted on case to case basis. Working hour meter shall be provided on control panels to monitor conditions and subsequent ageing / reduced efficiency, etc.

- Vibration readings, etc. of new installation shall be supplied.

- Pumps shall be installed and commissioned as per manufacturer's instructions. A continuous running for 72 hours shall be required before final acceptance is given to the pumping installation.

04.02.11 Shop testing of pumps

- All materials, casting and forging shall be of tested quality.

- Pump casing shall be of robust construction and hydrostatically tested at 200% of the rated pressure or 150 % shut off pressure, whichever is higher. The test pressure shall be maintained for at least 15 minutes.

- The impellers along with any other un-machined rotating parts shall be tested for proper balancing in order to avoid undue vibration during operation.

- Performance tests shall be carried on each centrifugal pump. Performance test shall be made to determine the following.

a) The discharge against a specified head when running at a specified speed under a specific suction head.

b) The power absorbed by the pump at the shaft (BHP) under the above-specified conditions.

c) Efficiency of the pump under the above specified conditions.

d) Variation of required NPSH with discharge.

- The pump accessories like bearings, couplings etc. shall be subject to shop tests as per manufacturer's standards.

- The materials of construction of various components of all equipment and material covered under the scope of his specification shall be certified by the contractor with regard to their compliance to specifications laid down for them under relevant clauses of applicable standards and /or the manufacturing drawings of the contractor duly approved by the purchaser. Formal material test certificates to the effect shall be issued by the contractor.

- All test results and certificates including material test certificates shall be submitted for approval to the purchaser before dispatch of equipment.

A stainless steel name plate shall be furnished and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information: -

- Name of Manufacturer
- Model No.
- Purchaser's item no. or tag No.
- Serial number of pump
- Capacity in cubic meters per hour
- Pumping head in meters of liquid column
- Specific gravity of liquid pumped
- Revolutions per minute
- Pump input power, kW

- Motor rating, kW

04.02.12 VERTICAL PUMPS:

Sl. No	ITEM	MATERIAL
1	IMPELLER	19-10 Molybdenum Austenitic Stainless Steel
2	CASING/ BOWL	2.5% Ni CI
3	CASING RING	CAST IRON (IS 210 FG 260)
4	LINE SHAFT	Chromium Steel AISI-410
5	SHAFT SLEEVE	SS – 410
6	GLAND	CAST IRON
7	BASE FRAME	M.S FABRICATED
8	COMPANION FLANGES	M.S
9	COLUMN PIPE & DISCHARGE HEAD	Carbon Steel IS-2062-1992
10	SUCTION STRAINER	MS GALVANISED

04.02.13 VERTICAL TURBINE PUMP

a. Vertical Turbine Pumps along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and manufactured for continuous duty at full load.

The vertical turbine pump shall be designed, manufactured and tested as per IS: 1710 – 1989 (Reaffirmed 1999).

b. The motor rating shall be maximum of the following requirements: -

a) 15% margin over the pump shaft input power at the rated conditions.
b) 5% margin over the maximum pump shaft input power required within its operating range including the shut-off point.

The above margin shall be in addition to temperature derating.

c. Capacity Vs discharge pressure curve for each pump shall preferably be continuously drooping from the shut-off point to the rated operation point and be suitable for

parallel operation. The pumps shall be designed to avoid cavitation at any of the operating points. The characteristic of the pump shall be non-over loading type.

The required duty range for a pump shall be on stable portion of its head-capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge.

d. The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment design shall incorporate provisions for reduction in noise level.

The rotating elements of the pumps shall be checked for critical speed in bending as well as torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating sped in case of stiff shafts.

The pumps shall be capable of reverse rotation upto 125% of rated speed due to reverse flow of water.

All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

The direction of rotation shall be clearly marked on a separate metal plate arrow securely fitted to the casing.

e. A stainless steel name plate shall be furnished and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information:-

- Name of Manufacturer
- Model No.
- Purchaser's item no. or tag No.
- Serial number of pump
- Capacity in cubic meters per hour
- Pumping head in meters of liquid column
- Specific gravity of liquid pumped
- Revolutions per minute
- Pump input power, kW
- Motor rating, kW
- Design code IS/IPSS

04.02.14 SUBMERSIBLE PUMP-MOTOR SET FOR BORE WELL

The bore-well pump shall be stainless steel(SS) with SS body and integrals, having jacketed submersible motor pump in multi stage construction with radial/mixed flow impellers coupled with water filled, water lubricated, three phase submersible squirrel cage induction motor. The motor windings shall be with water proof insulation. Motor shall be sealed by radial sealing rings to avoid contamination of motor water with well water. Cables shall be led out of the motor through cable glands and shall be protected against mechanical damage by means of cable clamps. Pumps shall be provided with spring loaded non-return valve to prevent reverse rotation of the unit and to prevent entry of abrasive particles.

04.02.15 INSPECTION & TESTING

The tests to be conducted at shop for various sub-assemblies/ assemblies of equipment shall include, but not limited to the following:

I. Material/ identification tests for all the components of the pump

II NDT as indicated below:

(a) Impeller	Dye Penetration Test (DPT)
(b) Shaft	DPT and Ultrasonic test
(c) Wearing rings	DPT
(d) Impeller	dynamic balancing
(e) Pump assembly	Visual inspection

III. Hydrostatic test:

Hydrostatic test shall be done for the following components at a minimum pressure of 200% of shut-off head. The test pressure shall be maintained for at least one hour.

(a) Bowl
(b) Suction bell
(c) Discharge head
(d) Column pipe

IV. Performance test:

Performance test shall be conducted on each pump with one of the actual drive

motors at the manufacturer's works in presence of Purchaser's representative as per the requirements of the relevant test codes.

Performance tests shall be conducted at rated r.p.m. to cover the entire range of operation of the pumps. These shall at least cover the range from shut-off point upto 1.3 times the rated capacity of pumps. A minimum of 5 readings shall be taken for capacity Vs Head, covering the above range. After performance test, the pump shall be dismantled for inspection of internal components.

Mechanical run test shall be carried on all pumps to demonstrate smooth running of the pumps, measurement of noise levels, vibration, etc. This test shall be carried out at site also and the site test shall be taken for acceptance of the pump. The noise level shall not exceed 85 dB at 1.0 m distance from the pump or as per the latest norm whichever is less.

The pumps shall be tested for vibration at the guarantee points. Vibration limit shall be as per Hydraulic Institute Standard/ API 610.

The following tolerances shall apply for the performance tests: -

i) Rated capacity : +2.5% at rated head

ii) Efficiency at rated capacity : No negative tolerance

Test reports and manufacturer's test certificates shall be submitted to the Purchaser/ Consultant for approval.

The final tests shall be conducted in the presence of the Purchaser's representative. Test certificates for different tests shall be made available to the Purchaser during the inspection. Material test certificates for bought out items shall be obtained from original manufacturer/ reputed test house. For all bought out items, test certificates as relevant to the items shall be furnished by the Contractor.

All the pumps shall be subject to stage inspection by the Contractor's own inspecting authority. However, Purchaser's Inspector may visit the works from time to time who should have free access to all the places of the manufacturing premises where any part/ parts are under manufacture.

The Contractor's inspecting authority shall have a close surveillance in respect of the quality of job for the design dimensions, tolerances, surface finish, etc.

04.02.16 List of Mandatory Spares for Pump sets

In general the spares to be supplied with pump sets shall include the following. The spares are intended to cover all wearable/damageable delicate items of the plant.

For all Centrifugal Pumps:

Impeller	: 1 no. for each variety
Impeller shaft and keys	: 1 no. for each variety
Bearings for pump	: 1 sets for each variety
Shaft sleeves	: 1 no. for each variety
Casing & Impeller wearing rings	: 1 set for each variety
Gland sealing arrangement (Mech. seal)	: 1 set for each variety
Washers of all sizes/types used	: 2 set for each variety
Pump and motor coupling	: 1 no. for each variety
Coupling pads/bushes	: 1 set for each variety
Impeller lock nuts	: 2 nos. for each variety
Gasket	: 1 set of each type
`O' ring	: 1 set of each type
Impeller sealing ring	: 2 nos. for each type
Pump motor bearings	: 1 set of each type

04.02.17 DIESEL ENGINE FOR PUMPSET

A) General

- The diesel engine shall be complete with all standard accessories, battery sets, battery charger, instruments & control panel, base frame etc. The noise level for diesel engine shall not exceed 85dBA at 1.0m distance or as per the latest CPCB (Central Pollution Control Board) norms. If required Acoustic enclosure to be provided

- The diesel engine shall be compression ignition mechanical direct injection type, capable of being started by a battery powered electric starter motor, and shall accept full load within 15 seconds from the receipt of signal to start.

- The diesel engine shall be natural aspirated, super charged or turbo charged and either air or water-cooled. In case of charge air cooling by means of a belt driven fan or of a belt driven auxiliary water pump, there shall be multiple belts such that half the belts should be capable of driving the fan or pump.

- The diesel engine shall be capable of operating continuously (24 hours) on full load.
- The diesel engine shall be provided with an automatically adjustable governor to control the engine speed with 10% of its rated speed, under any condition of load up to the full load rating. The governor shall be set to maintain rated pump speed at maximum pump load.
- The diesel engine shall be provided within-in-built tachometer to indicate the speed of the engine in rpm.
- Any manual device fitted to the engine, which could prevent the engine starting, shall return automatically to the normal position.
- Engines after correction for altitude and ambient temperature shall have bare engine horsepower rating of 10% in excess of maximum horse power required to drive the pump at its duty point.
- The coupling between the engine and the pump shall allow each unit to be removed without disturbing the other.
- The diesel engine capacity shall have a margin over its BHP absorbed at the pump shaft at duty point and the margin shall be 20% for engines of rating upto 200 HP and 15% for engines of rating above 200 HP.

B) Cooling System

- The engine shall be cooled by water from the discharge of the pump (takes off prior to the pump discharge valve) direct into the engine cylinder jackets via a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall be terminated at least 150 mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.
- The discharge from the engine shall be collected and drained into the nearest drainage channel.

C) Air Filtration

The air intake system ensures sufficient clean air to the engine. It shall incorporate the suction air filter, which shall be of oil bath type to supply clean air to the engine.

D) Exhaust System

The hot exhaust gases shall be let-off with suitable system. All the hot parts located at the working level shall be insulated. The exhaust system shall include:

- Exhaust manifold
- Silencer: The exhaust gas shall be let off through suitable silencer. The total back pressure shall not exceed the engine manufacturer's recommendation. Sufficient length of straight pipe shall be provided after the exhaust silencer to leave the gases at sufficient height 2 m above the roof of the engine room.
- Expansion joint in SS construction to reduce the forces and moment likely to be transmitted on the engine frame.

E) Fuel System

- Fuel for the engine shall be high-speed diesel oil as per IS : 1460 – 1974.
- Fuel tank and fuel feed pipe shall be provided for the engine.
- The fuel tank shall have the capacity sufficient enough to allow the running of the engine at full load for 4 hours.
- The fuel tank shall be of welded steel construction. The tank shall be mounted above the engine fuel pump to give gravity feed. The tank shall be fitted with a level gauge calibrated in liters, filling in and cleaning hand holes, drain cocks, self supporting from and connection to the engine fuel oil system.
- Valves in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and they shall be located in open position. Plastic tubing shall not be used.
- A duplex filter to suitable capacity shall be provided for the fuel feed pipe between the fuel tank and fuel pump.
- Suitable sludge and sediment trap shall be provided for the fuel feeding system.
- The fuel tanks shall be supplied with hand pump for tapping the fuel tank from oil barrel.

F) Lubricating System

The lubrication system shall be self-contained with the following equipment.

- Sump: To store sufficient lube oil for circulation, suitable sump shall be located in the engine.
- Pump: Suitable pump for forced lubrication.
- Filter
- Lubricating oil cooler
- Interconnecting piping & tubes in seamless construction.

G) Starting System

The engine shall be capable of manual starting by electric starter motor**.** Since the pump driven by the diesel engine is not required to run continuously for long period and the operation will not be frequent, special features shall be built –in the engine to allow it to start within a very short period, even if it has been remained idle for a considerable long period.

The engine shall be designed in such a way that is shall be started by one operator, if necessary, without any preliminary heating of the combustion chamber. All controls/mechanism, which has to be operated in the starting process, will be within easy reach of the operator.

Automatic cranking shall be effected by a battery driven 24V DC motor having high starting torque to have adequate ampere-hour capacity to provide the starting power for the diesel engine. A control panel for starting of the engine through battery to be provided. Engine START/STOP/TEST buttons shall be provided on control panel. The battery capacity shall be adequate for ten (10) Consecutive starts without recharging with a cold engine under full compression.

The battery shall be used exclusively for starting the diesel engine and kept fully charged all the time. Arrangement for both trickle and booster charge shall be provided. However, when the engine starts or is running, provision shall be kept to ensure that the charger is automatically disconnected and the battery is charged by the engine dynamo. At no times it should happen that the battery gets disconnected and is not available to start the engine.

The charger shall give constant D.C output voltage irrespective of incoming voltage variation specified. The charger shall be with fully controlled bridge circuit with diodes.

H) Governing System

The governor shall be fitted with a speed control device, which will control the speed under all conditions of load.

The governor shall offer the following features:

Engine should be provided with an adjustable governor capable of regulating engine speed within a range of 10% between shut-off and maximum load condition of the pump. The governor shall be set to maintain rated pump speed at maximum pump load. Engine shall be provided with an over-speed shutdown device. It shall be arranged to shut down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over-speed signal, until the device is manually reset to normal operating position.

The governor shall be capable of operating without external power supply.

I) Foundation Frame

Suitable foundation frame with foundation bolts & nuts shall be provided.

J) Instruments

The equipment shall be provided with necessary instruments to check the working of the engine continuously. The following instruments shall be minimum which will be provided and the same shall be fixed on a common instrumentation panel mounted directly on the engine base frame :

- Lubricating oil temperature indicator.
- Lubricating oil pressure indicator.
- Cooling water inlet temperature indicator.
- Cooling water outlet temperature indicator.
- Speed-cum-hour meter.

The pressure and temperature gauges shall be of reputed make. The following protections annunciation also shall be provided.

a. High cooling water outlet temperature
b. Low lubricating oil pressure

Any other instrument, control and protection equipment required for the safe operation of the engine shall also be provided.

All the pressure gauges, pressure transmitter, pressure switches etc. where viscous fluid enters inside the instruments shall be provided with diaphragm sealed flanged process connection with flanged isolation valves.

K) Spares & special tools

The Contractor shall furnish the list of spares & special tools including the following mandatory spares, in their scope of supply.

Two sets of fuel filters, elements & seals
Two sets of lubricating oil filters, elements & seals
Two sets of belts (where used)
Two sets of engine joints, gaskets & hoses
Two injector nozzles
Two complete sets of piston rings for each cylinder
Two inlet valve and two exhaust valves

In addition to the above, the bidder may include any other spare parts and special tools for maintenance/re-erection of the diesel engine/pump.

L) <u>Diesel Engine Tests</u>

Engine will be tested at test bed as per relevant standard as per details given below.

1. Before engine testing following details shall be recorded on engine test report.
   - Engine Sr. No.
   - Engine Model
   - Shop order No.
   - Fuel Pump Sr. No.
   - Ambient Temp and pressure
   - Testing Date
   - Test Bed No.
   - Tester/ Inspector

2. Start the engine and run at idle speed for some time.

3. Raise the load gradually and allow the performance parameter to reach steady state condition. Check power out put at full throttle as per specification and adjust if necessary. Note down following parameters on engine test report.

   - Time

- RPM
- Torque (N-M)
- BHP (Calculated)
- Fuel Pressure
- Fuel Rate
- Lube Oil Pressure
- Lube Oil Temperature
- Water Temperature
- Exhaust Temperature
- High Idle RPM
- Low Idle RPM
- Corresponding Lube Oil Pressure

@ High Idle and Low Idle RPM

- Governing %

Above parameters will be recorded at following load and duration.

Full load	-	60 Minutes
10 % Over Load	-	60 Minutes

4. Engine will be tested with standard test bed facilities.

For each of the items being manufactured/supplied, the following test certificates and documents, as applicable, in requisite copies including original shall be submitted to the Inspection Agency. All test certificates shall be endorsed by the manufacturer and the Successful Tenderer with linkage to the project, purchase order and acceptance criteria.

i) Raw materials identification and physical and chemical test certificates for all materials used in manufacture of the equipment/pipe.
ii) Static/dynamic balancing certificate for rotating components/machines.
iii) Pressure test certificates.
iv) Performance tests certificates for all characteristics.

Inspection at manufacturers' works shall not relieve the Successful Tenderer of responsibility for replacing at his own cost any defective part/material and repairing equipment for defective workmanship that may be discovered at site at a later date.

M) Accessories for the diesel engine :

Oil tank	:	1 set
Oil piping	:	1 set

Coupling (flexible coupling connecting the shafts of pump and engine)	:	1 Set
Coupling guard	:	1 No.
Battery	:	2 Nos per diesel
Battery charger	:	1 Nos per diesel engine
Cabling	:	1 set
Instrumentation	:	1 set
Panel for the engine	:	1 set
Companion flanges (suction and delivery side) of pump along with bolts, nuts, gaskets and washers	:	1 set
Exhaust piping along with common base plate, foundation bolts, nuts and washers	:	1 set

Contractor to provide diesel engine with all standard accessories, battery sets for auto starting, charger for battery, instrument & electrical panels, pressure switches etc. Rated power requirement of the diesel engine shall meet the requirement of clause no.7.4.5.2.3 of TAC manual (latest revision). The engine shall be capable of delivering the rated output continuously; (24 hours operation) shall run steadily at any load within its rated load, as specified in ISO: 3046. Suitable automatic governing system shall be provided. The fuel for the engine shall be high-speed diesel as per IS: 1460-1974. The diesel engine shall conform to Tariff Advisory Committee (TAC) requirements. The details refer to GTS. Exhaust pipe form the engine shall be extended beyond pump house and shall be terminated at 2 m above the roof of the building.

04.02.18 MATERIAL OF CONSTRUCTION FOR PUMPS

A) HORIZONTAL PUMPS:

Sl. No	ITEM	MATERIAL						
		Clear water/ Industrial Water(upto 12 kg/cm2)	Clear water/ Industrial Water(above12 kg/cm2)	Soft Water	DM Water	Drinking Water	Scale / Slurry Water	Surface Drain Water
a)	Casing	CI IS: 210 FG260	WCB	WCB	CF-8M	CI IS: 210 FG260	CI FG 260 2.5% NiCI or Chrome alloy BHN above 500	CI FG 260 2% NiCI
b)	Impeller	CF8M	CF8M	CF8M	CF8M	LTB 2 BR/ CF 8M	CA6NM or Chrome alloy BHN above 500	CIFG 260 2%NiCI
c)	Shaft	EN8	EN8	EN8	EN8	EN8	EN8	EN8
d)	Shaft sleeve	SS410	SS410	SS410	SS410	SS410	Chrome alloy BHN above 500	SS410
e)	Wearing rings	CI IS: 210 FG260	CI IS: 210 FG260	CI IS: 210 FG260	CI IS: 210 FG260	CI IS: 210 FG260	Chrome alloy BHN above 500	CI IS: 210 FG260
f)	Shims & packing	Bass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442	Brass IS: 442
g)	Neck ring	CI FG 260	CI FG 260	CI FG 260	CI FG 260	CI FG 260	Chrome alloy BHN above 500	CI FG 260
h)	Lantern ring	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220

Sl. No	ITEM	MATERIAL						
		Clear water/ Industrial Water(upto 12 kg/cm2)	Clear water/ Industrial Water(above12 kg/cm2)	Soft Water	DM Water	Drinking Water	Scale / Slurry Water	Surface Drain Water
i)	Gland	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220
j)	Bearing end	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220
k)	Bearing Housin	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220	CI FG 220
l)	Coupling Pump	CI FG 260	CI FG 260	CI FG 260	CI FG 260	CI FG 260	CI FG 260	CI FG 260
m)	'O' rings	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber	Nitrile Rubber
n)	Sleeve nuts	SS 410	SS 410	SS 410	SS 410	SS 410	SS 410	SS 410
o)	Cowl nuts	SS410	SS410	SS410	SS410	SS410	SS410	SS410
p)	Base plate	MS Fabricated	MS Fabricat	MS Fabrica	MS Fabricat	MS Fabricated	MS Fabricated	MS Fabricated

Note:
All pumps handling soft / DM water shall be provided with Mech. Seal.

04.02.19 Fire Water Pump set

01. FIRE WATER PUMP (DIESEL ENGINE DRIVEN) & DIESEL ENGINE DATA SHEET

A. FIRE WATER PUMP & DIESEL ENGINE DATA SHEET						
PLANT	1.	PROJECT	IGGL	4.	AMBIENT TEMP.	Max:50 deg.C Min: 01 deg. C
	2.	LOCATION	GUWAHATI	5.	TYPE OF FIRE HAZARD	CLASS A & B
	3.	ALTITUDE (ABSOLUTE)				
PUMP CHARACTERISTICS	6.	No. OF PUMPS	Six (06)	9.	SUCTION CONDITION	FLOODED
	7.	CAPACITY OF EACH PUMP.	785m³/hr	10.	OPERATION	PARALLEL
	8.	TOTAL HEAD - RATED	105mWC	11.	DUTY	CONTINUOUS
PUMP CONSTRUCTION	12.	TYPE OF PUMP	HORIZONTALLY SPLIT CASING			
MATERIAL OF CONSTRUCTION	13.	CASING	CI FG 260, IS: 210	17.	SHAFT SLEEVE	BRONZE Gr.2 IS: 318
	14.	CASING RING	BRONZE Gr.2 IS: 318	18.	WEARING RING	BRONZE Gr.2 IS: 318
	15.	IMPELLER	BRONZE Gr.2 IS: 318	19.	STUFFING BOX	Mechanical Seal
	16.	SHAFT	SS AISI 410	20.	LANTERN RING	BRONZE Gr.2 IS: 318
				21.	GLAND	CI, FG260, IS 210
LIQUID PUMPED	22.	TEMP.	55°C MAX.			

ACCESSORIES AND SERVICES REQUIRED	23.	MS COMPANION FLANGES WITH NUTS, BOLTS, GASKETS	YES	28.	RECOM. SPARES FOR TWO YRS. OF NORMAL OPERATION	YES
	24.	SS FOUNDATION BOLTS	YES	29.	ERECTION SUPERVISION	YES
	25.	COMMON BASE PLATE	YES	30.	COMMISSIONING	YES
	26.	COUPLING GUARD	YES	31.	PAINT	FIRE RED SHADE NO.536 AS PER IS-5
	27.	RECOM. MAINT. TOOL	YES			
DRIVE DATA	32.	PRIME MOVER	DIESEL ENGINE			
DIESEL ENGINE	33.	CYLINDER ARRANGEMENT	VERTICAL IN LINE	36.	COOLING SYSTEM	RADIATOR COOLED
	34.	WORKING CYCLE	4-STROKE DIESEL ENGINE	37.	STARTING SYSTEM OF THE ENGINE	24 V, ELECTRICAL SYSTEM
	35.	COMBUSTION SYSTEM	DIRECT INJECTION	38.	PAINT	FIRE RED, SHADE NO. 536 AS PER IS: 5

02. DATA SHEET OF DIESEL ENGINE:

1.	**PROJECT: IGGL GUWAHATI**
2.	**OWNER: M/s IGGL**
3.	**SERVICE: DRIVER FOR PUMP**

4.	NO. REQD.:	**ONE FOR EACH PUMP**
5.	NOTE: ■ SCOPE OPTION / INFORMATION SPECIFIED BY PURCHASER □ INFORMATION REQUIRED FROM VENDOR.	
6.	**SITE / INSTALLATION DATA**	
7.	**SITE CONDITIONS:**	
8.	**LOCATION: ■ INDOOR** ■ CLOSED ROOM WITH NORMAL AIR VENTILATION SYSTEM.	
9.	SITE DATA: AMBIENT TEMP. (^{0}C):	**MAX : 45 MIN : 8**
10.	RELATIVE HUMIDITY (%):	MAX : 85 %
11.	ALTITUDE (M):	
12.	EARTH QUAKE ZONE **V** WIND VELOCITY (KM/HR) **160 (MAX)**	
13.	**UTILITY DATA**	
14.	**COOLING WATER**	
➢	COOLING WATER TEMP. (^{0}C) SUPPLY (DESIGN/MAX/NOR/MIN): RETURN (MAX):	
➢	COOLING WATER PR. (KG/CM²G) SUPPLY (DESIGN/MAX/NOR/MIN): RETURN (MIN):	
➢	COOLING WATER CHARACTERISTICS:	

15.	**ELECTRIC POWER**
➢	ELECTRIC SUPPLY: AC / DC VOLTS HZ
16.	**APPLICABLE CODES & STANDARDS**
➢	NOISE SPECIFICATION: ■ APPLICABLE TO M/C **MAX. 85 DBA @ 1.0 M OUTSIDE THE PUMP**
➢	EXHAUST GAS EMISSION: - **STATUTORY REQUIRMENTS AS PER STATE POLLUTION CONTROL BOARD**
➢	LISTING/APPROVAL OF ENGINE REQUIRED FROM: □ UL/FM □ TAC
➢	SHELL AND TUBE TYPE EXCHANGERS MANUFACTURER'S STD.
➢	AIR COOLED HEAT EXCHANGERS/RADIATOR MANUFACTURER'S STD. □
➢	MAXIMUM BKW OF THE DRIVEN EQPT. KW: @ RPM
➢	FOR MECH. DRIVE APPLICATIONS: MINIMUM SITE RATING OF THE ENGINE REQUIRED KW @ RPM
➢	ACCOUNTING FOR ENGINE DERATION FOR SITE CONDITIONS & ALTERNATOR EFFICIENCY WITH ENGINE DRIVING ITS ALL AUXILIARIES.
➢	DIRECTION OF ROTATION OF DRIVEN EQUIPMENT VIEWED FROM COUPLING END :
➢	METHOD OF DRIVE: DIRECT THRU FLEXIBLE COUPLING OR V-BELTS
17.	**CONSTRUCTION FEATURES**
➢	MANUFACTURER: □ ENGINE MODEL:
➢	TYPE OF ENGINE: FOUR-STROKE ENGINE COOLING :

	➢ TURBO-CHARGED WITH CHARGE AIR COOLER □ NORMALLY ASPIRATED
	➢ NO. OF CYLINDERS: □ CYLINDER ARRANGEMENT:
	➢ BORE/STROKE (MM/MM): □ COMPRESSION RATIO:
	➢ SPEED (RPM): □ MEAN PISTON SPEED (M/SEC.):
18.	**PERFORMANCE**
	➢ RATED ENGINE POWER AT STANDARD OPERATING CONDITIONS AS PER ISO 3046/ BS 5514 (**ISO STD. POWER**): KW @ RPM
	➢ (USING ONLY THE ESSENTIAL DEPENDENT AUXILIARIES AND WITH 10 % OVERLOAD PROVISION
	➢ RATED ENGINE POWER AT SITE CONDITIONS GUARANTEED, NO NEGATIVE TOLERANCE): KW @ RPM
	➢ (USING THE ESSENTIAL DEPENDENT AUXILIARIES AND WITH 10 % OVERLOAD PROVISION
	➢ MIN. ENGINE SITE POWER AT, WHICH ENGINE CAN BE OPERATED CONTINUOUSLY. KW @ RPM
	➢ MIN. ENGINE SPEED & CORRESPONDING SITE POWER AT WHICH ENGINE CAN BE OPERATED CONTINUOUSLY. RPM @ KW

➢	STARTING TIME REQUIRED FOR FULL LOAD OPERATION (SECONDS):
➢	AIR FLOW REQUIRED FOR OPERATION OF THE ENGINE FOR: □ COMBUSTION & SCAVENGING □ COOLING & VENTILATION OF ENCLOSURE □ AIR COOLERS
➢	ESSENTIAL DEPENDENT AUXILIARIES ARE:
➢	ENGINE SHAFT DRIVEN RADIATOR FAN: KW
➢	ENGINE SHAFT DRIVEN CW PUMP: KW
➢	ENGINE SHAFT MAIN LO PUM: KW
19.	**SPECIFIC FUEL CONSUMPTION:**
20.	**SPEED GOVERNING SYSTEM**
➢	TYPE: □ SINGLE SPEED □ MULTIPLE SPEED □ ALL SPEED (VARIABLE SPEED)
➢	GOVERNOR TYPE: □ ELECTRONIC □ ELECTRO HYDRAULIC □ MECHANICAL
➢	MAKE: MODEL:
➢	GOVERNOR CONTROL MECHANISM: □ MANUAL □ REMOTE
21.	**STARTING SYSTEM**
➢	METHOD OF STARTING: AUTOMATIC
➢	METHOD OF STOPPING:
➢	TYPE OF COLD STARTING: (CONSIDERING MIN. AMBIENT

	TEMP
➢	TYPE OF STARTING SYSTEM: AIR STARTING THROUGH ENGINE MOUNTED PNEUMATIC
22.	**COOLING SYSTEM**
➢	TYPE: CLOSED CIRCUIT COOLING
➢	WATER PUMP DRIVEN BY: ENGINE
➢	COOLANT CIRCUIT PIPING WITH TEMP. CONTROL & MAKE-UP TANK.
➢	HEAT EXCHANGER WITH ANCHOR/FOUNDATION BOLTS: AIR COOLED EXCHANGER
➢	BY-PASS VALVE: CHECK VALVE:
➢	HEAT EXCHANGER TEMP (^{0}C) INLET: OUTLET:
➢	FAN DRIVEN BY: DRIVER □ RATING/SPEED (KW/RPM):
➢	ENGINE WATER TEMP (^{0}C): INLET: OUTLET:
23.	**FRAME LUBRICATION SYSTEM**
➢	TYPE: FORCE FEED LUBRICATION INCLUDING VALVES, OIL PUMP & PIPING
➢	OIL COOLER TYPE: □ □ AIR COOLED □ WATER COOLED
➢	OIL FILTERS □ SELF CLEANING □ DUPLEX □ PAPER CARTRIDGE

➢	PRELUBE OIL PUMP DRIVEN BY (IF REQUIRED):
➢	PRELUBRICATION □ MANUAL □ AUTOMATIC
➢	TYPE/GRADE OF LUB. OIL:
➢	OIL CONSUMPTION (LPH):
➢	OIL SUMP CAPACITY (LITRES):
➢	OIL COOLER TESTING PRESSURE (KG/CM²G):
➢	EXPLOSION RELIEF VALVE FOR CRANKCASE
24.	**AIR INLET SYSTEM**
➢	SUCTION AIR FILTER ■AIR INLET DUCTING / PIPING / MANIFOLDS INLET SILENCER
➢	EXPANSION BELLOWS (IF REQUUIRED) & ALL SUPPORTS / HANGERS
25.	**ENGINE EXHAUST SYSTEM**
➢	EXHAUST MANIFOLDS / DUCTING / PIPING TERMINATED AT SAFE HEIGHT OUTSIDE ENGINE ROOM EXHAUST SILENCER (RESIDENTIAL TYPE)
➢	EXPANSION BELLOWS ■ EXHAUST STACK / CHIMNEY ■ ALL SUPPORTS / HANGERS ■ PROTECTION INSULATION FOR COMPLETE EXHAUST PIPING
➢	PROVIDED AS ABOVE □YES □NO
26.	**INSPECTION AND TESTING**

➢	WITNESS ■ OBSERVE BY SUPPLIER □
➢	STAGE INSPECTION DURING MANUFACTURE
➢	FULL LOAD TEST AT ENGINE MANUFACTURER'S SHOPAS PER ISO (PERFORMANCE TEST)
➢	FUEL CONSUMPTION & GOVERNING TEST AT ENGINE MANUFACTURER'S SHOP AS PER ISO
➢	FULL LOAD TEST FOR 4 HRS FOR ENGINE WITH ALL AUXILIARIES & 1 HR @ 110 % LOAD AT SITE.
➢	NO LOAD MECHANICAL RUN TEST AT PACKAGER'S / DRIVEN EQUIPMENT MFR. SHOP
➢	VENDOR'S STANDARD MECHANICAL RUN TEST (FOR ALL ENGINE)
➢	INSPECTION/TESTING WITNESSED BY: □ OTHERS ■ M/S IGL OR THEIR REPRESENTATIVE
➢	CONTROL PANEL FUNCTION TEST
➢	PRIMEMOVER SHALL BE ALIGNED WITH PUMP AND TESTED FOR ALIGNMENT
27.	**MAINTENANCE DATA**
➢	EXPECTED PERIOD OF RUNNING BETWEEN TOP OVERHAULS: HOURS
➢	EXPECTED PERIOD OF RUNNING BETWEEN MAIN OVERHAULS: HOURS
➢	THE TYPE AND GRADE OF LUBRICATING OIL RECOMMENDED:
➢	LUBE OIL CONSUMPTION (KG/HR)/ (LITRES/HR)
➢	CHANGE OF LUBRICATING OIL AFTER:

	HOURS
28.	**SCOPE OF SUPPLY / WORK**
➢	ENGINE WITH LUBRICATION SYSTEM, GOVERNING SYSTEM, FUEL SYSTEM, COOLING SYSTEM AND STARTING SYSTEM AS SPECIFIED
➢	SUCTION AIR FILTER WITH SUCTIONPIPING
➢	INSTRUMENTS AND CONTROLS AS SPECIFIED
➢	INLET AND EXHAUST MANIFOLDS, EXHAUST PIPING WITH FILLINGS, BENDS AND INSULATION
➢	EXHAUST SILENCER (RESIDENTIAL, SPARK ARRESTING TYPE) WITH EXPANSION BELLOWS AND COMPLETE WITH EXHAUST PIPING FROM
➢	MANIFOLD TO OUTSIDE SHED WITH FITTINGS AND INSULATION.
➢	FLYWHEEL WITH BARRING DEVICE
➢	GUARDS FOR MOVING PARTS
➢	COUPLING FOR ENGINE - DRIVEN EQUIPMENT
➢	BASE PLATE FOR ENGINE & DRIVEN EQUIPMENT
➢	SPARES AS PER ORDER
➢	ERECTION AND COMMISSIONING SPARES
➢	TORTIONAL ANALYSIS REPORT ON ENGINE
➢	REFER TECHNICAL SPECIFICATION FOR COMPLETE SCOPE OF SUPPLY
➢	FOUNDATION/ ANCHOR BOLTS
➢	ANTI VIBRATION PADS
➢	FIRST FILL OF LUBRICATING OIL AND COOLANT.

REMARKS:

Pump Casing, Impeller & other internal part should be suitable for handling saline water also.

Any other details and requirements pertaining to pumps shall be in line with the Standard Specification For Centrifugal Pumps-Document No.- MEC/TS/05/28/081/05

03. FIRE WATER PUMP DATA SHEET (JOCKEY PUMP)

A. FIRE WATER PUMP DATA SHEET (JOCKEY PUMP)						
PLANT	1.	PROJECT	IGGL	4.	AMBIENT TEMP.	Max:50 deg.C Min: 01 deg. C
	2.	LOCATION	GUWAHATI	5.	TYPE OF FIRE HAZARD	CLASS A & B
	3.	ALTITUDE (ABSOLUTE)				
PUMP CHARACTERISTICS	6.	NO. OF PUMPS	Two (2)	9.	SUCTION CONDITION	FLOODED
	7.	CAPACITY OF EACH PUMP.	10 m3/hr	10.	OPERATION	PARALLEL
	8.	TOTAL HEAD - RATED	105 mWC	11.	DUTY	INTERMITTENT
PUMP CONSTRUCTION	12.	TYPE OF PUMP	END SUCTION			
MATERIAL OF CONSTRUCTION	13.	CASING	CI FG 260, IS:210	17.	SHAFT SLEEVE	BRONZE Gr.2 IS:318
	14.	CASING RING	BRONZE Gr.2 IS:318	18.	WEARING RING	BRONZE Gr.2 IS:318
	15.	IMPELLER	BRONZE Gr.2 IS:318	19.	STUFFING BOX	Mechanical Seal
				20.	LANTERN RING	BRONZE Gr.2 IS:318

	16.	SHAFT	SS AISI 410	21.	GLAND	CI, FG260, IS 210
LIQUID PUMPED	22.	TEMP.	55°C MAX.			
ACCESSORIES AND SERVICES REQUIRED	23.	MS COMPANION FLANGES WITH NUTS, BOLTS, GASKETS	YES	28.	RECOM. SPARES FOR TWO YRS. OF NORMAL OPERATION	YES
	24.	SS FOUNDATION BOLTS	YES	29.	ERECTION SUPERVISION	YES
	25.	COMMON BASE PLATE	YES	30.	COMMISSIONING	YES
	26.	COUPLING GUARD	YES	31.	PAINT	FIRE RED SHADE NO.536 AS PER IS-5
	27.	RECOM. MAINT. TOOL	YES			
DRIVE DATA	32.	PRIME MOVER	MOTOR			

Pump Casing, Impeller & other internal part should be suitable for handling saline water also.

04. INFORMATION TO BE FURNISHED BY THE TENDERER FOR BOREWELL PUMPS(SUBMERSIBLE), BOREWELL WATER TRANSFER PUMP(P1A), FIRE WATER PUMPS, CIRCULATION WATER PUMPS :-

INFORMATION TO BE FURNISHED BY THE TENDERER FOR FIRE WATER MAIN PUMP			
I	**PUMPS**	**:**	
1	MAKE & MODEL	:	
2	TYPE	:	
3	PUMP CAPACITY, m3/hr	:	
4	HEAD, mWC	:	
5	NO. OF PUMPS OFFERED	:	
6	OVERALL EFFECIENCY	:	
7	RPM OF PUMP	:	
8	POWER ABSORBED BY PUMP, kW	:	
9	MATERIAL OF CONSTRUCTION	:	
	CASING	:	
	IMPELLER	:	
	SHAFT	:	
	SHAFT SLEEVE	:	
	WEARING RINGS	:	
10	PRIME MOVER	:	
11	TYPE OF SHAFT SEALING	:	
12	BEARING LUBRICATION	:	
13	a) SHAFT POWER AT DUTY POINT b) SHAFT POWER AT 150% OF RATED DISCHARGE	:	
14	NOISE LEVEL (MAX). (AT ONE METER AWAY)	:	

15	MODE OF CONNECTION TO PRIME MOVER	:	
16	VIBRATION LEVEL (UNFILTERED)	:	
	MATERIAL OF CONSTRUCTION		
17	BASE PLATE TYPE	:	
18	WEIGHT - PUMP - BASE PLATE - PRIME MOVER	:	
19	TYPE OF COUPLING	:	
20	ACCESSORIES INCLUDED		

05. INFORMATION TO BE FURNISHED BY THE TENDERER FOR DIESEL ENGINE

INFORMATION TO BE FURNISHED BY THE TENDERER FOR DIESEL ENGINE			
Sl. NO.	**SPECIFICATION**	**UNIT**	
1	Make & Model	:	
2	Type	:	
3	No. of cylinders		
4	Direction of Rotation as seen from driven end		
5	Compression ratio		
6	Bore	mm	
7	No of strokes	mm	
8	Total displacement	cm^3	
9	Firing order (From Flywheel end)		
10	Peak pressure	kg/cm^2	
11	B.M.E.P. at rated speed & continuous power output	kg/cm^2	
12	Engine Speed :		
	Max. Operating (continuous rating)	rpm	
	Min. Operating speed (under loaded condition for continuous duty applications)	rpm	

	Min. idling speed	rpm	
13	Rated output at rated speed and Ambient conditions prevailing at site.	kW	
14	Derated capacity	Hp	
15	Type of Lubrication		
16	Lube oil consumption for well run-in engine		
17	Fuel injection pressure	Kg/cm²	
18	Specific fuel consumption (SFC) at rated speed for full load		
19	Height of fuel tank to be located from Diesel engine base frame	mm	
20	Overall dimensions of Standard engine with pump-		
	Length	mm	
	Width	mm	
	Height (total)	mm	
	Height (below crank shaft center line)	mm	
21	Weight / load of engine and pump (static / dynamic)	Kgs.	
22	Details of fuel tank.		
a	Type of construction		
b	Capacity (min 6 hrs running)	Lts	
c	Accessories		

6.0 DATA SHEET FOR ELECTRICS (Details to be furnished by tenderer)

MOTOR TECHNICAL DATA SHEET (Shall meet the minimum requirements specified under cl.5.0) To be submitted along with the offer

A. MOTOR DETAILS

1. Name of manufacturer

2. a) Rated voltage

   b) Voltage variation

3.	a) Rated frequency	
	b) Variation in frequency	
4.	No. of phases	
5.	a) Motor kw at _ 0 c ambient	
	b) Motor kw at 40 0 c	
6.	Frame size	
7.	a. Rated speed	
	b. Rated slip	
	c. Rated P.f	
	d. Rated efficiency	
8.	Enclosure class of protection	IP -
9.	Hazardous area suitability	- NA-
10.	Class of Insulation	
11.	Temperature rise above _ 0 c ambient	
12.	a) Locked rotor current / rated current	
	b) Starting torque / Rated torque	
	c) Pull out torque / rated torque	
13.	a) No. of equally spread starts / hour	
	b) No. of successive starts from cold condition	
	c) No. of successive starts from hot condition	
14.	External paint shade	
15.	Epoxy based painting	
16.	Terminal Box location (viewed from DE side	R.H.S / LHS
17.	Space heaters provided	

18. Temperature detectors provided

a) Type PTC / Pt-100

b) No. of detectors

19. Vibration level

20. Noice level at 1 mt (dba)

21. Bearings

a) Type – DE / NDE

b) Grease lubricated & Type of grease

c) Regreasing nipple provided

d)Expected bearing life (LIO)

22. Earthing details

23. Approx total weight

B. CONNECTED LOAD DETAILS

1. Connected load type

2. Connected load tag no

3. Shaft absorbed kw

4. Coupling type

C. ELECTRICAL & INSTRUMENTATION

Diesel engine control panel

i Type and make:
ii Control description :
iii Dimensions :
iv Typical control scheme :

Details of components (For diesel engine control panel)

(Please fill up data of the items applicable to the panel)

a) S/F units

i) Make :
ii) Type :
iii) Rating :
iv) Fuse type & make :
v) Contacts :
vi) Padlocking facility in OFF position :
vii) Availability of auxiliary contact :

b) Air breaks contactors/relays auxiliary

i) Make :
ii) Type :
iii) Rating :
iv) Max. rating fuses for s/c protection :

c) Timers

i) Make/ Type :
ii) Coil voltage :
iii) On delays / Off delays :
iv) Time adjustment range :
v) Timed NO / NC contacts :

d) Whether reset PB is provided :

e) Ammeter & voltmeter

i) Make :
ii) Type :
iii) Size :
iv) Accuracy class :
v) Range :
vi) Mounting type :

f) CTs

i) Make :

ii) Type :
iii) Class :
iv) Ratio :

g) Push buttons

i) Make :
ii) Type :
iii) No. of contacts :
iv) Rating of contracts :
v) Rated voltage :

h) Indicating lamps

i) Make :
ii) Type :
iii) Voltage :
iv) Wattage :
v) Series resistor ohms and wattage :

i) Mushroom head PB station

i) Make :
ii) Type :
iii) No. and rating of contacts :
iv) Enclosure type :

j) Wiring

i) Materials of conductor :
ii) Size :
iii) Type :
iv) Voltage grade :

k) Control transformer

i) Make :
ii) Type :
iii) Rating in kVA, voltage :

l) Terminal block

i) Make :

ii) Rating :

m) Cables

i) Make & type :
ii) Voltage grade :
iii) Applicable standard :

Details of battery and battery charger equipment

n) Battery

i) Make and type :
ii) No. of cells :
iii) No. of plates/cell :
iv) Amp. Hour rating :
v) Type of connectors & material :
vi) Boost charge voltage/cell :
vii) Trickle charge voltage/cell :
viii)Voltage at the end of 10 hrs. discharge :
ix) Applicable standard :
x) Type of cell container :
xi) Weight of cell with and without acid :
xii) Overall dimensions of each cell :
xiii) Overall dimensions of battery stand :
xiv) Total weight of battery & stand :

o) Battery Charger

i) Make & type :
ii) Whether DC output voltage constant:
iii) Protections :
iv) Provision for boost & trickle charging:
v) Panel GA drawing

04.02.20 RUBBER EXPANSION JOINTS

EQUIPMENT SPECIFICATION

Material specification:

Rubber Expansion Joints shall be made of high grade abrasive resistant natural rubber compound reinforced with adequate numbers of piles of heavy cotton duck, rayon cord, impregnated within rubber compound and further reinforced with square metal ring embedded in it. The outer exposed surface of rubber expansion joints shall be given a coating of synthetic/neoprene rubber and further painted with chlorinated rubber based paint. Rubber expansion joints will be suitable for design temperature of 50^{0}C and for handling clear water. Rubber expansion joints shall absorb vibration, shock and axial compression of 10 mm, axial elongation of 10 mm and lateral movement of 10 mm.

Control unit:

One set of control unit (stretcher bolt assembly) consisting of 2/3 nos. limit/tie rod (material IS: 3657 Gr. 6.6), Stretcher Bolt, Triangular Plate (material IS:226), Nuts (material IS:1363 Gr. 6.O) Steel Washer and Rubber Washer of durometer hardness of 100deg Centigrade +/- 5 deg Centigrade.

The control unit shall be made suitable to make RE joint and no. of limit/tie rod matched against each.

TECHNICAL PARAMETERS OF RUBBER EXPANSION JOINT

1. Test pressure : 18 kg/cm2 or as per relevant standards
   Max. Pressure (operating) : 12 kg/cm2
   Design pressure : 16 kg/cm2
   Burst pressure (Guaranteed) : 4 times design pressure

2. Leak test to check leak tightness : 18 bar(g), joint shall be kept immersed in water bath

3. Length : As per relevant Standard

4. Tie rod : 2 tie rods up to DN65.
: 3 tie rods from DN 80 to DN300.
: 4 tie rods above DN350 and above.

5. Material of construction
Body : Natural rubber compound
Cover : Neoprene rubber
Tie rod : Carbon steel

6. Design temperature : Normal 40 Deg Centigrade
Max 80 Deg. Centigrade (Worst Case)

7. End connection : Carbon steel forged loose flanges at both ends, with dimensions as per IS: 6392

04.02.21 DESIGN CRITERIA FOR VALVES:

Flow control /isolating valves, drain valves, air release valves and Compensators, wherever necessary, shall be provided for the complete pipe network including cross- country pipeline.

Motor operated valve shall be integral type complete with electric motor, starter, necessary gear drive, position limit switches, torque switches and all accessories as required. The valves shall also have hand wheel for manual operation.

All valves shall be suitable for service conditions i.e. quality of fluid, flow temperature and pressure under which they are required to operate.

All valves shall be minimum PN 16. The valve size shall be same as the size of pipeline.

Valves shall be provided on pipe network for isolation of pipe section and equipment, control of pressure and flow, venting, draining etc. They shall be suitable located considering ease of operation and maintenance. Unless there is change in flow quantity in the pipeline, the valve size shall be same as the size of pipeline.

All valves shall be provided with hand wheel and position indictor. The face of

each hand wheel shall be clearly marked with words "Open" and "Shut" with arrows adjacent to indicate the direction of rotation.

Valves shall be provided with suitable extension spindle and head stock assembly wherever required. In case gears or bevel system are used, these shall be of cast steel housing only.

a. SPECIFICATION FOR Butterfly valves:-

The butterfly valves shall be designed for bidirectional flow and shall be tested at works accordingly.

Sl No	Description	Material
01	Body	Cast steel ASTM A216 GR WCB
02	Shaft	Stainless Steel AISI 410
03	Disc	SS, CF8M
04	Seat -Body / Disc for metal seated valve	Stainless Steel CF8M
05	Seat -Body / Disc for soft seated valve	Neoprene /EPDM
04	Bearing	BS 1400 LG2 Leaded Gun Metal Bronze
05	Pressure testing	BS 6755 Part I
06	Manufacturing Standard	BS 5155 / AWWA C-504/API 609/IS 13095
07	Face to Face Dimension	short body BS EN 558 Series 13
08	Flange Drilling standard	BS EN 1092 PN16
09	Test certificate service	For Physical/chemical analysis & metallurgical
10	External Fasteners	A193 B7/A194 2H

11	End connections	Upto DN 150 - Wafer/lugged/flanged Above DN 150 – Lugged/Flanged

b. SPECIFICATION FOR Dual Plate Zip Check valve

1	Type	Dual Plate Zip Check Valve
2	Body	ASTM A 216 Grade WCB
3	Closure Plate	ASTM A 351 Gr. CF8 M (SS 316)
4	Stop Pin	AISI SS 410
5	Hinge pin	AISI SS 410
6	Spring	INCONNEL
7	Retainer	CF8M (SS 316)
8	Body Bearing	AISI SS 316
9	Plate Bearing	AISI SS 316
10	Spring Bearing	AISI SS 316
11	Design Standard	API 594
12	Dimensions	As per API 594
13	Testing	As per API 598
14	Special features required	1. Arrow indicating the flow direction. 2.Embossed name plate giving details of tag No. size, etc.
15	End Connections	Flanged

c. SPECIFICATION FOR LIFT CHECK VALVE (Size up To DN40)

1	Type	Lift Check Valve
2	Body	Forged Carbon Steel, ASTM A 105
3	Cover	Forged Carbon Steel, ASTM A 105
4	Seat ring	SS AISI 410
5	Disc	SS ASTM A 217, Gr CA15
6	Gasket between cover & Body	Spiral wound SS 304 filled with Graphite
7	Cover Bolt	Alloy Steel ASTM A 193 Gr B7
8	Spring	SS 316
9	Manufacturing Standard	API 602
10	Testing Standard	API 598

11	End connection	Screwed ends/Flanged end

d. SPECIFICATION FOR GATE VALVE

Sl No.	Description	Material
01	Type	Gate valve with rising spindle & bolted Bonnet.
02	Body /Bonnet	CS ASTM A216 Gr.WCB
03	Wedge	CS ASTM A216 Gr.WCB + 13% Cr.
04	Stem / Disc	AISI 410
05	Gland Bush	AISI 410
06	Gland flange	CS A216 Gr.WCB
07	Stud, Stud Nut, Eye Bolt nut	ASTM 193 Gr.B & 2H
08	Gland Packing	Graphoil
09	Hand wheel	Carbon steel / SGI
10	End Connection	Threaded/socket welded upto DN 40, DN 50 & above Flanged
11	Manufacturing Standard	API 600/BS 1414/IS14846
12	Pressure testing	API 598
13	Face to Face Dimension	API 600 / IS 14846

e. SPECIFICATION FOR GLOBE VALVE (CAST STEEL)

Sl No.	Description	Material
01	Type	Globe valve
02	Body/ Bonnet	CS A216 Gr. WCB

Sl No.	Description	Material
03	Disc	ASTM A351 CF8M
04	Stem	AISI 410
05	Body / Disc seat	AISI 410
06	Seating surface & rings	AISI 410
07	Hand wheel	ASTM A 216 Gr WCB
08	Gland, Gland plate, disc spindle nut	AISI 410
09	Gland Packing	25% Carbon filled PTFE rings
10.	Manufacturing standards	BS 1873/ API 600
11	End connection	Screwed upto 40 mm except otherwise mentioned. Flanged end for 50mm and above
12	Pressure Testing	As per BS 6755 Part I/API 598

f. SPECIFICATION FOR GLOBE VALVE (Gun Metal)

1	Type	Globe valve for water supply pipelines
2	Body & Bonnet	GM to IS : 318-1981,(RA'91)Gr LTB – 2,
3	Wedge	GM to IS : 318-1981(RA'91) Gr LTB – 2,
4	Stem	Stainless steel
5	Back seat	GM to IS : 318-1981(RA'91) Gr LTB-2
6	Seating surface & rings	Malleable Cast Iron ASTM A-4 Gr - 32510
7	Hand wheel	Cast Iron to IS:210-1993 Gr. FG-200
8	Gland, Gland plate disc	Non-ferrous alloy
9	Gland Packing	Asbestos IS:2712-1979
10	Pressure rating	PN = 1.6 N/mm2
11	Manufacturing standard	IS:778-1984 (RA 1990)/IS:781-1984

12	Max. operating temp	65 deg C
13	End connection	Screwed upto 40 mm except otherwise mentioned. Flanged ends for 50 mm & above, IS:6392-1971 (RA-1988), table 17
14	Hydro static testing	Shell test = 24 kg/cm2 Seat test = 16 kg/cm2 Back seat test = 16 kg/cm2 Test Duration – 2 min
15	Special features required	1- Arrow indicating flow direction
		2-Embossed name plate giving details of tag no., type & size

g. SPECIFICATION FOR CI / BRONZE PLUG VALVES

1	Type	DN 65 and above: C.I. Two way, lubricated type, tapered plug : Sizes up-to DN50: Bronze, T port 3 way lubricated type tapered plug
2	Body, Cover & Gland	CI as per IS:210-1993 FG 220 / Bronze as per IS:318 LTB-2
3	Plug	CI as per IS:210-1993 FG 220/ Bronze as per IS:318 LTB-2
4	Fasteners	Black Hexagonal bolt with nut as per IS:1364 Part 1 & 3,1992, class 4.6/4
5	Gland Packing	Non- Asbestos
6	Gaskets	Non- Asbestos
7	End connection	Screwed end up-to DN50, NPT/Flanged end for DN65 & above as per IS: 6392-1971 (RA'88) with matching flanges, table-17.
8	Pressure rating	PN = 1.6 N/mm^2
9	Manufacturing Standard	BS 5353/API 599

10	Hydro static testing	Body:24 kg/cm2 Seat:16 kg/cm2
11	Test certificates	Required for material/hydro test
12	Service	Cooling water for Blast furnace stove and stove
13	Max. operating	50 ^{0}C
14	Gear arrangement	Worm gear of C.S./forged steel
Note: 1.Type of threading for screwed end will be as per IS: 554 -1999. 2. Plug valve of size DN200 shall be provided with worm gear arrangement.		

h. SPECIFICATION FOR BALL VALVE / FULL BORE / 2 WAY / 3 WAY CAST STEEL

Sl	Description	Material
01	Type	Two piece (upto DN 50) / Three piece (above DN 50), Reduced bore, floating
02	Body & Connector	Cast steel ASTM A216 GR WCB
03	Ball	SS , ASTM A 351, Gr. CF 8M
04	Seat	PTFE
05	Stem	AISI 316
06	Body Seal	PTFE
07.	Gland & Stem Packing	35 % Carbon filled PTFE
08	End Connection	Screwed NPT/Socket end for less than 50mm, Flanged for 50mm & above. Socket weld connection with nipple of 100 mm (sch40 seamless pipe) welded
09	Fasteners	HT, SS 304 only
10	Operation	Lever operated

Sl	Description	Material
11	Valve Design	BS 5353/API 599
12	Pressure testing	As per BS 6755 Part I
13	Pressure rating	PN = 1.6 N/mm^2
14.	Face to Face	ANSI B 16.10
15.	Flange dimension	ANSI B 16.5
16	Max. operating temp	100 Deg ^0C

i. SPECIFICATION FOR AIR RELEASE VALVE

1	Type	Air release valves as per IS: 14845- latest standard total tamper proof design.
2	Body, Cover and Cowl	CI FG 200 as per IS 210
3	Small orifice Air release	Bronze/ St. Steel (IS 318 GR LTB2/ SS 304)
3	Floats small and large	Timber core with vulcanite/ rubber coating/ SS 304 /ss316
4	Seat Ring	IS 318 GR LTB2
5	Pressure rating	PN 1.6 N/mm2
6	Test pressure	As per IS 14845

j. SPECIFICATION FOR BALL FLOAT VALVE

1	Type	Single - beat type with balancing piston

2	Body/Cover/Gland/Piston	Cast iron Gr 200 as per IS 210-1993
3	Seat ring/valve guide	IS 318 Gr 2
4	Pilot valve seat/face	IS 318 Gr 2
5	Links	M.S. cadmium plated
6	Face ring/piston cups	Leather
7	Lever	M.S.
8	Float	Tinned copper
9	Pressure rating	PN = 1 N/mm^2
10	End connections	Flanged end, IS: 6392-1971(RA'88) 50 mm and above. Screwed end upto 40 mm. Threading as per IS: 554/BSP Thread.
11	Hydrostatic testing	Body - 15 Kg/cm^2

k. SPECIFICATION FOR COMPANION FLANGES

1	Type	Raised face plate flanges, Slip-on, welded, plate fabricated, machined finish.
2	Dimensional Standard	As per IS-6392-1971(RA'88), as per valve rating, Table-17/11, drilled off centre, RF. / As per BS EN 1092 PN 16/ ANSI B 16.5 / AWWA C 207 CLASS D
3	Material	C.S as per IS-2062 -1992 GR. 250A.
	Note: Valve flanges and matching flanges shall be drilled as per IS: 6392-1971 (RA'1988), table 17 for PN 1.6.	

Nominal size of the valve, make, pressure rating shall be cast on the body of the valve.

04.02.22 COOLING TOWER DESIGN DATA :

Sl. No.	Parameters	FRP Cooling tower
1.	Quality of Inlet Water	Borewell water
2	Type of Cooling Tower	Cross/ Counter Flow
3	Inlet water flow per cell	20 m3/hr (1W+1S)
4	Total water Flow rate	20 m3/hr
5	Temperature	
	- Hot Water (Inlet)	By Bidder
	- Cold Water (Outlet)	By Bidder
	Temperature Rise	By Bidder
	- Wet Bulb (Design)	290C (To be checked)
6.	No. of Fans per cell	one

MATERIAL OF CONSTRUCTION (MOC) FOR FRP COOLING TOWER

Sl No	Component	Material recommended
1.	Structural members / Supports	FRP Pultruded
2.	Casing / Cladding	Fiber glass reinforced polyester (FRP)
3.	Fill	PVC/Polypropylene
4.	Fill supports	Pultruded FRP
5.	Drift eliminator	PVC
6.	Louvers	FRP
7.	Cold water basin (over RCC tank roof / on ground)	As per manufacturer's design and retention time (to be specified clearly in offer with GA) RCC
8.	Hot water distribution system	PVC pipe with polypropylene nozzles / FRP basin with replaceable polypropylene nozzles installed in the basin floor.
9.	Access ladders with Cage	HDG
10.	Fan blades	FRP
11.	Fan guard	G.I. wire
12.	Fan hub	HDG Steel & Hardware SS 304
13.	Fan drive shaft	SS 304
14.	Hard wares / Fasteners	SS 304

15.	All other steel and iron parts except distribution valves and gear cases	HDG Steel

04.02.23 WATER CONDITIONING CHEMICALS – Design Criteria

All chemicals shall be supplied in liquid form.

Scale / Corrosion Inhibitors.

- The scale / corrosion inhibitors shall be preferably of Phosphate – Organo phosphonate type.
- For soft water cooling with high heat flux system with soft water shall be conditioned with Nitrite, Borate, Azole, Polymer since we cannot use Phosphate, Phosphonate for the reason if any CaH (Calcium Hardness) slipped out of the softener will form scale with Phosphate. Once phosphate reacts with CaH it will be immuned by corrosion protection. The phosphonate also would get reverted to phosphate due to high temp. Also Nitrite, Borate, Azole, Polymer contains buffering agent, which helps in maintaining the pH of water in the proper range and gives metal conditioning treatment.
- Suitable Iron dispersant / anti foulants etc. may be blended in the chemical if required for any particular system.
- The chemicals shall be continuously into the circulating water by metering pumps at the required dosage rate.
- These chemicals shall be supplied in Carboys.

A) Deposit control agents

Tenderer shall indicate the trade name, composition, appearance, odor, pH optimal, pH after dosage, solubility gravity dosage, feeding dosage, solubility, specific gravity dosage, feeding procedure at feeding points of the deposit control agent.

B) Corrosion inhibitors

Suitable corrosion inhibitors shall be used for the control of corrosion in open

re- circulating cooling water systems. The corrosion inhibitor shall be fed to the re- circulating water, wherever found necessary, by means of a metering pump. Corrosion resistant feeding equipment shall be used.

Tenderer shall furnish the trade name, composition, appearance, specific gravity, pH recommended dosage, optimal pH after dosage, solubility, and freezing point, feeding procedure and feeding points of the corrosion inhibitor.

C) Anti-foulants

Suitable anti-foulants shall be applied for the prevention and removal of iron oxide and other metallic oxides in the water re-circulating systems wherever found necessary. The anti-foulants shall have good dispersing properties.

Tenderer shall furnish the trade name, composition appearance, pH specific gravity, solubility, freezing point, recommended dosing rate, feeding procedure and feeding points of the anti-foulants.

D) Biocides

Suitable biocides shall be provided for the control of bacterial, fungal and algal growth in the re-circulating cooling water systems. The biocides shall have good solubility and dispersing properties to ensure good distribution throughout the system and efficient penetration of the slime masses, to the encountered. Dosing rate and dosing points shall be judiciously selected based on the water analysis and the test to be carried out taking the following factors into consideration:

i) The nature and extent of the anticipated microbiological contamination for the different re-circulating water systems.
ii) The type and volume of systems to be treated.
iii) Quality of the makeup water
iv) The degree of recommended control of microbiological contamination.
v) Retention time in the system.

Tenderer shall furnish the trade name, composition, appearance, odour pH, solubility, freezing point, recommended dosage and procedure of feeding for the biocide.

- Two types of biocides shall be provided for dosing into each system. Each type of biocide will be dosed alternately.

- The biocides shall be selected considering slug dosage after every 15 days
- The selected biocides shall be effective against all types of micro-organisms including Iron bacteria, Sulphate reducing bacteria, algae and fungi etc.
- These chemicals shall be supplied preferably in carbuoys having sizes suitable for convenient handling.

E) MONITORING CHEMICALS

- The tenderer shall provide all the monitoring chemicals required for monitoring of system variables which control the dosage of chemicals.
- The system variables will be measured three times a day i.e. once every shift.
- The tenderer shall clearly furnish the list of chemicals along with quantity of monitoring chemicals proposed for the system.
- These chemicals shall supplied in Kits. Each kit shall have all required chemicals and measuring jars and instruments etc. for monitoring the variables. One such kit shall be supplied for each of the pump house.

  The dosing chemicals shall preferably have minimum shelf life of one year. The chemicals shall not degrade while storage in an ambient temperature of 500 C.

  The chemicals shall not inflame when exposed to sunlight / naked flame.

  The chemical shall not produce excessive fumes and odour which are harmful to human beings.

  The material of carboys and drums shall be chemically non reactive to the chemical stored in it shall be supplied.

F) DOSING SYSTEM FOR SCALE / CORROSION INHIBITORS

A structural platform shall be provided by the Contractor in the pump house for stationing the dosing pumps. This platform shall be constructed at a suitable height so that either 200 lit. Drums or small carbuoys can be stationed below the platform and the dosing pumps shall draw the liquid from the drums / carbuoys and pump it through the pipelines upto the dosing point.

G) DOSING PUMPS

All chemicals for scale and corrosion inhibition are required to be dosed continuously at a constant rate and shall be dosed by metering pumps.

2 Nos. metering pumps (1 working & 1 standby) shall be provided for each chemical.

The metering pumps shall be electronically controlled electro-magnetically driven with stroke and frequency setting arrangement and shall be complete with lub rings, check valves in suction and delivery, suction tube, foot valve and ant siphon / backpressure valve etc.

Pump flow rate shall be adjustable from zero to 100 percent of the specified rated capacity even while the pump is in operation. The stroke adjuster shall have requisite graduations to indicate the set flow rate and shall be fitted with a locking arrangement so that the preset capacity does not change during pump operation. It shall also have suitable internal stops to prevent its detachment at settings below zero percent and above 100 percent.

Pumps shall be driven by electromagnetic power unit consisting of an epoxy moulded coil. The capacity of pump each chemical shall be decided by the tenderer depending on recommended dosage.

The MOC of chemical dosing pumps should be non-corrosive and polypropylene based. MOC of chemical dosing tanks shall be HDPE preferably.

H) PIPING

A piping network between the dosing stations and the dosing points shall be provided by the tenderer.

HDPE/UPVC/CPVC piping shall be used for pumping of the chemicals based on the suitability.

I) MONITORING APPRATUS

All monitoring apparatus like corrosion coupons, slides for bio testing etc. required for proper monitoring of each system shall be supplied and installed.

J) REPORTS

Three types of reports shall be furnished.

Test Reports

The test reports shall be furnished at an interval of every 1 months. The report's contents shall cover but not limited to the following items:

a) Predicted performance curves for the system with respect to corrosion rates and scale deposits

b) Actual performance curves

c) The details of variation in the various critical parameters being monitored in each shift for the previous period.

d) The dosage rate maintained during the period and its variation.

Monitoring reports

The monitoring reports shall be submitted every 2 months interval. The monitoring report shall include but not limited to the following:

a) Water loss figures, make-up water quantity for each system.
b) Health report of cooling tower
c) Actual cycle of concentration for various systems
d) Suggestions for improvement in cycle of concentration without affecting the guaranteed performance.
e) Suggestions for reuse of blow down of each system.

Chemical consumption reports

The report shall be furnished to Purchaser on a monthly basis. The report shall include the following:

a) Inventory position of each chemical
b) Ordered quantity
c) Chemical consumption figures for the previous month.

K) CONTROL PANEL

The control panel will be common for all the Chemical Dosing pumps of one dosing system and shall be suitable for mounting inside the Pump House Bay. The control panel shall be made of 2.5 mm thick CRCA sheet steel with IP-55 enclosure and shall be of floor / wall mounted type. The Chemical Dosing Pumps shall work in LOCAL made as per the control philosophy offered by the Tenderer.

The control panel shall consist of the following:

- Incoming MCCB of suitable rating.
- Outgoing feeders for all the Chemical Dosing Pumps consisting of fuses, contractors of minimum 32 Amp rating, thermal overload relays with built in single phasing preventer.
- All the control and protection components like HRC fuses, MCBs, relays, auxiliary contractors, selector switches, step-down control transformer, timers, push buttons, Power and control terminal blocks etc.
- LED indication lamps for incoming power supply ON, individuals Chemical Dosing Pumps ON / OFF / TRIP, etc.

L) FLUSHING OF CIRCULATING WATER PIPELINES

The tenderer shall ensure that the pre-cleaning chemical at the designed rate is being dosed in the flushing water during flushing of the circulating water pipelines.

M) PASSIVATION OF CIRCULATING WATER PIPELINES

The tenderer shall ensure that the Chemical quantity in the water during initial filling of circulating water pipelines is as per the designed quantity to ensure proper passivation of the piping network.

N) NORMAL OPERATION

During normal operation the tenderer shall ensure proper dosage of chemicals inside the circulating water.

All the manpower, equipments, consumables and chemicals required during testing, commissioning and normal operation shall be provided by the tenderer.

O) PERFORMANCE GUARANTEE

The Complete system shall be designed to achieve the following.

Uniform corrosion rate of 5 mpy maximum for steel components and 0.5 mpy for non ferrous components.

Pitting Corrosion rate of 12 mpy maximum. Uniform scale deposition rate of less than 3 mpy. Total Bacterial Count less than 100,000 per ml.

Sulphate reducing bacteria less than 100 colonies / ml. Iron Bacteria less than 100 colonies / ml.

In case, the treatment programme provided by the tenderer fails or requires additional chemicals to achieve the guaranteed performance, the tenderer shall supply the necessary additional chemicals and shall undertake suitable measures for the successful execution of the modified programme without any additional cost implication to the Purchaser. In case, the modified programme requires lesser dosage of the chemicals than originally quoted, the payment shall be made on the basis of the actual consumption of chemicals.

If any wastage of chemicals occurs due to improper storage environment / gradual development of cracks in the carbuoy / drum walls within the shelf life period, the tenderer shall supply the lost chemical without any additional cost implication to Purchaser.

04.02.24 Erection, testing and commissioning

i. The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the drawings, specifications, instructions, etc. duly approved by the Employer/Consultant.

ii. The welding work should be carried out as per the approved WPS and PQR.

iii. The Contractor shall supply all required manpower, tools and related equipment, all hoisting equipment, all necessary scaffoldings, all necessary transporting equipment, consumables. Construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compound, tapes, brazing and soldering materials, welding and brazing gases, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand/emery paper etc. as required for the

satisfactory completion of work.

iv. On completion of the work, the Contractor shall remove and dispose off all rubbish and other unsightly materials caused by his working to a distance of five kilometer from the proposed project or as directed by the Employer and thereby leaving the premises in good, clean, safe and operable condition.

v. Before giving call for final inspection, all the documents shall be furnished to the Employer. The record of manufacturing details, inspection and tests carried out by the successful bidder shall be made available to the final inspecting authority. However, approval and final inspection at the manufacturing works shall not relieve the successful bidder of responsibility of replacing at his cost any defective part/material which may be detected by the employer during erection and commissioning or guarantee period.

vi. All materials required for fabrication, construction, testing and inspection shall be supplied by the bidder. No material shall be free issue to the bidder.

vii. No equipment or part item shall be dispatched without final inspection and issuance of inspection certificate.

viii. All equipment, assemblies, sub-assemblies shall be shop tested as per relevant standards and the test certificates shall be submitted by the supplier.

ix. Erection, testing and commissioning of various equipment and piping etc. shall be done in line with standards.

04.02.25 Drawings and documents

Drawings/Documents to be furnished by the bidder for "Approval"

i. Process flow diagram indicating the water consumption figures complete with temperature, pressure and quality requirement.

ii. Process and instrumentation diagrams for the water systems indicating location of all instruments alarms and interlocks functions using ISA symbols.

iii. General arrangement and cross-sectional drawings, characteristics curves and technical details of all the equipment, valves and piping including GA drawings showing plan, elevation and sectional views of the water system as applicable.

iv. List of instruments comprising bill of materials and instrumentation data sheets.

v. Layout of piping system indicating pipe routing, location of supports, valves and other fittings as required.

vi. General arrangement drawings of pump houses and sump / tank (including civil, structural and other facilities) showing dispositions of various equipment

and piping as applicable.

vii. Data sheets, characteristic curves and technical details of all the equipment, valves and piping.

viii. List of safety interlocks.

ix. Test procedures for preliminary and final acceptance tests.

x. Quality Assurance Plan.

xi. All equipment and piping sizing calculations.

xii. Any other drawing/ documents as required by the Employer.

04.02.26 Drawings / Documents to be furnished by the bidder for "Reference and Record"

i. The successful Contractor shall submit required sets of all the approved drawings, documents and manuals for Employer's record and use. After erection of equipment, the Contractor shall submit one set of linen tracings/ reproducible in required number of prints along with soft copies in CD (in AutoCAD format) of each "As built drawings".

ii. Operating and maintenance manual.

iii. Spare parts recommendation and price list.

iv. Instruction for erection, testing and commissioning.

v. Manufacturer's test certificates.

vi. Lubrication schedule and quantity and quality of lubricant for one year's normal operation.

vii. Various equipment assembly drawings and bill of material.

viii. Welding procedure.

ix. Test certificates for the following:

x. Material test certificate for all major equipment and their components. Hydraulic test of equipment, pipe fittings & valves.

xi. Static and dynamic balancing of all rotary parts/ equipment

xii. Hydraulic test logs.

xiii. Equipment GA drawings and bill of materials.

xiv. Characteristics curves of the pumps, motors and other equipment as applicable.

xv. Operation and maintenance manuals for all equipment, valves and complete water system along with soft copies.

xvi. Test and calibration certificates.

xvii. Warranty/ guarantee certificates.

xviii. Technical literature, catalogues and manufacturer's drawings for all brought out equipment, valves and other items.

xix. All inspection/ test report/ certificates.

xx. Any other drawing/ documents as required by the Employer/Consultant.

04.03 AIR CONDITIONING AND VENTILATION SYSTEMS

04.03.01 INTRODUCTION

To ensure proper working environment for men & machines and to maintain necessary inside environmental conditions, Air Conditioning and Ventilation facilities have been envisaged for various buildings and rooms like in administration building, control building, control rooms, MCC Rooms, pump houses, hydraulic rooms, cable cellars, Switch gear rooms etc. present in the various premises of Gas compressor station at IGGL site at Barpalaha near Guwahati, Assam.

04.03.02 SCOPE OF WORK

The scope of work under this specification covers design, engineering, manufacture/ procurement, assembly, shop inspection & testing, shop painting, transportation of all materials to site and supervision services for storing, unloading and transportation from store to site and handling at site, erection, testing, commissioning and performance guarantee tests of all equipment and accessories related to Air Conditioning and Ventilation systems.

The scope of work by the contractor will include but not be limited to the following:

- To select, design, engineer, manufacture and supply the complete air conditioning and ventilation system specified under this contract specification.
- To supply at site all required materials in order to execute incidental works at site associated with air- conditioning & ventilation plant/system specified under this contract specification.
- Providing first charge of consumables like oil, grease, refrigerant etc. as required. The quantity and specification of such consumables will be indicated by the contractor.
- Supply of commissioning spares as may be required during erection, start up and initial operation of all the units/ systems till successful completion of commissioning. The price for the commissioning spares will be deemed to be included in the contract price for the offered systems.
- Itemized price list for spares for two years normal operation of the Air Conditioning and Ventilation systems as mentioned in the subsequent pages.
- Contractor shall also demonstrate the operation of the air conditioning and ventilation systems during commissioning and provide necessary handhold support.

- Necessary training for 2 executives and 8 non executives will be arranged in the existing running plant for VRF system. Training shall be minimum for 4 days.
- Supply of special tools & tackles required for maintenance of the Air conditioning & Ventilation systems.
- Provision of lifting arrangement / lifting hooks will be provided for units where heavy equipment is envisaged.
- Preparation and submission of all necessary heat load calculations, civil assignment drawings, general arrangement drawings, design drawings, fabrication & erection drawings, as built drawings, drawings of fast wearing parts etc. Approval will be taken on the heat load calculation, system layout drawings and equipment general arrangement drawings before start of manufacturing.
- Preparation, submission and obtaining approval of all necessary GA, SLD, power and control scheme, power and control cable schedule and their external connection diagram, earthing scheme and data sheet of all electrical and instrumentation equipment / systems. Preparation and submission of all as built drawings.
- Erection of all the equipment and complete Air Conditioning and Ventilation system as per approved drawing and instructions of site engineer of customer / Employer/ Consultant.
- Liquidation of defects.
- Fixing of anchor fastener on wall and ceiling for duct & pipe support, under deck insulation is included.
- Structural works for piping & ducting network support, monorail in Contractor's scope.
- Any other item /nature of work which is specifically not appearing in the contract specification but directly associated with the efficient working / completion of the air conditioning & ventilation systems.
- Submission of operation, maintenance and service manuals.
- Inspection and testing by Employer/Client's representative at works and at site.
- Portable Instruments will be provided by Contractor for flow and temperature measurement.
- Performance testing of various equipment associated with air-conditioning and Ventilation system at manufacturer's works and also performance testing of complete systems at site.

04.03.03 INSTRUCTIONS TO CONTRACTOR

04.03.03.1 **General Instructions to contractor**

- All items of equipment in this specification will be complete in all respect including mechanical and electrical equipment as specified including fasteners, bolts and nuts, gaskets, base frames, stiffeners, supports etc. and any item not covered in this specification but essential for superior design, operation and guaranteed performance of the system will be included by the contractor.

- The equipment will be designed, manufactured and tested in accordance with the relevant standards prescribed by the Indian Standard Institution (Bureau of Indian Standard) wherever possible. In cases where suitable Indian Standards are not available, the equipment will conform to AHRI/ASHRAE /Good Manufacturing Practice followed in the Industry.

- The equipment offered will be suitable for continuous, smooth, efficient and trouble free services in the climate prevailing at the plant site of IGGL, Guwahati for continuous duty condition.

- Facilities will be provided by the contractor to enable the Employer's authorized inspector to inspect the equipment and their auxiliaries at all stages of manufacture to satisfy themselves as to the use of proper material and workmanship and apart from this the equipment will be tested or suitable test facility will be provided by the contractor to enable checking of operational parameters.

- At the time of inspection, the contractor will furnish internal routine inspection certificate, material certificates, approved drawings, etc. to the inspector. Inspection will be regarded as a check only and will in no way relieve the contractor of his responsibilities to provide systems & equipment functions as designed.

- The contractor will take full responsibilities for the guaranteed operation and achieving rated out-put and performance of the systems offered as per relevant clause of specifications.

- The contractor will furnish all information required for smooth functioning of the systems including operation, day to day maintenance, preventive maintenance, capital repairs, schedules and programs and any other information required by the Employer for trouble free operation of the systems along-with the supplies.

- The contractor will ensure that all rotating elements viz impellers of fans and crank-shaft, piston assemblies will be statically and dynamically balanced as per the relevant IS /ISO standard.

- The contractor will adhere to the schedule for supply, erection, testing and commissioning etc.

- The contractor will ensure that each equipment is provided with SS name plate engraved in English language with the details like Supplier's address, operation and design parameters, weight, and precautions etc. contractor will submit standard operation & maintenance manual along with equipment specification and flow diagram including catalogues marking model No. used.

- The contractor will ensure that the systems are designed considering the fire safety norms and adequate fire safety measures in the form of hardware interlock provided accordingly.

- Provision will be made for switching off all air circulating devices, on receipt of fire fighting / detection signal. Necessary potential free contacts will be made available at the MCC for interlocking with the fire detection system.

- In premises which are prone to fire hazard, adequate fire fighting measures like fire resistant insulation, fire dampers, interlocks provisions with the automatic fire detection & alarm system / fighting systems will be provided by the Contractor.

- The Contractor has to indicate the final KW and frame size for the motors.

04.03.03.2 **SPECIAL INSTRUCTIONS TO CONTRACTOR**

- Performance tests and inspection

i) All the equipment will be shop tested according to the relevant standards and the test certificates will be furnished as evidence for such testing.

ii) The equipment may be subjected to a detailed inspection by Employer / Employer's representative at the manufacturer's works as per approved QAP and approved drawings.

- Welding

All welding will be of structural steel standard as per relevant IS code and only certified welders will be employed.

- Lubrication

Contractor will furnish a list of lubricant along with their specification and indicate the quantity and rate of lubrication recommended.

- Accessibility and safety

i) All equipment offered will allow adequate access to facilitate connecting, maintenance and repair.

ii) All moving parts of the equipment will be well guarded and protected for the operator's and personnel's safety.

- Noise level

Noise level generated by the equipment supplied will not exceed the permissible limit of 65-dB (A) within the air-conditioned served premises. Necessary acoustic insulation shall be considered, wherever required to adhere to the above noise level parameters of the conditioned/work zone environment. Acoustic insulation of AHU rooms & suitable length of duct will be acoustically insulated to maintain the conditioned premises noise level mentioned above.

- System of units

Metric system of units will be followed in design, manufacture and supply of all units. Name plates of equipment as well as operating/maintenance instructions will be in English language.

- Maintenance and guarantee

The contractor will guarantee the satisfactory performance of the equipment/systems supplied by them all through the year.

- The contractor will arrange for attending fault replacement of components etc. during commissioning of the system till handing over of plant to the Client.

- The contractor will supervise the demonstration of the functioning of electrical interlocks and control prior to offering the systems for testing.

- The contractor will ensure that the items supplied are properly packed to protect against transit damage, rusting & pest attack. Packing list & dispatch document will also be included along with packing.

- The Contractor will arrange tools, tackles and consumables, instruments, competent manufacturer expert as may be required for erection, testing, calibration and commissioning activities.

- All anchor fixing fasteners, pipe & duct support structural members & brackets, foundation bolts and erection accessories is included in Contractor's scope of work.

04.03.04 DESIGN CRITERIA FOR AIR CONDITIONING AND VENTILATION SYSTEMS

04.03.04.1 PREMISES ENVISAGED FOR AIR CONDITIONING SYSTEM

The air conditioning system shall include the following systems:

a. VRF system with cassette ACs, high wall units etc. for admin building.
b. Split air conditioners for rooms meant for stay in Canteen building.
c. Air cooled VRF system with AHU for electrical buildings (rooms like office room cum toilet room, conference room, electrical panel room, VFD room, solar panel room, FDA / CCTV room, panel room of HT cum LT substation building) and control building (PLC room, control room, shift incharge room, engineering room, server room, reception, conference room, viewing gallery, gallery portion at first and second floor).
d. Split air conditioners for metering panel and control room in MRS building
e. Split air conditioners for office room and planning room in mechanical workshop
f. Split air conditioners for office room in sub-stores

04.03.04.2 PREMISES ENVISAGED FOR VENTILATION SYSTEM

The ventilation systems shall include the following systems:

a. Dry ventilation system with tube axial fans to maintain 3ºC (maximum) above the ambient temperature for the following areas:

   a) Cable gallery of various buildings.

b) Transformer rooms of various buildings.
c) Power factor compensation room of electrical (HT cum LT substation) building.
d) Panel room of MRS building.
e) MCC room and hydraulic room of mechanical workshop building.
f) Pump houses like fire water pump house etc.

b. Tube axial exhaust ventilation (bifurcated type) with acid proof fan and explosion proof motor to maintain maximum 3°C rise above ambient temperature at any part of the year shall be provided for the following premises:

a) Battery rooms

c. Propeller type exhaust ventilation shall be provided for the following premises:

a) Toilets & Pantry

04.03.04.3 The Tenderer shall clearly specify basis of design being offered along with heat load calculations and back up guarantee on their design.

04.03.04.4 Equipment makes shall be from preferred makes given in TS.

04.03.04.5 **AMBIENT DESIGN CONDITIONS**

The following ambient design data shall be considered for selecting and sizing various equipment for air conditioning and ventilation systems:

SEASON	TEMPERATURE ºC (DBT)	TEMPERATURE ºC (WBT)	RELATIVE HUMIDITY (%)
Summer	32.2	25.6	59
Monsoon	31.1	27.8	78
Winter	11.1	8.3	69

04.03.04.6 **INSIDE DESIGN CONDITIONS**

Desired indoor conditions for the rooms are mentioned as under:

- For rooms served with VRF system = 23±2ºC, 55±5% RH

- For rooms served with split air conditioning system = 23±2ºC
- For rooms served with ventilation systems = 3ºC above ambient temperature

Note: If the indoor temperature mentioned in the electrical chapter is different from the temperatures mentioned here, the requirement mentioned in the electrical chapter shall prevail.

04.03.04.7 Detailed heat load calculations of Ventilation and AC system shall be submitted & got approved by successful Tenderer from the Client / Consultant before submitting any detail engineering drawing.

04.03.04.8 Fire damper interlocking provision with fire detection system shall be considered for all served air conditioned premises, cable cellars, other electrical premises, and other susceptible fire hazard premises.

04.03.04.9 **APPLICABLE CODES AND STANDARDS**

The execution of the work covered under this specification should conform to the latest Indian Standards specification where the same are available, or the reputed standards acceptable to the Purchaser. In case such specifications are not available, the work shall be according to good engineering practice & norms acceptable to Purchaser.

The following reputed/ accepted publications, norms/ guidelines, standards, acts & rules etc. shall be followed for execution of the works:-
a) B.I.S Publications
b) Indian Electricity Rules & statutory requirements of Central Govt. and State Govt. and IPSS.
c) ASHRAE handbook, ISHRAE handbook
d) ARI publication
e) I.S.O Publications
f) ASME codes for unfired pressure vessels
g) VDI stipulation for vibration level
h) AMCA standard for fan balancing of AHUs
i) Occupational safety and health act (USA)

In the cases where norms/ standards/ guidelines other than those listed above are followed, the Tenderer shall furnish a copy of such document (s) in support for the

Purchaser's perusal and acceptance. Wherever a contradiction is found between different documents being followed, the decision of the Purchaser shall be final and binding.

04.03.04.10 **GENERAL DESIGN CRITERIA**

- The selection/ design and manufacture of plant and equipment will be suitable for the intended service and the atmospheric/environmental conditions prevailing at the plant site at Barpalaha at Guwahati, Assam.

- Design and selection of equipment will be made with the following also in view:

a) Safety of personnel
b) Uninterrupted operation
c) Long life of equipment
d) Easy maintenance at low cost
e) Lowest operating cost
f) Spares will be easily available

Every endeavour will be made to achieve standardisation and unification in designing components and sub-assemblies.

- All working parts will be arranged / located for convenience of operation, inspection, lubrication, ease of repair, replacement and maintenance of parts and sub-assemblies with minimum downtime, without dismantling other equipment/ components/structures.

- Components will be designed to meet the specified mechanical properties like hardness, strength, rigidity, wear resistance, heat resistance, resistance to vibration, etc.

- Equipment will be provided with lifting attachments (wherever applicable) like lugs, bolts etc. to facilitate handling and lifting during erection and maintenance.

- The equipment will be suitable to operate satisfactorily under variations of load, pressure and climatic conditions as may occur during working.

- All equipment will be of acceptable modern design and free from all inherent defects.
- All the rotating parts will be statically and dynamically balanced.
- All materials used will be free from surface defects, rusts, cracks and deformations.
- The finish of the equipment and its components will be of first class quality.
- To the extent possible, models and sizes of equipment will be identical to ensure minimum inventory and interchange ability of parts, equipment and systems.
- While designing the layout of the equipment and system, the following points will be covered / considered:

- Co-ordinates and location of the building.
- Equipment, piping and ducting layout with description.
- Maintenance access and neatness of layout.
- Interference.
- Equipment handling and removal facility.
- Floor drain, cable trenches and conduits.
- Battery limit with elevation of utility services.
- MCC, IPBS, DB etc. location.

- While designing the equipment and systems, the following maintenance aspects will be taken into consideration: -

- Sufficient space for maintenance in the layout.
- Access to the equipment.
- Inspection and maintenance doors for equipment.
  Lifting/handling facilities

- Air Conditioning systems & ventilation system will be designed to operate continuously round the clock, twenty four (24) hours a day for all seasons of the year while maintaining the guaranteed indoor conditions.

04.03.04.11 **Equipment sizing to be considered for Air – Conditioning system**

The following air velocities will be considered for the air conditioning systems. However, standard sizes of equipment, ducts and accessories will be adopted satisfying the following limiting conditions:-

i)	Fresh/Make up Air filter	:	up to 2.0 m/s
ii)	Fine filter	:	2.0 – 2.5 m/s
iii)	AHU fan		
a)	Inlet (return)	:	6 – 8 m/s
b)	Discharge (supply)	:	8 – 10 m/s
iv)	Main ducts	:	6 – 8 m/s
v)	Branch ducts	:	4 – 6 m/s
vi)	Supply air diffuser	:	3 – 4 m/s
vii)	Return air grill	:	2 – 3 m/s

Supply and return air duct shall be thermally insulated. Supply air diffusers will be provided at the supply air duct inside the served premises at interval of 2.5m~5m centre to centre distance as per layout requirement.

Portable Instruments will be provided by Contractor for flow and temperature measurement. Anemometer vane type for measuring air flow velocity- 4 Nos., DB – WB sling type thermometer for measuring temperature & humidity-4 nos.

Heat load calculation shall be carried out to arrive at the final capacity required for cooling.

04.03.04.12 **Equipment sizing to be considered for Ventilation system**

The following air velocities will be considered for the ventilation systems. However, standard sizes of equipment, rectangular ducts and accessories will be adopted satisfying the following limiting conditions

i)	Fresh Air filter	:	up to 2.0 m/s
ii)	Dry panel filter	:	up to 2.0 m/s
iii)	Fan outlet	:	8 – 11 m/s
iv)	Main ducts, GI	:	8 – 10 m/s
v)	Masonry	:	6 – 8 m/s
vi)	Branch ducts	:	6 – 8 m/s
vii)	Supply air grill	:	3 – 4 m/s

Chemicals to be consumed for proper O & M of Air conditioning and Ventilation will be supplied for six months from successful commissioning.

For buildings directly exposed to sun, under deck insulation will be included.

The capacities mentioned in the tender for air conditioning and ventilation systems are indicative only. The contractor will satisfy by design calculation, heat load calculation etc. to arrive at the different equipment capacities being offered and supplied, at detailed engineering stage as per this design criteria. The Contractor without any commercial implication will supply any additional capacity requirement of air conditioning system as per design criteria of this specification.

In case of dry ventilation systems, the higher of the capacities arrived at through 20 air changes / hour and through heat load calculation shall be considered.

04.03.05 DESCRIPTION OF THE AIR CONDITIONING AND VENTILATION SYSTEM:

04.03.05.1 Air conditioning system by air cooled VRF system

- Air cooled VRF system shall be used for administration building, control building and electrical (HT cum LT substation) building. The indoor units shall be high wall / cassette ACs, AHUs or other types as per the requirement. Arrangement for fresh air shall also be considered. The outdoor units shall be of 3 x 50% capacity. The AHUs shall also be of 3 x 50% capacity, however, standby shall not be required for indoor units of the administration building. Ducting network with damper, fire damper, diffuser, acoustic and thermal insulation etc. shall be provided. Thermal insulation over condensate drains line shall be considered.
- Make-up air shall be provided. Electrical, instruments & control of total air conditioning system will be provided.

04.03.05.2 Air conditioning system by split Air conditioner

3 star inverter type split air conditioner system shall be provided for rooms envisaged for thermal comfort of people, and as per the list enclosed elsewhere in this specification. 3 x 50% configuration shall be followed if the split AC is used in any electrical room like metering panel and control rooms in MRS buildings etc.

04.03.05.3 **Fresh, Filtered, Dry Air Supply Ventilation System With Tube Axial Flow Fan for Cable Cellars**

The Fresh Filtered Air Supply ventilation system will comprise of :

- Tube axial fan with drive and accessories such as, structural base, supporting frame etc.
- Dry panel filters with fixing frame installed in suitably stiffened ducting.
- Intermediate fire partition wall with fusible link type fire damper will be provided.
- 90% of the air supplied through tube axial fans meant for supply shall be exhausted through tube axial fans meant for exhaust.

04.03.05.4 **Exhaust Ventilation System With Tube Axial Flow Fan**

The Exhaust Ventilation System with Tube Axial Flow Fan will comprise of:

- Tube axial fan with drive and accessories such as structural base, supporting frame etc.
- Rain protection arrangement and bird screen.

04.03.05.5 **Exhaust Ventilation System With Propeller axial fan**

- Propeller axial fan with drive and accessories such as structural base, supporting frame, non-return damper etc.

04.03.06 **EQUIPMENT SPECIFICATION OF AIR CONDTIONING & VENTILATION SYSTEM:**

The brief description of main equipment will be as given below:

04.03.06.1 **Air cooled VRF system:**

04.03.06.1.1 **For admin building:**

Air Conditioning system in the administration building shall be split VRF/VRV type to achieve desired room conditions.

Supply of VRF/VRV system shall be fully complying with ASHRAE standard 15.

The refrigerant used must be CFC free, i.e. R-410A or approved equal alternative. Units shall be air cooled; variable refrigerant flow type consisting of one outdoor unit and multiple indoor units, combination of outdoor and indoor units shall be selected.

External fresh air shall be provided from fresh air fan with ducting arrangement and connected with flexible connection to each indoor unit.

Each indoor unit shall have capability to cool independently for the requirement of the room. All indoor units shall be provided with isolation valves so that a particular unit can be isolated and removed for servicing while system keeps functioning in normal way. VRF/VRV system shall be selected to connect multiple indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually.

Compressor installed in outdoor unit shall be equipped with capacity control mechanism, and capable of changing the rotating speed / mass flow rate of refrigerant by scroll engaging / disengaging mechanism to follow variations in cooling. Outdoor unit shall be suitable for mix-match connection of all type of indoor units. The refrigerant piping between indoor units and outdoor units shall be extended up to 100m with maximum 50m level difference without any oil traps. Oil recovery system shall be managed without disturbance to normal operation cycle of the system / compressor. Both indoor unit and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivery to site.

Outdoor Unit:

The supply of outdoor unit shall be factory assembled, weather proof casing constructed from heavy gauge mild steel panels with powder coated finish. All outdoor units above 16 HP rating shall have minimum two number scroll compressors. In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.
The noise level shall not be more than 65 dB (A) at normal operation measured horizontally 1m away and 1.5 m above ground level.
The outdoor unit shall be modular in design with possible future expansions.

VRF/VRV outdoor unit shall not trip at 50 deg C. The unit shall be provided with microprocessor control panel.

The Outdoor unit shall be secured firmly to the base with anchor bolts. CONTRACTOR to use zinc-plated or stainless steel nuts and bolts, it must be withstand the wind speed of 67 mph (30 m/s). Use a rubber washer between the bolt and the outdoor unit to prevent bimetallic corrosion.

A discharge duct for outdoor shall be installed with wire mesh to prevent foreign substances from entering the unit.

Compressor

The compressor shall be high efficiency scroll type and capable for capacity controlling. It shall change the speed / refrigerant mass flow rate in accordance to the variation in cooling load requirement.
Refrigerant mass flow rate can be changed by speed modulation of compressor / mechanical control system. System shall incorporate liquid sub-cooling mechanism with liquid injection at intermediate pressure. The inverter shall be IGBT (insulated gate bipolar transistor) type for efficient and quiet operation. All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated.

Condenser

The Condenser shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fan coil and larger surface area. The fins shall have anticorrosion treatment for Heat exchanger coil. The treatment shall be suitable for areas of high pollution, moisture and salt laden air. The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical/ horizontal discharge. Each fan shall have a safety guard. Bird cowls (duct with bird screen) shall be provided for easy removal of Condenser heat.

Refrigerant Circuit

The Refrigerant circuit shall include liquid receiver /accumulator, liquid & gas shut off valves and a solenoid valve. All necessary safety devices shall be provided to ensure the safety operation of the system.

Safety Devices

Following safety devices shall be part of the outdoor unit:
High pressure switch, low pressure switch, fuse, crankcase heater, fusible plug, over current protection and short recycling guard timer etc.

Piping

All connections of refrigerant piping shall be in high grade Copper with eddy current testing and material test certificates.
All connections, tees, reducers etc. shall be standard make fittings.
Refrigerant piping, header & branch joint are selected and designed as per manufactures recommended software, all the distances such as distance between two branch joint, distance between indoor/ outdoor unit & branch joint, distance between branch joint & refrigerant pipe etc. shall be clearly mentioned (selection details shall be provided for information). Larger-capacity outdoor units shall be the master in a VRF/VRV system.

During VRF/VRV refrigerant piping installation, brazing shall be carried out by continuous N2 purging of pressure 30 to 40 PSI to avoid accumulation of carbon debris inside of refrigerate pipes.

CONTRACTOR to ensure pipework pressure tests are undertaken in accordance with the manufacturer's recommendations, pressure drops check shall be carried out for minimum 24 hrs. Proper triple evacuation procedures must be followed and will ideally be left until a specific level of vacuum is attained rather than by time alone. Sufficient time must be allowed, particularly in cold weather for all of the moisture to be drawn out of a system, it could sit under vacuum for 3-5 days before acceptable results are achieved. If leaks are detected they must be found and fixed, and the evacuation process repeated. Branch joint should be connected at the same or lower level as the refrigerant pipes leaving the outdoor unit.

CONTRACTOR to provide isolation valve with service-ports at supply& return refrigerant path of each indoor unit, this shall be helpful for immediate isolation of defected unit so that entire system will not get disturbed.

Insulation

Insulation of cold lines shall be carried out with Armaflex / K-Flex insulation sheets and tubes of appropriate thickness (insulation selection details shall be provided for approval) so that condensation does not occur.

A properly installed pipe system should be adequately supported to avoid pipe sagging. Sagging pipes become oil traps that lead to equipment malfunction. Clevis hangers should be used with shields between the hangers and insulation. Field

provided pipe supports should be designed to meet local codes. If allowed by code, use fiber straps or split-ring hangers suspended from the ceiling on all thread rods (fiber straps or split ring hangers can be used as long as they do not compress the pipe insulation). Place a second layer of insulation over the pipe insulation jacket to prevent chafing and compression of the primary insulation in the confines of the support clamp. A properly installed pipe system will have sufficient supports to avoid pipes from sagging during the life of the system. As necessary, place supports closer for segments where potential sagging could occur. Maximum spacing of pipe supports shall meet local codes. Pipe penetrations through walls, floors, and pipes buried underground be properly insulated and routed through an appropriate wall sleeve of sufficient size to prevent compression of refrigerant pipe insulation and free movement of the pipe within the sleeve.

Oil Recovery System

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping. System shall be designed for proper oil return to compressor along with the distribution of oil to individual compressor.

Indoor Units

Units shall be factory assembled, wired, piped and tested. Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer. Units shall have recirculation fans for adequate amount of Air circulation and low Noise. Units shall have inlet filters, which are easily cleanable and replaceable. All components of Units are easily accessible for connection, repairs and maintenance.

Indoor units shall be factory manufactured and grills shall have auto swing feature for proper air distribution.
All units shall be controlled by electronic expansion valves only.
Visible indoor units shall be provided with wired as well as wireless remotes.
Concealed indoor units shall have sensor mounted on supply air grilles / diffusers which can be controlled with wired remotes.
All units shall have adequate insulation or lining to avoid condensation.
Anticorrosion treatment shall be required to avoid corrosion of coils.
Noise from HVAC equipment transmitted through ducts shall not result in sound pressure levels inside the room higher than 10dB (A) below the maximum acceptable noise level in that room.

Ceiling Mounted Cassette type Unit (Multi-Flow Type)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The body shall be light in weight and shall be possible to suspend from four corners. Unit shall have an external attractive panel for supply and return air. Unit shall have four-way supply air grilles on sides and return air grille in centre.

Each unit shall have high lift drain pump, fresh air intake provision, low gas level detection system and very low operating sound.

Central Remote Controller

A multi-functional microprocessor based centralized controller shall be supplied; technical specifications shall be suitable for automatic operation of all indoor and out door units. The central controller shall have a liquid crystal display (LCD) and have the capability of controlling all indoor & outdoor units individually, in groups and unanimously with the following functions.

- Temperature setting for each zone, or group, or indoor unit.
- On/ Off as a zone or individual unit.
- Indication of operating condition & fault detection (with resolution).
- Select On / Off operation modes for each zone.
- The controller shall have wide screen liquid crystal display and shall be wired by a non-polar 2 wire transmission cable.
- HVAC Control system shall be capable to control the HVAC functionality from station PLC.
- VRF/VRV system shall be interfaced with remote I/O rack station PLC over MODBUS TCP/IP for fetching parameters/diagnostics.

Condensate

PVC shall be used for condensate, from evaporator unit to drain point. The joints shall be properly sealed so that there is no water leakage. U-trap shall be provided at the end. Additional insulation drain tray shall be provided below the evaporator unit, if required.

VRF/VRV indoor units shall be selected for inbuilt condensate drain pump arrangement, condensate drain pipe shall be levelled for smooth flow of condensate removed to adjacent drain pit.

Mounting

All indoor units shall be mounted with brackets, Hangers etc. with proper size anchor Fasteners. All the related electrics like Power / control cabling along with supports shall be included in CONTRACTOR's scope.

Fresh Air Fan

Fresh Air fan with ducting shall be mandatory for supply of fresh air to each of VRF/VRV indoor units. Supply of VRF/VRV indoor units shall be with fresh air intake provision. Minimum 1.5 air changes/Hr or 17 CFM/person whichever is higher shall be considered for calculating fresh air quantity for occupied areas of building.

Air intake point shall be located preferably at opposite side of process units. Fresh air shall be drawn from an electrically safe classified area as away as possible but not less than 16 m from area processing hydrocarbons and other gases.

Control and Electrical (HT cum LT substation) building:

Control Building and electrical Building shall be served by DX Air Conditioning Unit (AHU+ VRF/VRV ACCU).

The HVAC DX Air Conditioning Unit (AHU+ VRF/VRV ACCU) provided by the CONTRACTOR shall be fit for the purpose intended and suitably finished and protected to withstand deterioration due to the environmental conditions prevailing at the site.

The refrigerant used must be CFC free, i.e. R-410A, R-134A or approved equal alternative.

Each building shall be served by a total of Three [3] set of DX HVAC systems with one redundant DX system (2working+1standby), redundant equipment shall be suitable for automatic change-over operation. Schedule cycle of operation through automatic change over switch so that all Air Conditioners shall be uniformly loaded.

The HVAC DX Unit installations shall be such, so as to facilitate inspection, cleaning and repairs. All installations shall be designed, manufactured, supplied and installed to ensure satisfactory operation under all working conditions, and shall be capable of operating at the maximum speeds, duty and capacity specified without undue vibration or excessive noise as defined. HVAC DX Air Conditioning Units shall be prefabricated double skinned compact type, mounted ona rigid common self-supporting galvanized structural steel base with grouting bolts (if required).

AHU shall be of sectionalized double skin with PUF insulation construction, comprising of AHU with evaporator, mixing box section, filter sections, cooling coil section, and fan section.
Each section of AHU shall have an access door, CONTRACTOR shall provide inspection lights at each AHU sections.
DX VRF/VRV Condensing unit shall be with condenser, condenser fans & compressor section.
Each unit shall be constructed on galvanized structural steel base frame with all welded joints& reinforced sufficiently to limit the deflection.
CONTRACTOR shall select / design the AHU such that there shall not be condensation during operation.

Outdoor units: Outdoor units for electrical (HT cum LT substation) building and control building shall be of the same specification as mentioned in the preceding paragraphs for administration building.

Indoor Units (Air Handling Unit):

Air Handling Units shall be connected to energy saving VRF/VRV type outdoor units, redundant equipment shall be suitable for automatic change-over operation. Schedule cycle of operation through automatic change over switch so that all Air Conditioners shall be uniformly loaded. Units shall be factory assembled, wired, piped and tested. Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer. Units shall have recirculation fans for adequate amount of Air circulation and low Noise. Units shall have inlet filters, which are easily cleanable and replaceable. All components of Units are easily accessible for connection, repairs and maintenance.

All units shall have adequate insulation or lining to avoid condensation. Anticorrosion treatment shall be required to avoid corrosion of coils.
Noise from HVAC equipment transmitted through ducts shall not result in sound pressure levels inside the room higher than 10dB (A) below the maximum acceptable noise level in that room.

Filter Section

AHU Filter section shall be HDPE washable type panel filters with holding frames. The filters shall be Euro class G4 as per EN779. All filters shall be fixed in

galvanized angle frame duty epoxy painted with quick fixation clips for ease of removal.

Filter Sets: Provide three (3) complete sets of filters; one set for initial fill, one set for test/balance, and one set for final fill.
The air velocity across filter media shall not exceed 2.5m/s (500 FPM). Continuous neoprene foam rubber seal shall be provided on the filter frame for effective sealing.

Coil Section

The coils shall have minimum design pressure of 10 Kg/cm2G & shall be factory pressure tested at 12.5 Kg/cm2G. Detailed coil selection report shall be provided for along with AHU GA.
Coils shall have a face velocity < 500 ft/min (2.5 m/s) at design flow, an air pressure drop < 1.5 inch WC.
The coils shall be mounted on a fabricated 3 mm thick galvanized support frame to allow any coil to be individually removed through the access door.
The cooling coil shall be coated to the prevailing environmental conditions. The cooling coils shall have moisture eliminators where carryover of moisture takes place.
Cooling shall be suitable for VRF/VRV system and the coil shall work on demand basis of the VRF/VRV system.

Fan Section

The fans shall be centrifugal double width, double inlet with a non-overloading backward inclined bladed wheel. DIDW Fan shall be AMCA Certified for Air and Sound Performance. AHU fan shall be suitable for VRF/VRV system. AHU fan shall be suitable for VRF/VRV system and the fan shall work on demand basis of the VRF/VRV system.
All fans shall be dynamically trim (Two stage) balanced to ISO1940 and AMCA 204/3- G2.5 quality grade after assembly. A computer printout with vibration spectrum analysis shall be attached to the fans.
Fan shall be of Galvanised steel, the steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero spangle, skin passed, chromated and dry.
The fan housing & wheel shall be constructed of acid resistant heavy gauge Galvanised Steel.

Electric driver (motor) rating (exclusive of service factor) shall be minimum 110% of the maximum power required (including transmission losses) at operating conditions.
Grease cups shall be provided for fan bearings. Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable.
Ribbed neoprene rubber pads shall be provided as vibration isolators for the Air handling unit.
Fan and motor shall be earthed to prevent accumulation of static charge.
Fan housing shall have access door in fan scroll. All flanged joints shall have neoprene gaskets. Fan shall have lifting lugs. The fan shaft shall be solid steel& coated with rust inhibitor.
The fan housing shall have a drain pipe with valve and cap at the lowest point. Fan inlets shall be provided with safety screens.
The fan & motor assembly shall be integrally mounted on a heavy-duty common base frame which shall be mounted on spring isolators to limit transmission of vibrations. The isolation springs shall have non-skid acoustical pad, locking screw & adjusting leveling bolt.
Quality of the fan should be w.r.t its international standard.
Fan pulley should be 30% to 50% of impeller diameter.
Fan performance curve should be of Single RPM curve. It should not be multi RPM curve.
Adequate space shall be provided around fan / drive & final filter for proper maintenance.

Condenser coils

Condenser coils shall be constructed of aluminium fins mechanically bonded to internally grooved, seamless copper tubes which are then cleaned, dehydrated and sealed.

Central Remote Controller

A multi-functional microprocessor based centralized controller shall be supplied; technical specifications shall be suitable for automatic operation of all AHU and VRF/VRV outdoor units. The central controller shall have a liquid crystal display (LCD) and have the capability of controlling all AHU (working & standby) and VRF/VRV outdoor units (working & standby) individually, in groups and unanimously with the following functions.

- Temperature setting for each zone during normal and emergency operation

- On/Off as a zone or individual unit.
- Indication of operating condition & fault detection (with resolution).
- Select On/Off operation modes for each zone.
- The controller shall have wide screen liquid crystal display and shall be wired by a non-polar 2 wire transmission cable.
- • HVAC Control system shall be capable to control the HVAC functionality from station PLC.
- VRF/VRV system shall be interfaced with remote I/O rack station PLC over MODBUS TCP/IP for fetching parameters/diagnostics.

Condensate

PVC shall be used for condensate, from evaporator unit to drain point. The joints shall be properly sealed so that there is no water leakage. U-trap shall be provided at the end.

Miscellaneous Equipment

The panel / enclosure rating for indoor application shall be IP-42 and for outdoor application IP-65 minimum to provide sufficient protection from sand and dust infiltrations. All cable entries to and from these panels shall go through sealed cable glands. Cable gland material shall be Nickel Platted Brass.
Panel doors shall be equipped with sealing gaskets.

Provide a stainless steel, permanently embossed or engraved tag indicating the specified equipment number and capacity, securely fastened to the equipment.

Fresh Air

For control room building, fresh air requirements shall be calculated based on 3-air changes/Hr or 17 CFM/person whichever is higher. In addition, guidelines of OISD Std 163 shall be followed for estimating fresh air requirements for the control room. Provision shall be kept for increasing / decreasing the number of air changes per hour for maintaining design conditions inside the control room and also to take care of exigencies.

HVAC Controls and Instrumentations:

CONTRACTOR shall design, furnish and install a complete system of operational controls. All control devices shall be the product of a single manufacturer and shall be basically an electric/electronic system.

HVAC Control system shall be capable to control the HVAC functionality from station PLC.
CONTRACTOR shall furnish detailed HVAC control schematics and wiring diagrams showing all electrical connections and control devices.
All relays and switches shall be panel-mounted and properly labelled.
Each HVAC unit shall be suitable for accepting command signal from the Control & Automation (Fire & Gas) system to close its Fresh Air damper, Fire / Gas Damper & shut down the HVAC units on high level (60%) smoke or hydrocarbon gas detection outside and inside the building and at the HVAC duct, at low level (10%) it shall give an alarm and close the Fresh Air damper, HVAC system shall be in recirculation mode (no outside air in the system). Air conditioning and Ventilation systems shall be switched off during a hydrocarbon detection.
Provisions shall be made in HVAC panel for HVAC shutdown on receiving 'confirmed fire' or 'confirmed hydrocarbon leak' signals from F&G system.
Fire dampers shall be min 90 minutes fire rating.

Each HVAC unit shall provide feedback signals (i.e. running, HVAC trip etc.) to control and automation system via MODBUS TCP-IP communication. VRF/VRV system shall be interfaced with remote I/O rack station PLC over MODBUS TCP/IP for fetching parameters/diagnostics.

Air-Conditioned area shall be provided with a temperature sensor and shall be interfaced with the remote I/O rack of station PLC to get the feedback of temperature inside the Air-Conditioned room on real time basis.

Note: Refer below parameters/diagnostics listed for a typical unit. The same shall be considered for all the installed HVAC package units separately. RS-485 ports of all the HVAC package units shall be daisy looped or multi-dropped and an independent serial link shall be taken to remote I/O rack of station PLC over MODBUS TCP/IP protocol so that all the parameters/diagnostics of indoor and outdoor units ofHVAC package will be available at station PLC end.

- Running status of unit-1
- Stopped status of unit-1
- Running mode-1 of unit-1
- Running mode-2 of unit-1
- Running mode-3 of unit-1
- Running mode-4 of unit-1
- Fan speed-Low of Unit-1

- Fan speed-medium of Unit-1
- Fan speed-High of Unit-1
- Fan speed-very high of Unit-1
- Room temperature
- Set temperature of unit-1

04.03.06.2 **Insulation – Duct thermal Systems**

Thermal insulation of duct will be carried out with Aluminium foil faced Fibre glass of density not less than 24 Kg/m3. The thermal conductivity will not exceed 0.03 Kcal/hr Sq. m deg C. Thickness of Insulation will be 25mm for indoor application. For outdoor application 50mm insulation thickness will be provided with 24 gauge AL cladding.

Application

- Clean the surface of duct and apply one coat of Black Japan Paint of approved make @7Sq.m/Kg.
- Apply a thick layer of CPRX compound @1Kg/Sq.m of area.
- Fix the insulation material of required thickness before the adhesive dried up. All longitudinal joints/traverse joints will have the foil overlap of 50mm with Aluminium tape of minimum 75mm width.

The contractor may also propose other materials for duct thermal insulations. However, a comparison in a tabular form shall be provided comparing the various thermal properties. The decision of the client / consultant shall be final regarding the selection of the thermal insulation material.

04.03.06.3 **Insulation – Duct acoustic**

Acoustic lining of Duct will be carried out with 12mm thick Fibre glass rigid board of density not less than 32 Kg/m3. All ducts up to a distance of 5m from AHU outlet or as required to reduce noise levels to below 60 dB will be acoustically lined from inside.

Application

- Clean the inner surface of duct that is to be lined, with wire brush to remove the dirt.

- Apply Black Japan paint in the frame of duct.
- The adhesive will be non flammable and having vapour barrier property.
- Fix insulation material of 12mm thickness and cover with RP tissue paper and then cover the material with 26G perforated aluminium sheet having 2mm dia perforation at 3mm centre to centre distance with the help of nuts and bolts. It will be neatly finished to give true surface finish.

The contractor may also propose other materials for duct acoustic insulations. However, a comparison in a tabular form shall be provided comparing the various acoustic properties. The decision of the client / consultant shall be final regarding the selection of the thermal insulation material.

04.03.06.4 **Dry Panel Filter**

Dry panel type air filter will be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It will be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It will be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel will be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air will not exceed 2.0 m/sec. The resistance of air filter will not exceed 10 mm WC when dirty. Efficiency of the filter will not be less than 90% down to 10 microns. The whole filter and frame assembly will be mounted at the AHU inlet. Fresh air inlet will also have filters for efficiency 80% down to 20 microns.

04.03.06.5 **Duct Work**

Supply air duct of G.I. construction is to be connected with AHU fan outlet with flexible connection. The duct will supply conditioned air to the served premises.

For parallel fan connections, outlet damper will be provided for isolation. Supply air duct will be fabricated from GI sheet as per IS: 655 standards and Zn coating 120 GSM. Duct thickness will be considered for medium pressure rating of IS.655 for ventilation system .The ducting will be properly reinforced and braced to prevent sagging, buckling or vibration. All ducting network for ventilation system will be minimum medium pressure grade and accordingly duct thickness will be considered.

Flanges of sheet metal duct will be of angle iron type riveted with GI sheet on duct perimeter. Flange joints should be made air tight with use of felt gaskets. Spacing of duct flanges will be about 3 meters.

Turning guide vanes are to be provided inside the duct wherever change of direction occurs, to minimise eddy formation. The interior of all ducts will be smooth for free flow of air.

Bends/ elbows wherever used in duct work will have radius not less than the depth of duct work in change of direction.

Collar is to be provided to duct bottom to connect with throat of supply air diffuser.

Access eye / measuring hatch for measurement of air quantity will be provided in ducting at convenient location.

Duct work will be complete with flanges, stiffeners, fasteners, hangers, nuts, bolts, washer & gaskets etc.

Factory fabricated duct with connecting flanges may also be used. The thickness of the ducts etc shall remain as per IS 655.

The supply air ducts and return air ducts shall be thermally insulated.

04.03.06.6 **Hangers & Supports for Ducting**

All duct work will be provided with adequate supports - hanger type or cantilever type or bracket type - as required to ensure rigid support and to prevent vibration.

The fixing and supports interval will not exceed 2.3 meters. Hanger rods having U-bend at one end and threading at other end will be hanged ceiling by anchor/expansion bolts wherever required. Threaded rods may also be used. Hangers will be trapeze type constructed from angle iron (as per size of duct) and hung from steel rods of adequate size. GI slotted channels may also be used for supporting of ducts. Suitable vibration damping media will be used between support pedestal and duct for non transmission of vibration.

04.03.06.7 **Supply Air Diffusers**

Supply air diffusers will be square in shape for air-conditioning application. The throat of a diffuser will be connected with collar piece provided at the duct bottom for holding the diffuser as well as for supply of air. No part of diffuser will project into the main duct.Each diffuser will be provided with volume control damper. Each diffuser will comprise of fixed plate, damper blade, damper blade operating knob, spindle, connecting rod etc and will be of **removable core** type extruded aluminium section duly powder coated. The diffuser bottom should flush / match with the false ceiling. False ceiling will not bear the load of any diffuser. The load of any diffuser will be borne by the duct and collar. Each diffuser will be painted with appropriate colour to match with the colour of the false ceiling. The diffusers will be true to shape and will be checked with level gauge before being secured in position. No distortion or warping is permitted.

04.03.06.8 **Return Air Duct**

The air supplied in the served premises will generally return above false ceiling through the return air slit of 50mm / 75mm (as required) all around false ceiling along the walls of the served premises / through return air grills mounted on the false ceiling or through return air diffusers. From there it will pass into the AHU room through a return air duct. Insulated return air duct of suitable size will be provided for smooth flow of return air. Return air opening will be provided above false ceiling in the partition wall between served premises and AHU room..

04.03.06.9 **Strip Heater Box / Pan Humidifier**

Strip heater box will comprise of finned heater, mounting plate, heater box/ casing made of 18 SWG G.I. sheet, cable terminal, and terminal box with handle, angle flange/ frame. Strip heater box will be placed/ inserted in supply air duct. Safety thermostat / geyser stat will be mounted on strip heater package to prevent overheating. Strip heater box assembly will be a pre-fabricated unit with all its terminals & controls pre-wired. Indication of strip heater- on/off will be displayed on AHU power supply panel.

Pan humidifier will comprise of pre fabricated SS tank duly insulated along with sealed heater flanged on the tank body with provision of make up with float valve, quick fill, overflow and drain line with GM valves and humidistat, control element

all pre wired ready to be hanged underside of supply air duct for generation and control of humidity during dry season.

04.03.06.10 **Make up Air Filter With Damper**

Make up air for AHU room will be drawn from ambient through filter and volume control damper.

04.03.06.11 **Multi louver Damper (M.L. Damper)**

Multi louver damper (M.L. Damper) will be provided on the AHU and below flexible connection in the supply air ducting. The damper blades/ louvers will be provided with external operating links for manual operation of the damper to control air flow. The damper of aerofoil section will be made of GI sheet with GI frame. The fully close/ open/ partial closing position of the damper will be marked on the damper casing. Frame of the dampers will be from 18G and louvers as 20G. Damper blades will have nylon pivot on the casing for smooth movement.

04.03.06.12 **Fire Damper**

Fusible link type fire dampers having 90 mins fire rating as per Ul-555 will be provided for all the supply air duct / return air path. The casing thickness will be 2mm (min.) and blades of 1.6mm (min.) of MS construction.

04.03.06.13 **Split air conditioner**

The split air conditioner shall be minimum 3 star rated inverter type. Split air conditioning unit shall comprise of two sections - Indoor and Outdoor. Indoor section shall comprise of cooling coil, fan, supply air grill, filter. Outdoor section shall comprise of air cooled condenser, condensing fan, hermetically sealed compressor. Sealed refrigerant piping shall inter connect indoor and outdoor sections. Outdoor unit shall be installed in open space for easy heat dissipation from condenser. Indoor section shall be ceiling suspended or wall mounted type as per job specification requirement. Remote control unit, thermostat and other standard accessories for successful installation of split type air conditioner shall be included in the scope of successful tenderer. Any additional services as required, shall be included in line with job specification requirement. Split air conditioner unit shall conform to IS 1391 : Part 2 : 1992 (RA 1999).

04.03.06.14 **Tube Axial Flow Fan**

These fans will be of heavy duty (continuous) type and of two kinds, as per service requirement as follows:

a) Wall / shaft mounted supply air fan & b) Wall / shaft mounted exhaust air fan.

Axial fan design will confirm to IS:3588–1987(Reaffirmed 1994).
The fan will have multi-bladed cast aluminium impeller with short duct casing while the wall exhauster/ wall mounted supply air fan will have cone inlet suitable for ducted / free discharge of air. The fans will be capable of withstanding the stresses which may be experienced during normal operation under the condition which it is required for and during over speed test. The noise level will not exceed 85dB(A) at 1m distance from fan casing.

The first critical speed of the rotating assembly will be at least 25% above the operating speed. The speed of the fan will preferably be limited to 1500RPM for fan with diameter 600mm or less and 960RPM for fans with diameter more than 600mm to limit the noise generation.

Impeller

The impeller will be of cast aluminium alloy construction of high efficiency aerofoil section blades. The fan impellers will be cast in one piece, finished all over and carefully balanced both statically and dynamically as per ISO – 1940. Finally the assembled rotor will be dynamically balanced.

Casing

Axial flow fan casing and their components will be suitable for outdoor installation. The casing will be minimum 2.5 mm thick. The casing will be provided with flanges at inlet and outlet. All nuts & bolts associated with it will be of zinc or cadmium plated. Easily removable inspection cover having galvanised fly nut will be provided. The covers will be located such that the grease nipple for all bearings and also motor terminals are easily accessible through the cover.

Hood, Cowl, air intake louver

a) Supply air fans will be provided with hood for protection against rain and other contingencies. It must ensure no dripping of rain water under any circumstances and will have low pressure drop of air. The hoods will be provided with a heavy gauge (2mm) welded wire mesh bird screen.

b) All supply air fans will be provided with 75mm deep air intake louver fabricated from 2mm thick MS sheet (Hot dip galvanised) and followed by synthetic dry panel filter having efficiency not less than 90% down to 10 micron particle size, selected for 2.5 m/sec face velocity mounted in filter frame.

c) Rain protection cowls will be designed to suit wall exhausters for protecting fans from rain. The cowls will be provided with bird screen of heavy gauge expanded metal netting. The rain protection hood & cowl will be fabricated from minimum 2mm thick MS sheet (Hot dip galvanised).

Fan Drive

All direct drive axial flow fan impellers will be directly mounted on extended motor shafts.

04.03.07 SPARES, TOOLS AND TACKLES

04.03.07.1 Contractor will supply all the commissioning spares required for successful commissioning of air-conditioning & ventilation systems without any commercial implication.

04.03.07.2 Special tools and tackles required for operation & maintenance will be supplied by the contractor. However, any special tools and tackles if required during the execution of the project, the same will be supplied by the contractor without any commercial implication.

04.03.07.3 **Following minimum 2 years O & M spares will be considered by the contractor** :

- Compressor Oil - 10 Kg
- Nitrogen – 10 Kg

- Fusible Link for Fire Damper – 4 set
- Impregnated Canvas – 5 sq.m
- DB meter – 1 no.
- Tong Tester - 1 no.
- Taco-meter - 1 no.
- Multimeter - 1 no.
- Clamp on Ampere meter - 1 no.
- Megger 500V - 1 no.
- Thermometer – 5 no's
- Standard Tool Kit box - 1 no.
- Dry panel filter for AHU & Ventilation system – 5 no's of each type
- Consumables as required till handling over, shall be included

04.03.07.4 **Special tools and tackles:**

- Torque wrench – 1 set
- Hydraulic puller 8T – 1 no.
- Hydraulic puller 10T – 1 no.
- Box Spanners – 1 set
- D. Spanners – 1 set
- Ring Spanners – 1 set
- Bearing puller 1.5T – 1 no.
- Gas measurement manifold – 1 no.
- Gas charging machine – 1 no.
- Hand drill machine for drilling up to 12mm capacity - 1 no.
- Hand grinder machine - 1 no.
- Angle grinder machine - 1 no.
- Portable vibration measurement instrument – 1 no.

Any item not mentioned here specifically but required same shall also be supplied by the contractor as per mutually agreed

04.03.08 **ERECTION, TESTING, COMMISSIONING & PERFORMANCE TESTS**

04.03.08.1 **Testing**

On completion of erection of unit with utilities and auxiliaries, testing will be taken up by the Contractor jointly with the Employer/ Employer's representative to prove that the unit has been supplied as per specification/ approved drawings and erection is fit to be started up and commissioned. Testing will include the operation of all equipment/ system. During testing, the Contractor will deploy required personnel on three shifts a day basis, whenever required.

The following general checks will be made for all equipment.

- Check whether entire erection is complete and all equipment are in position and erection as per layout /relevant drawing.
- Check all rotating parts for free movement.
- The grease/lubricant in the motors etc. might be caked due to long storage at construction site. Check for first charge of lubricant.
- Check for smooth operation of valves.
- Check for proper supporting of piping, ducting, dressing & clamping of cabling etc.
- Ensure proper soldering of lugs on electrical cables and wires and the tightness of electrical connections in motors, starters and controls. Ensure proper earthing of all systems & equipment. Megger testing for motor. No load test for the motor.
- No load runs of AHU, fans and other equipment for a short time to check for abnormal noise, rotation and vibration.
- Check alignment of fan to motor etc.
- Test will be completed and approved before any insulation is applied.

- All piping will be pressure tested to test pressure of at least one and half times the maximum operating test pressure. All leaks and defects in the joints detected during the tests will be rectified to the satisfaction of the engineer. The test will thus ensure noiseless circulation achieved through the piping system. After elimination of the defects, hydraulic tests will be repeated.

- The following will also be checked :

- Functioning of all the flow components
- Functioning of all safety interlocks
- Air balancing and leakage in the ducting system
- Completion of all insulation work

A defect list / observations will be jointly prepared and duly signed by all concerned detailing the required rectification/ defects in erection etc. All the points in the defect list will be attended and rectified by the Contractor without any price implications and the equipment will be offered for re-inspection to Employer/ Employer's representative.

04.03.08.2 **Commissioning**

After testing as mentioned in the preceding paragraph, the contractor will start up and put the plant "On Load" run in an integrated manner and it is to be observed whether the system is delivering the desired results. At the same time, all other parameters like leakages, noise and vibration etc. are monitored and if necessary, adjustments are made to set up the plant at required conditions as given in T.S./ approved drawings / operating instructions. Commissioning of the plant will be deemed to be successfully completed when it is ready for regular operation and all the contractual scope of supply & installation is completed.

At site training will be provided during testing and commissioning of air conditioning system & ventilation system for Operation and maintenance personnel interfacing.

04.03.08.3 **Performance Guarantee (Technical) for air conditioning and ventilation systems:**

Following points on Performance Guarantee of equipment and accessories will be adhered to in line with job specification requirement.

- The Contractor will guarantee reliable regular working of all equipment against faulty design, materials, workmanship or any act of omission on his part affecting performance of all equipment for the specified duty condition. The Contractor will guarantee the material, workmanship and satisfactory performance of the equipment both individually as well as integrated performance of the whole system and all other facilities and work under their scope of work.

- The contractor will also stand guarantee for the various equipment against manufacturing defects.

- Any defects what-so-ever observed during the guarantee period will be rectified or the defective part (s) will be replaced, as the case may be, by the contractor at their own cost, failing which the employer reserves the right to take remedial measures at contractor's cost.

- After commissioning of systems, 72 hrs. continuous trial run will be made.

- In addition to the above, based on the technical data of this specification, the contractor will stand performance guarantee for the equipment as follows

.

- The contractor will guarantee that the equipment will deliver the required parameters.

- The contractor will guarantee that the fans, compressors etc. will deliver the required capacity at the required pressure and there will be no over-heating of bearings.

- The contractor will guarantee that performance of all equipment will conform to the latest relevant IS code / Acceptable standard.

- After successful completion of trial operation / commissioning of the plant and liquidation of all defects, the system / individual components will be subjected to performance and guarantee test of 72 hrs continuous trial run (performance guarantee tests) will be made. The required operators and persons for watch & ward, during testing, commissioning and period between performance guarantee and handing over the systems to Employer will be provided by the Contractor as per site requirement.

After successful commissioning, the said performance guarantee tests will be conducted by the Contractor in presence of Employer/ Owner having following objectives:

- To check safe & healthy operation of all equipment forming the total air conditioning system.
- To check the power consumption of the motors for which power consumption limits are guaranteed at specified capacity of the equipment.
- To verify the total capacity of the plant including stand by equipment.
- Capacity rating and guaranteed power consumption for all system components and system as a whole to be established during summer.
- To check the temperature and relative humidity conditions during summer & monsoon in the air conditioned space.
- Operating parameters of the system to be logged for the complete cycle with calibrated instruments at the time of capacity test and room condition test during summer.
- To check satisfactory operation of all safety switches and electrical interlocks for each individual equipment and complete system.
- Vibration and noise level to be measured for all rotating equipment.
- Noise level measurement in different rooms.

Performance Guarantee

In case unit capacities and design / performance parameters guaranteed by the Contractor for AC are not established during the performance guarantee testing, the Owner (Employer) at his discretion may reject or accept the plant after assessing its technical suitability.

PERFORMANCE GUARANTEE PARAMETERS FOR AIR CONDITIONING AND VENTILATION SYSTEMS (TECHNICAL)

Parameter for the conditioned space	Guarantee figures	Rejection / modification criteria
Served premises temperature	Design temperature variation less than ±2ºC	Design temperature variation more than ±2.5ºC
Air flow at supply grill	Design air flow variation less than ±10%	Design air flow variation more than ±15%

04.03.09 **DRAWINGS, DATA AND DOCUMENTS**

The drawings / documents given below will be suitably complemented / supplemented by contractor as per the requirement.

04.03.09.1 List of following Drawings minimum for approval

1. Overall system layout of each air conditioning System/ Ventilation system in plan & section.
2. Air conditioning and ventilation system ducting network layout of individual premises in plan and section.
3. GA of all equipment of air conditioning and ventilation systems such as split AC, VRF unit – indoor and outdoor units, AHU, ventilation fans, strip heater, humidifier, filter, air intake louver, MCC etc.
4. GA of any other equipment considered.
5. Drive list.
6. P&I diagram with all flow parameters including sizing.
7. Design calculation of Air conditioning and ventilation System capacity.
8. Data sheet of all bought out items (pressure gauge, temperature gauge, thermostat, humidistat, H.P. / L.P switch) etc.
9. Conceptual single line diagram with ratings of all components.
10. Control Scheme of PDB cum MCC.
11. Control write-up.
12. Cable route layout including incoming power cable with selection criteria.
13. Equipment layout diagram.
14. Motor data sheet including sizing calculation.
15. GA of distribution boards, Motors, LPBs, Control cabinet / desk etc.
16. Earthing layout including size selection / calculation.
17. Cable schedule, scheme, block logic.
18. GA, configuration of PLC and its peripherals.
19. Performance data & characteristic curves for the AHU fans and other equipment

04.03.09.2 List of Drawings and Documents for Reference and Records - In 8 Sets

- Operating Instructions and manuals
- Catalogue for all instruments
- Technical Data
- Functional Description
- Commissioning Instructions
- Motor power Calculations
- Assembly & Start -Up Instructions
- Maintenance Instructions
- Lubrication Chart
- AC Motor Specifications/data sheet
- Maintenance Manuals

- As built drawings
- Test certificate, inspection certificates / reports in bound volume
- Tracings, Floppy / CD ROM for all drawings / documents

Notes:

i. *The above list is indicative and minimum. The contractor will furnish any other drawings & documents which may become necessary or required by Employer/ Consultant*

ii. **All drawings & documents will be submitted with approved title block and drawing-numbering system as per standard format handed over to the contractor.**

04.03.10 SCHEDULE OF EQUIPMENT

04.03.10.1 SCHEDULE OF EQUIPMENT OF AIR CONDITIONING SYSTEM

Sl. No.	System envisaged	Description of equipment	Quantity / capacity
1.	ADMINISTRATION BUILDING		
	Variable Refrigerant Flow (VRF)	VRF outdoor condensing unit capacity with 3 x 50% capacity for outdoor units	Working requirement 140 TR
		Multiple in door units: Wall	For all the rooms

		mounted/cassette units	
2.	CANTEEN BUILDING		
	Split air conditioning system	SAC – 2.5TR	4 nos.
3.	ELECTRICAL (HT cum LT substation) BUILDING – LEFT WING		
	Variable Refrigerant Flow (VRF)	VRF outdoor condensing unit capacity with 3 x 50% capacity for outdoor units) with all accessories, pipe & pipe fittings, thermal & acoustic insulation, filters, ducting network, valves, electrics & control, instruments with all accessories.	Working requirement 100 TR
		DX type Air handling unit with 3 x 50% capacity	
4.	ELECTRICAL (HT cum LT substation) BUILDING – RIGHT WING		
	Variable Refrigerant Flow (VRF)	VRF outdoor condensing unit capacity with 3 x 50% capacity for outdoor units) with all accessories, pipe & pipe fittings, thermal & acoustic insulation, filters, ducting network, valves, electrics & control, instruments with all accessories.	Working requirement 60 TR
		DX type Air handling unit with 3 x 50% capacity	
5.	MRS BUILDING		
	Split air conditioning system	SAC for metering panel and control room – 2TR	3 nos.
6.	MECHANICAL WORKSHOP		
	Split air conditioning	SAC for office and planning room – 2	1 nos.

	system	TR	
		SAC for planning room – 2 TR	1 nos.
7.	CENTRAL STORES		
	Split air conditioning system	SAC for office – 1.5 TR	1 nos.
8.	CONTROL BUILDING		
	Variable Refrigerant Flow (VRF)	VRF outdoor condensing unit capacity with 3 x 50% capacity for outdoor units) with all accessories, pipe & pipe fittings, thermal & acoustic insulation, filters, ducting network, valves, electrics & control, instruments with all accessories.	Working requirement 90TR
		DX type Air handling unit with 3 x 50% capacity	
9.	MISCELLANEOUS		
		Duct Thermal Insulation, Acoustic insulation for the duct over a length of 5 m from AHU fan discharge mouth including plenum & AHU room acoustic insulation & under deck thermal insulation	Lot
		GI Ducting with supports, Aluminium SA/RA diffusers, Return air grill/linear grill, fittings, duct dampers & fire dampers , Fresh air intake arrangement with filter, damper, cowl & bird mesh etc.	Lot
		Strip heater, Acoustic and Thermal duct line Insulation, Thermostat & humidistat, Instruments & controls, pressure gauge, Thermometer, thermostat, humidistat , water flow Switch, HP/LP cut out switch, MCC, Electrics, etc.	Lot

		MCC, Electrics, cabling (power, control, communication) earthing and all connected erection accessories as per scope of work and TS.	Lot

04.03.10.2 **SCHEDULE OF EQUIPMENT OF VENTILATION SYSTEM**

Sl. No.	System envisaged	Description of equipment	Quantity
1.	ELECTRICAL (HT cum LT substation) BUILDING – LEFT WING		
	Cable gallery – Pressurized ventilation through tube axial fans	4 nos. of Tube Axial supply fan of 7000 m^3/hr, 25mm of WG and 4 nos. of tube axial exhaust fan of 6300m3/hr complete with fan, motor, dry panel air filter, fittings, Bird Screen Cowl and other accessories	1 lot
	Distribution transformer rooms – 2 nos.	Tube axial fans of 3500 CMH for each transformer room complete with all accessories	1 lot
	6.6 KV power factor compensation room	2 nos. tube axial fans of 6400 CMH each complete with all accessories	1 lot
2.	ELECTRICAL (HT cum LT substation) BUILDING – RIGHT WING		
	Cable gallery – Pressurized ventilation through tube axial fans	4 nos. of Tube Axial supply fan of 9000 m^3/hr, 25mm of WG and 4 nos. of tube axial exhaust fan of 8100m3/hr complete with fan, motor, dry panel air filter, fittings, Bird Screen Cowl and other accessories	1 lot
	Distribution transformer rooms –	Tube axial fans of 3500 CMH for each transformer room complete with all	1 lot

	2 nos.	accessories	
3.	MRS BUILDING		
	Panel room	3 nos. of tube axial exhaust fan of 3500 CMH complete with fan, motor, bird screen and rain protection cowl.	1 lot
4.	MECHANICAL WORKSHOP		
	MCC room	2 nos. of tube axial exhaust fans of 2500 CMH complete with fan, motor, bird screen and rain protection cowl.	1 lot
	Hydraulic room	2 nos. of tube axial exhaust fans of 3600 CMH complete with fan, motor, bird screen and rain protection cowl.	1 lot
5.	CONTROL BUILDING		
	Cable gallery	4 nos. of Tube Axial supply fan of 9000 m^3/hr, 25mm of WG and 4 nos. of tube axial exhaust fan of 8100m3/hr complete with fan, motor, dry panel air filter, valves, fittings, ducting, SAG, Bird Screen Cowl and other accessories	1 lot
6.	Battery rooms of electrical buildings	Tube axial exhaust fan of 3000 m^3/hr, 15mm of WG complete with fan, motor, dry panel air filter, valves, fittings, ducting, SAG and other accessories.	1 lot
7.	Toilets & Pantry of all buildings	Propeller types exhaust ventilation system of capacity 500m^3/hr, complete with louver shutter and other accessories.	1 lot
8.	Pump houses	Exhaust ventilation using tube axial fans, and ducting if required	1 lot

NOTE:

I. The above mentioned capacities are indicative only. The Tenderer shall do the design calculation to arrive at the capacities required as per the design criteria. Any additional capacity requirement of air conditioning and ventilation system as per design criteria of this specification shall be supplied by the successful Tenderer without any commercial implication.

II. Any other buildings and premises that needs Air conditioning or ventilation and not covered above shall be provided with necessary air conditioning and ventilation facilities on turnkey basis by the successful Tenderer without any commercial implication.

III. The successful Tenderer shall include all item / work not specifically mentioned in the specification but are required for the completion of the project in all respects within Battery Limits in their scope and any exclusion to this effect is not acceptable.

04.04 HANDLING AND HOISTING

04.04.01 INTRODUCTION:

This specification deals with the material handling and hoisting facilities envisaged for the natural gas compressor station at IGGL site at Barpalaha near Guwahati, Assam.

This natural gas compressor station will house the compressors, all auxiliary equipment and facilities, control room, admin building, electrical system facilities and all other related units.

Following facilities/ units have been envisaged to have handling/hoisting facilities:

- Gas compressor shed
- Air compressor shed
- Mechanical workshop
- Central store
- Fire water pump house
- Lube oil storage

List of Cranes envisaged:

1. One no. DG EOT crane of 15/5T capacity for maintenance of gas compressors. (Crane shall be suitable for flame proof area zone-1 and 2, gas group IIa and IIb).
2. One no. DG EOT crane of 15Tonne/3Tonne to be installed in mechanical workshop, and a 2T electric hoist in lean to area.
3. One no. SG U/S crane of 5t capacity for Central Store.
4. One no. Electrical hoist of 1T capacity for maintenance of air compressors.
5. One no. electrical hoist of 1T capacity for lube oil storage shed (Crane shall be suitable for flame proof area zone-1 and 2, gas group IIa and IIb).
6. For pump house, the details mentioned in the chapter 04.02 shall be followed.

The specification is meant for LSTK contractor of gas compressor station who in turn will prepare detailed procurement specification of cranes envisaged in the respective units. Approval of specification prepared by LSTK contractor shall be obtained.

Capacity mentioned above is tentative and shall be finalized during detail engineering.

04.04.02 **SCOPE OF WORK:**

The scope of work of the Tenderer shall consist of design, engineering, manufacture, inspection, assembly, shop testing, painting at manufacturer's shop as well as at site after erection, supply including dismantling for transportation, packing, loading and transportation to site, receipt, unloading, handling, storage and reconservation at site, erection, testing & commissioning of all the cranes mentioned in preceding paragraphs complete with electrics & standard accessories at Gas compressor station at Barapalah near Guwahati, Assam as per technical parameters indicated in corresponding clearance diagram.

04.04.02.1 Supply of cranes shall consist of the following:

- Supply of crane complete with its structural, mechanical and electrical components and standard accessories mentioned in the clearance diagrams.
- Supply of VFD for all mechanisms for all the cranes.
- Supply of suitably sized Junction Boxes on Crane girder for termination of incoming cables (as required)
- Supply of handling attachment.
- Supply of insurance spares & commissioning spares as indicated elsewhere in this specification.
- Itemized price list of spares for two (2) years normal operation & maintenance as

indicated elsewhere in this specification.

- Supply of required quantity of initial fill of lubricants, hydraulic fluid, cleaning / flushing fluid including replenishment and other consumables necessary for erection, testing and commissioning of the cranes. .

- Supply of necessary tools and tackles required for maintenance or testing / inspection.

- The scope of supply shall cover supply of required quantity of paints for intermediate, final coat and retouching.

- Supply of all associated drawings and documents.

- Anti-collision system shall be provided for all the cranes.

- Training on following types of equipment / system for the duration as mentioned below shall be imparted by the Tenderer:

1.	VFD :	0.5 man month
2.	Radio remote control :	0.5 man month

04.04.03 INSTRUCTIONS TO TENDERER:

04.04.03.1 The Tenderer shall prepare general arrangement drawing for each crane and handling attachment (if any) showing to scale the elevation, side view and plan of the crane along with information such as clearances, construction of bridge structure, hook approaches, height of lift, location of operator's cabin with direction of view of operator, wheel base, wheel loads, wheel diameters, over buffer dimensions, buffer height, LT & CT buffer compressions, motor ratings, hoist, CT & LT speeds, arrangement and disposition of all the drives and other equipment installed on the crane, speed torque characteristics for each motion etc. for approval by IGGL/MECON.

04.04.03.2 Following drawings shall be submitted in adequate number of copies for the crane to the Purchaser / his Consultant in stages for approval / reference

The general arrangement drawing containing all information (for approval)

i. General layout drawing of the trolley (for reference)

ii. Assembly drawing of individual drives likes hoists, long travel, cross travel etc. (for reference)

iii. Layout of cabin showing the location and fixing of all the equipment inside it such as controllers/ operator's seat, protective panel, isolating and control switches, fire extinguishers, exhausts and circulating fans, air conditioners etc. (for approval)

iv. Structural calculations for girder, end carriage and connection between the two. (For reference)

v. Calculations for selection of electrical braking equipments like chopper, resistor etc.

vi. Assembly drawing of handling attachments such as hook, Traverse beam, magnets, grabs, C-hooks, coil handling tongs, sheet pack lifters etc. along with complete technical characteristics of the same.

vii. Motor power & brake selection calculation. (For approval)

viii. Lubrication arrangement for the equipment (for reference only)

ix.
a) Power and control circuit diagram showing the wiring for all the panels for crane including the speed torque characteristics of each motion.
b) Layout of Electrical equipment on crane, cable layout drawings and layout of earthing system for equipment installed on crane.
c) Inter-connection diagram and cable schedule.
d) Current collection arrangement for the crane and details of current collector.
e) Power supply arrangement (details) to the trolleys and attachments.
f) GA of all panels, junction boxes, and limit switches etc. with their technical details.
g) Bill of materials for each panel and terminal plan drawings for each and every panel and equipment.
h) Single Line Diagrams for various panels
i) Power supply system including down shop lead and festoon cable arrangement.
k) Voltage drop calculations for DSL

l) Power and regulation schemes for VVVF.

m) Power and control schemes with bill of materials and technical specification.

n) Motors and field devices
- GA drawings
- Technical data sheet

x. In addition to the above, the Purchaser/ Consultant may ask for submission of other drawings, documents, structural, mechanical and electrical calculations of the crane for scrutiny and reference, if required.

04.04.03.3 A tool box containing all necessary tools like torque wrench, portable hydraulic jack, hand grease gun, set of spanners, set of screw drivers, etc. required for the maintenance shall be supplied with each crane.

A separate electrical engineers tool box with insulated tools shall be provided for each crane.

04.04.03.4 The Tenderer shall ensure that minimum amount of assembly at site is necessary for early commissioning of the crane after delivery. Site welding and riveting shall be avoided as far as possible. The Tenderer, before proceeding with design details shall satisfy himself about the site conditions so as to avoid any difficulty in erection, arising out of design.

04.04.03.5 The crane shall be completely assembled and tested in the Purchaser's works for full load and 25% over load on hoisting and cross traverse motion, in presence of Purchaser's representative in addition to other tests as specified in the IS : 4137-1985 as applicable.

04.04.03.6 The following test shall be carried out at manufacturer's works during inspection.

- High voltage test of panels.
- Contactor sequence test for all motions.

04.04.04 Painting:

All cranes shall be painted as per specification. Necessary surface cleaning by mechanical power tools as well as blast cleaning of the surface required as per TS have to be done before painting. The equipment has to be painted with requisite grade of primer and intermediate paint prior to finalize. Necessary heat resistant, anti corrosive and special paints have to be applied as per requirement.

Following shall also be considered for painting of cranes:

i) All parts of the crane shall be thoroughly cleaned of all mill scales, rust or foreign matters and then painted as specified. The surface cleaning shall confirm to Indian Standard/ Swedish Standard/ DIN standard.

ii) All parts of the crane (except motors, resistors, gears, thrusters etc.) shall be painted at shop with one primer coat of PVC copolymer alkyd resin with red oxide/ zinc chromate.

For corrosive atmosphere all surfaces shall be coated with two (2) coats of Epoxy Zinc based on zinc dust.

iii) Interior of all gear housing shall be painted with oil resistant paint.

iv) All machine pads, bearing surfaces on structure or housing shall be painted with white lead.

v) All parts inaccessible after assembly shall be painted before and assembled while paint is still wet.

vi) After erection the damaged portion of the painted surfaces shall be retouched and then one intermediate coat of PVC copolymer alkyd resin shall be applied. The colour shall be as per choice of the Purchaser.

As the crane is subjected to corrosive atmosphere, the intermediate coat of PVC copolymer alkyd resin with micaceous iron oxide (MIO) shall be applied.

vii) Subsequently one final coat of PVC copolymer alkyd with weather resistant pigment (approved by Purchaser) and glossy finish shall be applied.

viii) The detail of dry film thickness (DFT) of the different coats shall be as follows:

a) Primary coat = 30-40 micron/coat

b) Intermediate coat = 70-80 micron/coat

c) Final coat = 40-50 micron/coat

ix) For parts exposed to heat beyond 80^0 C & upto 150^0 C i.e in hazardous area, Zinc ethyl silicate primer shall be used followed by a coat of high build epoxy polyamide enamel. This shall be applicable to all structural parts of the crane except mechanical and electrical equipment.

x) The buffer and hook block of the crane shall be painted with yellow base and 100 mm wide black zebra strips at a gap of 100 mm at 30^0 inclinations.

xi) Colour scheme shall be as approved by the Purchaser.

04.04.05 Spares

04.04.05.1 Insurance Spares:

Not Applicable

04.04.05.2 Commissioning Spares (As applicable):

The Tenderer shall provide with each equipment minimum commissioning spares as listed below required for proper erection and commissioning of the equipment until final acceptance following demonstration of performance guarantee. However, the list of commissioning spares shall be firmed up based on the TS and actual system finalized during detail-engineering.

i) **Mechanical: -**

Sl. No	Item	Qty
1.	Oil seals and gaskets for all gear boxes	One set each

ii) **Electrical :**

Sl.No.	Item	Quantity
1.	Indicating lamp with holder	1 no. each type
2.	Power contactor a) Contactor contacts b) Coil	1 no.each type 1 set each type 1 no. each type
3.	Auxiliary contactor a) Contactor contacts b) Coil	1 no. each type 1 set each type 1 no. each type
4.	Push button	1 no. each type
5.	Power fuses	5% of each rating
6.	Control fuses	10% of each total quantity
7.	Control switches	1 no.
8.	Brake coil	1 no. each
9.	Overload relays of each type installed on crane.	1 no. each type
10.	Semiconductor fuses	3 numbers of each type

04.04.05.3 **Two years operation and maintenance spares :**

In addition to the standard items included by the Tenderer, the following are the list of spares required **for two (2) years operation** of each crane. However, the list of essential spares will be finalized during detail engineering.

i) Mechanical :

Sl. No.	Item	Qty
1.	L.T. wheel assembly (Driving)	1 No.

2	L.T. wheel assembly (Driven)	1 No.
3	C.T. wheel assembly (Driving)	1 No.
4	C.T. wheel assembly (Driven)	1 No.
5.	First reduction pinion shaft with bearing assly. For all drives.	1 no. each
6.	Brake drum for all drives	--do--
7.	Brake lining with rivets for all brakes	6 pairs each
8.	Rope sheaves with bearing assembly	1 no. of each size.
9	Floating Shaft with half gear coupling between LT wheel assembly & gearbox	1 no. of each size.
10	Electro Hydraulic disc brake assembly with complete with power pack unit and hose assembly along with liners for disc brake	1 no. of each size.

ii) Electrical:-

Sl. No.	**Item**	**Qty.**	**%of total equipment**
1.	Motors	1 no. of each rating.	
2	Controls		
	Power contactors	1 no. of each rating.	
a)	Fixed and moving contacts for contactors of each type	Minimum 1 set for each	25%
b).	Contact set for auxiliary Contactors	--do--	25%
c).	Coils for power contactors	Min. 2 nos. for each type	50%
d).	Coils for aux. contactors	Min. 1 no. for each type	25%
e).	Over load relay	Min. 1 no. for each type	100%
f).	Timers	Min. 2 nos.	15%
g).	Aux. Contactors	Min. 1 no. of each	25%

Sl. No.	Item	Qty.	%of total equipment
		type	
3.	Master controller: Moving contacts & fixed contacts	25% each	25%
4.	Limit switches: Fixed & moving contacts	25% each for individual mechanism	25%
5.	Fuses		
	a) Power circuit fuses	Min.1no. of each rating	100%
	b) Power circuit base	Min.1 no. of each type	25%
	c) Control fuse base	Min. 4 nos.	25%
	d) Control fuse base	Min. 1 no.	25%
6.	Indicating lamp with holder	Min. 2 nos.	25%
7.	Push buttons		
	Contact element set for push buttons	Min. 1 set	40%
8.	IGBT module of each type	Min. 2 nos.	For cranes with VFD control
9.	Semiconductor fuses Resistors		25%
10.	Punched stainless steel	Min. 1 no. grid for each current rating	5%
11.	D.C. contactor magnet panel	Min. 1 no. for each type	25%
12.	Bridge rectifier for magnet	---do--	25%

Sl. No.	Item	Qty.	%of total equipment
13.	Coils / thrustor unit for brakes of each type		100%

Note: Above list of spares are indicative. The list shall be finalized based on the make of the cranes.

04.04.06 TECHNICAL SPECIFICATION FOR DOUBLE GIRDER EOT CRANES

04.04.06.1 Mechanical & Structural

The following guidelines shall be considered:-

1. LT mechanism shall be provided with individual corner drives. Drives with common motor/ gearbox and line shaft shall not be acceptable

2. All wheels shall be of solid forged double collared type with a hardness of 300 to 320 BHN.

3. Minimum clearance of 300mm between the rail top and bottom of end girder shall be maintained for providing jacking and removal of LT wheels.

4. Jacking pads provided in the lower flange of end girders should be inline with the axis of main girder.

5. Except for planetary gears, reducers for other mechanisms of the cranes should be provided with hardened and tempered quality steel gear internals with induction/ flame hardened teeth, but not carburized.

6. End girder to main girder connection shall be over riding design (a portion of main girder end shall be sitting on the end girder and is bolted). End girder shall be so designed in case of damage of wheel housing the end piece grafting can be done in-situ position.

7. The sides of LT track rails heads are lubricated by oil lubrication system, which will be installed on the crane end girders. The lubricating rollers shall

be in contact with sides of rail heads where the wheel collar is in contact with the rail.

8. Trolley rail clamping shall be with slotted base plate welded on the girder where in the clamp bolts shall be inserted into the slots and rail clamps are provided.

9. Malmadie/Jaure make barrel coupling shall be used between rope drum and output shaft of all hoist gearboxes.

10. All input couplings between motors and gear boxes shall be pin bush type only for all the cranes as per relevant Indian standards.

11. Provision for easy removal of individual wheel changing in long travel mechanism without removing the balancer shall be kept.

12. All gear boxes shall be horizontally split only.

13. All gear couplings in LT & CT drive shall be as per as per relevant Indian standards.

14. Mechanized rope lubrication system in the hoist rope drum shall be provided.

15. All bottom blocks shall be of closed cover with hook locking arrangement.

16. For welded construction such as that of bridge girders, end-carriages, rope drums, gear-boxes etc., steel shall be as per IS: 2062-1992 quality. For welding these members low hydrogen electrodes as per IS: 814-1991 grade EB-542-C-83H shall be used. Plates used for this purpose shall be ultrasonically tested.

17. For design of structures as per IS: 807-2006, the following forces shall also be taken into consideration:-
    a) Vertical reaction on trolley rail arising from surge load.
    b) Skewing force.
    c) Collision force due to buffer impact.

d) Torsional moment due to cantilever load, eccentric wheel load (in case of wide BOX girder), starting/ stopping of LT motor.

e) Local bending stress of the flange.

Note: While calculating the allowable stress in compression, effective length of the compression flange the girder shall be taken as 0.85 of the span only.

18. Full length wearing plates or resilient pads of min. 10 mm thick shall be provided under the trolley rails.

19. Transverse fillet welding on load carrying members shall be avoided. All butt welds on tensile zone shall be X-rayed/ ultrasonically tested.

20. Thickness of chequered plates for platforms shall be 6 mm over plain. Chequered plates shall not be considered for strength calculations of load carrying members. Plates used for girders, end carriages, connection plates, trolley frame shall be ultrasonically tested for lamination as per ASTM 578B.

21. The top of the trolley frame shall be plated all over except for openings required for the ropes and flexible cables for bottom blocks etc to pass. The openings in the trolley frame shall be such as to keep the ropes or cables at least 125 mm away from or equipment to prevent damages for all positions of the bottom blocks.

22. Foot walks shall be of sufficient width to give at least 500 mm clear passage at all points except between railing and bridge drive where this clearance may be reduced to not less than 400 mm.

23. Thickness of web plate of crane girder shall not be less than 12 mm , for end carriage and wheel bogie web it shall not be less than 10 mm. Diaphragm plate shall be minimum 8 mm thick plate. Each diaphragm plate shall be made out of single plate cut to shape.

24. For trailing cable system minimum section for I- beam shall be ISMB -150 & minimum section for post shall be ISMC 150. One dedicated platform shall be provided for maintenance of trailing cable system along the girder length.

(This platform shall be additional to all other platforms required as per design).

25. The MH hook profile should match with the fixing arrangement of the mould / segment handling traverse. Lifting hook shall be of long shank type for ensuring proper engagement with the above mentioned traverse.

26. Following additional specification for various components shall be noted

Rope drums

Rope drums shall be fabricated out of rolled steel plates. Fabricated rope drums shall be stress relieved before machining. The grooves of the drum shall be smooth finished. Rope drum shall be flanged at both ends. Longitudinal weld of the drum shall be done UST. In no case seam tube shall be considered for making rope drums.

Rope sheaves

Rope sheaves shall be of cast steel only. Rope Sheaves shall have anti friction bearings only. In no case sheaves fabricated out of plate shall be considered

Wire ropes

The ropes shall be steel cored. Ropes shall be regular right hand lay as per IS: 2266-2002. The construction ropes shall be 6 x 36. No of total fall for main hoist shall be limited to max 16 with minimum rope size of 24 mm, whereas max no of falls in Auxiliary hoist is 4 with minimum rope size 16 mm. For calculating rope size, grade 1770 n/mm square shall be considered (1960 n/mm square rope grade shall not be considered as it is rare in our inventory)

Hook block

The sheaves shall be fully encased in close fitting guards fabricated out of steel plates. Smooth opening shall be provided in the guards to allow the free

movement of rope, and holes shall be provided for drainage of the lubricant. All the bottom blocks shall be closed cover type only and hooks shall have load locking device. Hook block shall not be provided with bush bearing. All the rotating parts shall have anti friction bearings. Main Hoist hook shall be Ram shorn hook type.

Gears & gear- boxes

Straight and helical spur gearing shall be used for all motions. Worm & bevel gearing shall not be used. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft.

All gears shall be hardened and tempered alloy steel having metric module. Overhung gears shall not be used.

As far as possible forged gear shall be used (for gear dia up to 700 mm only forged gears are to be used). All cast steel gear shall be tested by Gamma Ray. All gears shall be enclosed in oil tight gear boxes. Gear-boxes shall be of fabricated design from IS 2062 steel and horizontally split at each shaft centre lines. Fabricated gear boxes shall be stress relieved before machining. As far as possible vertical gear boxes shall be avoided. In no case taper roller bearing shall be used in crane gear boxes.

Connection between rope drum & gear-box

Connection between rope drum and gear boxes shall be drum/barrel coupling preferably of Malmadie/Jaure/Tschan make.

Wheels

Crab/crane wheels shall be double flanged. Flange less wheels shall not be considered. Wheels shall be mounted in anti-friction roller bearing housed in 'L' shaped bearing brackets for easy removal during maintenance.

All wheels shall be of solid forged double collared type with max.dia.900 with a hardness of 300 to 320 BHN. (Wheels shall be as per relevant Indian standards). Minimum wheel size for LT shall be dia 710 mm and for CT dia 630 mm

Coupling

All drives input side connection to motor shall be only pin bush type of relevant Indian standards. Gear Coupling shall not be used in input side. Rotating parts shall be suitably covered by 3.15 mm thick sheet steel hinged covers for safety. Half geared couplings with floating shaft shall be provided between the wheel and Gear box for Long travel and cross travel drive where ever required. Geared motor shall not be used for any drive. All gear couplings used for Long travel and Cross travel output and wheel connection shall be as per relevant Indian standards.

Bearings & bearing housing

Anti-friction bearings shall be used throughout except where required otherwise for technical reasons.

Brakes

The brakes shall be provided for all motions on the high speed pinion shaft of the gear train. For Main Hoist, minimum two brakes shall be used. Calculation of brake shall be 125% load calculation for each brake. All brakes shall be DC Electro Magnetic brakes preferably of BCH make.

04.04.07 TECHNICAL SPECIFICATION OF SINGLE GIRDER EOT/US CRANE

04.04.07.1 Same as clause no. 04.04.02

04.04.07.2 Technical Specification

- Single girder cranes shall be designed, manufactured, assembled and tested in accordance with the latest revision of IS:807, IS:3177, IS:3938 and other relevant codes and practices for the cranes to be used in steel plants, steel industry (IPSS) unless otherwise stated.

- The components of the hoist shall be designed, manufactured, assembled and tested in accordance with the latest revision of IS:3938 and shall be of standard make.

- All working parts requiring replacement or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

- All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and tested.

- For out-door cranes all electrical and mechanical components which are exposed to weather shall be completely covered or made weather proof. The covers shall be in segments to facilitate easy dismantling and assembly.

- No cast iron parts shall be used except for electrical equipment and no wood or other combustible material shall be used unless specifically mentioned otherwise.

- Where down shop leads are located below runway rails, guard shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads.

- All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washers.

- All trailing cables shall be clamped with PVC or non-metallic clamps.

- Steel frames carrying machinery shall be machined to true surface.

- All gears and bearings shall be lubricated by splash lubrication/ grease as required. All greasing points shall be easily accessible.

04.04.07.3 **Structural Design**

- The crane structure shall be designed in accordance with the latest revision of IS:807.
- The bridge girder shall consist of main and an auxiliary structure where necessary.
- End-carriages shall be fabricated from rolled steel sections or plates, or both, welded together to form a box.
- End-carriages shall be of ample strength to resist all stresses likely to be imposed on them under severe conditions, including collision with other cranes or stops. The length of the end-carriage shall be such that no other part of the crane is damaged in collision.
- The end-carriage shall be fitted with safety stops to prevent the crane from falling more than 25 mm in the event of breakage of a track wheel or axle.

Suitable jacking pads shall be provided on each end-carriage for jacking up the crane while changing track wheels.

- For single girder EOT cranes with central L.T. drive, full length M.S. chequered plate platform shall be provided along the bridge girder for mounting and access to long travel drive, current collection system, control panels, etc. A clear head-room of minimum 2000 mm shall be made available over the top of platform from the bottom cord of the roof truss.
- Black bolts shall not be used in the load bearing structures of the crane. Also high tensile friction grip bolts shall not be used unless approved by the Purchaser.
- Bolts used in shear shall be fitted into reamed holes.
- Transverse fillet welding on the load carrying members shall be avoided.
- All butt welds on structural members, subject to tensile stress, shall be x-rayed.
- Plates, bars, angles and where practicable, other rolled sections used in the load bearing members of the structure shall not be less than 6 mm thick.
- Steel sections and plates, used for construction shall be of the latest revision of IS:2062 quality.

04.04.07.4 **Mechanical Equipment**

- **Design of Mechanisms**

  Each mechanism of the crane shall be modular in construction with built in facilities for easy dismantling and maintenance of each assembly as an independent unit.

- **Rope Drums**

  Fabricated rope drum shall be stress relieved before machining. For the cranes used in steel plants, the material of the rope drum shall be limited to M.S.

- **Wire Rope**

  The wire ropes shall be regular right hand lay hemp cores as per IS: 2266/1989. However, ropes working under water and in corrosive atmosphere shall be galvanized and shall have steel core. For rope arrangement with 2 falls, wire rope shall be of non-spinning type. For the cranes in steel plant, selection of wire rope shall be as per IPSS.

- **Rope Guides**

Suitably designed rope guides with pressure ring/ rope tightener shall be provided for each lead of rope from the rope drum to prevent the rope from overriding, loosening or rope coming off the groove.

- **Rope sheaves**

  For cranes, material shall be either CS/MS. Bottom block sheaves shall be provided with suitable guards to retain the rope in the sheave groove. Equalizer sheave/ bar shall be arranged to turn and swivel to maintain rope alignment under all circumstances.

- **Wheels**

  For single girder EOT cranes, the wheels for long travel motion shall be double flanged with straight tread. The width of wheel tread shall be greater than the rail head by 30 mm. For under slung cranes hoists block, the wheels shall be single flanged with straight/ taper tread to suit the track beams. Minimum diameter of the LT wheels for S.G. EOT cranes shall be 320 mm. However, in case of steel plant duty cranes the combination of wheel diameter and rail size shall be ensured. Wheels shall be of forged/ rolled/ cast steel with minimum hardness of 200 BHN in case of single girder under slung cranes running on rolled steel joist and 300 BHN for EOT cranes and for under slung cranes/ hoists running on wear resistant flats welded to rolled steel joists. Minimum diameter of CT & LT wheels for under slung cranes shall be 150 mm.

- **Long Travel Drive**

  a) For Single girder EOT Cranes

  Individual wheel drive (one wheel in each end-carriage) shall be provided when the crane span exceeds 13 meters. All parts of the long travel drive shall be located above the platform and easily accessible. The gear-box mounted on platform with foot mounted motor and brake shall be connected with driving wheel by means of locating shaft and flexible geared coupling. The use of open gearing, chain and sprocket, pulley and belt etc. is not permitted.

  b) For under Slung Cranes

  Dual drive arrangement located at either end of each end carriage shall be provided. Flange mounted geared motors may also be used.

- **Hoist and Cross-Travel Drive**

The hoist and cross travel motions shall be combined in one block which shall be designed as per IS:3938/1983. It shall be ensured that skidding does not occur under any condition.

- **Gearing and Gear-boxes**

  Straight and helical spur gearing in metric module shall be used for all motions. Worm gearing shall not be used. All gears shall be of hardened and tempered alloy steel with machine cut teeth. Hardness for pinion shall be 220 BHN and for gears it shall be 200 BHN. All gearings shall be enclosed in oil tight gear-boxes. Fabricated gear-boxes shall be stress relieved before machining.

- **Bearings and Bearing Housing**

  Ball and roller anti-friction bearings shall be used throughout unless otherwise specified. Anti-friction spherical roller bearings shall be provided for live axles of travel wheels. Housings shall be split on shaft centre line to permit removal of the shaft. The underside of the base of each bearing pedestal shall be machined and shall bear upon a machined surface.

- **Couplings**

  Flexible coupling shall be used between the LT motor and gear-box and between gear-box out put shaft and wheel shaft. In case of single motor central drive for LT motion, out put shaft of the gear-box shall be connected through solid flange couplings. Half-geared couplings with floating shaft shall be provided between the wheel and the line shaft.

- **Hook Blocks**

  Hook blocks shall be of enclosed type leaving openings for ropes only so that ropes do not run off the sheaves. Standard swivelling shank hooks, mounted on thrust bearings shall be used unless otherwise specified.

- **Brakes**

  Electro-magnetic brakes shall be provided for each motion on the high speed pinion shaft of the gear-train.

- **Buffers**

The crane shall be provided with rubber buffers on the four corners of the end-carriages unless otherwise specified. For electrically operated hoists, steel stops at all the four ends of the track beam shall be provided.

04.04.07.5 DOCUMENTATION

- **List of Drawing/ Documents to be furnished by the Successful Tenderer for approval / reference**

a) General Arrangement drawings of cranes/ hoists / attcchments & signed copies of Clearance diagramme
a) Quality assurance plan for inspection.
b) Specification of oils and lubricants and other consumables and their quantity and frequency of change.
c) Detailed layout plan and sections for power supply system. (Angle Bus bar/Shrouded Bus Bar/ Festoon Cable etc.)
d) DSL / Trolley line arrangement layout.

- **List of Drawings/ Documents to be furnished alongwith equipment by the Successful Tenderer**

01. Requisite no. of sets of all GA drawings, complete assembly and sub assembly drawings of the equipment.
02. Drawing of all equipment/ component received from sub supplier.
03. Engineering and design calculations.
04. Test and warranty certificate for each item of equipment.
05. Detailed erection schedule and manuals, assembly/ erection drawings, erection sequence, special precautions to be followed during assembly/ erection (these shall be despatched three months prior to FOT/FOR delivery).
06. Test reports and inspection reports.
07. Instruction manuals for testing and commissioning.
08. Operation, maintenance and safety manuals.
09. Requirement of special tools and tackles, if any, for subsequent maintenance.
10. Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions (two sets and one reproducible and/or two sets of catalogues).
11. List of spare parts with drawings, sketches, specifications and manufacturer's catalogue (two sets and one reproducible and/ or two sets of catalogues)
12. All other drawings and documents as stipulated in General Conditions of Contract.

04.04.08 ELECTRIC HOIST

04.04.08.1 **Same as clause no. 04.04.02**

04.04.08.2 **TECHNICAL SPECIFICATION**

a) The hoist shall be designed in accordance with IS:3938-1983.

b) For outdoor hoists, motors, brakes & other equipment shall be covered to suit to outdoor operations.

c) All trailing cables shall be clamped with PVC or non-metallic clamps.

d) Defects in the materials like fractures, cracks, blowholes, or laminations are not allowed.

e) No cast iron parts shall be used except for electrical equipments and no wood or combustible material shall be used unless specifically mentioned otherwise.

f) All working parts requiring replacements or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

g) All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washer.

h) All parts of the hoist shall be thoroughly cleaned of all loose mill scales, rust or foreign matter & then painted as specified. All parts inaccessible after assembly shall be painted before assembly & assembled while paint is still wet.

i) All parts except motors, resistors, gears, thrustors, solenoids, etc. shall be de-rusted manually & painted as follows:

04.04.08.3 **Mechanical details**

- **Wheel & drive**

The electric hoist shall run on two pairs of wheels, a pair of which shall be driven by motor through reduction gear. The wheels shall be of cast steel/forged steel, single flanged with taper / parallel treads to suit to monorail. The wheels shall be mounted on anti-friction bearings & shall be easily removable for repair & replacement. The wheel diameter shall be selected such that skidding does not take place even under unloaded condition.

- **Hoist mechanism**

  The hoist mechanism shall consist of a bottom block fitted with a standard forged swivel hook of the specified capacity, supported on 2 or 4 falls of wire rope. However, non-spinning type of wire rope shall be used for 2 falls rope arrangement. The wire rope shall be wound on a grooved drum which shall be sufficiently long to accommodate in one layer the length of rope requisite for the specified lift & in addition not fewer than two turns at each anchored end & one spare groove at the opposite end. The hoist drum shall be motor driven through gears enclosed in oil filled reduction gearbox.

- **Gearing**

  Straight & helical spur gearing shall be used for all motions. Worm & bevel gears shall not be used with specific permission from purchaser. Preferably all first reduction gears shall have single helical teeth. All gears shall be hardened & tempered alloy or carbon steel with machine out teeth. Surface hardening of teeth is not acceptable. All gears shall be enclosed in oil filled gear box except when not possible.

- **Couplings**

  Each motor shall be connected to its gear drive by a flexible coupling.

- **Lubrication**

  All gears & bearings shall be lubricated either by splash lubrication or by grease. If possible, all the lubricating points shall be grouped together in easily accessible positions.

- **Bearings**

  Ball & roller antifriction bearings of reputed make shall only be used, with minimum bearing life as per IS: 3938.

- **Brakes**

  D.C. Electromagnetic brake shall be provided for each motion, however in case of conical rotor motors manufacturer's standard brake can be used.

- The Electric hoists shall be inspected as per IS: 3938 - 1983.

04.04.08.4 DOCUMENTATION

- **List of Drawing/ Documents to be furnished by the Successful Tenderer for approval / reference**

a) General arrangement drawing of equipment showing full details in plan and sections.
b) Quality assurance plan for inspection.
c) Specification of oils and lubricants and other consumables and their quantity and frequency of change (reference)
d) Detailed layout plan and sections for power supply system.

- **List of Drawings/ Documents to be furnished along with equipment by the Successful Tenderer**

a) GA drawings, complete assembly and sub assembly drawings of the equipment.
b) Engineering and design calculations.
c) Test and warranty certificate for each item of equipment.
d) Test reports and inspection reports.
e) Instruction manuals for testing and commissioning.
f) Operation, maintenance and safety manuals.
g) Requirement of special tools and tackles, if any, for subsequent maintenance.
h) All other drawings and documents as stipulated in General Conditions of Contract.

04.04.09 ELECTRICAL

04.04.09.1 SCOPE OF WORK:

The scope of supply covers all electrical equipment commencing from main current collectors on the crane and all other electrical items beyond the main current collectors of the crane i.e. DSL main current collectors, power disconnecting switch on bridge platform after main current collectors, protective and control switch gear, VFD panel, Isolator panel including cables at both the repair bay ends, motors, control and brake panels, resistors, brakes, limit switches, all power and control cables including supports, socket outlets, lighting distribution panel, lighting fixtures with lamps, festoon cable system, indicating lamps, push buttons, earthing materials etc.

However, scope of tenderer includes complete crane electrics design &

engineering.

Design & Engineering of incoming cables, erection materials like cable trays, cable supporting structures etc. shall be done by Tenderer.

The scope of work also includes complete assembly and cabling/wiring of crane and testing at manufacture's works, erection, testing and commissioning of all electrical equipment, supply of all commissioning spares with minimum quantities as indicated in relevant clauses of this T.S .

All sundry erection materials required for installation and connecting up of electrical equipment with cable laying and fixing accessories shall be in the scope of supply by Tenderer.

The Tenderer shall carry out all necessary engineering related work, voltage drop calculation and based on which the contractor shall supply and erect incoming cables, column isolators & trolley line system.

04.04.09.2 Standards:

The design, manufacture, assembly and testing as well as performance of the equipment shall conform to the IPSS in respect of items for which IPSS have been issued; otherwise, to the relevant IS specifications (latest revision). In case the Tenderer is not in a position to comply fully with certain IPSS/BIS specifications, or in respect of certain items for which there are no IPSS/BIS specifications, the Tenderer may base his proposals on IEC recommendations or other reputed national or international standards subject to the approval of the Purchaser.

All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the Government of India and the Government of Orissa and with the Indian Electricity Rules.

04.04.09.3 Climatic conditions:

The ambient temperature conditions met within the different shops/ units of the complex will be as follows:

Electrical rooms (ventilated)	: +45°C
Cable cellars (ventilated)	: +45°C

For specific areas and shops, the ambient temperature conditions indicated above shall be taken into consideration and equipment suitably derated where necessary. For areas not covered above, equipment selection and Derating shall generally be based on ambient temperature of +50°C.

The equipment offered shall be suitable for smooth, efficient and trouble free service in the climate prevailing at site and under the ambient temperature conditions indicated above for the different shops and areas. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

The equipment shall be designed to give efficient and reliable performance under heavy conditions and shall be such that the risks of accidental short- circuits due to animals, birds or vermins are obviated.

04.04.09.4 Power supply and standard voltage levels:

The following standardized voltage levels shall be adopted:

a)	LTAC	:	415V, 3 phase, 50 Hz, 4 wire solidly earthed system for all cranes and hoists. The 4th wire being the earthed conductor. Other voltages shall be obtained by providing transformer/ transformer – rectifier unit with MCBs on both primary and secondary side and ±5% and ±10% taps on transformers secondary.
b)	AC control and signaling voltage	:	240 V AC obtained using suitable control transformer
c)	Socket outlets for		
	Hand lamps	:	24 V, single phase, 50 Hz, AC obtained through suitable transformers
	Hand tools	:	240 V, 15A, 2 pin plus earth with plug interlocked switch
d)	Electro-magnetic	:	220 V, DC obtained through individual brake

	brakes		control panels.
e)	Monitoring and signaling in electronic installations, mimic panels	:	24/ 48 V. DC
f)	Illumination/ lighting	:	240 V, AC

The three phase symmetrical short-circuit ratings of the switch gear at 415 V shall be 50 kA for 1 second.

The system/ unit/ equipment shall be designed so as to be suitable for the following variations in voltage and frequency :

	Voltage	**Frequency**
Permissible variations with rated performance, rated current and control effectiveness maintained.	± 10% For LT system	+5% & -5%
Permissible variations for control and regulation equipment with rated performance and control quality maintained	± 10%	+5% & - 5%

Voltage dip on the starting of largest LT motor shall be limited to 20% of the nominal voltage at the motor terminals.

Total voltage drop on crane shall be limited to 2% on crane and 3% in DSL system.

The equipment selected shall be suitable for voltage and frequency variation as mentioned above and any combination of the above. However, drive system shall be selected for voltage operating range of 70% to 110% of declared supply. Also this shall operate satisfactorily in case of a voltage dip upto 30% for duration of 500 ms.

04.04.09.5 Trolley Lines and Power Supply Arrangements for Crane (DSL System):

01. Power Supply Arrangements for Crane (DSL System)

Electric power for operation of the crane will be available at 415 V, 3-phase, 4-wire, 50 Hz, the 4th wire being the earthed conductor.

Power to crane shall be fed from crane LTSS through PDB's installed in respective bays. Number of panels shall be decided as per requirement (to be indicated by the Tenderer. Isolator (ACB / MCCB) for each feeding section will be provided in each bay. The Tenderer shall provide bimetallic joints and cable lugs for termination of incoming cables.

In case of circuit breaker rating more than 630A, ACB's shall be provided. All the ACB's shall be installed in a PDB which shall in turn be installed in the bay/shop floor. In case of circuit breaker rating is 630A or less, than the MCCB (as isolator) with earth fault protection and magnetic over current release shall be mounted in the respective column of the feeding bay in a separate enclosure at man height level.

Signal lamps shall be provided just below the trolley lines at 60m intervals as well as at the beginning and end of each section/repair section to indicate whether the trolley lines are energized or not.

Insulation air gap between two sections of a sectionalized trolley line shall be minimum 50 mm for voltage levels upto 500V, but in no case should be greater than the length of the current collector on the crane.

02. **Trolley power conductors**

The Power conductors or down shop lead (DSL) shall have 4 conductors, 3 phase, 4 trolley line system (3 power + 1 earth).

Following sections of DSL shall be used for different crane / hoists capacity:-

Upto 10 t capacity	: 50 x 50-x 6 mm MS angle.
Above 10t upto 100 t	: 75 x 75 x 6-mm MS angles.
Above 100 t	: rail size of 75 lb.

The crane power conductors (Down Shop Leads) of EOT crane shall not be of copper head rail. The section shall be straight, unbranded and smooth on the running surface. The power conductors shall be made from standard rolling length. The jointing of standard lengths shall be made by 100% butt welding and top surface finished smooth by grinding to get free movement of the current collectors. The conductors shall be painted with anticorrosive paint, except for contact surface. Parallel aluminum buses shall be provided as specified. The maximum continuous length of power conductor section shall not exceed 30 m without an expansion joint in between. DSL conductor shall be shrouded. Expansion and section gaps shall be provided in rails at every 30m. The gaps shall be cut at an angle of 30 degree to the rail and shall be 50mm wide. The gaps shall be provided with flexible joints.

The conductors shall be supported at 3000 mm intervals by insulators mounted on brackets welded to crane girders. Typical drawings indicating details of trolley line power conductors, supporting insulators, brackets, expansion joints, parallel aluminum bus, signal lamp assemblies etc. shall be furnished by successful Tenderer.

In order to provide electrical continuity across the expansion joints the power conductors on both sides of the joints shall connected by stranded aluminum conductor jumper, fitted with steel Aluminum strap and lugs suitable for the steel angle sections.

Looping cables shall be used in parallel with the conductor rails and copper equalizing strips shall be provided, wherever necessary, for limiting the voltage drops.

The sizes of conductors shall be selected to suit the total current requirements of EOT crane keeping the voltage drop in the crane DSL system upto the crane power collecting point on DSL within 3% of the declared voltage under worst operating condition.

The power supply feeder and trolley line conductors/looping cables shall be selected so as to limit the voltage drop to within 15% of the rated voltage at the crane motor terminals for the short time peak current corresponding to the

starting of the largest capacity motor and the maximum continuous operating current of the rest on the system.

Maintenance Bay

Necessary DSL arrangement, sectionalizing isolator etc. for repair section shall be provided by Tenderer as per mechanical scheme/crane clearance diagram.

Isolator panels (ACB / MCCB panels including cables) shall be provided for each repair section for maintenance. Dead zones shall be provided with isolator arrangements to prevent collision between cranes and momentary paralleling to two incomer supplies. Incomer ACB's shall be provided with earth fault protection and magnetic over current release. The DB's shall be located suitably on the shop floor.

For end zones, minimum length of maintenance bay shall be 2 m plus the crane width. For middle zone, the length of maintenance bay shall be 4 m plus the width of crane.

Repair section shall be provided with red lamp steady/flashing fixtures at four corners. These fixtures shall be located at crane gantry with manual ON/OFF provision.

Boarding or access platform shall be arranged within the limits of each repair section for approach to the crane.

03. Insulators and trolley line holders:

The insulator assembly used for the manufacture of trolley line holders shall be preferably polyester resign bonded fibre glass type or better insulation material having substantial mechanical strength specifically against blows and vibrations. They shall be capable of withstanding the impact and shocks resulting from operation of the machine. The creep age distance of the insulators shall not be less than 80 mm.

The insulators used in the LT/AC system shall have flash over values and mechanical strength not less than the following:

Dry flashover voltage : 25 kV

Wet flashover voltage : 12 kV
Ultimate mechanical strength : 1000 kg.

The trolley line holders shall generally conform to the design shown in the drawing to be furnished to the successful Tenderer. All sharp edges shall be ground smooth. The porcelain insulators shall be manufactured and tested as per IS: 1445 –1997

04. Supporting brackets:

The trolley line conductors shall be mounted on holders. The holders shall be bolted on to brackets which in turn shall be welded on to crane girder at stiffeners at regular intervals. In normal run, intermediate type of brackets shall be used, but when sectionalizing gaps or expansion joints are provided, sectionalizing type of brackets shall be provided.

05. Steel to Aluminium straps:

These are meant for connecting parallel aluminium bus, at expansion joints, power supply cables from load break switch. They shall be complete with MS cadmium coated bolt nuts, spring washers, lugs etc.

06. Signal lamp assembly:

Signal lamp assembly shall be industrial, heavy duty dust tight and water proof in construction suitable for indoor or outdoor locations. The units shall comprise three lamps for three phases with red glass lens and reflectors. The lamp shall be LED cluster type.

4 Nos. cluster LED type red warning lights shall be installed at the four corners of the crane to indicate that the crane is down undergoing repairs.

07. Aluminium parallel bus:

These buses shall be of E.C. grade aluminium. They shall be free from any deformity in profiles.

04.04.09.6 Current Collectors:

2 nos. per trolley line shall be provided. The collector shoe will be of heavy duty design and chamfered at both ends, each rated for 100% of total crane rating.

Double collectors on each earth trolley line shall be provided and these shall be different from those on power trolley line. Collector shall be multi hinged for self – aligning. Collector will be designed in such a way that load is transmitted not on the insulators but on the insulator stud to avoid damage to insulators.

All the current collectors shall be spring loaded to avoid any loose contacts during the movement.

05.02.01 Power distribution on crane:

One adequately rated load break manual isolator (MCCB/ACB) with locking facility shall be provided immediately after current collectors on incoming line on the crane. The isolator shall be capable of carrying current of two largest motors.

Power from the isolator shall be taken to the air circuit breaker to be provided in operator's cabin. In case of pendant/RRC operated cranes, this circuit breaker shall be located in protective panel located at bridge platform.

The breaker shall be provided with under voltage, over load and short circuit releases. The breaker shall also be with earth fault protection. The breaker can be closed only when:

- All master controller/ RRC handles are in neutral position.
- None of the stator or directional contactors are in closed positions.
- Emergency corner switches not operated.
- Door/Gate switch are not actuated and gravity limit switch for hoist motion not operated. Power for lighting shall be tapped from the incoming side of isolators near current collectors.

04.04.09.7 Power supply for CT. motion:

Flexible trailing cable systems mounted on retracting support system shall be used. The system shall consist of insulated multi-conductor or several single conductor cables with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cable. Provision later stage in case of necessity. The flexible cable shall be butyl rubber or EPR

insulated CSP sheathed type.

For trolley cranes, power supply shall be through festoon cable arrangement, slip ring or cable basket.

Flexible cables system mounted on latest PVC linked chain system in normal area & metallic chain systems in hot area shall be provided.

04.04.09.8 Meters:

Ammeter and voltmeter with selector switches shall be provided on the incoming line in protective panel.

Ammeter and voltmeter shall be provided on DC side for Electromagnets.

04.04.09.9 Control features:

All the motors of all the mechanism of the EOT cranes shall be provided with VFD control using Squirrel Cage Induction Motor. However all controls shall be operated through Radio Remote Control.

ACB/MCCB should have shunt trip coil, it should close if all gravity LS are in position (not operated) . ACB/MCCB should have feature of ON & OFF.

Control of crane should be separate. All the features i.e master controller / RRC "0" position, contactor drop out condition, emergency switch etc. should be incorporated in control of crane.

Lamps shall be LED cluster type. Microprocessor based digital EMPR with LCD display features shall be considered in place of Thermal O/L / other EMPR relays, wherever used.

Brakes shall not be used for speed control.

Proper cooling arrangement shall be provided. All the VFD panels shall be provided with panel mounted AC and shall be installed on crane girder. Appropriate derating of VFDs is to be done, if ambient temperature is greater than design temperature of VFD.

Hoist control circuit shall also be provided with anti-drop feature i.e., whenever the master controller/RRC is brought back to zero position from higher notches in both directions, the motor shall automatically be connected to hoisting direction for some time (time adjustable through timers or through drive software) to avoid the downward drift of the load. Brakes shall be clamped in zero position of the

master controller/RRC.

Speed feedback shall be provided for each motor through pulse tacho mounted on the non-driving end of the motor shaft. All the pulse tacho output shall be hardwired to the respective VFD terminals directly.
Closed–loop speed control of AC motor shall be provided with speed reference signal given by the Radio Remote Control and feedback signal by the pulse tacho–generator coupled to the motion drives.

The control and regulation equipment shall be able to maintain their rated performance and control quality even under conditions of variation of +10% and - 15% in voltage and ±5% in frequency. The reversing of motor direction shall be done at zero current. Braking down to zero speed shall be electrical with mechanical brake setting only at zero speed. Protective features like anti-drop etc. shall be incorporated to prevent load setting. The circuitry shall also provide for the protection against failure of motor torque such that the mechanical brake sets in such cases. All other features of conventional crane controls shall also be built into the scheme. The following shall also be provided on the power incoming AC side.

- Surge suppressor
- Over current protection
- Overload protection
- Single phase protection
- Phase sequence protection
- Ammeter and voltmeter with selector switches
- Isolating switches

Control and auxiliary supply shall be provided with separate transformer and under voltage protection.

Details of the system offered shall be furnished along with necessary single line diagrams and block diagrams.

All the control modules shall be grouped in a sheet steel enclosure. The VFD panel shall be suitably mounted so that vibrations are not reflected to the components and connection.
Anti-vibration pad for electrical panels shall be provided to withstand vibrations on crane grider.

The cables for the VFD and associated equipment shall be laid and clamped separately on the crane.

04.04.09.10 VFD Control Drives

VFD control shall be provided for all the mechanism of all the cranes. Control shall be achieved through master controller/RRC for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting, lowering, forward and backward. Creep speed shall be 10% or lower as per operational requirements of rated speed.

AFE Drives shall not be considered.

The VFD shall be fully controlled and suitable for four quadrant operation. Other details of VFD shall be as per respective clause for VFD in the TS.

All Squirrel cage motor with VFD application shall be designed specifically for this type of application with emphasis on insulation class. Motor insulation shall be Class-H with temperature rise limited to B with VFD application.

The cables for the VFD and associated equipment shall be laid and clamped separately on the crane.

The common DC bus shall have 02 incomers and a bus coupler. All the incomers shall be double pole DC switch disconnector. The DC switch disconnector shall be suitable for minimum 1000 V DC.

Rating (Heavy Duty Current) of the invertors shall be minimum **150% of the motor name plate current.** Converter rating shall be equal to the inverter of two largest motion mechanism of the cranes.

Vector control drives having redundant common converters feature and individual inverter for motors of all motions shall be provided.

Input contactors shall be provided in the incoming side and Output contactors / motor duty MCCB shall be provided between inverter and motor to electrically isolate the motor from the VFD with the common DC bus charged.

To take care of the under voltage in the incoming power supply system of the crane for more than the set time in under voltage relay due to the motor regeneration and motoring mode, a UPS of proper rating shall be provided for

the power supply of the drive control section to avoid control voltage power outage resulting in dropping of all the contactors/breakers.

Variable Voltage Variable Frequency (VVVF) Drive:

1)	Basic design particulars	- Digital control technology with vector control (with / without PG as per requirement) . - IGBT based with sine coded PWM control. - Active front end type for 4 quadrant operation. - Industrial and continuous duty.
2)	Overload capacity	- 150% of the rated current for 1 minute following 100% load & to meet the drive overload capacity. - 200 % for 3 sec.
3)	Efficiency	More than 96% at full speed and load.
4)	Input power supply	- 415 V AC + 10% to – 15%. - 50 Hz + / - 5 %. - 3 phase, 4 wire neutral earthed system.
5)	Regulated power supply for reference setting	- Voltage variation of (+/-) 0.1 % with an input variation of +10% - 15%. - Steady state regulation of (+/-) 0.25% guaranteed against 100 to 200 % load disturbance and + 3%, -6% input supply frequency variation.
6)	Input reference voltage	- +/-10 V DC / 0-10 V DC / 4 mA to 20 mA.
7)	Output frequency	0.5 - 400 Hz.
8)	Output frequency resolution	0.01 Hz.
9)	Starting torque	- 150 % / 1 Hz. (without PG) - 150 % / 0 RPM (with PG)
10)	Torque accuracy	+ / - 5 %.
11)	Speed control	+ / - 0.02 %.

	accuracy	
12)	Ramp rate	Linear acceleration and deceleration adjustable independently from 0 to 999.9 seconds.
13)	Vibrations	Suitable to withstand vibrations more than 0.5g.
14)	Main power components in incoming AC side	- ACB/MCCB with 50 KA rating - Matching input isolation transformer / line reactor for harmonic and noise suppression. - AC line surge suppression network. - Input contactor.
15)	Converter –Inverter Equipment	- Diode bridge/ IGBT bridge for AC/DC. - DC link circuit with reactor / capacitor - IGBT bridge for Inverter for DC / AC. - Harmonic transformer.
16)	Load side components	Filter network Over-load relay for each motor. Output contactor in output side. Output reactor / terminator
17)	Diode Bridge	Minimum ratings of Diode cells. PIV rating : 2.5 times the peak value of line voltage dv/dt rating : 200V/microsecond for voltage control and 1000V/ microsecond for inverter control. di/dt rating : 100A / microsecond.
18)	Protective features	AC line surge suppression network and overvoltage protection. Under voltage in supply network Phase sequence protection and monitoring Under voltage in DC bus

		Over voltage in DC bus Over speed monitor Over load Earth fault Instantaneous over current Transformer fault ,If applicable Cooling fan failure – Stall monitor for motor alarms.
19)	Annunciations	Following faults shall be annunciated in keypad of the drive / HMI. - AC line surge suppression network and overvoltage protection. - Under voltage in supply network - Phase sequence protection and monitoring - Under voltage in DC bus - Over voltage in DC bus - Over speed monitor - Over load - Earth fault - Instantaneous over current - Transformer fault ,If applicable Cooling fan failure Stall monitor for motor alarms. Motor fault (winding / bearing temperature, vibration) as applicable Loss of frequency command Shall be able to store at least 16 previous faults in memory on FIFO sequence.
20)	Meters	Output voltmeter and ammeter with selector switches. Input volt meter and ammeter with selector switches Output frequency meter KW meter for drive ratings above 200 KW.

21)	Selector switches	Local / Remote. Auto / Manual. Main / Bypass.
22)	Pushbuttons	Trip reset. Start. Emergency stop.
23)	Lamps	Drive ready. Drive trip. R , Y , B phase power ON . Control supply ON.
24)	Regulation & control facilities	Reference speed setter Ramp generator Speed feed back Current feed back Trigger module Pulse transformers Logic control module Sequence module PID control Zero speed / over speed monitor as applicable. Momentary power loss restart. Auto tuning. Current limiter Counter current/braking unit as applicable Active electronic components used shall be of industrial grade hermetically sealed. Output signals for fault alarm, frequency arrival, running signal.
25)	Remote control facilities	Shall have transducer to monitor the outputs like motor speed at remote place /HMI. Facility to accept speed reference from HMI / engineering station. All software and hardware required for

		communication and parameterization of drives with PC shall be provided. Any special application program, if developed for a drive, shall also be provided.
26)	Operator panel	Shall be mounted on the front door of the unit.
27)	Membrane keypad	The keypad shall be logically designed for two operating areas with required number of keys. Local operator control like local start /stop , jog forward / reverse . Programming. All PIN/Passwords required to use advance programming features of the drives shall be provided.
28)	LCD display	Display shall be black lighted, enabling viewing in extremes of lighting conditions. Display shall be in alphanumeric (in English only) 16 characters, 2 lines. All the last 16 faults stored in memory (in FIFO sequence) shall be displayed by scrolling.
29)	Construction features	Floor mounted, free standing Dust and vermin proof Sheet steel clad Minimum 2.5 mm thick for panels. Minimum 2.0 mm thick for doors and side covers. Suitable to withstand vibrations to be encountered in steel plant application. Cubicles with illumination lamps, door switches, space heaters and adequate sockets for power supply to CRO, laptops & soldering.

		All control blocks plug–in-type with necessary test sockets. Units shall be self contained and serviceable.
30)	Enclosure and ventilation	Enclosure conforming to IP-42 or better with weather proof enclosures. Units shall be provided with cooling fans and louvers at the bottom sides. All louvers shall have fine mesh behind them. Ventilation through individual ventilation ducts, from bottom not acceptable.

04.04.09.11 Panels

There will be separate panels for each motion in addition to the protective panels and resistance panels.

All panels shall be of free-standing floor-mounting construction, suitable to withstand vibrations encountered on crane. Hinged doors shall be provided for closed type panels. Panels shall be front wired. Front wired live points of bottom most equipment shall be mounted at least 350 mm above the bottom cover of the panel. Panel shall be fabricated from 2.0 mm thick steel sheet.

Power and control terminals shall be segregated. 10% spare terminals shall be provided in each panel. Equipment in the panel shall be so mounted that their removal or replacement from the front is easy. Suitable Door mounted DPM shall be provided for each mechanism for simultaneous display of 3 phase current of the motors. The DPM and associated equipment shall be designed to withstand the ambient conditions and vibrations.

Separate control panel for each motion shall be provided.

Panels installed outside the box girder enclosure

Panels shall be of closed type when mounted on bridge platform.

The panels shall be mounted along the girder facing the hand railing. Sufficient

clearances shall be provided between the panels. A minimum clearance shall be provided in front of the panels for walkway and approach as per I.E. Rules. The panels shall be supported in the back from the girder to avoid vibrations.

04.04.09.12 Switchgears:

Each mechanism motor shall be provided with MCCB, line contactors on incoming sides.

MCB shall be provided in the control circuit of each motion.
Each brake circuit shall be provided with a suitable contactor.

Rating of contactor selected for any mechanism shall be at least 50% higher than the respective motor full load current for the mechanism at 40% duty cycle. The minimum rating of the contactor used shall be 32A and the life of each contactor shall not be less than 10,000 hrs. of operation.

Reversible directional contactors shall be inter locked both mechanically and electrically.

Current rating of the circuit breaker shall be as per requirement. All the circuit breakers shall operate at ambient temperature mentioned in TS. Temperature Derating (above the designed temperature of 40 deg. C) shall be considered as per IS / IEC while selecting the circuit breaker

04.04.09.13 Motors:

The hoist shall be provided with twin motor drives through planetary gearing so that in case of failure of one of the motors, the other motor shall be utilized to handle the hot metal ladle at half the speed.

Heavy duty reversible crane service, totally enclosed fan cooled, foot mounted, and inverter duty squirrel cage motor conforming to latest edition of IS: 325-1996 shall be used for various drives. Class of insulation shall be H with temperature rise limited to that for 'B'. Each motor shall be fitted with a pulse tacho for speed feed back.

Motors for all the cranes and hoists shall be AC squirrel cage induction motor.
Pullout torque to the not less than 250% and 275% of full load torque corresponding to 40% CDF for class M3 & M5 and class M7 & M8 duty cranes respectively.

Mechanically and electrically shall be suitable for required number of switching / reversals or starts per hour.

Duty cycle shall not be less than S4-40%, with a minimum of 300 starts per hour.

Motor selection shall be done as per IS: 4137-1985 (Reaffirmed - 2006)

Following Derating factors shall be considered on mechanical KW (considering all types of toque required) while selecting motors for VFD application:

i. Temperature deration at ambient temperature as mentioned above from 40 deg C (motor design temperature) as per IS/IPSS.
ii. A deration factor of 1.18 for motor operated through VFD.
iii. No other factor shall be considered for motor deration.

The motor shall have following speed ranges:

a) Class M3 & M5 duty cranes:

Main & auxiliary hoist	750 rpm
Long & cross travel	1000 rpm

b) Class M7 & M8 duty cranes:

Main & auxiliary hoist	750 rpm
Long & cross travel	750 - 1000 rpm

All motors shall have the terminal box at top. Frame sizes shall conform to IEC Standards.

Material of motor body shall be iron / fabricated steel.

Horizontal foot mounted and with tapered shaft extension for all crane drive motors shall be provided. Tapered shafts Motors in 225 and above frame size shall have tapered shaft (1:10).

While selecting the motor rating following shall also be taken into consideration:

- Duty type S4 & S5as per mechanism application.
- Cyclic duty factor
- Number of switchings per hours
- Type of controls used
- Inertia of the motor and mechanism

- Ambient correction factor
- Service factor
- Derating for VFD

Maximum permissible operating speed shall be 250% of synchronous speed or 2000 rpm whichever is less. Over load capacity 150% of full load current for 2 minutes without damage or permanent deformation.

All the motors (frame size more than 280) shall have insulated bearings to reduce shaft current.

The encoder couplings shall have capacity to tolerate Axial, Radial and Transverse displacements.

04.04.09.14 Brakes:

Brakes shall be D.C. electromagnetic type conforming to AISE Standard. The brake coils shall be made of copper and of insulation class 'F'.

Brakes shall be designed to fail safe whenever the current is interrupted either intentionally or by failure of the main supply.

Brake circuit forcing shall be provided for D.C. brakes. D.C brake circuit shall be switched off on D.C. circuit for quick operation of brake.

A separate set of parking brake for L.T. motion shall be provided for each out-door crane. Power supply for these brakes shall be obtained from protective panel.
The brake of the Long travel and Cross travel drives shall remain open at the time of running & shall hold after few seconds of bringing the master controller / RRC lever in neutral position.

In addition to service brakes, one set emergency disc brakes to be mounted on each rope drum shall be provided along with suitable over speed protection device so that in any case the speed of the load tends to exceed the rated maximum speed due to any mechanical failure on any part of the driving system in between motor and rope drum, the protection device will cause the power supply to be shut–off, and the emergency brake will be applied immediately to hold the load.

04.04.09.15 Limit switches:

Roller lever operated, resetting limit switches shall be provided for all travel motions.

For each hoist motion, a rotary cam type over hoist and over lower, self resetting limit switch shall be provided. This limit switch shall have independently adjustable cams for hoisting and lowering motion. The cams shall have adjustability such that end limit can be set to within 100 mm of the hoisting or lowering motion. In addition to this, a back up ultimate limit switch of series/ shunt gravity type shall be provided to prevent over hoist. The later shall be of manual reset type. In case of cranes handling hot metal, the gravity limit switch shall preferably be of shunt type. Provision shall be made to bridge the gravity type limit switch contact by push button/ switch or any other means to lower the load. An indication shall be provided to the operator whenever this limit switch has operated. Suitable limit switch shall be provided for slack rope, gate/door opening, slew mechanism, grab closing/ opening etc. wherever necessary. Protection class of the limit switch shall be minimum IP 65.

Anti- Collision Devices: In cranes where two or more cranes are operating in the same bay (at same or different level) all cranes shall be provided with suitable Anti- collision system. Anti-collision device shall be **electronic type.**

A sound signal shall be provided to the crane operator when they are at certain safe distance apart (distance to be adjusted as a function of speed at site) and crane shall stop. After few seconds, it shall be possible to run the cranes towards each other (or only one crane can move towards the other) till buffers of the cranes meet by providing “by pass’ in the operators cabin/at suitable place.

Anti-collision shall also be provided on trolley for twin trolley cranes along with suitable by pass arrangement.

04.04.09.16 Resistances (if any)

Air cooled, robust, heavy duty, corrosion resistant punched stainless steel grid type. Resistance shall be in single phase execution.

Rated for 10 minutes duty. Continuous duty rating of resistances shall be provided in case of hoist motions controlled by thyristor converters. Maximum temperature of resistor elements shall be limited to 275° C (measured by

resistance method) at desired duty. Suitable tapping points shall be provided. Resistance boxes shall be mounted in racks that permit independent removal of any selected box.

04.04.09.17 Lighting, socket outlets, bells etc.

Lighting shall be provided in staircases, platforms and working areas.

Minimum 4 nos. 400 watts high pressure sodium vapour flood lights equally spaced (under crane girders) about the crane span shall be provided along with shock absorbing and anti-swing suspension arrangements. More numbers of fittings shall be provided if required for cranes with longer span and/or longer height of lift.

LED Energy Efficient lamps with necessary fittings shall be used for staircases, platforms etc.

Adequate number of hand lamp socket outlets (2 Pin, 10A, 24V) and power socket outlets (3 Pin, 20A, 240V) shall be provided along with switches socket & switch shall be interlocked suitably. A hand lamp (160W SLS lamp with enclosed type battery and wire guard) along with sufficient length (15m) of cable with a plug shall also be provided for each crane.

An alarm bell shall be provided on each crane.

Radio remote control:-

In this mode of control system, all the 4 motions

- Main Hoist.
- Auxiliary Hoist.
- Cross travel.
- Long travel.

can be controlled .

The system shall have capability to provide range of 1.5 times the long travel distance of the crane.

Two sets of Remote Controls with 2 sets of chargeable batteries and 2 battery chargers are to be given.

In the case of signal failure, all motion shall come to a safe stop.

The system shall have facility of controlling speed in two steps:-

I) Slow speed on the first step of the breaker contact / pushbutton of the radio remote control representing the first or second notch of the master controller.

II) Full speed on the second step of the breaker contact / pushbutton of the radio remote control representing the final notch of the master controller.

Transmitter:-

Transmitter shall have following features:-

- Constructed with sophisticated microprocessor technology and surface mounted electronics.
- Transmission type: - FM FSK
- Transmission speed: - 9.6 Kbps.
- Built in self test for all functions.
- Transmitter shall consist of switching breaker, dial switch and push buttons.
- Switching breaker shall be non locking to zero position or maintained function.
- Indications:-
  - Operation status
  - Battery status
  - Indicators that display information from crane.
- PIN -code (Personal Identification Number)
- Internal antenna.
- Rechargeable battery.
- Battery 7.2 V NiCd
- Operating time: - About 8 hours.
- Different operating frequencies (minimum 16 nos.)
- Two hand upstart.

- Stop push button.
- Operating conditions: - Areas having large temperature variations, dusty, more vibrations, oil and humidity.
- Operating temperature range: - Min. 10 deg.C to Max. 60 deg.C
- Protection class: IP - 54.
- Casing material: Polycarbonate / ABS plastic.

Receiver:-

Receiver shall have following features:-

- Upto 20 functions exclusive safety relays (for transmitting preset reference values to VFD in the crane).
- 2 safety relays (for control of main contactor)
- Power supply suitable for 240 V AC, 6 A.
- Minimum 16 different operating frequencies.
- Two redundant microprocessors for monitoring each others.
- Cyclically redundancy check check for high secutity of transmitted radio messages.
- Frequency scanning in the receiver .
- Memories last 10 users .
- Interlocking of the relays .
- Momentary or latched relay functions .
- Two hand up start (to avoid unintentional start).
- Protection class : IP - 65.
- Casing material : Aluminium profile for fast mounting on DIN rail –
- Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C

04.04.09.18 Enclosure Class

a) For indoor operations

- Resistance boxes : IP : 11
- Motors : IP : 55
- All other electric equipment : IP : 54

b) For outdoor operations

- Resistance boxes : IP : 33 with canopy
- Motors & panel : IP : 55 with canopy
- All other electrical equipment : IP : 65 with canopy

04.04.09.19 Cables:

Power cable suitable for 3 Phase, 4 wire, AC power supply system.

LTSS to DSL Aluminum, XLPE armoured cables shall be considered.
All cables on the cranes shall be copper.

Control wiring shall be with 2.5 mm^2 copper; minimum size of power cable shall be 6.0 mm^2. Fixed wiring on cranes shall be carried out with XLPE insulated. PVC sheathed armoured cable or EPR insulated CSP sheathed cable or better.

All flexible cables (i.e. trolley, feed, pendant unit etc.) shall have copper conductor, EPR insulation and CSP sheathing or better.

All cables shall be of 1100 Volts grade.

All accessories like cable glands, clamps, pipes, wire, cable trays, supports, brackets and terminal marks etc. as required for cable installation shall also be provided.

Cable laying and terminations shall be such that the chances of cables getting damaged is remote.
All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and maintained and any damaged cable can be accessed and replaced individually when necessary.
Power & control cables shall be clamped in groups separately. All trailing cables shall be clamped with PVC or non metallic clamps. All cable shall be suitably de-rated for grouping and higher ambient temperature. Group derating factor shall be appropriately taken according to the recommendations of the cable manufacturers based on the method of laying and number of cables being laid together.

Cable sizes shall be selected considering motor rated current.

In all passages and on trolley the cable shall be laid in trays and shall be covered by similar trays and properly clamped & fixed.

a) LT Power Cable

1.1 kV, heavy duty power cable, 4/3.5 core with stranded sector shaped (sm) or with compact circular stranded (rm/V) or circular stranded (rm) Aluminium / Copper conductors as applicable, XLPE insulated suitable for operation as per IS: 5831-1984, core stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi core conforming to IS:1554 (Part-I – 1988) Type TWY.

b) Control Cables

1.1 kV, circular stranded (rm), annealed copper conductor, PVC insulated, as per IS:5831-1984, cores stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi-core similar to IS:1554- (Part-I)-1988, Type YWY.

c) Flexible Trailing Cable

1.1 kV grade, heavy duty type with tinned annealed high conductivity flexible copper conductors, ethylene propylene (EPR) insulated and chlorosulphorated polyethylene (CSP) sheathed conforming to IS: 8130-1984, IS:6380-1984 and IS:9968 (Part-I)-1988.

04.04.09.20 Earthing

A ring earthing system shall be provided on the crane. Each and every electrical equipment shall be connected to this earthing at least at two points. However the electronic circuit insulated earth wire shall run in panel and terminate at main earth connection only at one point. The earthing shall be connected to the fourth trolley line in DSL system through 2 nos of current collector. Additionally current collectors shall also be provided on crane rails for earthing on crane. All these collectors shall be connected to earthing ring.

An earth core shall be provided in trolley feed cable. The cable reeling drum shall have a separate slip ring for earthing purpose.

It shall conform to general specification for earthing.

Rubber mattings shall be provided in front of the protective and control panels.

All bonds between earth conductors and crane parts shall be welded if possible, or riveted and soldered. Where screwed bonds are made, care shall be taken that there is satisfactory contact surface and nuts shall be locked to prevent their loosening. Earth connections to equipment shall be made by means of multi strand flexible conductor to adequate section.

The earth ring on the crane/ machine shall be connected to the plant earthing system through to gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system.

In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks.

Flexible copper bonds shall be provided across any gap in the running gantry rail.

For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

04.04.09.21 Colour code for electrical equipment

Sl. No.	Description of equipment	Colour	Paint shade No. as per	
			IS : 5-1991	Equivalent RAL Code
I	**MOTOR**			
1.	LT AC Motors (415V or below	Brilliant Green	221	6010
II	**Mounted Electrics**			
1.	Equipment installed on or alongwith motor (Viz Tacho-generators, brake etc.)	Same as that or motor		

Sl. No.	Description of equipment	Colour	Paint shade No. as per	
			IS : 5-1991	Equivalent RAL Code
2.	Equipment installed on mechanism but separate from motor (Viz. Limit switches, pull cords, speed switches, load calls, photo elec. relays etc.	Light Gray	631	7042
III	**Transformers**			
1.	Outdoor transformers (incl. Their associated equipment/ panels installed outdoors)	Aluminum		
2.	Indoor transformers	Dark Admiralty Gray	632	7012
IV	**Switchgear of substation**			
1.	6.6 kv switchgear	Light Gray	631	7042
2.	415 switch gear (Substation equipment)	Brilliant Green	221	6010
V.	**Control Gear**			
1.	All control panels (MCCs, PDBs, thyristor panels etc.)	Light Admiralty Gear	697	7001
2.	Light distribution board	Brilliant Green	221	6010
3.	Fire fighting panel	Post Office Red	538	3002

Sl. No.	Description of equipment	Colour	Paint shade No. as per	
			IS : 5-1991	Equivalent RAL Code
4.	Local control box	Light Gray	631	7042
5.	Control desk	Light Gray	631	7042
6.	Pulpit equipment	Light Gray	631	7042
VI.	**Miscellaneous Equipment**			
1.	Junction boxes		631	7042
2.	Conduit pull boxes		631	7042
3.	Light fittings		631	7042
4.	Welding sockets/ power sockets - 415 V - 230 V	 Green Light Orange	 221 557	 6010 2000
5.	110 V and 24 V transformer, sockets, lamp sets etc.	Canary yellow	309	1016
6.	Earthing strip	Black		
7.	Battery charger	Brilliant Green	221	6010
8.	DC DB	Oriental Blue	174	5018
9.	Battery charger cum DC DB	Brilliant Green	221	6010
I	**MOTOR**			
2.	LT AC Motors (415v or below	Brilliant Green	221	6010
II	**Mounted Electrics**			

Sl. No.	Description of equipment	Colour	Paint shade No. as per	
			IS : 5-1991	Equivalent RAL Code
1.	Equipment installed on or alongwith motor (Viz Tacho-generators, brake etc.)	Same as that or motor		
2.	Equipment installed on mechanism but separate from mtor (Viz. Limit switches, pull cords, speed switches, load calls, photo elec. relays etc.	Light Gray	631	7042
III	**Transformers**			
1.	Outdoor transformers (incl. Their associated equipment/ panels installed outdoors)	Aluminum		
2.	Indoor transformers	Dark Admiralty Gray	632	7012
IV	**Switchgear of substation**			
1.	6.6 kv switchgear	Light Gray	631	7042
2.	415 switch gear (Substation equipment)	Brilliant Green	221	6010
V.	**Control Gear**			
1.	All control panels (MCCs, PDBs, thyristor panels etc.)	Light Admiralty Gear	697	7001

Sl. No.	Description of equipment	Colour	Paint shade No. as per	
			IS : 5-1991	Equivalent RAL Code
2.	Light distribution board	Brilliant Green	221	6010
3.	Fire fighting panel	Post Office Red	538	3002
4.	Local control box	Light Gray	631	7042
5.	Control desk	Light Gray	631	7042
6.	Pulpit equipment	Light Gray	631	7042
VI.	**Miscellaneous Equipment**			
1.	Junction boxes		631	7042
2.	Conduit pull boxes		631	7042
3.	Light fittings		631	7042
4.	Welding sockets/ power sockets - 415 V - 230 V	 Green Light Orange	 221 557	 6010 2000
5.	110 V and 24 V transformer, sockets, lamp sets etc.	Canary yellow	309	1016
6.	Earthing strip	Black		
7.	Battery charger	Brilliant Green	221	6010
8.	DC DB	Oriental Blue	174	5018
9.	Battery charger cum DC DB	Brilliant Green	221	6010

04.04.10 ELECTRICAL DETAILS FOR HAZARDOUS AREAS

The scope of supply shall cover all items of electrical systems includes VFD panel consisting of VFD Drive system, switch gears, control transformer, DBR panel etc., motors, brakes, limit switches, power and control cables, encoder, socket outlets, lighting fittings with lamps, Cable drag chain system, Wired pendant and wireless remote operated Pendent, push button station and equipment earthing. All sundry erection material required for installation and connecting up of electrical equipment with cable laying and fixing accessories shall be included in the scope of supply by the tenderer.

- Electrical equipment for hazardous area EOT Cranes shall be flameproof type conforming to Job Specification/ IEC-60079-1 suitable for hazardous area classification as specified in job specification.
- All cable glands shall be explosion proof double-compression type suitable for equipments/panels/motors installed in hazardous area and shall be weatherproof / single compression for those installed in safe area.
- For cranes to be installed in hazardous areas, the electrical equipment shall be selected as per IS-5571, IEC 60079, Indian Petroleum Rules and DGMS regulations (where applicable) and shall meet the requirements of relevant IS, IEC or NEC Standards. The electrical equipment for Zone-1 and 2 areas as a minimum shall be Ex `e'/ Ex 'd' type as specified in data sheet, subject to the same being acceptable to the concerned statutory authorities. However all motors for hazardous area cranes shall be flameproof type (Ex`d' or Ex-‘de’) irrespective of zone of the classified area. All spark producing electrical equipment shall be Ex`d' type. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NEC, USA) shall not be used in Zone-1 or 2 areas.
- Electrical equipment for hazardous areas shall have test certificates issued by recognized independent test house (CIMFR/CPRI/ERTL/Baseefa /LCIE/UL/FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by recognized testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals (e.g. PESO, DGMS etc). as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities. Flameproof electrical equipment shall be suitable for specified gas group and temperature Class T3 as minimum.

TECHNICAL REQUIREMENTS

The electrical equipment for EOT Cranes, shall be complete in all respects, including but not limited to, the incoming load break switch at shop floor level,

power rail and collector shoe assembly /flexible trailing cable arrangement (as specified in Data Sheets), control panel(s) housing starters, breakers, control and indication devices, drive motors, starting resistors and all other devices required for safe start / stop and operation of the system. The equipment shall comply with the following requirements.

Power Supply

The power, on the bay down-shop leads shall be available at 415 Volts, 3 phase, 4 wire, 50 HZ. The power and control equipment selected shall be suitable for operation on ±10% variation in the voltage and ± 3% variation in supply frequency.

The following voltage shall be used in the cranes:

i)	415 volts, 3 phase, 50 HZ A.C (unearthed system)	:	For drive motors
ii)	Intrinsically safe circuit- 100 V DC contactor circuit 230 v AC for Lamp & Socket	:	Control circuit in VFD panel
iii)	Intrinsically safe circuit	:	Pendent and limit switch interfacing.

Control Supply

The voltage level for control and other applications shall be as mentioned above. Control transformer shall be double wound air-cooled control type of suitable rating and shall be located either in main control panel or separately housed in a suitable flameproof enclosure. The control transformer shall be provided with an earthed screen between primary and secondary winding.

One pole of control transformer secondary / control supply shall be earthed. The transformer will be provided with DP MCB on primary side and secondary side. One end of the coil of all relays and contactors shall be connected to the earth side of the control circuit supply and this connection shall not be interrupted by any fuse or contact. Control voltage for pendant-operated cranes shall not be more than 110 V AC or DC.

Flexible Trailing Cables

Erected on EOT Crane Crab through suitable cable drag chain system. The power supply arrangement shall be provided through cable drag system. The flexible trailing cable shall have braiding and shall be supported on hangers having rollers

moving on I beam. Cross travel shall always be provided with festooned type cable arrangement.

PENDANT FOR CONTROL

System shall be provide with wired and radio remote control pendant for operation:

WIRED PENDANT:-

Push button station with intrinsic safe barrier Isolation shall be used. The control ON push button shall be of lockable at OFF type (with key) so that power and control supply is cut off when the crane is not in use to prevent inadvertent operation. Selector switch with two position shall be provided for lights ON/OFF. Indicating lamp for control ON shall be provided on the pendent. An emergency stop push button with mushroom Red knob latched type push button with 2 NO & 2 NC shall be provided. A reset main contactor PB to be common for all drives provided to reset Drive fault. Push button for warning bell and one no's of spare push buttons shall be provided. The drive fault indication lamp shall also be provided in pendent.

The pendant station shall be suitably supported by means of a SS chain and it shall be ensured that no strain is caused to the pendant cable. A minimum of two spare cores shall be provided in the pendant cable. The pendant station shall move along the bridge girder on four wheeled cable trolleys with antifriction ball bearings running on a separate track. Each trolley shall be provided with buffers to avoid entanglement. Tension coming on the cable due to trolley movement shall be avoided by provided SS chain between trolleys. All push buttons shall automatically return to `off position immediately after their release. The Push buttons and indication lamps in pendent to be interfaced with VFD panel through intrinsic safe isolators and solenoid drivers. The indication lamps shall be intrinsically safe. The pendant shall able to control the speed in two steps of all the four motion Main hoist, Auxiliary hoist, cross and long travel.

Radio remote control:-

In this mode of control system, all the 4 motions

- Main Hoist.
- Auxiliary Hoist.
- Cross travel.
- Long travel.

can be controlled .

The working limit for radio control shall be limited to 40-50mtr from transmitter .Two sets of Remote Controls with 2 sets of chargeable batteries and 2 battery chargers are to be given. In the case of signal failure, all motion shall come to a safe stop. The sending of a continuous or continuously repeating secure signal when transmitter is in use, which the crane receiver can identify. A secure signal includes at least three characteristics separately recognizable by the receiver. If more than one crane are provided with this type of controls, only the intended crane and its motion is operated at one time. The transmitter shall be constructed so that it is capable of withstanding rough handling.

The system shall have facility of controlling speed in two steps:-

i) Slow speed on the first step of the breaker contact / pushbutton of the radio remote control representing the first or second notch of the master controller.

ii) Full speed on the second step of the breaker contact / pushbutton of the radio remote control representing the final notch of the master controller.

Transmitter:- (Shall be suitable for operation in hazardous Zone-1 and 2, Gas group IIA and IIB)

Transmitter shall have following features:-

Constructed with sophisticated microprocessor technology and surface mounted electronics.

- Transmission type: - FM FSK
- Transmission speed: - 9.6 Kbps.
- Built in self test for all functions.

Transmitter shall consist of switching breaker, dial switch and push buttons.

Switching breaker shall be non locking to zero position or maintained function.

Indications:-

- Operation status
- Battery status
- Indicators that display information from crane.

PIN -code (Personal Identification Number)
Internal antenna.
Rechargeable battery.
Battery 7.2 V NiCd
Operating time: - About 8 hours.
Different operating frequencies (minimum 16 nos.)
Two hand upstart.
Stop push button.
Operating conditions: - Areas having large temperature variations, dusty, more vibrations, oil and humidity.
Operating temperature range: - Min. 10 deg.C to Max. 60 deg.C
Protection class: IP - 54.
Casing material: Polycarbonate / ABS plastic.

Receiver:-

Receiver shall have following features:-

- Upto 20 functions exclusive safety relays (for transmitting preset reference values to VFD in the crane).
- 2 safety relays (for control of main contactor)
- Power supply suitable for 240 V AC, 6 A.
- Minimum 16 different operating frequencies.
- Two redundant microprocessors for monitoring each others.
- Cyclically redundancy check check for high secutity of transmitted radio messages.
- Frequency scanning in the receiver .
- Memories last 10 users .
- Interlocking of the relays .
- Momentary or latched relay functions .
- Two hand up start (to avoid unintentional start).
- Protection class : Flameproof suitable for Zone-1 and 2.
- Casing material : Aluminium profile for fast mounting on DIN rail –
- Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C

<u>Motors</u>

All crane motors shall be Flameproof (Ex-d, Temp classification T3) squirrel cage induction motors. Motors shall have S4 DUTY, 40% CDF, min of with 300 starts per hour, Inverter Duty (NEMA MG1 Part 31 requires motor insulation systems for 460V rated motors to be capable of withstanding 1,600 volts peak, at a rise time of 0.1 microseconds) with IP 55 Class of protection. The motor shall be flameproof as per IEC 60079.

All the motors shall have a provision to connect encoder in its shaft. Overload capability shall be 150% of full load current for 2 minutes without damage or permanent deformation from zero to base speed.

Motor selected are such that the maximum current drawn with full load should not exceed 80% of the full load rated current of the selected motor.

Pull-out torque to be not less than 275% of the full load torque corresponding to 40% CDF.

Class of insulation shall be 'H' with temperature rise limited to 'B'.

All the motors shall preferably be housed with inbuilt THERMISTOR. Independent thermistor relay need to be used. Alarm and Trip input to be wired separately as a input to VVVF control unit. Protection like switch OFF / TRIP the motor in case of increase in surface temperature more than T3 classification.

Motors shall have preferably sealed 'ZZ' bearing. If not, suitable lubrication provision to be provided. Insulated bearing or housing shall be considered at NDE side of motor to prevent motor from circulating current.

While selecting the motor rating, following shall also be taken into consideration:

- Duty type S4 and S5.
- Cyclic duty factor (25 % to 40%).
- Voltage variations.
- Number of switchings (starts) per hour.
- Type of control used like thyristor control etc.
- Permanent rotor resistance value.
- Inertia of the motor and mechanism.
- Ambient correction factor.
- Service factor.
- The motor shall be able to withstand 150% of full load current for 2 minutes without damage or permanent deformation.

Intrinsic safe / flame proof hollow shaft incremental encoder to be used to achieve vector control mode of operation for Hoist application. All Encoder

signals shall be suitable for VVVF drive input. Screened cable /fiber optic cable as per manufacturer recommendations and as decided by purchaser shall be used for encoder.

CRANE CONTROL

Controls in FLP cranes shall be made suitable to operate in hazardous environment Zone-1 and 2, Group IIA and IIB, class T3. In order to control the speed during lowering, mechanical braking shall not be employed. On all motions, the circuit shall be so designed that brakes come into operation immediately and in the event of tripping of main circuit breaker. Additionally, the control circuit shall be so designed that following functions are fulfilled.
Hoisting shall take place only when hoisting push button operated. Lowering shall take place only when hoist lowering push button is operated. Both the push buttons should be interlocked such that only one direction operation is possible at a time. This type of control should be followed for all the motions of the crane.

CIRCUIT PROTECTIVE SWITCHGEAR

One four pole MCCB Incomer , rated to carry at least combined full load currents of the two motions on the crane having largest power (KW) shall be provided.

On the Crane: Each side of the LT platform 1 No. of 1 phase, 230 Volts AC FLP switch cum socket with plug top with necessary isolating switch / MCB inside the panel.

VVVF DRIVES

The power (kW) rating of VVVF drive shall be higher than the selected or finalized electrical power (kW) rating of the motor. All VVVF & electrical panels shall be made suitable to operate in hazardous environment Zone-II, Group IIA/IIB, T3 and is to be located on the Crane girder. The panels shall be braced with crane girder from back to withstand any vibrations. Sufficient clearances (minimum 100 mm) shall be provided between the panels. A clearance of at least 600 mm shall preferably be provided in front of panels for walkway and approach. Suitable input choke for controlling harmonics and output choke for reducing dv/dt and terminal peak voltages at Motor. The continuous current rating of the VFD drive shall be at least equal to the 1. 5 times the motor rated current. The power rating of VVVF drive shall be minimum one size higher than motor power rating. VFD shall be IGBT based Vector controller closed loop encoder feedback for Hoist, CT & LT without encoder feedback. VFD shall be

provided with AC input choke of suitable rating to limit THD and output side chokes shall be provided to protect motor from dv/dt & voltage peaks.

Suitable Drive software with valid license needs to be supplied along with drive. Drive communication cable suitable for support either USB or RJ45 of the laptop need to be supplied.
Combined Advanced Operator Panel capable of commissioning the individual drive need to be provided.

All the limit switch terminals (Hoist, CT, LT and Brakes, etc) need to be wired up to the terminal block of the VVVF panel. Interconnecting / looping of above terminals need to be carried out in the VVVF panel terminals only. Interconnecting of above terminals in the equipment's and bringing the common terminals to the VVVF panel is not acceptable.

Hoist Drive Shall be provided with 2 Nos. (1 Working + 1 Standby). Three positions selector switch shall be provided for selecting the drive and shall be indicated by means of indication lamp. CT & LT Drives shall be supplied with 1 No. (1 Working). All drives shall have a provision for communicating to the automation system via. TCP/IP protocol. VFD shall comply IEC-61800 standards towards VFD functional Safety and Electromagnetic compatibility.

Dynamic Braking and Resistor panel

VFD shall be offered with dynamic braking function, a built in dynamic braking module consisting of power electronic switch (IGBT) and discharge/ braking resistor shall be provided. The braking resistor of a hoisting drive shall be selected considering the possible lowering height of the load being lowered at the maximum speed with full load. . For cross traverse and long travel motions, the braking resistor shall be capable of absorbing the regenerative energy during deceleration of the motion also taking into account the possibility of a swinging load. Necessary calculations to be submitted before choosing of DBR rating. Dynamic Braking Resistors shall be adequately protected to prevent contact with live parts. There shall be thermistor protection to trip DBR from drive for excessive temperature rise. Hoist DBR shall be sized for 150% of full load torque & shall not be less than the torque limit setting of VFD in hoisting directions. DBR panel shall be suitable for flame proof area Zone1 and 2 or else regenerative braking system shall be employed by using suitable Active front end VFD.

LIMIT SWITCHES:

Limit switches shall be heavy duty type with protective enclosure of IP 55 as per IS 2147. Limit switches shall be heavy-duty type and of shall be wired in the Intrinsic Safe circuit to operate in hazardous environment Zone I & 2, Gas group IIA and IIB as mentioned above.

All hoist motions shall be provided with limit switches to prevent the crane hook from over hoisting and over – lowering. Two limit switches shall be provided for proper backup protection. The first limit switch to act in the event of over hoisting and over lowering.

This shall be screw type with self-resetting feature and be incorporated in the control circuit of the respective drive motor. The second one shall be of gravity operated hand resetting type switch Connected in the trip circuit of the main incoming breaker. The second limit switch shall act only to prevent over hoisting limit switch incorporated in the motor control circuit shall be made to act first but in case this limit switch fails to operate, the second limit switch connected in the main incoming circuit breaker's control circuit shall operate and trip the breakers.

BRAKES:

All motions of the flame proof cranes shall be provided with A.C Electro hydraulic thruster brakes to arrest the motion safely. This brake should be provided with brake release mechanism. The Brakes shall be protected with suitable MPCBs and suitable for hazardous area Zone 1 and 2.

The torque capacity of brakes shall be 2.0 times the rated full torque of the selected motor for hoist and for LT and CT the torque capacity of brakes shall be 1.5 times the rated full torque of the selected motor.
The brake logic shall be through VVVF Drives. There shall be Two brakes for Hoist one will act as Main and other one will act as redundant brake. Each brake shall be operated with two numbers of contactors connected in series driven by two number of VFD output relays. This arrangement will prevent brake opening in case of drive relay/contactor welding and free fall of loads. All the brakes shall be supplied with open/Close limit switch and to be interlocked with control circuit.

LIGHTING:

Two numbers of under slung flame proof lamps of 250 W HPMV well glass fixture and with shock absorbing & anti swing suspension shall be provided for

uniform floor illumination. Screw cap type holders and lamps shall be used for crane lighting. These light fittings should be provided with wire mesh and glass to avoid free falling of lamp. Lighting transformers shall have 50% reserve capacity. Lighting control ON/OFF shall be possible from pendant station. The light fittings shall be so located that free access for maintenance is possible. The Under bridge lights, junction boxes etc., provided in bay shall be flame proof Ex-d and complying requirements suitable for hazardous area classification zone, Gas Group IIA, IIB with Temp classification T3

CABLING

All wiring for power control, lighting etc., shall be carried out with 1.1.K.V grade PVC flexible/Armored copper conductor FRLS Sheathed cables as possible. All power cables shall be minimum 4sq.mm Cu and control cables minimum 2.5 sq. (cu). Cable cores shall be of stranded construction.

Cable selection and routing on the crane shall form part of the crane design. Selection of cable sizes shall take into account the following factors.
a) Ambient derating factors
b) Group rating factor.
c) Intermittent duty factor.

Suitable cable trays firmly secured to crane structure shall be provided with due regards to cable weight and vibration encountered. Cables shall be routed so that they do not constitute a safety hazard, pose any obstruction to free movement of personnel, and properly laid to present an orderly appearance. The cables shall have proper cable drag chain system & Drag chain except for pendent station.

IDENTIFICATION OF CIRCUITS, CABLES ETC.

Labels of permanent nature shall be provided on supports of all switches, fuses, contactors, relays etc., to facilitate identification of circuits and replacement. All panels are to be properly marked for each motion. All power control cables, lighting and other cables are to be tagged at both ends as per cable number indicated in the supplier‘s drawing. All equipment terminals are also to be marked likewise.

EARTHING

The Earth strip /Cable size shall be minimum 25 X 6 to be used for earthing purpose. The LT rail at both sides to be earthed. All electrical equipment mounted on crane including Mechanical structure to be earthed with double runs. Suitable Bridge Clamp provided on crane for tapping earth points. Along with

pendent control cable an additional wire braided flexible copper strip of 12mm wide shall run as a special earth from the control panel up to the pendent station.

04.04.11 **PERFORMANCE & GUARANTEE:**

After erection and commissioning of equipment, performance tests shall be carried out to prove the performance of the system and equipment.

These tests shall be binding on both the parties of the contract to determine compliance of the equipment /system with the performance guarantee.

All the equipment, tools and tackles required for successful completion of the performance tests shall be supplied by the Tenderer.

All the instruments for the performance tests, as required, shall be supplied by the Tenderer and shall be retained by him till the satisfactory conclusion of all tests at site. All costs associated with the supply, calibration, installation and return of test equipment shall be included in the scope of supply. All test instruments shall be as per standards approved by the Purchaser.

If the Tenderer fails to achieve the guarantee and performance parameters, he shall investigate the causes and shall rectify and/or replace, free of cost to the Purchaser the defects of the equipment/system within a period of 1 (one) month from the date of commencement of performance and guarantee tests and again prove the guarantees. In such cases, the cost of modifications including labour, materials, and cost of additional testing etc. shall be borne by Tenderer.

If even after necessary alteration and modifications are affected, the performance guarantees are not fulfilled, the Purchaser reserves the right to reject the equipment. In the event of exercising this right, the Tenderer shall replace the defective equipment/ system with the equipment / system that meet the performance guarantee parameters. The cost of replacement inclusive of labour, materials and repeat testing to prove compliance with the performance guarantees shall be borne by the Tenderer.

04.04.11.1 The cranes after erection shall be tested as per IS-4137-1985, Reaffirmed- 2006 - Code of Practice for Heavy duty Electric Overhead Traveling Cranes including Special Service Machines for use in Steel Works

04.04.11.2 Cranes shall be deemed to be have been successfully commissioned after all the tests as per IS-4137-1985, Reaffirmed- 2006 - Code of Practice for Heavy duty Electric Overhead Traveling Cranes including Special Service Machines for use in Steel Works are carried out satisfactorily.

04.04.12 LIST OF DRAWINGS ENCLOSED

1. Clearance diagram of DG EOT crane

04.05 INSTRUMENT AIR COMPRESSOR AND DG SET

04.05.01 Instrument Air Compressor

Oil free, air cooled screw type air compressors, heatless desiccant type air dryers along with air receiver having suitable capacity to meet the requirement of compressed air for the natural gas compressor station shall be provided.

04.05.01.01 Scope of work

The compressors, air dryer units and air receivers shall be complete with all materials and equipment whether specifically mentioned herein or not but required for satisfactory operation of plant & equipment individually as well as integrated manner.

At the outlet of compressor pressure and temperature measurement shall be envisaged & same shall be indicated in the control room or may be hooked up with PLC system. Suitable hoisting facility for maintenance purpose shall be considered.

The compressors along with air dryer shall be located inside a structural building near natural gas compressor shed.

Compressed air system shall comprise of but not limited to the following main units:

Oil free, air cooled, rotary screw packaged type air compressor complete with electric motor of suitable capacity and all its accessories & auxiliaries along with pipes, fitting, valves, etc including the following accessories / auxiliaries to meet the requirement of service/ instrument quality air for the entire Natural Gas Compressor Station. The specification of air compressor, air dryer unit and air receiver are indicated here in after.

a) Intercoolers, moisture separator with auto drain trap station,

b) Suction air filter system

c) Lube oil system.

d) Heatless Desiccant type of Air Drying unit of suitable capacity.

e) Air receiver of suitable capacity

f) All necessary interconnecting pipes, valves, fittings including supports and supporting structures.

g) Drain pipelines from compressed air station to nearest drain / drain pit.

h) Necessary electrics, instrument & Controls for compressors, air drying unit and air receiver & its auxiliaries.

i) A set of tools & tackles for repair and maintenance.

j) All anchor bolts & nuts, washers & base frame for equipment.

k) Provision of interconnection between instrument quality air line and nitrogen line with isolation valve.

04.05.01.02 Equipment Specification

a) Air compressor:

No. of Compressors	:	Working + 100% Stand-by
Discharge flow	:	As per requirement
Discharge Pressure at outlet flange of after cooler and moisture separator	:	As per requirement
Type	:	Oil free, air cooled, screw
Installation	:	Indoor
Service duty	:	Continuous/ intermittent
Environment	:	Dusty
Oil content	:	Nil
Dust particle size	:	Not to exceed 3 microns

Compressor shall be complete with motor of suitable capacity. Driving motor shall have adequate margin not less than 10% over the maximum power requirement at motor terminal (considering motor efficiency) at maximum capacity of the compressor.

Suitable lubrication system for bearings and other moving parts of the compressors shall be provided. Lubrication system shall be complete with necessary filters / strainers, oil coolers, level indicators, pumps, pipes, valves and fittings etc.

Compressor shall be provided with a dry type air intake filter system. The suction filters supplied shall be of appropriate type such as to prevent ingress of dust into the machine.

The compressor shall have capacity control with constant discharge pressure over full range. For this purpose suitable air intake control valve with other connected system shall be provided.

Compressor shall be provided with inter cooler, moisture separators etc..

Compressors shall be provided with adequate safety, protection and control system.

b) Air Drying Unit

There shall be desiccant air drying unit of suitable capacity. Selection of dryer shall be such that performance of the same shall not be affected at different loads of the system. This dryer shall be installed adjacent to the compressor. The system shall be designed such that under no circumstances the dry air supply shall be stopped.

The air drying and filtration shall be designed to continuously supply dry and oil free air. Both manual and automatic change over from one mode to other should be possible. The design, fabrication and materials of construction of various pressure vessels shall be as per the pressure vessel code IS:2825 latest edition or ASME Section VIII.

Pre filters shall be provided to remove dust and any other contaminant from the air stream. After filters located downstream of the absorber towers shall prevent carryover of fine particles with the efficient air stream.

Both the pre filters and after filters shall have 100% standby unit. All filters shall have individual isolation valves, safety valves and drains with trap stations and pressure gauges.

The air drying plant shall be provided with dew point measuring devices.

Design considerations of the drying unit are indicated below:

Air flow rate (each)	:	Tenderer to work out
Normal inlet pressure	:	Same as compressor outlet
Maximum air temp (inlet)	:	Same as compressor outlet
Dew point of outlet air (ADP)	:	(-) 40^0 C
Maximum allowable pressure drop	:	0.5 kg/cm^2 g.
Oil content in the outlet air	:	Nil

The dryer shall be supplied along with all necessary auxiliaries. The operation and controls of the dryers shall be fully automatic.

The dryers shall have built control panel with auto / manual operation. Indication of outlet air temperature and pressure shall be provided at prominent place. Lifting eyebolt shall be provided for installation and maintenance purpose. First fill of all consumables shall be supplied along with the dryer unit.

c) Air receivers

There shall be suitable capacity of air receivers for service/ instrument air. Air receivers shall be of carbon steel material, welded construction complete with all accessories. The air receiver shall conform to IS:7938 latest edition. The air receivers shall be designed, manufactured and tested according to IS:2825 latest edition and shall be complete with pressure gauge, lifting lugs, manhole, safety valve and foundation bolts. The material of construction of shell, header, nozzle, etc. shall be as per IS – 2002 – Gr. – 2A or equivalent.

d) Pipe work, valves & specials

Piping layout must follow good engineering practices. Proper attention shall be paid to obtain full functional requirement of air, water and oil piping with a layout which provides sufficient clearance for various auxiliaries, other equipment and operating personnel, easy access for operation and maintenance, convenient supporting arrangement.

Except otherwise specified, all pipes shall be provided with butt welded connections and with flanged joints only at the connections with equipment, vessels and valves. Pipes laid inside the R.C.C. trenches shall be supported at intervals on steel sections and the arrangement shall facilitate easy maintenance.

Valves in the air line shall be of shall be of cast steel / forged steel full bore, two / three piece design ball valves with Stainless steel internals. For waterlines, either wafer type butterfly valves sand witched between two flanges or double-flanged butterfly valves shall be provided. In butterfly, gate, globe valves, face of the hand wheel shall be clearly marked with word `open and shut' with arrows adjacent to indicate the direction of rotation. In butterfly, non-return & globe valves, direction of flow shall also be marked on the valve body.

All the globe valves shall be designed to prevent erosion of valve seats when the valves are operated in throttled conditions. Design of valves shall be such that it shall permit packing of glands while under pressure.

Non return valves shall be of double flanged and dual plate spring design.

The solenoid valves shall have heavy duty, double impregnated tropicalised coil and shall be suitable for operating temperature and for operation continuously energised in tropical climate. The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be suitable for continuous duty. The enclosure shall be water tight, dust tight and the valve shall be suitable for mounting in any position.

All the valves for water line and air line shall be of 150 class rating. The valves with flanged ends shall be provided with flanged ends having raised face, serrated finish. The drilling of the flanged ends shall be done as per IS:6392 - 1971 (RA 1988) .

Valves of size NB 125 - 400 shall be of gear operated type.

Ball valves shall confirm to BS:5351 / API 608.

Cast Iron Gate valves shall conform to IS:14846.

Cast Iron Globe valves shall conform to IS:9338

Gate & Globe valves below 50 NB shall conform to IS:778 - 1984(RA1990).

Non return valves shall conform to IS:5312 - 1984(RA 1990).

All pipelines shall be provided with drain connections, generally at the lowest point for removal of accumulated condensate or water and also for draining of the water after hydro testing of the erected pipe work. Vents with valves shall be provided at highest point of the pipe line.

The drain piping shall have drain pocket followed by a connection of drain pipe with isolation valve. Line shall be provided with slope towards the drain point.

MS Pipes of following specification shall be provided for industrial water and air applications.

NB 15 - 150: ERW, Black, Heavy pipe having plain ends as per IS:1239 Part-I – 1990.

NB 150 & above: ERW, Black pipe of minimum thickness 6.35 mm having plain ends as per IS:3589-1991

Pipe fittings conforming to IS:1239 Part-II - 1992 shall be provided for pipes of size up to NB 150. Fabricated fittings manufactured from the pipes shall be provided for pipes of sizes NB 200 and above.

Complete pipe network after erection shall be hydraulically tested at a pressure of 1.5 times the working pressure. The pipe network shall be subjected to the test pressure for a minimum period of 4 hours.

04.05.02 Emergency Diesel Alternator Set

04.05.02.01 Scope of Work

Bidders scope shall include two nos. each of 500 kVA DG sets minimum capacity including exciter, AVR, Independent AMF cum control panel, acoustic enclosure, battery, battery charger, cables, relays, meters and all other items required for smooth running of the DG set.

The design ambient temperature for all the electrical equipment shall be 50^0C.

04.05.02.02 Alternator and Electrics

a) Codes and Standards

Alternator	:	IS-4722/IEC-60034,IS12065, IS12075
Speed of Diesel Generator	:	BS649 / 195B
Permissible limits of noise level of rotating machines	:	IS 12065
Measure, evaluation and limit of Vibration severity of rotating Electrical machines shaft 65 mm dia or higher	:	IS 12075
Code of practice for Fire Safety	:	IS 3034
OSID standard on lightning protection	:	OISD-GDN-180

b) Equipment complying with other internationally accepted standards such as ASA, IEC, BS, VDE etc. will also be considered if they ensure performance and constructional features equivalent to or superior to standards listed above. In such a case, the Tenderer shall clearly indicate the standard(s) adopted and also furnish a copy in English of the latest revision of the standards along with copies of all official amendments in force as on date of opening of bid. Tenderer shall clearly bring out the salient features for comparison.

c) Technical Requirements

i) The DG set shall be capable of starting largest size of emergency 415 V drive (motor) having locked rotor KVA/rated KW ratio of 8 and starting power factor of 0.2 with terminal voltage drop being restricted to 15%. Alternator loading before starting of this motor shall be considered as 50% of Alternator rating

ii) The emergency DG set shall automatically come in to operation in the event of total power failure in the station.

iii) The alternator shall be externally regulated type with a voltage variation of ± 5% of the rated voltage with ± 1% frequency variation. Automatic Electronic voltage regulator shall be provided

iv) The starting time required from the initiating signal until the operating speed and voltage is attained and the engine and Alternator are ready to take load, shall not be greater than 30 seconds. Three attempt starting facility shall be provided either by using two impulse timer and a summation timer or by using microprocessor based controller along with auxiliary panel if any. The DG set shall lockout automatically in case of failure of above.

v) The DG shall be capable of being stopped manually from remote as well as local. Interlock shall be provided in DG control panel to prevent shutting down operation (when in auto mode) as long as the circuit at Alternator output is closed.

vi) Electrical self starting system shall be provided, the source of energy shall be batteries backed up by battery chargers which shall be supplied by the Bidder.

vii) The DG Set shall be located inside the acoustic enclosure and shall be suitable for outdoor duty. The Tenderer shall recommend his own layout and indicate the space requirement. The exhaust shall be discharged through a silencer and stack outside the enclosure. Necessary lightning protection shall be provided by the Tenderer for the stack. The generating set shall be suitably placed and enclosed so as to meet the technical, functional and statuary requirement like Noise level, IP protection etc.

viii) Critical speed of the machine shall not be lesser than 120% of the normal speed.

ix) The alternator shall withstand a short circuit at its terminal for three seconds with excitation adjusted to develop rated voltage at no load without any damage.

x) All couplings shall be capable of withstanding the maximum Alternator sudden short

circuit torque.

xi) The sub-transient impedance shall be suitable to start biggest drive at minimum voltage dip.

xii) The field winding shall be fully insulated from the core. The field system shall have low inductance to allow good voltage regulation.

xiii) The line and neutral ends of each phase winding of the Alternator shall be bought out on six suitably located terminals. Tenderer shall provide suitable clamping arrangement for connecting the cable to the terminals. The terminal shall be suitably enclosed to prevent short circuits by rodents etc.

xiv) Suitable cable glands shall be provided on the enclosure to facilitate entry of the above cables. The cable terminal box size shall be adequately dimensioned to accommodate PVC insulated, aluminium power cables of required size.

xv) The alternator shall be provided with two nos. earthing terminals which shall be separated from the neutral terminal. The neutral shall be brought out to fully insulated terminal.

xvi) DG power shall be considered for instrument air compressor, dryer and nitrogen compressor in addition to other emergency loads.

d) Alternator

i) The Alternator shall be of totally enclosed or screen protected drip proof and self air cooled type. The alternator shall be driven by the Diesel engine specified and shall match the same in all respects. The alternator shall conform to IS 4722 or IEC-60034.

ii) AC alternator shall be supplied along with its excitation system, AVR including all necessary auxiliaries.

e) Rating

The Alternator shall be star connected-3-phase, 50 Hz synchronous Alternator and shall have a continuous rating. The continuous rating of the alternator under the specified ambient condition shall be at least equal to the net electrical output specified for the DG set plus the power requirements of all electrical auxiliaries connected to the alternator terminal including excitation (if it is taken from alternator terminals). The operating condition for each electric Alternator shall be as follows:

i) Voltage 415V

ii) Frequency 50Hz (+3 to -5%)

iii) Power factor 0.85

f) Conductor, Insulation and Temperature Rise of Winding and Core

All insulated winding conductors of alternator shall be of copper. The Alternator stator and rotor windings core insulation and all connections including main and neutral leads shall have insulation conforming to IEC-60034 Pt.-I. The winding shall be given power house treatment i.e. two coats of varnish and backing followed by final coat of resin. The total insulation shall be non hygroscopic. The temperature rise of the stator core and mechanical parts in contact with or adjacent to winding shall not exceed the specified limits of IEC-60034 Pt.-I, Elastimold terminals with protective covers shall also be acceptable.

g) Temperature Detectors

Resistance element temperature detector shall be installed at the following locations :
Six numbers of RTD's (Duplex type) or 12 nos. Simplex type Resistance element Temperature Detectors (RTDs) shall be suitably distributed at locations where highest temperatures may be expected in stator windings and for each bearing, one (1) Duplex RTD. The RTD's shall comply with the latest edition of IS:2828.

h) Space Heaters

Suitably rated 240 V, single phase, 50 Hz, space heater located in lower part of alternator shall be provided to maintain the internal temperature above the dew point to prevent moisture condensation on the insulation when the set is not running. These heaters shall be switched on automatically, when DG set is not working.

i) Terminal Box

Separate terminal boxes shall be provided for phase and neutral side of leads. The terminal boxes shall be dust tight, weather proof having degree of protection of IP-54 as per IS: 13947.

The terminal box shall be of sufficient size to conveniently terminate the size and number of cables which shall be finalized during detailed engineering. Suitable tinned copper pads shall be provided for power cable termination. For single phase cables gland plate shall be of nonmagnetic material and shall be removable type. As far as

possible connection between exciter and alternator shall be contained within the machine frame and connections carrying AC and DC current shall be segregated from each other. The necessary CT's for differential protection shall be provided on neutral side.

j) Alternator vibration level shall not exceed the values as defined in IS:12075. Alternators in case driven by Diesel engine shall be able to withstand vibration level of 9mm/sec. as per BS 5000 Part III. Vibration level shall not exceed the permissible levels for Alternator however the same shall in any case not exceed 250 micron peak to peak.

k) The Alternator shall be complete with voltage transformers necessary for AVR/ Synchronisation. The VT turns ratio shall preferably be 440/110 V.

l) Excitation System

The Alternator shall be provided with complete excitation system capable of supplying the excitation current of the Alternator under all conditions of output from no load to full load and capable of maintaining voltage of the Alternator constant within +/- 1% of set value. The setting range available on voltage regulator shall be at any value with +/- 10% of the rated voltage. It shall be possible to set the same from remote also.

m) Brief details of Alternator

i) Continuous rating	:	500 kVA (Min.), 415V, 0.85 pf at specified site conditions at Alternator terminal
ii) Output	:	415 V, 3 phase, 4 wire,50 Hz AC
iii) Allowed voltage drop	:	15% on start of biggest motor
iv) Allowed frequency drop	:	5% transient
v) Ambient temperature	:	50 degree C
vi) Relative Humidity	:	100%
vii) Operating Speed	:	1500 rpm
viii) Noise level at source	:	85 dB(A)
ix) Starting System	:	Manual & Auto Both (Manual/ Auto) Manual start by push button starter from DG control room & sub-station control room. Machine shall have single push button start/ stop from control room. Starter
x) Type of alternator	:	Air cooled.
xi) Type of enclosure	:	Shall be totally enclosed or Screen

		protected, drip proof, self ventilated with removable covers to provide easy access to excitation unit, enclosure IP-23.
xii) Mounting	:	Horizontal, foot mounted with end shield bearings.
xiii) Excitation	:	Brushless static excitation
xiv) Insulation	:	Class H, temperature rise limited to class F
xv) Acoustic Enclosure	:	Yes, if required for keeping the noise level within specified limit for DG Set
xvi) Vibrations	:	Max. 250 microns peak to peak with anti-vibration pads
xvii)Battery System	:	Battery Charger with Lead Acid Battery
xviii)Other details		
Engine Control Panels	**:**	**Yes**
Gauges	**:**	**Yes**
Meters	**:**	**Yes**
Alarms	**:**	**Yes**
Trips	**:**	**Yes**
DG Control Panel	**:**	**Yes**
xix) Applicable Standard	:	Conforming to IS:4722 – 1992

n) Loading pattern

Industrial load with maximum demand of the highest rated drive to be decided as per the technological requirement (Largest rating motor with DOL starting). On failure of main supply, DG set shall be started automatically as per the selected option i.e Auto/Manual selection.

DG will be loaded to maximum demand in one stroke.

It shall be possible to run the DG set on lesser load also.

o) Operation philosophy

Tenderer shall note that the Power supply from AMF cum breaker panel shall be fed to FGD Emergency DB supplying power to respective loads.
In case of under-voltage sensed by bus PT of FGD Emergency DB, Start command to AMF panel shall be given to start the DG set. After DG set is started and voltage stabilized, the ACB mounted in the AMF panel shall be closed. After closing of this

breaker, the incomer breaker provided with FGD Emergency DB shall be closed automatically.

When the power to FGD Emergency DB gets restored from the normal source, DG set shall be turned OFF and disconnected from the FGD Emergency DB by switching OFF the AMF breaker manually.

Tenderer shall provide all the necessary controls, meters, interlocks and alarm system for the system

p) Diesel Alternator Control Panel / AMF panel

i) **Construction details**

The local control panel shall be of robust construction, floor mounting, free standing type made of 2.0 mm thick CRCA sheet steel. Neoprene gaskets shall be provided between all openings and joints. It shall be provided with hinged door with locking arrangement. The control panels shall have IP-54 degree of protection as per IS: 13947 Part-I.

The panel shall be painted with electro statically powder coated paint of shade RAL 7032 after necessary sheet metal treatment to remove dust, grease, oil, chemical compound, uneven surfaces and any foreign materials. The Gland plate shall be of at least 2.5mm thick sheet steel.

Control panel with provision for local starting shall be provided which shall incorporate all controls required for starting, monitoring, regulating and stopping DG set. It shall be equipped with all necessary instrumentation to provide adequate surveillance of DG set under all operating conditions including 'Standby'.

All cables shall have bottom entry. Enough space shall be provided in the control panel for easy access during maintenance and repairs.

A tinned copper/ aluminium bar of adequate dimension shall be provided for earth connection complete with nuts and bolts as required for external connection to earth grid.

CT shorting links, test terminal blocks etc. shall be provided. All the equipment mounted inside the control panel shall be identified by lamicoid labels/ stenciling by paint.

Panel shall be provided with panel illumination lamp operated by the door switch and

thermostat-controlled space heater. Control panel shall be furnished complete with all accessories and wiring for safe and trouble free operation of the system

All control wiring inside the control panel shall be carried out with 2.5 mm^2 1100V grade PVC insulated copper wires. DG set control panels shall be provided with suitable cable glands for DG set power and control cables. The AMF panel shall be suitable for termination of PVC aluminium outgoing power cables.

One No. ACB, fixed type, 4 pole construction, electrically and manually operated with shunt trips, spring charge closing facility, close trip push button in addition to manual closing and emergency tripping. ACB shall be relay operated type.

ii) **Fuses**

All fuses shall be of HRC cartridge link type. Screw type fuses are not acceptable.

iii) **Relays**

A voltage relay for sensing the supply to control Panel shall be provided. The relay shall operate at about 90% of voltage

Relays for protections like Earth fault protection and associated neutral CT mounted in Alternator neutral terminal box, Inverse time over current relay for Over load and Short Circuit protection, U/V and O/V relays with timer, Voltage healthy check relay (to monitor voltage availability after ACB), Reverse power relay with timer shall be provided. In addition, Tenderer shall also provide other protective functions/relays as per the requirement of the offered system. Protection relays shall be microprocessor based.

The Control panel shall be complete with the following

iv) **Microprocessor based control unit**

Microprocessor based control unit with the following:

(a) Voltage sensing mains supply failure monitor

(b) Auto engine start / stop & failure to start lock out.

(c) Alternator voltage & frequency sensing

(d) Selector switch and push button to facilitate remote starting/stopping, speed & voltage control

(e) Manual / Auto / Test selector switches

(f) DG start /stop push button
(g) DG Incomer Breaker close / trip push button
(h) Mains breaker close / trip push button
(i) Auto manual Speed adjustment
(j) Auto manual Voltage adjustment
(k) Auto manual selector switch for priming pump motor (if required)

v) **LED indication lamps**

LED indication lamp shall be provided for the following

(a) 'DG ON' indication lamp'
(b) 'DG Breaker ON' indication lamp
(c) 'Mains ON' indication lamp
(d) 'Mains Breaker ON' indication lamp
(e) Charger ON indication lamp
(f) Engine running-hour indication
(g) DG breaker spring charged

vi) **Annunciation**

Annunciation for the following shall be provided with fault indication, alarm & trip contact, accept, reset and test facility and hooter. Any one or more of the following defects shall cause the alarm or running diesel Alternator to be tripped. In case of tripping, re-start shall be prevented until the fault(s) are removed and manual resetting is done. Separate indicators shall be provided for each of the following in control panel :

(a) Engine fails to start (Alarm)
(b) Low lube – oil pressure (Trip)
(c) High cooling water temperature (Trip)
(d) D.G. overload (Alarm)
(e) DC failure
(f) DG over speed (Trip)
(g) Fuel level low in day tank (Alarm)
(h) Fuel level very low in day tank (Trip)
(i) Alternator stator temperature high (Alarm)
(j) Electrical protection operated (Trip)

(k) Incomer to emergency switchgear from DG closed
(l) Earth fault (alarm) input from switchgear.
(m) Priming pump tripped alarm (If applicable)
(n) Priming pump Emergency stop (indication only)

vii) **Metering**

Following meters shall be provided in the panel :

(a) Digital voltmeter
(b) Digital Ammeter
(c) Digital Frequency meter
(d) Electronic kW meter with counter display.
(e) Digital KW meter
(f) PF meter

Suitable 4-20mA transducers with dual output shall be provided in the control panel for voltmeter, ammeter, frequency, P.F. and 'KW' meter for owner's use at remote.

The Tenderer shall provide coupling relays (with diodes) having 24V DC energising coil in the control panel for the following :

(a) DG Start
(b) DG Stop
(c) DG Voltage raise
(d) DG voltage lower
(e) DG speed raise
(f) DG speed lower
(g) DG auto start

viii) Provision for following status/ signal for Owner's information shall be made available in the DG control panel:

(a) DG fail to start.
(b) DG start command actuated/ reset.
(c) DG working/ stop signal.
(d) DG trouble/ normal signal.
(e) DG control supply failure/ normal signal.

ix) Tenderer shall provide all CTs, VTs, relays, timers and auxiliary contacts as per the system requirement. CTs for protection and metering shall be 10P15 and class 1.0, 15VA (min.)

x) The Tenderer shall supply any other controls and indications for diesel Alternator set though not specifically mentioned here but which the supplier may recommend and are required to make system complete for satisfactory operation of DG sets.

xi) Indicating lamps shall be of the panel mounting LED type with series resistor and of low power consumption. Lamps shall be provided with series resistor built-up lamp assembly.

xii) Necessary pressure switches, level switches, thermostats, flow switches, auxiliary relays, etc. required for the all controls, interlocks and alarm/ annunciation system shall be provided by the Tenderer within their scope of supply.

xiii) Tenderer shall provide following in the main control room and/or DCS

1. Auto/Manual selection.
2. DG Start/stop push buttons.
3. Voltage raise/lower push buttons.
4. Frequency raise/lower push buttons

xiv) Coupling relays (with diodes) having 24V DC or suitable energising coil in the control panel shall be provided for remote application for the followings

(a) DG Start
(b) DG Stop
(c) DG Voltage raise
(d) DG voltage lower
(e) DG speed raise
(f) DG speed lower
(g) DG auto start

q) Battery and Charger

i) The charger shall be protected by a suitable current limiting device. The battery shall be sized for site minimum temperature. Battery and battery charger shall also feed the control supply of DG control panel.

The minimum voltage at the end of load cycle shall not be less than 1.75 volts per cell.

ii) A suitable battery charger shall be housed inside the panel to recharge the battery within ten hours. The battery charger shall be SMPS based automatic and shall be complete with the following

a) DC voltmeter
b) DC Ammeter
c) Float / Boost selector switch
d) Auto / Manual selector switch for Boost to float change over.

iii) The Battery charger panel shall have Battery voltage low indication lamp with alarm.

iv) **Battery**

24 volts battery of suitable capacity (at 10 hours discharge rate) lead acid battery bank complete with connecting leads, first charging and routine check instruments including hydrometer and cell tester. Tenderer shall indicate the AH capacity in the offer. Battery stand should also be supplied along with the battery.

r) Type Tests

i) All equipment to be supplied shall be of type tested quality. The Tenderer shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

ii) In case the Tenderer is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Tenderer shall conduct all such tests under this contract free of cost to the owner and submit the reports for approval.

iii) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

iv) Type test reports for the following type tests shall be submitted:

Type test reports on Alternator

(a) Measurement of resistance

(b) Phase sequence test

(c) Regulation test

(d) Measurement of open circuit and short circuit characteristics

(e) Efficiency test

(f) Temperature Rise Test

(g) Momentary overload test

(h) Over speed test

(i) High Voltage test

(j) Insulation resistance test (both before and after High Voltage Test)

(k) Noise level as per IS: 12065

(l) Vibration as per IS: 12075.

(m) Determination of Deviation of voltage waveform from sinusoidal.

(n) Degree of protection test on control panel

(o) Battery and battery charger as per relevant standards.

s) Commissioning Checks

i) In addition to the checks and test recommended by the manufacturers, the Tenderer shall supervise the following commissioning test to be carried out at site.

The battery or compressed air system for starting the engine shall be capable of performing six (6) normal start without recharging.

ii) **Insulation Resistance Test for Alternator**

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500 V megger shall not be less than IR= 2x (rated voltage in KV) + 1.

iii) **Insulation Resistance of Wiring**

Insulation resistance of control panel wiring shall be checked with 500V megger. The IR shall not be less than one mega ohm.

t) Functional Tests

i) Functional tests on control panel.

ii) Functional tests on starting provision on the engine.

iii) Functional tests on all field devices.

iv) Functional tests on DG Set complete with AVR and speed governor.

u) Measurement of vibration

The vibration shall be measured at load as close to maximum achievable load and shall not exceed 250 microns. Any modification/rectification required to bring down the vibration level within allowable limits specified by the manufacturer shall be done by the Tenderer at site.

v) Noise Level (Sound Pressure Level) check

Noise level measurement shall be done generally following the guidelines given in IS:12065. The measurement shall be carried out with a calibrated integrating sound level meter as per IS : 9779 at site.

w) Installation of DG sets

i) The installation work shall conform to Indian Electricity Act and Indian Electricity Rules as per latest amendment up to the date of issue of this specification. Any approval required from statutory authorities shall be obtained by the Bidder. Nothing in this specification shall be construed to relieve the Tenderer of this responsibility.

ii) The installation, testing and commissioning of Diesel-Alternator sets shall be carried out by the Tenderer strictly in accordance with the applicable Codes of practice, the manufacturer's instructions, drawings etc., and/or as directed by the Owner.

iii) The Tenderer shall install and commission the DG set, control panels, along with other accessories, starting equipment (Battery & battery charger/ compressed air system), fuel oil tank and fuel oil piping upto the DG sets. Minor civil works like fixing of anchor bolts, grouting etc. wherever required shall be done by the Bidder.

iv) The Tenderer shall provide all tools, equipments and instruments required for installations, testing and commissioning.

x) Drawings and Documents to be submitted by the Tenderer

i) **Drawings/data to be submitted with the Tender**

Following drawings/information shall be furnished with the tender :

1. General arrangement drawing of D.G. sets.
2. GA drawing with tentative dimension of the control and Relay panels.
3. Electrical schematic diagram and characteristics of electrical equipment.
4. Single line diagram indicating make and rating of each equipment.
5. A brief write-up giving description of control and annunciation scheme and safety interlocks.
6. List of all equipment and other accessories with specification.
7. List of recommended spare parts offered.
8. List of special tools/ tackles offered.

ii) **Drawings/data to be submitted after placement of order for review / reference of Purchaser**

1. Complete design and engineering drawings / datasheet w.r.t. generators and their control, protection, metering, interlocking, synchronisation and annunciation systems
2. G.A. drawing of D.G. set.
3. GA / Facia diagram of control panel, local control boxes, push button starter etc with complete dimension and weight.
4. Schedule of complete equipment/devices with specifications.
5. Single line diagram, power and control schematics and annunciation circuit diagrams.
6. Terminal wiring and external cable connection diagrams.

7. Test certificate

04.05.02.03 Diesel Engine

a) General

The diesel engine shall be vertical, multi cylinders, coolant / radiator cooled, turbo charged, single acting, Vee / In line construction, mechanical injection type suitable for cold starting and shall be furnished with atleast the minimum equipment according to the standard practice. The horse power rating, auxiliaries, guarantee of fuel consumption, governor performance and torsional vibration shall be in accordance with BS:649 or approved equivalent standard.

4 stroke, Air cooled, turbo- charged diesel engine, capable of driving continuously synchronous Alternator to give net required output at Alternator terminals at rated speed under site conditions as mentioned in the specification.

The design of engine shall be such that it can take fluctuating load, sudden loading and load throw off from rated load to zero load without adverse effect and deration in the engine.

The design of the engine shall consider the case of maintenance, repair, cleaning and inspection.

The engine and DG set shall be capable to withstand 10 % overload for one hour in a period of 12 hours operation.

The engines shall be designed to burn HSD fuel oil (net calorific value of about 10,000 kcal/kg as per IS:1460 and as available in India).

Engine cylinder heads shall be suitable for heavy duty application and shall be secured firmly to the engine frame. The liners of the cylinders shall be of suitable materials to resist the wear and tear of piston rings. Cooling water space shall be provided around cylinder jackets and arrangement shall be provided to compensate thermal expansion of the liner.

Flywheel with cover including suitable coupling between engine and Alternator shall be provided.

The crank shafts shall be made of high quality forged steel with smooth machining, grinding & honing all over.

The connecting rods shall be made of high quality forged steel of suitable cross section for heavy duty application.
The main bearings shall be made of suitable soft material. Arrangements shall be provided for lubrication of main bearings, big end and small end bearings. A vibration damper shall be provided to control torsional vibration resonances, if required. Conveniently located inspection window to facilitate removal of big bearing, piston etc. without sump removal shall be provided.

The pistons shall be made of suitable light metal having high thermal conductivity and low thermal expansion. There shall be oil scraper rings and sufficient number of compression rings.

The valve mechanism shall be actuated through cam shaft, push rods and rocker arms by means of a suitable gear train and shall be accommodated in the engine frame itself.

The diesel engine shall conform to relevant parts of ISO 8528 and ISO 3046. Performance test of DG set shall be carried out as per latest standard of ISO 8528 and ISO 3046 and other relevant standard as applicable.

b) Fuel Oil System

The fuel injection system shall be driven by the engine itself and the system must ensure the proper timing of fuel injection, control of rate of fuel injection, proper atomisation of fuel in accordance with the type of combustion chamber used, proper distribution of fuel in combustion space and arrangement to return excess quantity of fuel oil to the oil tank. Priming pump will be provided.

Rate of fuel injection shall be automatically controlled in accordance with variation in engine load. Hydraulic/ Electronic governor [conforming to class A1 of ISO: 3046 (latest)] shall be provided to maintain the speed of the engine constant within limits of tolerances.

A “Day Tank” of 990 litres capacity with mechanical oil level indicator to indicate low and high levels shall be supplied. An engine driven booster pump shall be provided to deliver fuel oil from the supply line to the fuel oil injectors through duplex filters or two full capacity filters. Hand pump shall be supplied for pumping oil from barrels to “Day Tank”. The Day Tank shall be provided with float valve, high/ low level switches for

alarm.

i) **Day Oil Tank**

One number cylindrical box type metallic (M.S) fuel oil day tank of capacity 990 litres shall be provided with all accessories & fittings for each DG Set. The tank shall be fabricated from MS plates of minimum 14 SWG thickness conforming to IS : 2062-1992 and shall be complete with level switch, level gauge, vent, drain, inlet & outlet connection, manhole, pocket for instruments, low level alarm, high level alarm (audio visual type in control room) and supporting structures. The fuel oil shall be brought in barrels and transferred to the above tank by hand filling pump.

ii) **Filter**

Quantity : 2 set.

Type : Duplex type

Mesh size : at least 30 mesh

Filter element: Mild steel body and stainless steel (SS 316) wire mesh

Location : At inlet and outlet of day tank.

Capacity : As required.

iii) **Pipes & Fittings:**

All external pipes shall conform to IS:1978, line pipe, ERW medium grade. Necessary standard bends, tees, couplings, flanges, bolts, nuts and gaskets shall be used for laying the pipelines.

iv) **Valves**

All isolating valves shall be of self lubricating, taper plug, tight shut off type and of reputed make. Open/close position of valve and direction of flow shall be clearly indicated on the valve body.

v) **Hoses**

Type	:	Flexible
Standards	:	BS:1435 (latest)

vi) **Flanges**

As per ANSI B 16.5 with pressure rating of 150 class minimum.

vii) **Dip Rod**

The dip rod shall be of suitable length, calibrated and made of Aluminium. It shall be used to measure the contents of the oil in the tank. Diameter of dip rod shall be minimum 12 mm.

c) Lube Oil system

Diesel engine shall be provided with suitable lubricating system for effective lubrication of all components. The system should be complete with gear type lube oil pump, oil cooler and duplex fine mesh filters or two full capacity filters, differential pressure gauge across the filters or pressure gauge on either side of the filters. The system shall be provided with oil pressure and temperature indicating instruments /gauges and all control/safety devices against loss of oil pressure and high oil temperature. It will have L.O. topping and draining arrangement, vapour extraction and oil cooling system. Lube oil heater, priming pump will be provided, if required, for smooth starting of the engine.

d) Engine Cooling System

The engine cooling water / coolant shall be forced through the system by engine driven cooling water pump and the hot return water shall be cooled by passing it under thermostatic control through a radiator/ heat exchanger.

Jacket water system shall be complete with water cooling arrangement, thermostatic control with alarm on high jacket water temperature, expansion tank with topping arrangement, controls/ safety devices. A separate or combined close water circuit shall be provided for injector cooling, if required.

e) Air Intake and Exhaust System

The engines shall be supplied with dry type air filter or through oil bath type intake, pressurised through exhaust gas turbine driven turbo charger and if required, cooled in a charge air cooler. The filter shall be made of special anti-corrosive materials, preferably

stainless steel to SS 316.

The exhaust system shall consist of an exhaust gas driven Turbo-charger of reputed make, residential type exhaust gas silencer, expansion joints, necessary piping adapters, noise attenuation system, insulation supports etc.

The exhaust gas pipelines of the engines shall be led upto required height as per statutory norms and shall be provided with weather proof cowl. The exhaust pipe and exhaust silencer shall be made of carbon steel suitable for the maximum exhaust gas temp. Suitable supports shall be provided for supporting the exhaust pipe and silencer. Suitable expansion joints/flexible connections shall be provided between exhaust pipe and exhaust manifold of the engine to ensure that no undue vibration is transmitted to the piping system. The exhaust pipe shall be suitably lagged and cladded with 20 gauge Aluminum sheet for personnel protection against burning. Silencer shall be designed to have sound level below the acceptable limit. The sound level shall not exceed more than 85 dBA at the generating source.

f) DG Set Starting System

Starting of diesel engine shall be through electrical starting system. The electrical starting system shall comprise of starter, batteries, motors and battery charger and all the necessary instruments and accessories.

The diesel Alternator set will be normally at rest when the station AC supply is available from normal power source. Set shall have auto as well as manual starting system. In auto mode (A/M selection switch), signal to start the engine will be initiated from AMF panel and automatically in a sequence manner. DG set will be started and after reaching desired voltage & frequency Alternator circuit breaker will be closed. On restoration of mains supply DG set shall be tripped automatically in auto mode of operation. In case of manual start mode, DG set shall be started manually by initiation ON push button either from panel or push button mounted on DG skid and also manual closing of Alternator circuit breaker.

As soon as the diesel Alternator set reaches its rated speed and generates its rated voltage (a period not exceeding 30 seconds) a voltage and frequency sensitive relay shall permit the closing of the Alternator circuit breaker.

g) Governing System

Engine governing shall be in accordance with BS 5514 Part 2 to 7- 88 and/or ISO 3046

Part 4 class A1. Governor shall be provided for keeping constant speed within certain limits with variable loads. The governor shall be Hydro/ Electronic class AI. It should be capable of operating on isochronous mode i.e. the speed of the engine (frequency of the Alternator set) should remain constant irrespective of the load on the DG set upto 100% capacity. A droop of 0 – 10% should also be available.

The governor shall be suitable for isochronous load sharing. It shall have external speed trim facility with speed adjustable within ± 5% of rated speed. The governor shall have automatic start fuel limit feature so that fuel is limited during start up overspeed. The automatic fuel shall be adjustable. It shall have a failed speed detector, which shall stop the engine in the event of speed sensing signal from magnetic pickup. The steady state speed band shall be ± 0.25% of rated speed. It should be capable of operating within 20V to 32 V DC in an ambient temperature of -10 C to 75 C. Remote operation of governor should be possible.

h) Technological Structures

Steel structures envisaged as supports for fuel oil tanks, starting batteries, exhaust pipes, valves, vent pipe and overhead pipelines (if any) in the DG station.

Superimposed loads considered in the design of steel structures shall be in accordance with IS:875 (part 2) in addition to technological loads, if any.

The design of steel structures shall be carried out according to IS:800 and other relevant Indian Standards. Fabrication shall be carried out in accordance with IS:800 & IS:7215.

i) Enclosure

The acoustic enclosure shall be free standing floor mounting type independent of the DG set. It shall be an all weather proof one, pre-fabricated, factory built and modular in construction, so that it can be easily assembled at site around the DG set without any anchor to the ground. It consists of specially designed panels, sliding doors, louvers and locking arrangements. The enclosure shall have four sliding doors, two sets of detachable ventilating systems for fresh air intake and hot air exit. The attenuator openings shall take care of the temperature of the DG set. The panels are made out of CRCA sheet steels stuffed with insulation material mainly Mineral wool/Rock wool of high density covered by G.I. perforated sheet. The Enclosure shall be provided with inlet and outlet specifically designed ventilating louvers for air movement and sound absorption across the Enclosure. All the supporting structure and frame work shall be built out of ISM channels and IS Angles. Finally the Enclosure shall be finished with zinc chromate yellow suitable primer

and epoxy based paint of 631 shade of IS5.

j) Painting and Packing

Equipment shall be painted with two coats of epoxy based primer followed by two Final coats of epoxy based paint. Sheet metal work shall be subjected to degreasing, Pickling and phosphating prior to painting. Exhaust pipe shall be painted with heat resistant paint for high temperature.

The equipment shall be shipped to site suitably packed to prevent any damage. Each Package shall have labels to show purchaser's name, purchase order and equipment number suitable lifting lugs etc. shall be provided and lifting points shall to clearly marked on the package. Packing shall be suitable for storage at site for a minimum period of six months.

04.06 CIVIL WORKS

04.06.01 Introduction

This section covers entire civil engineering work including design, supply and construction for all buildings, structures and facilities for all production, auxiliary units, foundations for all buildings, structures and equipments, paving's, roads, water supply and sanitary system and all other miscellaneous civil engineering work that will be necessary for completing this package on a turnkey basis for installation of Natural Gas Compressor Station at Guwahati in line with scope of works specified elsewhere of this specification. All civil, works including design as per system requirements are in Bidder's scope. Description of various civil items of work under this specification and nature of work in detail are given hereinafter.

a) It is not the intent to specify herein all the works in the scope of the contract. The scope also includes all other buildings, structures and works necessary, which are not specifically mentioned here but required for construction, operation and maintenance of all structures covered under the EPC package, are deemed to be included in the scope of the Bidder. All works shall conform to the relevant specifications. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification. The Bidder's detailed design and scope of supply shall include all components and systems, whether included in the system descriptions or not, required to provide a complete and fully functional facility. This shall include all type of Civil work required for successful completion of scope of work of the bid document.

b) The work to be performed under this specification consists of design, engineering as well as providing all labour, materials, consumables, equipment, temporary roads, temporary works, temporary labour and staff colony, construction of plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion of this package, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

c) All materials including cement, reinforcement steel, foundation bolts, inserts, structural steel, Vibration isolation system(VIS) etc. and all other construction materials required for successful execution of civil works shall be supplied by the Bidder at his own cost.

d) The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project.

e) The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Owner/ Consultant. For all buildings and structures, foundations, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory & functional requirements of the Natural Gas Compressor Station and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Bidder's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Owner.

f) Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the Bidder will be construed as evidence that such an examination was made and any later claims / disputes in regard to price quoted shall not be entertained or considered by the Owner on account of ignorance of prevailing site conditions.

g) The Bidder's detailed design and scope of supply shall include all components and systems, whether included in the system descriptions or not, required to provide a complete and fully functional facility.

h) The works covered in this section consists of collection of all site related data, conducting site investigations, Soil investigation, design, preparation of all construction drawings, supply of all labour, supervision, all materials, scaffolding, fuel, water, construction equipment, tools and plant supplies, transportation, storage, construction, fabrication, erection and testing where necessary, of all structures required for housing all equipment and civil works for all services required for the package as defined in the specification document. The Civil works shall include those required for Installation, Commissioning, testing, operation and maintenance of structure/ system required for the package.

i) The Site System shall provide roadways inside the plant boundary, micro grading levelling and storm water runoff drainage up to the boundary wall terminal point.

04.06.02 Scope of Work

All Civil Works including design , related to all facilities required for the Completeness of this Package, shall be within the scope of this package.

The civil works for the buildings, structures, equipment foundations, facilities and miscellaneous civil works to be provided for the project shall include but not limited to the following:

a) All foundations,footings,basements,piles etc

b) Cable trenches, cable racks, duct banks, manhole and pipe trenches, Cable sleeper etc.

c) Supporting structures and platforms with access for utility pipelines, ventilation ducts, Bus ducts and other equipments.

d) All water supply, plumbing and sanitary works including all fixtures for sewage disposal for buildings / units / shed covered within the battery limit.

e) Collection & disposal of industrial effluents collected from buildings / units / shed covered within the battery limit.

f) All necessary waterproofing, damp proofing and anticorrosive treatment with epoxy coating to all reinforced bars, structures and foundations, including underground construction.

g) All necessary civil works for crossing pipes/cables below for roadways and other services within the battery limit etc.

h) Construction of all temporary facilities, building, offices, labour colonies, staff quarters, roads and services required for this package.

i) Removal of debris, micro levelling of the site, included in the scope of contract prior to completion of work.

j) Dismantling of buried/semi-buried structures, if any, encountered within the plant limits and disposal of it from the site as directed by the Owner. Any facility / structure/ utilities dismantled shall be re-constructed by Bidder on his own Cost.

k) Site clearing, dressing, levelling and grading of formation to required levels and soil compaction as necessary within the battery limits as shown in the bid drawing or as directed by Owner.

l) Earthwork for buildings and equipment foundations,pilecaps, tanks, trenches, pits, sewers and other underground / above ground construction work. Dewatering of the underground works.

m) Back filling, soling and sub-grade work for all foundation, grouting, flooring, trenches, pits for all structures/equipment included in the scope.

n) Encasing structural steel column bases as well as structural steel wall beams in RCC at various locations as required.

o) Reinforced concrete work and PCC work in foundations, sumps, pits, trenches, tanks, all equipment and other underground structures.

p) Reinforced concrete work and PCC work in open foundations/pile foundation, columns, tie beams, beams, staircases, slabs frames and other substructure/superstructures.

q) All masonry work in sub structure and super structure including plastering as required.

r) All finishing work to flooring, walls, ceiling, false flooring and false ceiling as required.

s) All finishing and painting work to masonry, concrete structures, steel works and wood works.

t) All fencing and gates as required.

u) Doors, windows, ventilators, rolling shutters, fire check doors, gates shutters etc.

v) All necessary Buildings / Units and equipment supporting structures and their foundation system.

w) All Handrails, inserts, kerb angles, bolts, cage ladders, platforms and other miscellaneous steel works.

04.06.03 General work requirement

The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark as per the directions of the Owner.

All levels have to be established with respect to the permanent bench and reference bench mark shall be indicated by the Owner.

The bidder shall be solely responsible for the correctness of the civil works.

04.06.04 General Concepts for Buildings

Design and construction of buildings, structures etc. shall take into account requirement for operation and maintenance of all equipment and its users. The surrounding areas shall be properly micro levelled and graded.

- Drainage of rainwater from roof shall be ensured by PVC rainwater down comers with necessary fittings & fixture and proper slope.
- All buildings shall be provided with rain water harvesting facility.
- All concrete roofs exposed to weather shall be provided with water proofing treatment using latest Polymer based cementatious material of approved reputed manufacturer like CICO,SIKA,FOSROC or equivalent consisting of minimum 2 coats of acrylic polymer based cementatious slurry coating with one layer of fiber glass cloth in between over screed concrete laid to required slope. 50mm thick PCC (1:2:4) shall be cast over water proofing treatment, in panel not exceeding 1.2M X 1.2M size with 0.56mm diameter galvanized chicken wire mesh reinforcement. Joints shall be sealed with sealing compound.
- Fly ash bricks confirming to IS: per IS:13757 or IS:12894 shall be used. In case of unavailability of fly-ash brick within 50 Km radius of work site, bricks as per IS:1077 can be used after prior approval of Owner. The minimum compressive strength of brick shall be 5 N/mm^2.
- Grade slab shall be of RCC/PCC construction resting on 75 thk. PCC ,which in turn will be resting on 250thk. boulder soling/GSB and well compacted earth.
- All buildings shall be provided with 1000mm (minimum) wide apron along with garland drain all round the periphery of the building. Apron shall be of minimum 75mm thick PCC(M 20) finished with 15mm thick cement mortar (1:4) and neat cement (chequered).
- Separate ladies and Gents Toilet & rest room facilities in all major buildings
- Separate fire exits shall be provided in all buildings as per requirements.
- Equipment foundations for all the systems specified in mechanical, electrical section of this specification.
- All other civil and structural buildings shall be developed in conjunction with the above aspects.

04.06.05 Specific requirement for site work

In addition to Scope of work specified elsewhere in the volume of this Tender specification site specific requirements are listed below:

- Site development work.
- Site clearance.
- Temporary roads/drains required for construction/pre-commissioning purpose.
- Construction of enabling works.
- Ground preparation including minor grading, if required shall be done by the Bidder.
- Paving, trenches, tunnels, channels, duct banks, etc. involved in all system.
- Non shrink free flow grout for equipment foundations and grouting below all Steel structure, Skids, etc.
- Plinth protection all around buildings minimum 1 m wide and with peripheral drainage.
- Sewage System
- Drinking & service water distribution network for complete Natural Gas Compressor Station area.
- All roads, culverts, drainage and street lighting for the Natural Gas Compressor Station area.
- Plant storm water drainage system.
- Rain water harvesting for the complete package within the battery limit.

04.06.06 VOID

04.06.07 Site Development Work

04.06.07.01 Site Clearance

The Bidder shall be deemed to have visited and carefully examined the site and surroundings and studied the conditions prevailing in and around the proposed site and to have satisfied himself about the nature of the work, general site conditions, the site for disposal of surplus materials, debris, surplus earth etc. and all other items affecting the work. Claims due to ignorance of site conditions will not be considered

after submission of Bid.

Ground preparation including minor grading, shall be done by the Bidder. However the Bidder of the package shall consider removal of grass, shrubs, plant & its root from the proposed area which are likely to grow again after first cut cleaning by site grading work done by Owner. Certain amount of cutting, filling, and removal of top layer of expansive soil, if any, shall be included in the scope of this bid document. Where earth fill is intended, the area shall be stripped of all loose / soft patches or top soil containing objectionable matter before filling commences. Any structure or services existing at the site shall be removed / re-routed with the permission of the Owner. Existing wells, pits, marshy areas etc. shall be filled up with earth of approved quality.

04.06.07.02 Road, Drains and Culverts

Roads shall be designed and constructed as per relevant IRC codes/MORTH specification. Vehicular parking areas shall be of flexible pavement type with wet mixed macadam (WMM) base and bituminous topping on prepared surface. The roads shall be of Bituminous type.

On either side of the roads, open drains with concrete grating shall be provided. Minimum clear width of the drain shall be 450 mm. All the drains shall be in RCC. Drainage lines and other underground services shall be located at least 1.2 m clear from the edge of the road. All service and utility lines crossing the roads shall be taken up through NP3 class RCC pipe designed for impact loading. Culvert shall also be generally using NP3 class pipe. The Contractor may adopt option of providing RCC box culvert.

04.06.07.03 Storm water Drainage

The storm water drainage of the Natural Gas Compressor Station area is included under the scope of the Bidder.

04.06.07.04 Sewage/ Waste water drainage

The scope of Bidder shall include collection of the entire sewage form toilet, wash area, etc. in a catch pit located just outside individual building / unit.

Carrying out the work of Sewage routing, shall provide the network of underground sewage collection in gravity flow and shall arrange to lead the sewage to Sewage line/ manhole. Individual Septic Tanks & Soak Pits shall be provided at each toilet blocks

of buildings.

All paving works shall be carried out after successful installation of underground sewage system.

04.06.07.05 Paving/Plinth Protection

Entire paving area shall be provided with RCC paving. Plinth protection around all buildings shall be provided to a min width of 1000 mm or the distance between the brick wall to the garland drain.

Paving shall be carefully planned such that maintenance access roads minimum 4 m wide to all major equipments are available. This area shall be designed for heavy loads similar to design of roads. All drain / trench covers in these areas shall be designed to withstand truck loading.

04.06.07.06 Water supply

Plumbing and fixing of fixtures within the battery limit shall be provided in line with the technical specification.

04.06.07.07 Rain Water Harvesting

All the buildings will be provided with rain water harvesting system approved by relevant state govt. authority for entire Natural Gas Compressor Station area.

04.06.08 Design Requirements

04.06.08.01 Meteorological Data

Altitude above MSL	50 m
Ambient Temperature	40 °C (max) & 5 °C (min)
Relative Humidity	100% (max) & 25% (min)

04.06.08.02 Seismic Zone

The site is located in Zone Vas per IS: 1893.

04.06.08.03 Wind Zone

The site is located in basic wind speed zone of 50 m/s as per IS: 875 (Part 3).

04.06.08.04 Loads and Load Combinations

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, wind loads, seismic loads, temperature loads, forces developed due to differential settlement and any other loading conditions which can occur during the design life of the facility. (All the buildings shall be designed for one extra floor keeping in view future provision).

Dead Loads

Dead loads consist of the weights of the complete structure with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including storage structures, partitions, roofing, piping, cable trays, bus ducts etc. The content of storage structures etc. shall be measured at full capacity for this purpose.

The piping loads, cable tray loads and the contents of the storage structures shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing load for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Table 1.1
Weights of Material

Material	Unit weight (kN/m^3)
Plain cement concrete	24.0
Reinforced cement concrete	25.0
Brick work	20.0
Cement plaster	21.0
Floor Finish	24.0

Superimposed Live Load (SILL)

Listed below is the minimum SILL for the areas involved. Floors and supporting members subjected to heavy equipment live loads shall be designed on the basis of the equipment loads specified by vendor or specifically defined SILL whichever is greater.

The specific minimum floor SILL is listed below:

Table 1.2
Superimposed Live Load (SILL)

Sl. No	Description	SILL Value
a)	Roof	
	Flat accessible roof	1.5 kN/m^2
	Flat accessible roof with HVAC equipments, etc.	5 kN/m^2
	Flat inaccessible roof	0.75 kN/m^2
	Sloped Roof	As per code IS: 875 (Part-2)
b)	All building floors & Stairs	5 kN/m^2
c)	Walkways of Conveyor Galleries	5 kN/m^2 or Concentrated Load of 3 kN at centre whichever is critical
d)	M.C.C. Floor	10 kN/m^2
e)	Equipment Load	As applicable
f)	Culverts & its allied structures including Concrete pipes	Class "A" / Class "70R" as per IRC standard whichever is higher / load due to bull dozers
g)	Underground basement,	Surcharge of 10 KN/m^2
h)	Vehicular traffic	Surcharge of 20 KN/m^2
i)	Covers for Channels	Surcharge of 10 KN/m^2
j)	Pump Houses	
	Operating Floor Slab	15 KN/sqm or as required by equipment supplier whichever higher
	Workshop	10 kN/m^2
k)	Other areas:	
	• RCC floors (Offices, laboratories, conference rooms and	5 kN/m^2

Sl. No	Description	SILL Value
	general floors)	
	• Balconies	5 kN/m^2
	• Chequered plate / gratings	5 kN/m^2
	• Walkways	3 kN/m^2
	• Toilets	2 kN/m^2

- In addition to LL, Hung loads for electrical, ventilation & air conditioning minimum of 0.5 kN/m^2 shall be considered.
- For other areas LL shall be considered as per IS: 875 (Part-2).
- Pounding effects due to framing deflections for roofs, if any shall be considered.

Seismic Load

The various structures for the project are to be designed as per codal provisions of IS:1893 for earthquake loads. The loads due to Earthquake are generated by the response of the structure to design spectrum as specified in IS1893. The site is located in Earthquake zone V and factors corresponding to that zone are taken in calculation of response. The mass to be considered in seismic analysis shall comprise of full dead load and the reduced percentages of live loads for calculating inertia masses as given in Table 1.2A.

Table 1.2A – Live load reduction factors under seismic condition

Sl. No.	Description	Percentage reduction of Design Live load
1	Uniformly distributed Live loads on floors up-to and including 3 kN/Sq.m.	25
2	Uniformly distributed Live loads on floors above 3 kN/Sq.m.	50
3	Roof	100

Following values are used for the defining Design Basis Earthquake (DBE) which is considered for the analysis:

Zone factor, Z = 0.36
Damping (R.C structure) = As per IS:1893
Importance factor I = As per IS:1893

Response reduction factor is considered as 5 and Ductile detailing of Reinforced concrete structure is mandatory.

Ductile detailing of Reinforced concrete structure subjected to seismic forces shall be as per Is 13920.

Wind Load

Wind load calculation shall be as per IS: 875 (part-3) 2015 where Basic wind speed (V_b)shall be taken as 50 m/sec with Risk coefficient k1 as 1.07 (important building having mean probable life of 100 years, k2 as Terrain roughness and height factor for Terrain Category –2 and depending upon the height of the building,k3 as topography factor k4 as per code ,

Wind pressure at any height above mean ground level,

$p_z = 0.6\ V_z^2$ (clause 7.2 of IS 875 (Part-3) – 2015)

$V_z = k_1.k_2.k_3.\ k_4.V_b$ (clause 6.3 of IS 875 (Part-3) – 2015)

Design wind pressure, $p_d = k_d.k_a.k_c.p_z$ (clause 7.2 of IS 875 (Part-3) – 2015

where k_d=Wind directionality factor

k_a=Area averaging factor

k_c=Combination factor

The value of p_d, however shall not be less than 0.7 p_z

For the design of structures, wind force on Equipment, supported on frame including all fixtures, piping, staircase, ladder, etc., exposed to wind shall be considered.

Design of structures shall be checked for the condition of wind load with gust factor.

Earth Pressure Loads

For earth pressure the worst condition with dry / submerged and active, passive or at rest condition shall be considered. (The pressure coefficient shall be adopted as recommended in Soil Report or for the backfill material used.)

Thermal Loads (during operating condition)

Thermal loads wherever applicable shall be considered.

Equipment Loads

General

Static and dynamic loads of major equipments shall be based on the manufacturer's data of the specified equipments and shall be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered e.g. control room floors are usually designed for a live load that includes the equipment weight also.

All equipments, tanks and piping design loading shall include hydraulic test loading. Weight of equipments, ducts, tanks, pipes, conduits, etc. supported by structure shall include maximum possible loading conditions i.e. flooded conditions and associated impacts, test loading, anchorages and constraint effects.

Air and gas duct loads shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads applicable.

Design philosophy

The design of machine / equipment foundation shall be as per IS: 456 and IS: 2974. The provisions of DIN 4024 may also be followed for machine foundations. All machine / equipment foundations and structures subject to vibrations shall be suitably proportioned so that amplitude and frequency of the foundation / structures are within permissible limits.

Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers shall be satisfied. Minimum reinforcement shall be governed by IS: 2974.

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. Vibration isolation shall be designed suitably.

All such foundation shall be separated from adjoining part of building and other foundations. Joints at floor/ slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitable to ensure integral action.

Loads

All static and dynamic forces / loads which equipment supplier considers applicable shall be considered for analysis and design of machine foundations.

Foundation Sizing

The outline plan dimensions of foundations as given by the machine supplier will be adopted. The height of foundation will be selected after taking into consideration soil strata and operating level of the machine. The eccentricity of common CG of machine and foundation with respect to the centroid of base area should not exceed 5 % of the corresponding base dimensions of foundation. Partial contact between the foundation and soil strata shall be considered wherever applicable. The footing will be checked for minimum contact area of 80 % and maximum bearing pressure will be calculated for the actual contact area only.

Analysis and Design

The minimum grade of reinforced cement concrete shall be M30, unless specified otherwise.

- The analysis and design of machine foundations will be carried out to ensure the following:
- Compliance with the manufacturer's requirements and relevant standards
- No resonance phenomenon of a disturbing nature to machine operation should exist at the normal running speed
- Calculations to be performed for dynamic as well as static cases for reinforced concrete block type pedestal
- Soil bearing capacities
- Deep foundation capacities
- Lateral earth pressures
- Allowable settlements
- Structure, equipment and environmental loadings
- Equipment performance criteria
- Access and maintenance requirements

- Temporary construction loadings

The foundation will be designed for the most critical combinations of forces and moments, resulting from all possible combinations of the various loading from the equipment system. The foundation sections will be sized and reinforced adequately for bending moments and shear stresses and uplift.

The foundation shall be checked for overturning, sliding and uplift as per relevant IS Codes. The foundation will be checked for overturning with minimum and maximum vertical loads.

For analysis of machine foundation following data will be furnished by the equipment manufacturer:

- Loading diagram showing static and dynamic loads and points of application of loads
- Operating speed of machine
- Weight of rotating parts, maximum eccentricity of rotating mass from the geometric axis of rotation
- Location of C.G. of machines in all three axis
- Mass moment of inertia
- Allowable amplitude / velocity of vibration at machine bearing points
- Temperatures at various areas during operation

While designing following aspects shall also be taken care of:

- All dynamic foundations shall be isolated from building foundations. The isolation gap shall be of minimum 25 mm.
- Natural frequencies of structures and components shall be away from running speed of equipment by at least 20 % and preferably 50%

However following minimum factor of safety shall be followed:

- Factor of safety against overturning due to wind, seismic or other lateral loads shall be 1.5
- Factor of safety against sliding shall be 1.5

- Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5. Uplift check shall be carried out during construction stage also.

Specific requirements for Compressor Foundation

Compressor foundation shall consists of :

Alternative-1

The Compressor foundation shall comprise of RCC block supported on steel helical springs & viscous dampers (herein after called as the Vibration Isolation System – VIS). The VIS shall be placed on a group of RCC block . The general arrangement & details of VIS and supporting group of columns and beams shall be based on Compressor Equipment detail of the Bidder.

Alternative-2

The Compressor foundation shall be conventional machine foundations comprising of RCC block directly supported on soil/pile without any steel helical springs and viscous dampers.. The entire foundation system shall be isolated from the main plant building structural system and no connection between the main plant structure and Compressor foundation is permitted.

Bidder has the option to choose either Alternative -1 or Alternative-2 based on his design philosophy and practice.

Miscellaneous Machine Foundation

For miscellaneous machines, most suitable type of foundation shall be provided. Foundation for pumps, and minor rotating equipment etc., are usually in the form of solid block foundations, resting on the ground or on a floor of the building. At such machine supports, floor may be thickened and extra reinforcement may be provided. Also the machines, which are almost vibration free, light to moderately heavy, may be supported in the above manner. Rubber or neoprene pads under some of these machines to reduce transmission of vibrations to the supporting floor will be provided if required.

All block foundations resting on soil shall be designed using the Linear elastic weightless spring method/Barkan method as per IS 2974. Alternately, Elastic half space theory can also be used by referring to specialized literature. The mass of the RCC block shall not be less than three times mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled

modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers shall be satisfied. Minimum reinforcement shall be governed by IS: 2974.

Hoists, Monorail and Elevator loads

All lifting beams and monorails shall have their design loads increased for impact factor. Loads for hoists, monorails and elevators shall be taken as per IS: 875.

Vibration and Noise

The design shall ensure that vibrations from any moving machinery transmitted from its immediate foundations to adjacent buildings or areas of the same building shall be suppressed in accordance with the recommendations of relevant codes of practice. Any control room, administration facility and other permanently occupied office area shall be structurally isolated from plant areas subject to frequent shock loads or containing large oscillating or rotating plant and equipment.

Other Loads

- Dust loads: All buildings / structures shall be designed for a dust load of 1 kN/m^2.
- Construction Loads: The integrity of the structures shall be maintained without use of temporary framing struts or ties and cable bracing as far as possible. However, construction or access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented to ensure the stability and integrity of the structures during any periods involving use of temporary bracing systems.
- Future Loads: Loads from future expansion shall be considered when so directed by the Owner/Consultant. Future loads may include any of the loads listed above.
- Surge Loads: Surge loads may occur in some vessels or equipment. In such cases, the magnitude and direction of the load shall be given by the equipment supplier.

Basic Load Cases

In general following basic loads shall be considered for analysis and design:

Dead load	:	DL
Superimposed dead load	:	SIDL
Self weight of permanent equipment	:	EL

Live load on floor / walkway	:	LL
Superimposed live load	:	SILL
Live load on roof	:	LLR
Hoist, monorail loads	:	MR1
Wind load	:	WL
Seismic load	:	SL
Load due to soil pressure	:	SP
Load due to surcharge	:	SCL
Load due to hydrostatic pressure	:	HP
Load due to temperature	:	TL
Special loads	:	SPL
Cable loads	:	CL
Piping loads	:	PL

Load Combinations

The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion. Permissible stresses for different load combinations shall be taken as per IS: 456, IS: 800 & IS: 875 (all parts) and other relevant IS codes.

Wind and seismic forces shall not be considered to act simultaneously.

Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loading.

Load Combinations for underground structures/Liquid retaining structure

- Ground water shall be considered at FGL (Finished Ground level) for design of all underground structure.

- RCC water retaining structure like storage tanks shall be leak proof and designed in accordance with IS: 3370 (Part 1 to IV) by Limit state method. However the parts of such structures not coming in contact with liquid may be designed according to IS: 456.

- Substructure of pump houses shall be designed as per IS 456

- In all liquid retaining structures, PVC water bar shall be provided at each construction / expansion joint. The sequence of construction shall also be specified on drawings showing construction joints.

- The walls shall be designed for a surcharge load of 2000 Kg/m² or actual whichever is higher.

- Base slab / raft of all liquid retaining structure shall be designed to withstand the uplift pressure in tank empty condition.

04.06.09 Reinforced Concrete Structures and Foundations

04.06.09.01 General

All structures, open foundations/pile foundation, machines / equipment foundation, water retaining structures, trenches, pits, etc. shall be designed as per latest relevant IS codes in general. Construction in general shall follow provisions of IS: 456 and IS: 3370 for normal and water retaining structures respectively.

04.06.09.02 Design Methodology

General

All designs of RCC structures shall be carried out by limit state method as per IS: 456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456.

IS: 11384 shall be followed for design of steel concrete composite beams. For reinforcement detailing IS: 5525, SP: 34 and IS: 13920shall be followed.

The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

04.06.09.10 Non-Shrink Grout for Equipment Foundations

Special non-shrinking grout of approved make shall be provided in strict accordance with the manufacturer's instructions / specifications. Ready mix non-shrink grout of GP2 brand or equivalent, of approved make shall be used for base grouting for foundation of vibrating machines.

04.06.09.11 Stability of Structures

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground storage tanks, pits, trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed

loading. For the purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area of the base slab shall be taken in to consideration. Maximum 500mm widening/Extension/projections all around in foundation to take advantage of soil weight in uplift check is permissible.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other latest relevant IS codes. However following minimum factor of safety shall be followed:

- Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum
- Factor of safety against sliding shall be 1.5 minimum
- Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In cases where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

04.06.09.12 Minimum Thickness of Concrete Structural Elements

Table 2.5
Minimum Thickness of Concrete

Sl. No	Description	Thickness, mm
a)	Suspended floor / slab / walkways /canopy slabs, etc.	125
b)	Ground floor slab (non-suspended)	150
c)	Water Retaining slabs / walls, partition wall	200
d)	Cable/pipe trenches/underground pits/Launder walls and base slab	125
e)	All footings (including raft foundations) other than	300

Sl. No	Description	Thickness, mm
	pilecap.	
f)	Parapets	125
g)	Sunshades	75 at edge
h)	Precast louvers / fins	50
i)	Precast trench cover slabs / louvers	75
j)	Paving	150
k)	Basement walls and base slab	200
l)	Underground tank: Below ground water table Above ground water table	 200 150
m)	Metal deck floor slab (top of crest)	125
n)	RCC Road	300

From fire resistance point of view minimum cover to reinforced concrete members shall be as per Table 16A of IS:456.

04.06.09.13 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and Appendix A of IS: 456 shall be taken as guideline for durability considerations. The exposure condition shall be very severe.

Minimum fire rating of 2 hours shall be considered where fire hazard is expected and accordingly minimum cover shall be taken as per Table 16 A of IS: 456.

For structures below ground level which are exposed to sulphate /chloride attack, requirement of cement shall be as per IS: 456. Intermixing of different grades of concrete in the same structure shall not be allowed in a particular element.

Mix design concrete shall be used for all areas other than plain concrete work used for lean concrete, screeds and backfill.

The following minimum grades of concrete as per IS: 456 shall generally be used for

the type of structures noted against each grade.

Table 2.7
Grades of Concrete

Concrete mix/Grade	Type of structure
M10	Fill concrete
1:3:6	Blinding layer below foundations, trenches and underground structures, foundation below brick wall, etc. Minimum thickness of layer shall be 75 mm
1:2:4	For screed layer below water retaining structures
M20	Plinth protection work around buildings
M25	Encasement of structural steel work, all PCC paving work
M25	All RCC structures and equipment foundations, super structure, grade beams, columns, roof slabs and all underground RCC structures, cable and pipe rack foundation, pedestals, cable and pipe trenches, ground floor slabs, etc.
M-30	Water retaining structures below and above ground, Compressor foundations, precast concrete work etc.
M-40	RCC road

Reinforcing bars shall be HYSD/TMT of grade Fe-500D conforming to IS : 1786. Test certificate for reinforcement steel shall be obtained from required agency, before using. If the steel is purchased by the Bidder, Owner may desire to check the testing of the same & the Bidder shall arrange it in approved laboratory at his own cost.

04.06.10 Building & Structures

All civil works for the buildings, equipment foundations, facilities and miscellaneous civil works to be provided for the project will include but not be limited to the following:

i. Gas Compressor Shed

The four nos. Gas Compressors will be located inside Gas Compressor shed of steel structural construction with RCC open foundation/pile foundation and RCC grade slab.

Gas Compressor shed shall also include the following

a) Drainage all around the building.
b) Pipe trenches and Cable trenches.
c) Pipe/Cable Rack column foundations.
d) Pre-cast slab/ chequered plate cover over the pipe and cable trenches.
e) Area paving.
f) RCC paving inside Compressor shed.
g) Approach from the connecting road.

ii. Gas Compressor After coolers

The four nos. Gas Compressor After coolers will be placed on RCC open foundation/pile foundation.

iii. Air compressor shed

Air Compressors along with air dryers will be located inside a shed of steel structural construction with RCC open foundation/pile foundation and RCC grade slab. The shed will have side brick walls upto 1m.

Air Compressor shall also include the following:-

a) Drainage all around the building.
b) Pipe trenches and Cable trenches.
c) Pipe/Cable Rack column foundations.
d) Pre-cast slabs/ chequered plate cover over the pipe and cable trenches.
e) Area paving.

iv. Administration building

The administration building shall be of RCC construction with open foundation/pile foundation and grade slab. The building shall be in G+1 configuration. Load for one extra floor is to be considered for structural analysis and design of building.

v. Canteen

The building shall be of RCC construction with open foundation/pile foundation and grade slab. The building shall be in G+1 configuration.

vi. Fire tender house

The building shall be of steel structural construction with RCC open foundation/pile foundation and RCC grade slab..

vii. Rest room building for workers

The building shall be of RCC construction, and in G+1 configuration with open foundation/pile foundation and grade slab.

viii. Car Parking shed

Parking shed shall be of structural construction with open foundation/pile foundation and grade slab.

ix. Scooter & cycle parking shed

Parking shed shall be of structural construction with open foundation/pile foundation and grade slab.

x. Mechanical workshop

The building shall be a structural building with RCC open foundation/pile foundation and RCC grade slab. All rooms of lean to bay will have civil enclosures.

xi. Biometric security block

Building is of RCC construction with RCC open foundation/pile foundation and grade slab.

xii. Guard room

Building is of RCC construction with open foundation/pile foundation and grade slab.

xiii. Gate Complex

Gate Complex shall be of RCC construction with open foundation/pile foundation and grade slab.

xiv. Store

The building shall be a structural building with RCC open foundation/pile foundation and grade slab.

xv. Fire tanks

Fire tanks Shall be of structural construction with RCC of open foundation/pile foundation and grade slab.

xvi. Nitrogen Generating Unit

Nitrogen generating unit shall be located inside a shed of steel structural construction with RCC open foundation/pile foundation and RCC grade slab. The shed will have side brick walls upto 1m.

It shall also include the following:-

a) Drainage all around the building.
b) Pipe trenches and Cable trenches.
c) Pipe/Cable Rack column foundations.
d) Pre-cast slabs/ chequered plate cover over the pipe and cable trenches.
e) Area paving.

xvii. Fire Water Pump House

Fire water pumps shall be located inside a shed of steel structural construction with RCC open foundation/pile foundation and RCC grade slab. The shed will have side brick walls upto 1m.

Fire water pump house shall also include the following:-

a) Drainage all around the building.
b) Pipe trenches and Cable trenches.
c) Pipe/Cable Rack column foundations.
d) Pre-cast slabs/ chequered plate cover over the pipe and cable trenches.
e) Area paving.

xviii. Diesel Generator Shed

Diesel Generator Shed shall be a structural building with RCC open foundation/pile foundation and RCC grade slab. The shed will have side brick walls upto 1m.

Diesel Generator shed shall also include the following

a) Open foundation/Pile foundation for Equipments.
b) Pipe trenches and Cable trenches.
c) Drainage all around buildings

d) Pre-cast slab/ chequered plate cover over the pipe and cable trenches.
e) Area paving.

xix. Lube Oil and HSD Storage Shed

Lube Oil and HSD Storage Shed shall be a structural building with RCC open foundation/pile foundation and RCC grade slab.

xx. Watch Tower

xxi. Emergency Assembly Point

xxii. MRS Area

a) Total Outdoor Area for State Utility Switchyard & Metering Yard including Peripherial Road.

Equipment shall be resting on open foundation/pile foundation. Fencing shall be considered for the total periphery with Gate arrangement

b) Transformer foundation

Transformer foundation shall be of RCC construction

c) Panel Room & Control Room

Panel Room & Control Room shall be of RCC Construction. Cable Trenches shall also be of RCC construction

d) Cable Trenches

Cable Trenches with RCC Cover Slab for Substation shall be of RCC construction

e) 4m wide Road inside MRS.

xxiii. HT & LT Sub-station cum Control room building

Building shall be of RCC construction with open foundation/pile foundation and grade slab. The building shall be in G+1 configuration with open foundation/pile foundation and grade slab.

a) HT cum LT Sub-station building , Electrical Panel Room etc- Right Wing

HT cum LT Sub-station building, Electrical Panel Room etc shall be Double storied building of RCC construction with Open/pile foundation.

b) HT cum LT Sub-station building , Electrical Panel Room etc-Left Wing

HT cum LT Sub-station building , Electrical Panel Room etc -Left Wing shall be shall be Double storied building of RCC construction with Open foundation/pile foundation.

c) Control room building shall be double storied building of RCC construction with Open foundation/pile foundation

xxiv. High Mast

High Mast foundation shall be resting on with Open foundation /pile foundation.

xxv. Interplant Cable & pipe trenches and Cover Slab shall be of RCC construction.

xxvi. Central Monitoring Basin

One no. Central Monitoring Basin of RCC construction shall be provided by Tenderer. The basin shall be located underground and covered with RCC grade slab.

04.06.11 Specification

Specification for civil works comprises, besides this section, one volume of General Specification for Civil Engineering Works (11-CIVIL-GS-07). That volume shall also form part of this section and therefore shall be read in conjunction with this section. If the specification for any item of work and material is not available in the above mentioned specification, then "specification of work" (latest edition) published by CPWD shall be followed.

04.06.12 Engineering related Special Requirements

Bidder shall submit all drawings and supporting design calculations for approval of Consultant/Owner.

a) Approval of the Bidder's design drawings / documents means that these are checked for conformity with applicable specifications and general conformity with the engineering requirements covered in the specifications. Approval of the Bidder's design drawings and documents shall not relieve the Bidder in any way whatsoever of any of his responsibilities under the Contract and the Bidder shall

remain wholly responsible for any error in his design drawings, unapproved disagreements with contract technical specification.

b) The Bidder shall not make any change in the approved design drawings without the prior written approval of the Owner/Consultant. Owner is not liable for approval of document having additional changes on the design/ drawings already approved. Manufacturing / procurement / fabrication prior to approval of design drawings shall be solely at the Bidder's risk.

c) In case of any deviations from the approved design drawings being called for at site due to any reason, Bidder shall take approval on such change from Owner/ Consultant before carrying it into effect at site. However, Owner is not liable for re-approval of design/ drawings already approved.

d) In general no foundation shall rest over back filled soil. However, small foundation may rest over the back filled soil after asserting the designed bearing capacity subjected to clearance from Owner/ Consultant.

e) All facilities to be functionally & operationally connected, wherever process requires, to the facilities of other package areas at interface points.

f) All design calculations and drawings shall be in English and shall be in SI units.

g) Designs, drawings and other documents submitted by the Contractor shall be thoroughly checked and approved by the authorized Contractor's engineer. Any unchecked / unsigned documents will not be reviewed by the Owner/Consultant. Also design calculations not accompanied by supporting engineering drawings, incomplete or shabbily done design calculations, design calculations without adequate reference or backup data and documents where previous comments have not been incorporated will not be reviewed by the Owner/Consultant. No claim from the Contractor for extension of time or extra cost on this account shall be entertained by the Owner/Consultant under any circumstances.

h) No check will be specifically carried out by the Owner/Consultant to verify arithmetical / numerical accuracy of the calculations, input data, compatibility of dimensions among various drawings or between drawings and design calculations.

04.06.13 Documents to be submitted by Bidder after the Award of Contract

The following documents are to be submitted for the approval of the

Owner/Consultant, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (Metric system). The list is not exhaustive but indicative only.

a) Layout drawing with co-ordinates of roads, buildings and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping, diversion drains, equipment lay down areas etc. within the battery limit.

b) Drawing showing underground facilities with co-ordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps, pits, culverts, foundations etc.

c) Geotechnical investigation Methodology along with layout of various proposed tests and Geotechnical investigation report along with foundation recommendation for various buildings / structures / facilities.

d) Storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc. for storm water drainage system.

e) Design basis memorandum for all buildings, facilities, services and structures.

f) Landscaping scheme, scheme for supply of potable and service water to all buildings.

g) Design calculations and drawings for foundations/substructure and superstructure of all structures within scope

h) Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads. Design and drawing of vibration isolation system shall also be furnished.

i) A write up on dewatering system proposed at the time of construction where deep construction such as for Conveyor tunnels and pump house etc. are to be executed where water table is encountered.

j) Design calculations and drawings for all facilities and services like roads, culverts, bridges, paving, road crossings, drainage pump house (if required), drains, sewers, water supply, water tank, sumps, tunnels, trenches, ducts, equipment, DG, silos etc.

k) Design calculations and drawings for plumbing and building drainage.

l) All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the Owner/Consultant.

m) Design calculations and drawings for structures and foundations in switchyard, transformer yard, etc.

n) All drawings / prints shall bear a stamp at a prominent place indicating whether the drawings are submitted for approval or for information. Drawings supplied by the Bidder shall bear the date and signature of a responsible person of the Bidder.

o) Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) in all construction drawings.

p) Copies of all reports on investigation and studies carried out by the Bidder as per the scope.

q) Field Quality Assurance plan for Civil works.

r) Structural analysis/ design shall be carried out using latest version of STAAD.Pro Connect software. All loads applied on structural frame work in STAAD.Pro input shall be clearly shown in load calculation. Soft copies of design calculations in editable format, sources and validation report for software, drafting (AutoCAD), shall be submitted for Owner's acceptance.

s) All relevant civil/structural materials shall be brought to site along with necessary test certificates and should be submitted to the Owner at site for approval. Bidder shall submit a list of preferred makes as given in the format for the materials.

SPECIFICATION

FOR

CIVIL ENGINEERING WORKS

मेकॉन लिमिटेड
MECON LIMITED
RANCHI - 834 002, JHARKHAND

JUNE, 2008

SPECIFICATION FOR CIVIL ENGINEERING WORKS

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SPECIFICATION FOR CIVIL WORKS

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1.0 GENERAL

1.1 Scope

This part deals with the requirements of materials for use in construction work with regard to quality, testing, approval and storage, before they are used on work. This part is supplementary to Part-II: Workmanship and Other requirements of the Technical Specifications for civil works.

1.2 Standard

A high standard of quality is required for all materials used in construction work. They shall be the best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and assurance of timely supply.

1.3 Approval and Tests

1.3.1 All materials to be used in construction shall be subject to approval of the Engineer. The Contractor shall apply sufficiently in advance with samples of the materials including the supporting test results from the approved laboratory and other documentary evidence from the manufacturer wherever applicable and indicating the types of materials and their respective sources. The delivery of materials at site shall commence only after the approval of the quality, grading and sources of the materials by the Engineer.

1.3.2 The quality of all materials once approved shall be maintained throughout the period of construction and periodical tests shall be carried out to ensure that it is maintained. Such routine tests shall be listed under the different materials and/or as may be ordered by the Engineer from time to time.

1.3.3 Where a particular "Brand" or "Make" of material is specified in the Schedule of Items or Technical Specifications, such "Brand" or "Make" of material alone shall be used on the work. Should it become necessary for any reason (such as non-availability/ceased to be produced), to use any material other than the specified "Brand" or "Make", the Contractor shall submit sample of the same to the Engineer for approval together with test certificates and other documents necessary for examining and giving approval thereof. Should such change or substitution of materials, subsequently approved, results in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately reduced. Similarly, in case the substitution results in use of material of

price higher than that specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately increased.

1.4 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

1.4.2 In case of any conflict in meaning between these specifications and those of BIS or IRC, or British /International Standard; the provisions of these specifications shall prevail.

1.5 Rejection of Materials

1.5.1 Any material brought to site which, in the opinion of the Engineer is damaged, contaminated, deteriorated or does not comply with the requirement of this specification shall be rejected.

1.5.2 If the routine tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification or of I.S. Codes as applicable, then that material shall be rejected.

1.5.3 The Contractor at his own cost shall remove from site any and all such rejected material within the time specified by the Engineer.

2.0 MATERIALS FOR CONCRETE

2.1 Aggregates

2.1.1 Aggregates shall comply with the requirements of IS: 383-1970 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalies of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

2.1.2 Testing

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386-1963 "Methods of Test for Aggregates for concrete".

2.1.3 Grading

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete made therefrom to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

2.1.3.1 Size and grading of fine aggregates

The grading shall conform to IS: 383-1970 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

2.1.3.2 Size and grading of coarse aggregates

The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall depend upon the description of the particular item in the Schedule of Items and/or according to relevant clauses of IS: 456-1978. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383-1970 depending upon the maximum nominal size as specified or as required.

2.1.3.3 Fine aggregate for mortar and grout

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and IV as defined in IS: 383-1970.

2.1.4 Storage & stacking

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate.

In case of stockpiling, care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

2.2 Coarse Aggregates

2.2.1 Types

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

2.2.2 Stone chips

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383-1970. If found necessary the stone chips shall be screened and washed before use.

2.2.3 Gravel

It can be either river bed shingle or pit gravel. It shall be sound, hard, clean, irregular in shape and suitably graded in size with or without some broken fragments. It shall be free from flat particles, powdered clay, silt, loam and other impurities. Before using, the gravel shall be screened and washed to the satisfaction of the Engineer. However, the foreign/deleterious materials shall not exceed 5% by weight.

2.2.4 Broken bricks / Brick aggregates

These shall be obtained by breaking well burnt or over burnt dense brick bats. They shall be homogeneous in texture, well graded in size, roughly cubical in shape, clean and free from dirt, clay, silt or any other deleterious matter. Before use, these shall be screened.

2.3 Fine Aggregates

2.3.1 Unless specified otherwise it shall either be natural river sand or pit sand.

2.3.2 Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other impurities which is likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screened or washed before use to the satisfaction of Engineer.

2.3.3 Crusher dust

Crusher stone dust (that is retained on 300 micron sieve) may be used as replacement for certain quantum of sand aiming to improve the fineness modulus of fine aggregate. The quantum of replacement for sand shall be arrived at by suitable trial mixes. The Engineer will decide the final usage of crusher dust depending on the circumstances.

2.4 Lime

Lime for mortars and concrete shall conform to IS: 712-1984 The total of CaO and MgO content in quick lime shall not be less than 85% (MgO shall not exceed 5%). Quicklime, after slaking, shall leave a residue of not more than 5% by weight on IS sieve 85.

2.5 Surkhi

Surkhi used in lime concrete for flooring, terracing etc., shall conform to IS: 3182-1986. Surkhi shall be made from well burnt bricks or brickbats. Surkhi shall pass through I.S. sieve 3.35mm with at least 50 % of it passing through I.S. sieve 1.70mm and be perfectly clean and free from foreign matter. Surkhi shall not be made from bricks which have come in contact with any mortar.

2.6 Cement

Ordinary Portland cement / Portland slag cement complying with the requirements of IS:269-1989 and I.S. 455-1989 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards :

Portland Pozzolana Cement	IS: 1489-1991
Rapid Hardening Portland Cement	IS: 8041-1990

43 Grade Ordinary Portland Cement	IS: 8112-1989
53 Grade Ordinary Portland Cement	IS: 12269-1987
Hydrophobic Portland Cement ..	IS: 8043-1991
High alumina cement for structural work	IS: 6452-1989
White portland cement	IS: 8043-1989
Sulphate Resisting Portland Cement	IS: 12330-1988

2.6.1 Testing of samples

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535-1986. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) 1988 to 1991 & IS: 4032-1985.

2.6.2 Contractor's responsibility

From the time a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition and at his expense and risk. Any cement which deteriorates while in the Contractor's charge and is rejected as unsuitable by the Engineer, shall be removed from the site to outside the limits of work at the cost of contractor within two days of ordering such removal by the Engineer.

2.6.3 Stock of cement

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

2.6.4 Storage of cement

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately.

Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

2.7 Water

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-1978. Water shall be obtained from an approved source.

Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.

2.8 Admixture for Concrete

2.8.1 Approval

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

2.8.2 Types

2.8.2.1 Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645-1975. The application and doses shall be as per manufacturer's specification.

2.9 Interval of Routine Test

2.9.1 The routine tests of materials, delivered at site, shall be at the following intervals :

Aggregates - Fortnightly or for every 200 m3 for each aggregate whichever is earlier and in other respects generally as per IS : 2386 (Part 1 to 8)-1963.

Cement - Fortnightly or for each consignment, within 4 days of delivery and in other respects generally as per IS : 4031-1988.

Water - Once in two months for each source of supply and in other respects generally as per IS : 456-1978.

Reinforcement - For each consignment within 4 days of delivery in accordance with I.S. 1786-1985, I.S. 1599-1985 and I.S. 1608-1972.

3.0 STEEL

3.1 For Reinforcement

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing :

i) Plain mild steel bars conforming to Grade-I of IS : 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".

ii) "High strength deformed steel bars conforming to IS : 1786-1985 for Concrete Reinforcement".

iii) Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786-1985 is as given below.

Nominal Size (Dia) (mm)	Mass Per Metre Run (Kg)
6	0.222
8	0.395
10	0.617
12	0.888
16	1.580
18	2.000

20	2.470
22	2.980
25	3.850
28	4.830
32	6.310

3.2 Binding wire

Binding wire for reinforcement shall be annealed steel wire 20 BWG conforming to IS : 280 -1978 "Specification for Mild Steel Wire".

3.3 Light structural work and inserts

Steel for light structural work and for preparation of inserts and embedments shall conform to IS: 2062-1992 "Steel for general structural purposes - Specification."

3.4 Steel Tubes

Steel tubes for use in light structural work and inserts shall be of light or medium class (as may be specified in drawings or the schedule of items) and of grade YST 25 conforming to IS : 1161 - 1979 "Specification for Steel Tubes for Structural Purposes".

3.5 Foundation Bolts

3.5.1 Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS : 5624-1970 "Specification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be of steel conforming to IS : 2062-1992.

3.5.2 Nuts and locknuts shall conform to IS : 1363 (Part 1 to 3) -1992 "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (Diameter 6-39 mm) and Black Hexagon Screws "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".

3.5.3 Plain washers shall conform to IS : 2016 -1967 "Specification for Plain Washers and spring washers shall conform to IS : 3063 -1972 "Spring Washers for Bolts, Nuts & Screws".

3.6 Steel Tubes for Non-structural use

3.6.1 Steel tubes for non-structural use shall conform to IS : 1239 (Part-I) -1990 "Specification for Mild Steel Tubes, Tubular and Other Wrought Steel fittings, Part-I : Mild Steel Tubes".

3.6.2 Fittings for steel tubes used for non-structural purposes shall conform to IS : 1239 (Part-II) -1992 "Specification for Mild Steel Tubular and Other Wrought Steel Pipe Fittings".

3.7 Threaded Fasteners

Bolts and nuts for fastening shall conform to IS:1367 (Part 1)-1980 "Technical Supply Conditions for Threaded Fasteners".

3.8 Testing

Test certificates from manufacturer shall be submitted for each consignment. Any additional test which the Engineer may require shall be done according to IS : 1786-1985, 1566-1982, 280-1978, 2062-1992, 1161-1979, 2614-1969, 3063-1972, 1239 (Part 1 and 2)-1990 and 1992 and 1367-1980.

3.9 Cast Steel

3.9.1 Quality

Cast steel shall conform to IS : 1030-1989 "Carbon Steel Casting for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade2.

3.10 Conduits

3.10.1 Steel for electrical wiring

Rigid steel conduits for electrical use shall conform to IS : 9537 (Part 2) -1981 for rigid pipes and to IS : 3480-1966 for flexible conduits. Fittings for conduits shall conform to IS : 2667-1988.
All conduit pipes shall be finished with galvanised or stove-enamelled surface. All accessories shall be of threaded type and pipes shall be jointed by means of screwed couplers only. Bend in conduits shall be made to the dimension shown in drawing, but a minimum of 12 times the diameter. Where shown in drawing they shall be treated with anticorrosive preservative as specified.

3.10.2 Non-metallic conduit for electrical wiring

Non-metallic conduits for electrical use shall conform to IS : 9537 (Part 3) -1983 for rigid pipes and to IS : 6946 -1973 for flexible pipes. Fittings shall conform to IS : 3419-1989.

Bends shall be achieved by bending the pipes by inserting suitable solid or inspection type normal bends, elbows or similar fittings.

4.0 ASBESTOS CEMENT PRODUCTS

4.1 General

Asbestos cement products shall be free from visible defects, uniform in colour, of required density, length, thickness and diameter within the allowable tolerance. They shall be obtained from an approved source of manufacture and stored safely. Methods of test shall be according to IS:5913-1989 "Method of Test for Asbestos Cement Products."

4.2 Building Boards

These shall be of Class A, B and C with board thickness being 6.5mm , 5mm and 4mm respectively. The length shall be 2400, 1800 and 1200mm and width in all cases 1200 mm. Building boards shall conform to IS : 2098 - 1964 "Asbestos Cement Building Boards". They shall, when tested in two perpendicular directions, take a load of not less than 15 kgf for Class-A and 10 Kgf for Class-B and Class-C boards.The boards shall show water absorption of not more than 40% of their dry weight.

4.3 Flat Sheets

Flat sheets shall conform to IS : 2096-1992 "Asbestos Cement Flat Sheets". They shall have a bending stress of not less than 225 kgf/cm2 & a density of 1.6 kg/dm3 for compressed sheets & a bending stress of not less than 160 kgf/cm2 and a density of 1.2 Kg/ dm3 for uncompressed sheets. Nominal thickness shall be 5,6,8,10 and 15 mm , length 2400, 1800 and 1200mm and width 1200mm. Water absorption shall not exceed 28% of dry wt.

4.4 Pipes and fittings

Pressure pipes shall conform to IS : 1592-1989 "Asbestos Cement Pressure Pipes" and to IS : 9627 -1980 "Asbestos Cement Pressure Pipes (Light Duty)". Pipes for sewerage and drainage shall conform to IS : 6908 -1991 "Asbestos Cement Pipes and Fittings for Sewerage and Drainage ". Building pipes gutters and fittings shall conform to IS : 1626 - (Part 1 to 3)-1980 to 1991 "Asbestos Cement Building pipes and pipe fittings".

Pressure pipes shall satisfy Hydraulic test and transverse crushing test as per IS : 5913-1989.

4.5 Corrugated and Semi-Corrugated Sheets

These shall conform to IS : 459 -1992 "Unreinforced Corrugated and Semi-Corrugated Asbestos Cement Sheets". Unless otherwise stated

the sheets shall be corrugated and not less than 6mm thick. The sheets shall have a load bearing capacity of not less than 5 N/mm width of specimen and shall not absorb more water than 28% of its dry weight. Overall width of corrugated sheets is 1050mm and of semi-corrugated sheet is 1100mm.

4.6 Asbestos Cement Roof fittings

These shall conform to IS : 1626 (Part 3)-1981. Shapes and dimensions shall be as given in the above mentioned code. All finished products shall be free from visual defects that impair appearance or serviceability. Surface of fittings shall be of uniform texture and shall have neatly trimmed edges. Mean water absorption shall not be more than 28% of dry mass of the material.

5.0 BRICK AND STONES

5.1 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 5 N/sq.mm., or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Underburnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS : 3495 (Parts-1 to 4) -1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in table 1 of IS : 1077-1992.

5.2 Handling

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

5.3 Samples and Inspection

Representative samples shall be submitted by the contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and shall be to the approval of the Engineer who may reject such consignment as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer without additional charges.

5.4 Brick Bats

Brick bats shall be obtained from well burnt bricks of approved quality.

5.5 Laterite Stone Blocks

These shall conform to IS : 3620 -1979 "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum compressive strength of 30 kg/cm2 and to be tested as per IS : 1121-1974. The blocks shall be minimum 15 cm thick but not exceeding 30 cm. They shall be dressed to the desired sizes and shapes with an axe. Laterite stones shall be well seasoned by exposure to air before dressing and using on work.

5.6 Stone (granite, trap, sandstone, quartzite etc.)

5.6.1 Stone used shall be strong, durable, dense, compact, close grained, homogeneous, fire resistant and shall be obtained from sources approved by Engineer. Stones shall additionally be hard, sound, free from cracks, decay and other flaws or weathering and shall be easily workable. Stones with round surfaces shall not be made use of.

5.6.2 Stones shall have a crushing strength of not less than 200 kg/cm2. Stones with lesser crushing strength may be used in works with prior approval of the Engineer. Stones shall be non-porous and when tested in accordance with IS : 1124 -1974 "Method of Test for Determination of Water Absorption Etc.," shall show water absorption of less than 5% of its dry weight when soaked in water for 24 hours. Tests for durability and wheathering shall be done in accordance with IS : 1126-1974 and IS : 1125-1974 respectively. The working of stones to required sizes and their dressing shall be as per IS : 1127-1970 "Recommendations for dimensions and workmanship of natural building stones for masonry work" and IS : 1129 -1972 "Dressing of Natural Building Stones". Stones

especially limestone and sand stones shall be well seasoned by exposure to air before use in construction works.

5.6.3 Size

Normally stones shall be of size that could be lifted and placed by hand, between 20 to 30 kg per piece. The length of stones shall not exceed 3 times the height and the breadth on base shall not be greater than 3/4 of the thickness of wall or less than 15cm. The height of stone may be upto 30cm.

5.6.4 Dressing

5.6.4.1 Random rubble

Stones shall be hammer dressed on the face, the sides, and the beds to enable it to come into close proximity with the neighbouring stone. The bushings in the face shall not project more than 4cm on all exposed faces and 2cm on a face to be plastered, nor shall it have depressions more than 1cm from the average wall surface.

5.6.4.2 Coursed rubble - First sort

Face stones shall be hammer dressed on all beds, and joints, so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for atleast 5cm back from the face, and side joints for atleast 4cm such that no portion of the dressed surface is more than 6mm from a straight edge placed on it. The bushing on the face shall not project more than 4cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 2.5cm along the four edges of the face of the stone, when stone work is exposed.

5.6.4.3 Coursed rubble - Second sort

Dressing shall be as specified in 5.6.4.2 except that no portion of dressed surface shall exceed 10mm from a straight edge placed on it as against 6mm for first sort.

5.6.4.4 Stone for veneering

Stone lining upto 8cm shall be treated as veneering work. The stone shall be cut into slabs or required thickness along the planes parallel to the natural bed. Every stone shall be cut to the required size and shape so as to be free from any waviness and to give truly vertical and horizontal joints. Adjoining faces shall be fine chisel dressed to a depth of a 6mm, so that when checked with a 60cm straight edge, no point

varies from it by more than 1mm. All edges shall be chisel dressed to be true, square and free from chippings. Top and bottom faces shall be dressed to within 3mm tolerance and vertical faces to within 6mm tolerance, when checked with a 60mm straight edge. Dressing at the back shall not be done.

5.7 Hollow and Solid Concrete Blocks

5.7.1 Cement concrete blocks used in the construction of concrete masonry load bearing as well as non-load bearing walls shall conform to the requirements of IS : 2185 (Part 1)-1979. Physical properties such as density, compressive strength, water absorption etc., shall be determined in accordance with the procedure laid down in IS : 2185 (Part 1) - 1979 and shall conform to the requirement laid therein. When inspected visually all blocks shall be sound, free from cracks, broken edges, honeycombing and other defects which would interfere with the proper placing of blocks or impair strength or permanence of construction.

5.7.2 Dimensions and tolerance

The blocks shall be made in sizes and shapes to suit the particular job and shall include stretcher, corner, double corner or pier, jamb, header, bullnose and floor units.

5.7.2.1 The nominal dimensions of concrete block shall be as follows :

Length	:	400, 500 or 600mm
Height	:	200 or 100mm
Width	:	50, 75,100, 150, 200, 250 or 300mm

In addition, blocks shall be manufactured in half and other suitable lengths and shapes to suit Architectural requirements.

5.7.2.2 The maximum dimensional tolerances shall be plus or minus 5mm in length and plus or minus 3mm in height and width.

5.7.3 Hollow blocks (open and closed cavity)

5.7.3.1 The blocks having solid material about 50% to 75% of total volume of the block calculated from the overall dimensions shall be termed as hollow blocks. Grade-A blocks used as load bearing units shall have a minimum block density of 1500 kg/m3 and shall have minimum average compressive strength of 3.5, 4.5, 5.5 or 7.0 N/mm2 at 28 days as specified.

5.7.3.2 Grade-B Blocks used as load bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and shall have compressive strength of 2.0, 3.0, or 5.0 N/ mm2 or as specified.

5.7.3.3 Grade-C blocks used as non load bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and compressive strength of 1.5 N/mm2 at 28 days.

5.7.4 Solid blocks

The blocks having solid material more than 75% of the total volume of the be block shall be termed as solid block. Solid blocks (Grade-D) used as load bearing units shall have a block density of not less than 1800 kg/m3 and compressive strength of 4.0 or 5.0 N/mm2 as specified.

5.7.5 Mix proportion

The concrete mix used for blocks shall not be richer than one part by volume of cement to six parts by volume of combined aggregates before mixing.

5.7.6 Surface texture and finish

Surface texture, that is, very fine closed texture or coarse open texture and finish, whether coloured or not shall be according to the drawing, description in the Schedule of Items or instructions of the Engineer.

5.7.7 Marking and certificate

The blocks shall be marked permanently indicating the Grade of the unit, identification of the manufacturer and the year of manufacture. Manufacturers test certificate shall be supplied with the delivery of each lot.

5.8 Cement, Lime and Water

Cement, lime and water shall conform to the specification under the Section Concrete of this part.

5.9 Sand for Masonry Mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS : 2116 - 1980 "Sand for Masonry Mortars". The sand shall be hard, durable, clean and free from adherent coatings and shall not contain amount of clay, silt and fine dust more than 5% by wt. Sand shall not contain any harmful impurities such as iron pyrites, alkalies, salts, coal, mica and organic matters. The particle size grading of sand for use in mortars shall be within the limits as specified in Table I of above code.

6.0 SAND FOR PLASTERING

Sand for use in mortars for internal wall, ceiling and external plastering and rendering shall conform to IS:1542 -1992. It shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. Percentage of salt and dust shall not be more than 5% by weight. Grading of sand shall be within the limits specified in clause no. 5.1 of above code. Fineness modulus of naturally occuring sand shall not be less than 1.5.

7.0 MATERIALS FOR FLOORING & PAVING

7.1 Cement and Binders

7.1.1 Cement

Cement, fine aggregates, reinforcement and water used shall comply with the requirements of concrete as per clauses 2.1, 2.3, 2.6 and 2.7 of this part.

7.1.2 Water

Water for construction shall be clean, soft, free from loam, salt and organic materials. Hard water shall not be used.

7.2 Aggregates

7.2.1 Coarse Aggregate

7.2.1.1 Coarse aggregate shall conform to the requirement as per clauses 2.1 and 2.2 of this part.

7.2.1.2 For granolithic floor the screeded bed shall comprise of aggregates size 15mm and down graded and topping shall comprise of clean fine stone chippings, size 4mm and down. For concrete floor with hardener treatment the topping shall comprise of stone chippings, size 6mm and down and for in-situ terrazzo flooring, chippings shall be within sizes 12mm to 6mm graded. The marble chips for topping of terrazzo floor shall be of 3-6mm size and shall conform to Grade-I of IS : 2114-1984 "CP for laying in-situ terrazo floor finish".

7.2.2 Common burnt clay bricks

Common burnt clay bricks shall conform to IS : 1077-1992 and comply with requirements under the section "Brick and Stones" of this part.

7.2.3 Rubble

Rubble of approved quality shall be used and shall be clean and free from dirt. The loose and weathered sections shall be removed before use. Rubble used as hard core shall have a least lateral dimension (thickness) between 100mm and 225mm, depending on the thickness of hardcore.

7.3 Tiles

7.3.1 Terrazzo Tiles

Terrazzo tiles shall be machine made under a minimum pressure of 140 kg/cm2. It shall have a minimum total thickness of 20mm including a minimum of 6mm thick topping. It shall be of size, texture, colour, shade and pattern as specified in schedule of item and as approved by the Engineer.

7.3.2 White Glazed Tile

White glazed tiles shall be of approved manufacture and quality and shall conform to IS:777 - 1988 "Glazed Earthenware Tiles. They shall be true in shape, free from hair cracks, crazing spot, chipped edges and corners and surface shall be perfectly flat without warps and of uniform colour. The top surface shall be glazed either gloss or matt as specified. The tiles, normally shall be 149mm x 149mm or 99mm x 99mm size and shall not be less than 5mm thick or as specified. The tolerance on average facial dimension value shall be plus or minus 0.8 and on thickness plus or minus 0.5mm. The specials such as coves, internal and external angles, beads, cornices and their corner pieces shall be of specified sizes and of thickness not less than the thickness of tiles.

7.3.3 Coloured tiles

Only glaze shall be coloured as specified. The size and specification of tiles shall be same as for the white glazed tiles.

7.3.4 Marble tiles

It shall conform to IS : 1130 -1960 "Marble (Blocks, Slabs and Tiles)". Marble for paving and facing work shall be of selected quality, hard, sound, dense and homogeneous in texture (with crystalline texture) and free from cracks, decay, weathering and flaws and shall be of kind and quality, size and thickness as specified in schedule of items. The samples of tiles shall be got approved by the Engineer before use. The tiles shall be cut to the requisite dimensions.

7.4 Pigments

Pigments incorporated in mortar or used for grouting shall be subject to approval of Engineer and as per table I of IS : 2114-1984.

7.5 Red Oxide of Iron

Red oxide of iron where used for "Red Artificial Stone Flooring" shall be of quality approved by the Engineer, and shall be of uniform tint.

7.6 Hardening Agents

Hardening agents such as ironite used for "Cement Concrete Flooring with Hardener Treatment", shall be of quality approved by the Engineer for every work.

7.7 Dividing Strips

Dividing strips shall be of aluminium, glass, brass, copper, plastic or similar materials as specified in the schedule of item and of quality approved by the Engineer. Strips shall be 1.5 mm thick unless otherwise specified penetrating to the full depth of the flooring. Aluminium strips when used shall have a protective coating of bitumen.

7.8 Marble Chips

It shall be in sizes varying from 1mm to 25mm and in different colours as per requirement. Marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from cracks, stains, decay and weathering and shall be obtained from approved source.

7.9 Marble Powder

It shall be clean, free from dust and other foreign materials and of approved quality, obtained from approved source. It shall pass through sieve 300 conforming to IS: 460- (Part-1)-1985.

8.0 TIMBER

8.1 General

All timber used for carpentry and joinery works shall be new. It shall be well seasoned by a suitable process conforming to IS : 1141-1973 before being planed to the required sizes. It shall be sound, straight, free from sap, radial cracks, decay, fungal growth, boxed heart, pitch pockets, borer holes, splits, loose knots, flaws or any other defects and shall show a clean surface when cut. Timber shall conform to the requirements of IS : 1003 (Part 1&2)-1983 to 1991. The finished

components shall be given suitable preservative treatment wherever necessary.

8.2 Teak wood/Sal / Bija Sal / Deodar / Kail and other varieties of timber

8.2.1 Teak wood

The timber shall be of good quality and well seasoned. It shall be of fairly uniform colour and shall be free from defects such as cracks, dead knots, shakes etc. No individual hard and sound knot shall be more than 15 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. Wood shall be generally free from sap wood but traces of the same shall be allowed. The timber shall be fairly grained having not less than 2 growth per cm width in cross section.

8.2.2 Sal / Bija Sal wood

Timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 6 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall not be less than 5 growth rings per 2 cm of the width.

8.2.3 Deodar wood

The timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 15 sq.cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall be at least 3 growth rings per cm width in cross section.

8.2.4 Kail wood

The timber shall be generally as specified in clause 8.2.3 for Deodar wood. However, there shall not be less than 2 growth rings per cm width in cross section.

8.2.5 Other varieties of timber

The timber as named in the item of work shall be used. It shall be well seasoned and generally free from defects such as dead knots, cracks, shakes, sap wood etc. However, traces of sap wood shall be allowed and sound and hard knots up to 2 % of the area of the piece shall be allowed.

8.3 Storage and Inspection

Timber shall be carefully stored and subject to inspection on site, piece by piece. The Engineer may reject such pieces as are considered by him not of the quality or meeting the requirements specified herein.

8.4 Moisture Content

Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS : 287-1973.

8.5 Tolerances for Timber

For timber allowance as specified in the IS : 1003 (Part 1&2) 1983 to 1991 shall be applicable.

8.6 Flush Door Shutters, Shelves

Flush door shutters, shall be wooden, solid core or cellular and hollow core type, as may be shown in drawing or described in the Schedule of Items or directed by Engineer. They shall be obtained from an approved source of manufacture, covered on face with commercial ply, wood veneer or other finish as may be necessary. Solid core shutters shall conform to IS : 2202 (Part 1&2)-1983 to 1991 and cellular or hollow core shutters to IS : 2191 (Part 1&2)-1983. The resin used shall be phenol formaldehyde. A full size sample door shall be offered for inspection and approval.

8.7 Wood Particles Boards

Particle boards for general purposes shall be of medium density conforming to IS:3087-1985. These are of four types, Flat pressed single layer board (FPSI),Flat pressed three layer board (FPTH), Extrusion pressed solid board (XPSO) and Extrusion pressed tubular core (XPTU). Adhesive shall be BWR, WWR or un-extended CWR type. High density wood particle board shall conform to IS:3478-1966 and are in flat sheets or moulded forms. These shall be of type 1 (BWR type of resin) or Type 2 (WWR or CWR type of resin). Both types of boards shall be of Grade A (resin content 20 to 50 percent) and Grade : (resin content 8-12 percent).

8.8 Veneered Particle Board

These shall conform to IS : 3097-1980 and shall be of two grades. Exterior (grade-I with BWP or BWR type adhesive) & interior (grade-II with WWR or CWR type adhesive). Each grade of boards shall be of 4 types, solid core general purpose, solid core decorative, Tubular core general purpose and Tubular core decorative and accordingly designated.

8.9 Plywood for General Purpose

Plywood for general purpose shall conform to IS:303-1989. Depending on type of adhesive used for bonding veneers, it is of 4 grades, BWP (boiling water proof), B.W.R (boiling water resistant), WWR (warm water resistant) and CWR (Cold Water resistant). Any species of timber may be used for plywood manufacture. However list of species, for the manufacture of plywood is given in Annexure 'B' of the IS : 303-1989 for guidance.

Plywood is classified in 10 different types as per appearance of the surface. These are type AA,AB,AC,AD,BB, BC,BD,CC,CD and DD as detailed in IS : 303-1984. It is available from 3 ply to 11 ply with thickness from 3mm to 25mm.

8.10 Veneered Decorative Plywood

This quality of plywood shall conform to IS : 1328-1982. These plywood shall be of two types Type 1 and Type 2 as per details given in IS : 1328-1982. Species of timber for decorative face commonly used are given in Table 1 of IS : 1328-1982 but the purchaser shall specify the particular veener to be used. Timber for cores and backs shall be either class I or II as specified in IS : 303-1989. Adhesive used shall be BWR or WWR synthetic resin.

9.0 FITTINGS FOR DOORS, WINDOWS, ETC.

9.1 General

Fittings shall be of iron, brass, aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enameled or copper oxidised or painted as specified. Brass fittings shall be finished bright, oxidised or chromium plated and aluminium fittings shall be finished bright or anodised as specified. Fittings shall be got approved by the Engineer before fixing. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodised cadmium/chromium

plated M.S. screws of approved quality shall be used for fixing aluminium fittings.

9.2 Hinges

9.2.1 Butt hinges

These shall be mild steel but hinge (medium), brass butt hinges, extruded aluminium alloy butt hinges or as specified. Type (light/medium/heavy weight) and size shall be as specified in the drawing or schedule of items. Brass / Aluminium and M.S butt hinges shall conform to Indian Standard Specification for butt hinges IS : 205-1992 and IS : 1341-1992 respectively. Hinges shall be finished bright or satin polished or anodised.

9.3 Sliding Door Bolts

Mild steel sliding door bolts shall conform to IS : 281-1991 and are of 2 types, plate type and clip or bolt type. Plate type bolts shall have plates and straps stove enameled black with hasp and bolt finished bright or copper oxidized or nickel / chromium plated. Clip or bolt type are copper oxidized or plated. All screw holes in the M.S bolts shall be countersunk. Diameter of bolt for plate type is 12mm and for clip type is 16mm.

Non ferrous metal sliding doors are of brass or aluminium alloy and shall conform to IS:2681-1979. Brass sliding bolts are of 150 to 450mm size with bolt dia being 16mm for 150 to 300mm and 18mm for 375 and 450 size. Aluminium alloy sliding bolts are of size 200 to 450mm with 16mm bolt dia. Brass quality is finished satin, polished or plated and aluminium alloy bolts are anodised.

For both ferrous and non-ferrous metal bolts the size of the sliding bolt is determined by the length of the bolt.

9.4 Door Rim Latch

This shall be of mild steel, brass, aluminium alloy or as specified and of sizes 75, 100, 125 and 150mm denoted by overall length of the body measured from outside face of the fore end to the rear end. These are of type 1 and type 2 and shall conform to IS : 1019-1974.

9.5 Tower Bolts

Tower bolts may be of one of the following types and shall conform to IS : 204 (Part 1 and 2)-1991 and 1992.

i) Barrel tower bolts

These shall be of bright finished/stove enamelled/ black painted mild steel tower bolts, brass barrel tower bolts with cast brass barrel and rolled or drawn brass bolt/brass barrel tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt/brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt. Aluminium barrel tower bolts with barrel and bolt of extruded section of aluminium alloy-bolts and barrel anodised.

ii) Semi-barrel tower bolts

These shall be mild steel semi barrel tower bolts full cover/open type with mild steel sheet pressed barrel and cast iron/mild steel bolt. Bolt bright finished other parts stove enameled black.

iii) Rivetted or spot welded tower bolts

These shall be mild steel tower bolts rivetted type with black flat and mild steel/cast iron bolt and open staple.

iv) Skeleton tower bolts

These shall be of bright finished / stove enameled / black painted mild steel or brass bright finished skeleton tower bolts with cast brass/extruded sections plate and staples and rolled or drawn brass bolt or Aluminium skeleton tower bolts with plates staples and bolt or extruded sections of Aluminium alloy plate and staple anodised.

9.6 Door Handles

Door handles shall conform to IS : 208-1987 and shall be of 4 types. Type 1 is cast Iron / Brass / Aluminium or zinc alloy die casting and available in 75,100,125 150mm sizes. Type 2 is mild steel pressed oval in 75, 100,115 and 135mm sizes. Type 3 is mild steel present half oval in 75,90 and 100mm sizes. Type 4 is fabricated (brass / aluminium alloy) in 75,100 and 125mm sizes. The size of the handle shall be determined by inside (grip) size overall size and internal depth of the handles shall be as detailed in IS : 208-1987.

Finish for type 1 shall be satin/nickel plating, copper oxidising and bronze finish for cast-brass and zinc die cast handles and stove enamelled black or copper oxidized for cast iron handles. Aluminium

handles shall be anodized. Type 2 and 3 handles shall be stove enamelled black. For type 4 it shall be satin finish, nickel plating, copper oxidized and bronze finish for brass handles and anodizing for aluminium handles.

9.7 Mortice Lock and Rebated Mortice lock

Mortice lock with latch and pair of lever handles shall have body of steel, Aluminium alloy or brass and shall be right or left handed as shown in the drawing or as directed by the Engineer. It shall be of the best Indian make of approved quality and shall conform to IS: 2209 / 6607-1976/1972. The shape and pattern shall be approved by the Engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face. Lever handles with springs shall be mounted on plates and shall weigh not less than 0.5 kg per pair. These shall be of brass, finished, bright chromium plated or oxidised. The locks shall be of 65, 75 and 100 mm sizes.

9.8 Floor Door Stopper

These are for the use of the door shutters of 30, 35,40 & 45mm thickness. It is made of aluminium alloy/ brass with springs of phosphor bronze or hard drawn steel wire and tongue of aluminium/brass/nylon/ plastic. The floor door stoppers shall conform to IS : 1823-1980 and shall be best Indian make of approved quality. Width of cover plate is 40mm but its overall length is 140mm for 30 and 35mm thick shutters & 150mm for 40 and 45mm shutters. The body shall be cast in one piece and fixed to cover plate by brass or M.S screws. On the extreme end there shall be rubber cushion to absorb shocks. The extension of the door stopper shall be in flush with floor and be finished bright/satin/chromium plated or anodised.

9.9 Hooks and Eyes

These shall be of mild steel or hard drawn brass and shall generally conform to IS : 207-1964.

9.10 Casement Window Handles

These shall be made of cast brass, steel protected against rusting, aluminium, pressed brass or as specified. Casement handles for single leaf window shutter shall be left or right handed and shall weigh as specified.

9.11 Casement Peg Stays

These shall be made of cast brass, steel protected against rusting, aluminium, cast alloy or as specified. The stay shall be made from a channel section and shall be 300mm long with steel peg and locking bracket. The peg stay shall have three holes to open the window in three different angles. The shape and pattern of stays shall be approved by the Engineer. The peg stay shall be minimum 2mm thickness in case of brass and aluminium and 1.25 mm in case of steel.

9.12 Quadrant Stays

These shall be made of cast brass, aluminium alloy, CP iron or as specified. The shape and pattern shall be approved by the Engineer. It shall weigh as specified.

9.13 Fan Light Pivots

These shall be made of mild steel, cast brass or aluminium alloy or as specified and shall generally conform to IS : 1837-1966.

The pattern and the shape of the catch shall be as approved by the Engineer and size and finish shall be as specified.

9.14 Fan light catch

These shall be made of mild steel, cast brass, aluminium alloy or as specified and shall generally conform to IS : 364-1993. Steel springs of the catch shall be 0.90 mm dia, 6 coils, 12 mm internal diameter and 20 mm long. The pattern and the shape of the catch shall be as approved by the Engineer.

9.15 Steel Frames

These shall conform to IS:4351-1976. The frames shall be manufactured from commercial mild steel sheets of 1.25mm thickness and are suitable for door shutters 30 to 40mm thick. The door frames are designated as per profile A, B and C.

Profile A Size 105x60mm : rebated for one set of shutters

Profile B Size 125x60mm : rebated for one set of shutters

Profile C Size 165x60mm : rebated for two sets of shutters.

Miscellaneous Items :

9.16 Putty

The material shall be homogeneous paste and shall be free from dust and other visible impurities. Putty shall conform to IS : 419-1967 for wood work.

10.0 METAL DOORS, WINDOWS, VENTILATORS AND ROLLING SHUTTERS

10.1 General

Materials used in the fabrication of doors, windows, and ventilators shall be the best procurable and conforming to relevant Indian Standards.

10.2 Steel Doors, Windows and Ventilators

Steel sections used for fabrication of doors, windows and ventilators shall be standard rolled steel sections specified in IS : 1038, IS : 1977, IS : 1361 or IS : 7452 year 1983, 1975, 1978 and 1990 respectively as appropriate or as specified in drawing and Schedule of Items. Rivets shall conform to IS : 1148-1982.

10.3 Aluminium Door, Windows and Ventilators

Aluminium sections for fabricating doors, windows, ventilators, partitions etc., shall be extruded sections conforming to IS : 1948-1961 & IS : 1949-1961 or as manufactured by Indian Aluminium Company Limited or approved equivalent The alloy used shall conform to Designation HE 9 - WP of IS : 733-1983.

10.4 Steel Rolling Shutters, Rolling Grills

These shall conform to IS : 6248-1979.

10.5 M.S. Bolts etc.

M.S. bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated for corrosion. Putty for glazing shall conform to IS : 419-1967. Glass panes and glazing shall conform to the specification detailed under this series.

10.6 Hardware and fixtures shall be as specified in the drawings or Schedule of Items. All hardware and fixtures shall be able to withstand repeated use. Door closers shall be suitable for doors weighing 61 80 kg, unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge.

Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements and endurance test stated in IS : 3564 1986 Appendix-A.

10.7 The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall conform to IS : 1081-1960 and/or as approved by the Engineer.

11.0 GLASS

11.1 General

Plain, ground, frosted or rough cast wired glass shall be used as shown on the drawing or as specified in the Schedule of Items. It shall be procured from a reputed source of manufacture and be of the best quality. All glass panes shall be free from flaws, specks, bubbles etc. Glass panes shall be of thickness 3mm or more as required. Weight of 3mm thick glass pane shall not be less than 7.5 Kg//sqm. The tolerance of glass panes, except wired glasses, in length and width shall be plus or minus 2 mm for 3 to 6.3 mm glass sheets. Tolerance in thickness of glass sheets shall be +/- 0.2mm for 3mm and 4mm thick glasses and +/- 0.3mm for 4.8, 5.5 and 6.3mm thick glasses.

11.2 Plain Transparent Glass

Plain transparent glass for glazing and framing shall conform to IS: 2835-1987. It shall be free from flaws, specks, bubbles or distortions.

11.3 Ground and Frosted Glass

Glare reducing or heat absorbing glass shall be "Calorex" or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

11.4 Thickness

Glass shall have the following thickness, unless otherwise stated in the Schedule of Items or drawings

Upto 60 cms x 60 cms	...	3 mm
do- of larger size	...	4 mm and 4.8mm

Sheet glass for doors	...	5.5 mm
Rough cast wired	...	6.4 +/- 0.4 mm

11.5 Inspection

All glasses shall be subject to inspection on the site. Glass found to suffer from defects shall be rejected. Samples submitted for inspection shall be selected so as to be representative of the consignment.

12.0 PAINTS

12.1 General

All paints, varnishes, distemper or other surface coating materials shall be of approved quality conforming to the appropriate Indian Standard, wherever such standard is available, and be obtained from a manufacturer of repute. If there is more than one quality for one particular product, only first quality shall be used unless otherwise stated in the Schedule of Items.

12.2 Sampling and Testing

The Engineer may, at his discretion, require samples of paint to be tested. In such cases testing will be according to IS : 101 (Part 1 to 8) - 1964 to 1993.

12.3 Storage

Paints, primers, distempers and varnishes shall be delivered in sealed containers. They shall be stored in cool dry condition to the satisfaction of the Engineer.

12.4 Paints for Priming

Ready mixed paints for priming coats of steel and iron work shall either comply with IS : 2074-1992 "Ready Mixed Paint", "Red Oxide Zinc Chrome Priming" or Red Oxide metal primer as specified. For wood work it shall be pink/white wood primer as specified by the manufacturer of the synthetic enamel paints, conforming to IS : 3536-1966.

12.5 Paints for finishing

Ready mixed oil synthetic enamel paint of approved manufacturers like Berger, Jenson & Nicholson, Shalimar, I.C.I., Asian, Garware and

Goodlass Nerolac paints only shall be used unless otherwise specified. Paint shall be of first grade quality of the above manufacturers ie., Luxol Brolac, Superlac, Dulox gloss, Apocolite, Garcoat and Nerolac respectively.

If for any other reason, thinning is necessary, the brand of the thinner recommended by the manufacturer, shall only be used with the specific permission of the Engineer.

Aluminium paint for general purpose shall be in Duel Containers. It shall be of manufacturers as for synthetic enamel paints above.

12.6 White wash

White was shall be prepared from freshly burnt fat, white in colour lime slaked on spot, conforming to IS : 712-1984 mixed and stirred with sufficient water to make a thin cream. Best and approved quality gum and ultra marine blue only shall be used in lime wash.

12.7 Colour wash

Colour wash shall be prepared by adding mineral colours, not affected by lime, to white wash.

12.8 Water proofing Cement Paint

Cement paints shall comply with IS: 5410-1992 and shall be of approved brand and manufacture like Snowcem India Ltd., Berger, Jenson & Nicholson & Shalimar paints. The shade shall be approved by the Engineer before its application.

12.9 Distemper

Dry/synthetic washable distemper of approved brand and manufacture like Berger, Jenson & Nicholson, Asian, Shalimar, Garware & Goodlass Nerolac shall be used. The shade shall be approved by the Engineer before application of the distemper. and shall comply with IS : 427-1965 and IS : 428-1969.

12.10 Varnish

Varnish for the finishing coat shall be copal finish or synthetic class varnish of approved brand. Varnish for the under coat shall be flatting varnish of the same make as the top coats and shall be to the satisfaction of the Engineer.

12.11 Polish

French spirit polish shall be of an approved make conforming to IS: 348-1968. In case it is to be prepared on site, the polish shall be made by dissolving 0.7 kg of best, shellac in 4.5 litres of methylated spirit without heating. To obtain required shade pigment may be added and mixed. Shallac shall conform to IS : 5467-1986.

12.11.1 Wax polish for Wood work

The polish shall consist mainly of waxes and Organic solvents with or without water and shall be of smooth consistency, homogeneous, Semi-Solid mass and free from gritty materials. It shall not flow at ordinary temperature. It may be tinted with an oil soluble colour. The polish shall not crumble or dry too rapidly and shall produce non-tacky polished surface. The polish shall be amenable to smooth spreading on the furniture surface and the gloss shall appear on gentle rubbing with a soft polishing cloth.

The wax polish shall conform to IS : 8542-1977.

12.11.2 Where wax polishing is to be prepared at site, it shall be prepared by heating two parts of "Bee Wax" two parts of boiled linseed oil over a slow fire. When dissolved but still warm, one part of turpentine is to be added. The boiled linseed oil, bees wax and turpentine used shall be of approved quality and complying with IS : 77-1976, IS : 1504-1974 and IS : 533-1973 respectively.

12.12 Plastic (Acrylic) emulsion paint

Plastic emulsion paint of approved manufacturers like Jenson & Nicholson, Goodlass Nerolac, Shalimar, Berger, Asian and Garware paints only shall be used unless otherwise specified and shall comply with IS : 5411 (Part 1)-1974 & (Part 2)-1972 as applicable. Cement primer used for priming work both for oil bound distemper and plastic emulsion paint shall be of the same manufacture as that of distemper or plastic emulsion paint used. For dry distemper priming, whiting of approved quality shall be used.

12.13 Creosote oil or Coaltar Creosote

It is primarily used for preservation of wood. It shall be a homogeneous liquid and shall liquify completely on being warmed to 38 degree C with stirring and shall remain liquid on cooling down to 32 degree C and on standing at that temperature for 2 hours.

The material shall conform to IS : 218-1983. All persons handling the creosote oil should be fully aware of the hazards involved in handling . Skin should be protected from coming in direct contact and eyes

should be protected by using safety goggles while handling the material.

12.14 Coaltar Black Paint

Coaltar paint film protects surfaces by serving as a barrier against the action of moisture and other corrosive agents. Coaltar black paint is generally used as a protective and anti corrosive paint of iron and steel as well as protection of other building surfaces. For this it has to be applied under proper condition and on suitably prepared surface. Coaltar should be applied by brush only and is not recommended for locations which are not likely to be well ventilated. Coaltar paint shall conform to IS : 290 1961.

The material is of two types : Type A Quickly drying and Type B Slow drying. It shall be a homogenous black solution type paint consisting of a base prepared by blinding suitable grades of Coltar pitch, washed free from ammoniacal liquor, tar acid bases etc. Consistency, permeability, thickness and surface preparation etc. shall be as per para 5 and A-2 of the above code.

12.15 Floor Polish - Paste

The polish shall consist mainly of waxes and organic solvents with or without water.

The paste floor polish shall be of smooth consistency, homogenous, semi-solid-mass and free from gritty material. It shall not flow at ordinary temperature. It shall be so constituted and prepared that on application by means of a clean cloth, it shall spread easily and evenly and shall give with minimum buffing a firm and glossy surface free from greasiness or tackiness. The polish film after spreadng with a cloth shall not take more than 10 minutes to dry. The polished floor shall neither be slippery nor show any resistance to easy walking.

Floor polish paste shall conform to IS : 8591-1977.

13.0 WATER PROOFING MATERIALS

13.1 Integral Cement Waterproofing Compounds

Integral cement waterproofing compounds, i.e. admixture for waterproofing purposes shall fully comply with the requirements of IS : 2645-1975. Properties like permeability, setting time, compressive strength shall be in accordance with the requirements of this code when tested as per procedure laid therein. Calcium chloride content of the product used shall be made known to Engineer before use.

13.2 Bitumen

The bitumen bonding material for waterproofing shall conform to the requirements laid down in IS : 702-1988 or IS : 93-1992 or IS : 217-1988 or IS : 454-1961 depending upon whether industrial bitumen, paving bitumen or cutback bitumen is used. For selecting the particular type and grade of bitumen to be used the relevant item in Schedule of Items shall be referred to.

13.3 Bitumen Primer

Bitumen primer used for application to concrete and masonry surfaces and bitumen for the purpose of waterproofing shall conform to requirements given in IS : 3384-1986 and pass tests in accordance with the procedure laid down in appropriate IS mentioned in Table-I of IS : 3384-1986. Bitumen primer should be free from water and shall preferably ;be made from the same grade of bitumen as used in bonding.

13.4 Bitumen Felt

Bitumen felts used for water proofing purposes shall be as specified in IS: 1322-1982. Physical properties shall conform to the requirements and tests shall be carried out as per procedure laid down in IS :1322-1982. Base, (whether fibre or Hessian), type and grade of felt shall be as mentioned in the relevant items under Schedule of Items. Unless otherwise stated, hessian base felt Type-3, Grade-2 shall be used.

13.5 Bitumen Mastic

Bitumen mastic used for water proofing of roofs shall have the physical properties as mentioned in IS : 3037-1986 when tested with the procedure laid down in appropriate IS mentioned in IS : 3037-1986.

13.6 Bituminous Compounds

Bituminous compounds when used for waterproofing of porous masonry, concrete floors, walls and roofs shall conform to the requirements of IS : 1580-1991. Physical properties shall be governed by the requirements of this code when tested in accordance with the procedure laid therein.

13.7 Surface Application Materials

Waterproofing material for application on mortar or concrete surface shall conform to IS: 9862 1981. The primer shall be suitable for spray or brush application. It shall have properties enabling it to penetrate

through pores or cracks and fill them up, making the surface impervious.

13.8 Polymer based paints

The materials used shall be high polymer based chloride and sulphide free cement and waterproofing additions and epoxy based waterproofing paints as per manufacturer's specification and approved by Engineer.

13.9 Fibre glass R. P. Tissue

The fibre glass R.P. tissue is a thin flexible uniform mat, composed of glass fibre in an open porous structure bonded with a suitable inert material compatible with coal tar, asphaltic enamel and oil plastic based wall paint. The fibrous glass mat is reinforced with continuous filament glass yard at 3/8" (10mm) pitch in the longitudinal direction.

PHYSICAL PROPERTIES

i)	Weight	The average weight of fibre glass R.P. tissue shall not be less than 50 gms/sq.sm.
ii)	Thickness	The fibre glass R.P. tissue shall have a thickness not less than 0.4mm.
iii)	Tear Strength	The tear strength shall be not less than 900 grams in the transverse direction.
iv)	Breaking Strength	This shall have a minimum breaking strength of 13 lb/in (2.32kg/cm) in the longitudinal direction.
v)	Porosity	This shall have a porosity when related to pressure difference across the sample of not less than 0.022" (0.56mm) and not more than 0.76" (1.92mm) of water guage at an air velocity of 200fpm.(100cm/sec.).
vi)	Pliability	There shall be no cracking of the tissue mat when bent over a 1/8" (3.2mm) radius after immersing for 10-15min. through a 90 degree arc.
vii)	Temperature	The fibre glass tissue shall be Resistance under a load of hot bitumen at 530 degree F (276 degree C) for one

minute.

13.9.1 Primer

Primer shall conform to requirements laid down in IS : 3384-1986. It is to be prepared by blending turpentine and blown grade bitumen in the ratio of 60:40 by weight.

13.9.2 Blown Materials

Blown grade bitumen shall be conforming to IS : 702-1988 and residual grade bitumen conforming to IS:73 respectively. This shall be prepared by heating to correct working temperature.

13.9.3 Surface finish

Pea sized gravel/grit 6mm and down.

13.10 P.V.C. Membrane/Sheets

Polyvinyl chloride sheets for the purpose of water proofing and other underground use are specially developed sheets made from the compounded resin of grade MP/DP/CR-02 and shall be resistant to the passage of gross water and water vapour. It shall be corrosion resistant and resistant to a wide range of acidic and alkali reagents, saltpetre action, salt water and ultra violet rays etc. PVC sheets manufactured by approved and reputed firms like Maxlok Polymer Ltd. shall only be used

The sheets shall consist of Knobs or Lugs jutting out of the sheets in a grid fashion so as to provide a perfect grip in the mortar and concrete. Sheet thickness, spacing of the knobs and their projection from the sheet shall be as specified in the item. The sheets shall be of maximum practicable length and width unless otherwise specified.

The adhesive used for jointing shall be of approved quality and of grade C-02.

The sample of the material shall be got approved before use.

13.10.1 Properties

i)	Chemical Composition	:	Resin Plasticiser Inhibitor Stabiliser UV Barrier.
ii)	Thickness	:	Not less than 0.25 mm
iii)	Rupture/Tensile Strength	:	Not less than 225Kg/cm2
iv)	Adhesive bond Strength [width]	:	: Not less than 7.1 Kg/cm

v) Elongation at Break : 130%

14.0 WATER BAR

14.1 General

Water bar for use in construction/expansion joints in concrete and reinforced concrete structures shall be of copper sheet, galvanised steel sheet, rubber or PVC as shown in drawing or described in the Schedule of Items. It shall be subject to approval of Engineer.

14.2 Jointing

The water bar shall have dimensions as shown in drawing. Where water bars are required to be lengthened or otherwise jointed the joining shall be done in such a way as to achieve a perfectly watertight joint.

15.0 LEAD

15.1 General

Lead for joints in cast iron spigot and socket pipes shall be melted from pure soft pig lead conforming to Type-I of IS : 782-1978. "Caulking Lead". Where lead wool is allowed for caulking, it shall be equal to or better than Type-II of IS : 782-1978. Lead flashing shall conform to IS : 405 Part I&II-1992.

16.0 BUILDING PAPER

16.1 Building paper shall be bitumen impregnated paper conforming to IS: 5134 1977, or such other as may be approved by the Engineer.

17.0 FILLING MATERIAL

17.1 General

Filling material shall conform to what is shown in drawing, described in the Schedule of Items or otherwise directed by the Engineer. Earth or sand for filling under floors shall correspond to those described elsewhere in these specifications.

17.2 Mastic Bitumen

Mastic Bitumen shall conform to IS : 3037-1986 or IS : 5871-1987 as appropriate.

17.3 Flexible Boards

Flexible boards for use in expansion joints shall correspond to the description given in drawing or the Schedule of Items or the instruction of Engineer.

18.0 DRAINAGE & SANITATION (INTERNAL)

18.1 General

All materials, pipes, specials, fittings, fixtures etc., to be used in the works shall be of best quality and class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from manufacturer or their accredited stockists and be marked with manufacturers' names and trade mark. Contractor shall submit to the Engineer samples of all materials, pipes, specials, fittings fixtures for approval before use in the works. Such approved samples shall be retained by the Engineer till completion of works. Pipes and Specials may be any or combination of following types:-

i) PVC Pipes

ii) Stone Ware Pipes

iii) Sand Cast Iron Pipes for soil waste & Ventilation

iv) CI Pipes for rain water

v) AC Pipes for rain water

vi) R.C.C Pipes

18.1.1 High density PVC pipes and fittings

This shall conform to IS : 4984-1987 and IS : 8008 (Part 1 to 7)-1976 unless otherwise specified.

18.2 PVC Waste Pipe

This shall conform to IS : 4985-1988 unless otherwise specified.

18.3 Stoneware Pipes & Fittings

All stoneware pipes, bends, gully traps and sewer traps shall be of the best salt glazed variety inside and outside, hard burnt dark grey colour, perfectly sound, free from fire cracks and imperfection of glaze, truly circular in cross section, perfectly straight, of standard nominal length

and depth of socket and barrel. These shall be of approved manufacture and shall comply with the requirement of IS: 651-1992. These pipes shall be of grade AA unless otherwise specified.

18.4 Sand Cast Iron Pipes & Fittings conforming to IS : 1729-1979

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS: 1729-1979. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior of the pipe and fittings shall be clean, smooth painted inside and outside with DR Angas smiths solution or other approved anti-corrosive paint.

The standard weights and thickness of pipe shall comply with the requirements of IS: 1729-1979. The tolerance on wall thickness and weight shall be minus 15 percent and minus 10 percent respectively. Pipes weighing more than the nominal weight given below may be accepted provided they comply in every other respect.

Nominal size	Weight per piece in Kg. excluding ears Overall length		
	1500 mm	1800 mm	2000 mm
50	9.56	11.41	12.65
75	13.83	16.52	18.37
100	18.14	21.67	24.15
150	26.70	31.92	35.66

Specials and Fittings shall include bends, offsets, branches of various types, junctions etc., as required for the work which shall be provided according to drawings and directions of the Engineer. B.M. trap shall have water seal as per I.S. provisions.

The specials and fittings shall be provided with access doors where so specified or directed by the Engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3 mm thick rubber insertion packing, and when closed and bolted they shall be water tight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

18.5 Cast Iron Pipes & A.C. pipes : Rainwater pipe

18.5.1 Pipes shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric and shall conform to IS : 1230-1979. These shall be sound and uniform casting, free from laps, pin holes or other imperfections and

shall be neatly finished inside and outside. The ends of pipes shall be reasonably square to their axis.

18.5.2 Dimensions

CI rain water pipes shall be of the dia specified in the description of the item and shall be in full lengths of 1.8 metres including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall in each case be with sockets. The pipes shall be supplied without ears unless otherwise specifically mentioned.

The pipes supplied shall be factory painted with a tar based composition both inside and outside which shall be smooth and tenacious unless specified otherwise.

Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw.

Where the pipes are to be embedded in masonry they shall be of Class of pipes as are used for soil and vent pipes. For the weights of different sizes of these pipes, the specifications under SCI and vent pipes may be referred to.

18.5.3 A.C. pipes and fittings the pipes and fittings shall be of approved manufacture and shall conform to IS:1626. These shall be homogeneous and free from cracks and other defects. The pipes shall be straight, smooth and regular in thickness.

The diameter of the pipe shall be as specified. The fittings like heads, bends of different degrees, offsets of different projections, shoes and junctions shall be of the type, diameter and size as required for the work. The pipes shall be used in full lengths as far as possible.

18.6 Sanitary appliances

Sanitary appliances like I.W.C/E.W.C pans, wash basin, urinals and sinks etc. shall be made of vitreous china or fire clay as specified. These shall be of Hindustan Sanitary ware or Parry ware make unless otherwise specified and to be approved by the Engineer. These shall conform to A class quality of IS : 2566 (Part 1 to 15)-1972 to 1985 and IS : 771 (Part 1 to 15) –1979 & 1985 respectively.

18.6.1 European Pattern W.C.

Unless otherwise specified, these shall comprise of :

a) White 'glazed earthenware wash down closet set with 'S' or 'P' trap of standard size.

b) 'Duco' spray painted 12.5 litres mosquito proof low level M.S or C.I flushing cistern with valveless siphon, 15 mm ball cock, C.P. brass unions & couplings for the 32 mm dia flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.

c) 'Duco' spray painted 1 1/4" (32 mm) dia G.I. telescopic flush pipe with buffer clamp, holder bat clamp and 38mm dia PVC pipe or 35/40mm O.D. high density polythene flush pipe with buffer clamp, holder bat clamp.

d) Approved quality solid plastic W.C. seat and cover, bar hinges, screws bolt, rubber buffers conforming to IS : 2548 (Part 1&2)-1983.

e) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass CP cock.

f) Hard wood wooden blocks or other suitable fixing arrangement with screws and detofix for fixing WC in floor and putty joint with flush pipe and soil pipe.

18.6.2 Indian Pattern W.C.

Unless otherwise specified these shall comprise of :-

a) White glazed earthenware WC pan back entry type.

b) White glazed earthenware 'P' or 'S' trap with or without vent.

c) 12.5 litres approved make mosquito proof M.S.high level flushing cistern with valveless siphon, 15 mm ball cock, galvanised iron chain handle, cast iron brackets with wall plugs, brass unions and couplings for flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

d) 32 mm dia GI telescopic or 35/40 mm O.D high density PVC flush pipe with holder bat clamps.

e) One pair of white glazed earthen ware foot rest set in cement mortar 1:3.

f) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass stop cock.

18.7 Wash Hand basin

Unless otherwise specified these shall comprise of :-

a) White glazed earthenware basin with 2 nos. Concealed Cast Iron Brackets with wall plugs.

b) 1 no. 15 mm C.P. brass pillar tap.

c) 32 mm C.P. brass waste fitting, C.P. brass chain and rubber plug.

d) 32 mm PVC waste pipe with brass couplings/32 mm C.P. bottle trap.

e) 15 mm PVC connection pipe with brass couplings and 15 mm brass stop cock.

18.8 Flat Back Lipped Urinal

Unless otherwise specified these shall comprise of:-

a) White glazed earthenware urinal basin back type.

b) CI/M.S mosquito proof high level automatic flushing cistern of capacity as specified in the Schedule of Quantities with all accessories, cast iron brackets with wall plugs, brass unions and coupling for flush pipe, 20 mm dia overflow pipe with mosquito proof cover.

c) 25 mm dia CP brass flush pipe and spreaders with wall clips and brackets.

d) 15 mm PVC connection pipe with brass couplings joint at both ends and 15 mm brass stop cock.

e) 32 mm C.P. brass outlets complete with PVC waste.

18.9 Mirror Frames

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make.

18.9.1 Mirror shall be of superior glass with edges rounded off or leveled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.0 mm. The glass for the mirror shall be uniformly silver plated at the back and shall be free from silvering

defects. Silvering shall have a protective uniform covering of red lead paint.

18.10 Toilet Shelf

18.10.1 Glass shelf unit shall consist of an assembly of glass shelf, anodised aluminium / CP brass guard rail and supporting brackets. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws, specks, bubbles and of thickness not less than 5.0 mm. The shelf shall have guard rail, resting on rubber washers on glass plate.

18.10.2 Ceramics shelf shall be of shape, size and design as specified in the Schedule of Items.

18.11 Towel Rail

Towel rail shall be of CP brass / anodised aluminium with two brackets of same material, diameter and length as specified.

18.12 Soap Container

Soap container shall be of C.P brass, PVC with cp brass brackets of approved make and design.

18.13 CP Flush Valves for EWC

The CP flush valve for EWC shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asia Continental Metallwaren Fabric or equivalent quality.

18.14 CP Flush Valve for Urinals

CP flush valve for urinal shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asian Continental Metallwaren Fabric or of equivalent quality.

18.15 Gully Trap

Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight pre-cast R.C. cover 300 x 300 x 40 mm thick with 1:1 1/2:3 mix concrete (one cement: one and half sand : 3 stone chips 20 mm down) including neat cement finish.

18.16 CI Manhole Covers & Frames

These shall be of light or medium duty (LD or MD) as specified in

Schedule of Items and of cast iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material,. Light duty covers and frames shall be of either rectangular type, single seal, pattern 1 and 2 having minimum weight of cover and frame 38 Kg and 25 Kg. respectively or with double seal, minimum weight of cover and frame being 52 Kg. These may be of square type also. Single seal with clear openings of 455 and 610 mm with minimum weight of cover and frame being 20 Kg and 38 Kg respectively, double seal of same openings shall have minimum Wt. of cover and frame 30 Kg and 55 Kg respectively. Medium duty covers and frames shall be either of circular type with 500 and 560 mm clear openings and minimum Wt. of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum Wt. of cover and frame 144 Kg.

The C.I. manhole covers and frames shall conform to IS : 1726-1991.

18.17 Flushing Cisterns

Manually operated high level and low level flushing cisterns are of 5 litre and 10 litre capacities, both single flush and dual flush type. The cisterns shall conform to IS : 774-1984 and be made of Cast Iron, Vitreous China or enamelled pressed steel. The cisterns shall be mosquito-proof.

The thickness of the body including cover shall be not less than 5 mm for Cast Iron and 6 mm for Vitreous China Cisterns. Steel and lead flush pipe shall have internal diameter of 32 plus or minus 1 mm for high level cisterns and 38 plus or minus 1mm for low level cisterns. For high density polyethlyne and unplasticised PVC pipes the outside diameter of the pipe shall be 40 mm. In case of PVC plumbing pipes the outside diameter of the pipes shall be 40mm for high level and 50mm for low level cisterns. Steel flush pipes shall be hot dip galvanized electroplated or vitreous enameled.

The flush pipe shall be securely connected to the cistern outlet and made airtight by means of a coupling net. Float valve shall conform to IS : 1703-1977 or IS : 12234-1988. Polyethylene float valve shall conform to IS : 9762-1981.

Cast Iron Cisterns shall be painted and finished in accordance with recommendation made in IS : 1477 (Part 1&2)-1971 or shall have a coating of enamel.

In general, Materials Construction and operational and performance requirements shall be as specified in para 3, 4 and 6 of IS : 774-1984.

18.18 Plastic Seats & Covers for Water Closets

These shall conform to IS : 2548 (Part 1&2)-1983 and shall be either of thermo-set or of thermo-plastic quality.

Thermo-set Seats and Covers are moulded from phenolic plastics (Type A) or Urea Formaldehyde (Type B). Thermo-plastic Seats and Covers are also of Type A, moulded from Polystyrene or Type B, moulded from Polyprophlene.

Underside of the seats may be either flat or recessed and colour shall be as agreed. Table Dimesions of the seats and covers shall be as per Table-I of the Code (both Part 1&2). Hinging device may be either of the following materials :

i) Bronze or Brass with Nickel Chromium Plating

ii) Mild Steel with Nickel Chromium Plating

iii) Aluminium alloy with anodic coating

iv) Suitable plastic with reinforcement.

19.0 WATER SUPPLY & PLUMBING (INTERNAL)

19.1 General

This section deals with the specification of material for pipes, fittings, fixtures etc., to be used in water supply works.

All materials, pipes, fittings, fixtures to be used in the works shall be of the best quality and of the class specified in various clauses herein under. Where specified these shall be of specific manufacture and quality and shall be procured from the manufacturer or their accredited stockist and be marked with manufacturers name and trade marks. The Contractor shall submit to the Engineer samples of all pipes, fittings, fixtures for approval before being used in the works. Such approved samples shall be retained by the Engineer till completion of works.

Pipes and pipe fittings may be of any or combination of following types:

i) Wrought iron galvanised pipe

ii) PVC pipes

iii) Cast iron pipes

iv) Steel pipes coated with bitumen composition inside and galvanised outside.

v) Reinforced concrete pipes

vi) Asbestos cement pipes

vii) Pre-stressed concrete pipes

viii) Lead pipe (not to be used for potable water)

19.2 Galvanised Iron Pipes and Fittings

Generally pipes for installations in buildings shall be medium quality malleable steel galvanised pipe 'B' class for cold water supply and 'C' class for hot water supply, having threaded ends with socket at one end.

The details of standard medium quality "B" class pipes and sockets regarding nominal bore thickness and weight in kg/m are given below:-

Pipe Dia (Nominal Bore)	Dimension of Pipe		Thick -- ness	Dimension of ordinary socket		Wt. of Pipe plain end
	Max. (outside dia)	Min.		Outside dia (approx.)	Min. length	
mm	mm	mm	mm	mm	mm	Kg/m
15	21.8	21.0	2.65	26.90	34	1.21
20	27.3	26.5	2.65	33.70	36	1.57
25	34.2	33.5	3.25	42.00	43	2.42
32	42.9	42.0	3.25	51.00	48	3.11
40	48.8	47.9	3.25	57.00	48	3.59
50	60.8	59.7	3.65	70.00	56	5.07
65	76.6	75.3	3.65	88.00	65	6.49
80	89.5	88.0	4.05	101.60	71	8.43

Note :- Manufacturing tolerances shall be permitted on tubes and sockets in addition to above as per IS : 1239 (Part 1&2) 1990 to 1992.

The galvanised iron pipes shall be of approved make and conform to IS:1239 (Part 1&2) 1990 to 1992 and of tested quality. The GI pipes shall be of threaded ends with a socket at one end only. The fittings for GI pipes shall be either galvanised wrought iron or galvanised malleable iron.

19.3 R.C.C, Asbestos, Prestressed Pipes and Fittings

These shall be of approved manufacture and quality and shall conform to IS : 458 1988, IS : 1592 1989, IS : 9627 1988 & IS : 784 1978 respectively.

19.4 Cast Iron Pipes and Fittings

The cast iron pipes shall be of approved manufacture and quality and shall conform to IS: 1536 1989 "Centrifugally Cast (Spun) iron pressure pipe and/or IS : 1537 1976". Vertically Cast Iron pressure pipe for water, gas and sewage. CI fittings shall conform to IS : 1538 (Part 1 to 23) 1976.

19.5 Steel Pipes

This shall conform to IS: 1239 (Part 1&2) 1990 to 1992) and IS : 3589-1991. Steel pipes shall be coated with bituminous composition inside and galvanised outside.

19.6 Bib Tap and Stop Tap

Bib tap and stop tap for water services shall be of brass screw down type and shall conform to IS: 781. Minimum finished weight of bib and stop taps shall be as given below:

No. of size (mm)	Bib taps (kg)	Stop tap (kg)
10	0.30	0.35
15	0.40	0.40
20	0.75	0.75
25	1.25	1.30
32	-	1.80
40	-	2.25
50	-	3.85

The taps shall be tested under internal hydraulic pressure of at least 20 kgf/cm2 and maintained at the pressure for a period of at least two minutes during which period it shall neither leak nor sweat.

19.7 Valves

Unless otherwise mentioned in the Schedule of Quantities these shall be copper alloy gate, globe and check valve of nominal sizes 8 to 100mm and shall conform to IS : 778 1984. Valves shall be of class 1 and class 2, suitable upto a temp. of 45 degree C and can sustain non

shock working pressure upto 1.0 and 1.6 MPA respectively. They shall have screwed or flanged ends. All the metal parts shall be of brass/brass alloy except hand wheel of Cast Iron or other approved quality.

19.8 Shower Rose

The shower rose shall be of heavy quality chromium plated brass with flat bottom, of diameter 100 mm or as specified with uniform perforations.

19.9 Storage Tank

Storage tank shall be either pressed steel, Galvanised iron, R.C.C or PVC of specified sizes, capacities, make, manufacture as specified in Schedule of Items. It shall have facilities for connecting inlet, outlet overflow and washout pipes and a top cover. Where tanks are to be fabricated by the Contractor the fabrication/R.C.C detailed drawings shall be got approved by Engineer.

19.10 Miscellaneous items

19.10.1 Half round channel

This shall be made of vitreous china channel with or without outlet/stop end as specified in Schedule of Items and shall be of approved manufacture.

19.10.2 Urinal partition

This shall be made of vitreous china or R.C.C. with mosaic finish or marble as specified and shall be of approved make and quality.

20.0 EXTERNAL SEWERAGE & DRAINAGE

Unless otherwise specified CI pipe and specials, caulking lead, SW pipe, RCC pipe shall conform to the following.

20.1 C.I. Pipes

i) C.I. pipe shall conform to IS : 1536 - 1989 or/and IS : 1537 – 1976 of class as specified in Schedule of Items.

ii) C.I. pipe fittings shall conform to IS : 1538 (Part 1 to 23) -1976 as specified in Schedule of Items.

iii) Bolts and nuts shall be hexagonal bolts and nuts conforming to IS : 1363 (Part 1 to 3) - 1992.

20.2 Washers

Spring washers conforming to IS : 3063 - 1972 shall be used near the pumps to take care of vibration. In other places plain washers conforming to IS : 2016 - 1967 shall be used.

20.3 Gaskets

Gaskets shall be reinforced rubber sheet or compressed fibre board conforming to IS : 638 - 1979 of thickness between 1.5mm to 3mm or as specified.

20.4 Caulking Lead

Lead for the spigot and socket joints shall conform to IS : 782 - 1978.

20.5 Salt Glazed Stone Ware Pipes

Salt glazed stone-ware pipes used shall conform to IS : 651 - 1992 and shall be laid as per IS : 4127 - 1983. The pipes shall be of grade AA unless otherwise specified.

20.6 Steel Pipes

Steel pipes and fittings used for encasing shall conform to IS : 1239 (Part 1&2) - 1990 to 1992 medium Class upto 150 mm dia and as per IS : 3589 - 1991 for pipes of dia 200 mm and above. For pies of dia 200 mm and above fittings, if required shall be fabricated from pipes itself.

20.7 Cast Iron Manhole Covers & Frames

These shall be of medium or heavy duty (M.D. or H.D.) as specified in Schedule of Item and of Cast Iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material. Medium duty covers and frames shall be either of circular type with 500 mm clear opening and minimum weight of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum weight of cover and frame 144 Kg.
Heavy duty covers and frames shall be either of circular type with clear openings of 500 and 560 mm and 170 and 208 Kg weight respectively or of double triangular type with clear openings of 500 and 560 mm and 229 and 255 Kg weight respectively.

The CI manhole cover and frames shall conform to IS : 1726 - 1991.

21.0 ROAD

21.1 General

Roads shall be understood to include road bed, the wearing surface, berms, foot-paths, kerbs, culverts and bridges.

21.2 Soling Stones

Material for soling shall be natural stone boulders or crushed blast furnace slab. Stones for soling shall be of height equal to thickness of the soling with tolerance of plus or minus 25mm and shall not have a base area of less than 250 sq.cm. nor more than 500 sq.cm. and the smallest dimension of any stone shall not be less than half the largest dimension. Stones shall be tough, angular, durable and generally free from flat, elongated, soft and disintegrated particles. They shall also be free from dirt or other objectionable matter and be obtained from quarries approved by the Engineer.

Crushed slag obtained from air-cooled blast furnaces slag shall be angular, of reasonably uniform quality and density and generally be free from any thin, elongated, and soft pieces, dirt or other objection able matter. The density of slag should not be less than 1.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS:2386 (Part-III) - 1963. "Methods of Tests for Aggregates for Concrete : Specific Gravity, Density Voids, Absorption and Bulking", shall not exceed 10%.

21.3 Coarse Aggregate for Water Bound Macadam

Coarse aggregate for water bound macadam shall be natural gravel, crushed stone obtained from approved quarries or crushed blast furnace slag. Crushed stone shall be hard, durable, tough and of uniform quality, generally free from flat, elongated, soft and disintegrated particles. It shall have sharp edges and also not have excess of dirt and other objectionable matter. When tested as per IS: 2386 (Part-IV) - 1963 for Los Angeles Abrasion Value or Aggregate Impact Value, the limiting values shall be 50% and 40% respectively for base course and 40% and 30% respectively for surfacing course. The flakiness index shall not exceed 15% when tested in accordance with IS: 2386 (Part-I)-1963 "Methods of Test for Aggregates for Concrete : Particle size and Shape". Crushed slag aggregates shall meet the requirements given for soling stones from blast furnace slag.

Size and grading requirements of coarse aggregates shall be as specified in Table-2 of IRC : 19 - 1981, "Standard Specification and Code of Practice for Water Bound Macadam". The grading number of the table shall correspond to the following layer thicknesses :

Grading Number	Size Range	Layer Thickness
1	90 mm to 40 mm	More than 90 mm
2.	63 mm to 40 mm	90 mm to 75 mm
3.	50 mm to 20 mm	75 mm to 50 mm

21.4 Screenings

Screenings used for filling voids in coarse aggregates for water bound macadam shall generally be of the same material as the coarse aggregate. Non-plastic materials such as Kankar nodules, moorum or gravel (other than river bore rounded aggregates) may be used, provided that the liquid limit and plasticity index are below 20 and 6 respectively. The fraction passing 75 microns sieve shall not exceed 10%. Size and grading of screenings shall be as specified in Table-3 of IRC-19 - 1981. Type-A screening shall be used for grade number 1 coarse aggregate. Type-B screenings shall be used for grade number 3. Either Type-A or Type-B screenings may be used for grade number 2.

21.5 Stone Chips for Bituminous Surfacing

Coarse aggregate shall consist of crushed stone, crushed slag or crushed gravel (Shingle) retained on 2.36 mm sieve. The aggregates shall be clean, strong, durable and fairly cubical, free from disintegrated pieces, organic and other objectionable matter. The aggregates shall preferably by hydrophobic and of low porosity. The mechanical properties and grading shall be in accordance with IRC-29 - 1988 "Tentative Specifications for 4 cm Asphaltic Concrete Surface Course", having aggregate impact value 30%, Flakiness Index 25% and graded between 20mm and 2.36 mm.

21.6 Sand

Sand for use as fine aggregate in bituminous surfacing shall consist of crushed screenings, natural sand or a mixture of both, passing a 2.36mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, uncoated and dry, free from injurious, soft or flaky pieces and organic deleterious substances.

21.7 Binder

Binding material for water bound macadam shall consist of fine grained material such as stone dust, kankar modules or moorum. The plasticity index shall be between 4 to 9 when water bound macadam is to be used as surface course and upto 6 when used as sub/base or base course.

21.7.1 Paving Bitumen

It shall conform to IS : 73 - 1992 and shall be of the specified type and grade. The material shall be homogeneous and shall not foam when heated to 175 degree C. Various properties like specific gravity, flash point, softening point, penetration etc. shall be as given in the above code.

21.7.2 Bitumen Cut Back

Bitumen cut-back shall conform to specification given in IS : 217 - 1988. It shall be of three types, Rapid Curing (RC), Medium Curing (MC) and Slow Curing (SC). These shall comply with the requirements specified in Table - 1, 2 and 3 respectively of the above code.

The above three types of cutback bitumens shall be classified into different grades on the basis of Kinematic viscosity. Rapid curing type shall be used with aggregates containing practically no fine aggregates passing through 2.36 mm sieve. Medium curing bitumen shall be used with aggregates containing less than 20 per cent of fine aggregates passing through 2.36 mm sieve. Slow curing type shall be used with aggregates containing more than 20 per cent of fine aggregate passing through 2.36 mm sieve.

Medium curing bitumen of 30 grae i.e. MC 30 shall be used as primer. Manufacturer shall indicate source and type of the bitumen.

21.8 Kerbs

Kerbs may be of stone, concrete or brick as may be shown in drawing or otherwise directed by Engineer.

21.8.1 Stone kerbs

Stones shall conform to the dimensions and shapes given in drawing.

Exposed faces shall be dressed to lines.

21.8.2 Concrete kerbs

Shape and dimension shall conform to the drawing. They shall be pre-cast and the road side top corner shall be given a chamfer.

21.9 Galvanized Steel Barbed Wire for Fencing

These shall be of two types A&B. In both types Barbs shall have 4 points formed by twisting two point wires, each two turns. In type A (Iowa type) twisting is done around both line wings and in type B (Glidden type)

around one line wire, in both cases making altogether four complete turns. It shall conform to IS : 278 - 1978 and shall have the diameter of line and point wire as described in schedule of item. Galvanized mild steel wire shall conform to IS : 280 - 1978.

Line and point wire shall be circular in section, free from scales and shall be uniformly galvanized. Line wire shall be in continuous length and shall not contain any welds other than those in rod before it is drawn.

21.10 Galvanized Steel Chain Link Fabric

It will conform to IS : 2721 - 1979. It shall be of width, mesh and wire dia as per description of Item. For chain link fabric having width upto 2.00 M, of all mesh sizes, two line wires shall be provided. Whereas for width of 2.40 M and mesh size exceeding 50mm three line wires shall be provided. These shall be provided at top and bottom of the fabric, but wherever three line wires have been specified, these shall be provided at top, bottom and middle of fabric.

The mesh wire and line wire of the fabric shall be manufactured from Galvanised steel conforming to IS : 280 - 1978. It will have zinc coating of type medium as given in IS : 4826 - 1979. " Specification for Hot dipped galvanized coatings on round steel wires". Unless otherwise mentioned in the description of item fabric with both ends twisted shall be used.

The galvanised steel pipe posts shall consists of 80 mm and 50 mm nominal diameter. The pipe posts shall conform to IS : 1161 and shall be of medium grade and galvanised.

22.0 LIST OF MATERIALS OF APPROVED BRAND AND/OR MANUFACTURE

Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials as listed below, of only these brand names/Company's names, which are mentioned in the approved list for civil, water supply and sanitary items thereon.

A. <u>BUILDING MATERIALS</u>

1.	TILES (Terrazzo Mosaic Plain)	Mehtab Tiles, "NITCO"Indore, Shriram Tiles. Ahmednagar & any other approved brand conforming to IS : 1237 -1980

2.	FLUSH DOORS	Vidarbha Veneer Industries, Woodcrafts, Western India, Plywood, Kit Ply, Godavari Plywood, Art Plywood, National Plywood Industries Pvt. Ltd.
3.	PLYWOOD PRODUCTS PARTICLE BOARDS	IPM, Novopan
4.	STEEL DOORS, WINDOWS AND VENTILATORS	San-Harvice Godrej-Boyce, Mann, Hopes, Multiwyn, Chamundeshwari, Doorwyn, Agew Steel.
5.	ROLLING SHUTTERS AND ROLLING GRILLS	Standard, Swastik, Diana, Hercules, Prabhat, Vinayagar
6.	ALUMINIUM DOORS, WINDOWS, PARTITIONS	Godrej, Ajit India Alumilite, Aardee, Indal
7.	WATER PROOFING COMPOUNDS	CICO, Impermo, Accoproof
8.	HARDENERS	Ironite, Ferrok, Hardonate
9.	PAINTS AND DISTEMPERS	Jenson & Nicholson, Asian Paints, Shalimar, ICI, Goodlass Nerolac, Garware, Berger
10.	REDOXIDE (For IPS Flooring)	Shalimar, Blundel, Eomite
11.	WATER PROOF CEMENT PAINTS	Super Snowcen, Berger, Jenson & Nicholson and Shalimar.
12.	PRESSED STEEL DOOR AND WINDOW FRAME	Shirke Polynorm, T.I. Frames, Madras; Mann, Jaipur; Chandan Metal Products, Baroda; Agew, Ahmedabad; Multiwyn, Calcutta.
13.	DOOR CLOSERS	Everite, Gloster Engineering, Amar, A.K. Industries, Hardiwyn, Vigvijay, Dewan Industries.
14.	ASBESTOS SHEETS	Everest Building Products Bombay/Calcutta; Hyderabad Industries Ltd., Hyderabad; Southern Asbestos Cement

			Limited, Karnataka.
	15.	CONSTRUCTION CHEMICALS	Choksey, CICO

B. **SANITARY AND WATER SUPPLY WORK (INTERNAL) (FIRST QUALITY TO BE USED)**

1.	Cast Iron Pipes and Fittings	Hindustan Engineering Products Company Calcutta, E.L.C., Standard approved manufacturers of any other brand of fittings having ISI marking.
2.	RCC Pipes	Indian Hume Pipe Company, Delhi / Allahabad / Chandigarh / Lucknow; Hindustan Pressure Pipes, Kolhapur; Dhere Concrete Products, Pune or any other approved manufacturer conforming B.I.S. Standard
3.	GI Pipe	Indian Tube Company, Calcutta; Kalinga Tubes Limited, Cuttack; Gujarat Steel Tube; Zenith Tube Co. Kolaba; Bharat Steel Tube, New Delhi; Jindal; Shivmoni Steel Tubes Limited, Bangalore; Sekhar Iron Works, Calcutta; Jain Tubes, Ghaziabad; Khandelwal Tubes, Nagpur.
4.	G.I. Fittings	International Pipe Works, Calcutta; R.M. Engineering Works, Jalandhar; Bombay Metal Company, Bombay; Tarapada Das & Sons, Howrah; Annapurna Metal Works, Calcutta.
5.	Gun Metal Valves and Copper Alloy Valve	Leader Engineering Works, Jalandhar; Neta Engineering Works, Jalandhar; Lakshmi Metel Works, Jalandhar; Bombay Metal & Alloys, Bombay; Luster Sanitary Fittings, Jalandhar; Annapurna Metal Works, Calcutta.
6.	Sluice Valves, Check Valves etc.	Shiva Durga Iron Works, Howrah; Leader Engineering Works, Jalandhar; Kirloskar Bros. Limited,

		Pune; Indian Valve, Calcutta; Geeta Iron & Brass Works, Baroada.
7.	Brass Fittings	Leader Engineering Works, Jalandhar; L & K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial Corporation, Bombay.
8.	C.P. Fittings	Ego Metal Works, Ballabhgarh; Jaquar Industries, Delhi; Soma Plumbing Fixtures Limited, Calcutta; Gem Sanitary Appliances Pvt. Ltd.,Delhi; Essco Sanitations, Delhi; Bilmet, Bombay.
9.	W.C. Pan Wash Basin, Urinals, Sink Low down Flushing Cistern	E.I.D. Parrys, Madras, Hindustan Sanitaryware, Calcutta; Neiveli Ceramics, Tamil Nadu; Cera Ceramics.
10.	E.W.C. Seats	Nuchem Plastics Limited, Faridabad; Commander, Bombay; Bestolite Jasco Sales, Bombay; Agarwala Products, Bombay.
11.	Flushing Cistern	Arail Brothers, Delhi; Allied Industries, Jaipur; Fordham Pressing (India) Pvt. Limited, Bombay; Klassik Enamellers, Bombay; Sushila Industries, Sundergarh; Small Machine Tools Company, Howrah; Thakurdass Surekha Engg. Corporation Pvt. Ltd., Calcutta; E.I.D. Parry (India) Pvt. Ltd., Madras; Hindustan Sanitaryware & Industries Ltd., New Delhi; Neiveli Ceramics and Refractories Limited, Tamil Nadu.
12.	Hydrants	Brady's, Bombay; Firex, Bombay; Upadhya Valves, Calcutta; Eddy Foundry, Calcutta, Minimax.
13.	Mirrors	Atul Glass Works, Vallabh Glass Works, Goldenfish
14.	White Glazed Tiles	H & R Johnson TilesCompany,

		Bombay; Somani Pilkingtons Co., Haryana
15.	Asbestos Cement Pipes and Fittings	Ganga Asbestos Limited, U.P.; Hyderabad Asbestos Cement Products Limited; J.K. Super Pipe Industries, Nanded; Konark Cement and Asbestos Limited, Orissa; Maharashtra Asbestos Limited, Bombay; Poddar Industrial Corporation, Patna; Sarbamangala Mfg. Company, Calcutta
16.	Stone Ware (Salt-Glazed) Pipes	Hind Ceramics Limited, Orissa; Ceramic Industries Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati Moulds Limited, Nagpur; Kiran Potteries, Hyderabad; Perfect Sanitary Pipes, Bharatpur.

23.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.

SPECIFICATION FOR CIVIL WORKS

PART – II WORKMANSHIP

C O N T E N T S

1.0 GENERAL

1.1 Standard

A high standard of workmanship in all trades will be required. The Contractor shall ensure that only skilled and experienced workmen are employed.

1.2 Supervision

The Contractor's supervising staff shall be fully qualified and experienced in the types of work being carried out under their supervision and shall be capable of ensuring that work is executed efficiently and as per specification.

1.3 Temporary works

Where required, the Contractor shall furnish such details of his temporary works as may be called for by the Engineer and the Contractor shall satisfy the Engineer as to their safety and efficiency. The Engineer may direct that temporary works, which he considers unsafe or insufficient, shall be removed and replaced in a satisfactory manner.

1.4.0 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

In case of any conflict in meaning between these specifications and those of BIS or IRC, or British/International Standards, the provisions of these specifications shall prevail.

1.5 Base lines and bench marks

The Contractor shall establish and maintain, to the satisfaction of Engineer, the base lines and bench marks, based on which the works are set out. Where such base lines and bench marks are provided by the Engineer, the Contractor shall maintain these throughout the period of construction without causing any disturbance to them.

1.6 Setting out

The Contractor shall set out all the works to be executed by him, in line with the standard base lines, levels, position and bench marks and truly as per drawings within the accepted tolerance limits at no extra cost to Owner. The Contractor shall be solely responsible for the setting out of all the works, to be executed by him and the approval of such setting out by the Engineer shall in no way absolve the Contractor his responsibility for carrying the work to the true lines, levels and positions as per drawings.

1.7 Dewatering

The Contractor shall carry out all the works, in dry and workable condition and maintain the same in dry condition till the final handing over of works at no extra cost to the Owner. For this the Contractor shall make all the necessary provisions of dewatering, wherever necessary, to the entire satisfaction of the Engineer.

1.8 Safety of existing work

Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work at no extra cost to the owner.

1.9 Protection of existing services

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or overground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material at no extra cost to the owner.

1.10 Handing over of work site

On completion of work, the Contractor shall remove all rubbish, debris, surplus materials, temporary work etc., from the site. The site shall be handed over in a tidy and workmanlike manner at no extra cost to the owner.

2.0 EARTH WORK

2.1 Scope

This chapter deals with earth work and excavation for civil works in site, formation/oversite leveling, foundations, cutting and grading for roads/pavement and railways, canals, embankments other than water

retaining embankments trenching for drainage and other burried services and the like.

2.2 General

The Contractor shall carry out the excavation strictly to the lines and levels, in conformity with the drawings or instructions of the Engineer.

2.3 Setting out

Before commencement of earthwork block levels of existing ground shall be taken by the Contractor jointly with the Engineer, plotted and signed in token of acceptance of ground levels. Excavation shall not be commenced until the initial ground levels have been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails, marking boundaries or centre lines, as the case may be, and the same maintained for reference and future checking. Chainaie stones at regular intervals shall be set up for embankments. All setting out operations shall be got checked and approved by Engineer. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing, and in case any error is noticed at any stage in the contractor's work, it shall be corrected/rectified by him without any cost to the Owner.

2.4 Site clearance and demolition

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material, if any, shall be the property of the owner and shall be stacked properly as directed by the Engineer. The areas to be covered with embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. Payment for cutting and removal of trees, stumps, dismantling existing structures and stripping shall be regulated by the description in the Schedule of Items or Part V of these specifications.

2.5 Classification of soil

The Engineer will decide the class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor :

A) Ordinary Soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

B) Hard Soil

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.,

C) Soft /Decomposed Rock

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates etc .and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation. The fact that contractor resorts to blasting for his own reasons shall not mean that the rock is hard and classified as hard rock.

D) Hard Rock

This comprises of rocks which require blasting for excavation. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any other agreed methods.

2.6 Method of excavation

The Contractor may carry out excavations, filling and compaction by any method considered most suitable, and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come, during the construction. No

foundation work shall be taken up until the surfaces are properly drained.

2.7 Excavation of soils other than hard rock

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc., Such approval shall not make the Engineer responsible for any consequent damage or loss caused. All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his own cost in a manner approved by the Engineer. All excavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in stable condition by adequate stepping and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer, shall be provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to be exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected at no extra cost.

Excavation shall be carried out in any material encountered including road surfaces, pavements, burried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 metres of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations.

In firm soil the sides of the trenches shall be kept vertical upto a depth of 2.0m from the bottom and for a greater depth, trench shall be widened by allowing steps of 50cm on either side after every 2.0m depth from the bottom, so as to give a vertical side slope of 1/4 : 1. Where the soil is soft, loose or slushy, the width of the steps shall be suitably increased or sides suitably sloped or suitable shoring and strutting provided as directed by the Engineer. For trenches deeper than 2.0m, the Contractor shall obtain detailed instruction from the Engineer in writing regarding the stepping, sloping of sides or shoring and strutting to be done. For these bye-works, no extra cost will be paid to the Contractor.

2.8 Excavation in hard rock

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary licence for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc., shall be such that they will neither open seams nor damage or shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-5 grade or (1:5:10) cement concrete in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required, is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods. All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

2.9 Cutting and filling for site leveling

Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimised. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and deslushed before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made

for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials encountered to enable laying of service lines or drainage channels or any other desired purpose. Excavation shall be done to lines and levels shown in drawings and shall be done providing adequate measures for stability. Vertical wooden sleepers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Centre lines shall be marked on horizontal sleepers or rails, laid across the trenches. Depths of excavation and pipe invert levels shall be checked by means of boning rods of appropriate lengths. Trench beds shall be trimmed and rammed with sprinkling of sand or moorum to required gradients for continuously supporting the pipelines. Trenches shall be locally deepened and widened to receive sockets and permit joints to be inspected.

Timbering

In case of trenches, tunnels, channels, drains, manholes, chambers, basement and other places where the soil is not capable of being retained without the support, timbering as directed by the Engineer shall be resorted to. It shall be the responsibility of the Contractor to take all the necessary steps to prevent the sides from collapsing.

2.11 Excavations for foundations

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be transported, spread and levelled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorised by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc., These shall be removed only when work in the pit is completed, with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-5 grade, or (1:5:10) cement concrete if so ordered by the Engineer at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further

excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-5 grade/(1:5:10) cement concrete or sand as directed. If the bottom of excavation has been left exposed not through neglect or fault of the Contractor and it has become deleteriously affected by atmospheric action and water, such portion of deteriorated foundation material shall be removed and made good by lean concrete of grade M-5/(1:5:10) cement concrete or sand as directed and such extras will be paid for.

2.11.1 For deep excavation in the proximity of existing buildings, foundations, streets, railway tracks, underground cabling, gas piping, water and drainage lines, and the like, adequate appropriate precautions shall be taken to protect such structures or works from damage, displacement or settlement, either as an immediate result of the excavation or as after effect, discernible with the passage of time. The method of protection of existing structures and services may include sheet piling, shoring, strutting slinging or any other method including dewatering. Payment for such protective work shall be governed by the description given in the Schedule of Items for the particular work.

2.11.2 For excavation adjoining existing piles care shall be taken to ensure that no pile under any circumstances is exposed from the top for a height exceeding 2 metres. No strutting shall be done against exposed piles, nor exposed piles ever used for tying guy ropes or supports either temporarily or permanently.

2.12 Excess excavation

All excavation done beyond the specified limits or directions of Engineer shall be considered as excess excavation. They shall be made good as prescribed below by the Contractor at his cost:

i) Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.

ii) Excess excavation in case of trenches shall be made good by filling and compacting with selected earth to the same compaction as the surrounding material or as directed by Engineer. This shall be done in layers not exceeding 150 mm thick, moistened and thoroughly compacted by tamping.

iii) Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-5 grade/(1:5:10) cement concrete.

2.13 Disposal of excavated materials

Excavated materials that are unsuitable for use in construction works or in excess of construction requirements shall be disposed off in dumping yards or in locations indicated by Engineer. Waste piles/heaps shall be located in such places where they will not interfere with natural flow of rain water access or transport or with the access to nearby structures. When required, they shall be levelled and trimmed to such lines and levels as indicated by Engineer.

2.14 Back filling of trenches

Trenches shall be backfilled after pipes or service lines are tested and approved. Filling shall be done with earth in 150 mm thick layers free from unwanted material and well rammed. Soft material shall be used in bottom of trenches upto a level of 150 mm above the top of pipes before backfilling with other fill materials. All clods and lumps shall be broken before placement. Care shall be taken not to disturb, break or damage the pipes during backfilling and compaction process.

2.15 Backfilling of foundations

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations. all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Hydro-insulation, Bitumen painting or application of anti-corrosive protective and anti-termite treatments shall have been completed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layers shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to lines and levels indicated in the drawings and/or as directed by the Engineer. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.16 Filling under floors

Material for filling under floors shall be soil free from harmful minerals, vegetable matter etc., and shall not be expansive soils. Filling shall be done in well compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area to be covered by flooring shall be finally dressed and trimmed to required

levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.17 Load bearing fills

Load bearing fills include embankments for roads and railways and such other earth fills above ground levels provided for protection of fuel oil tanks, pads for storage tanks, drain, bunds and the like. Fill materials shall either be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soils selected for filling in embankments shall be of uniform quality and free from boulders, organic materials and other objectionable matter. Soils having high silt and clay content and having laboratory maximum dry density less than 1.44 gms per c.c. shall not be used for load bearing fills. For fills greater than 3 m in height soils shall have laboratory density not less than 1.52 gms per c.c. Soils for top 500 mm of fills for roads and railways shall have laboratory density not less than 1.65 gms per c.c. and shall not have marked swelling and shrinkage properties.

Foundation preparation for embankments shall be done as prescribed under site clearance. The founding strata shall be compacted as much as possible by rolling or tamping before placement of fill material. The water content of founding strata should be same as that specified for embankment fill. Any pockets of loose material or depressions left in founding strata as a result of clearing operation shall be filled and compacted with the same material as the surrounding founding strata. When an embankment is to be placed on steep sloping ground the surface of the ground shall be trenched in steps or trenched or broken up in such a manner that the new materials bonds well with the founding strata.

Fill material shall not be placed until foundation has been inspected and approved by Engineer. Material shall be placed in even, continuous, horizontal layers over full width of embankment in well compacted layers not exceeding 200 mm thickness. Each layer shall be compacted by means of smooth rubber tyred rollers, sheep-foot rollers, tractors, tampers or other mechanical means as may be found suitable for the location. Before rolling, the water content shall be checked and corrected by sprinkling with water or adding dry material or aeration as may be required. This shall be followed by mixing and the layer left for soaking before compaction. The water content shall be within plus or minus 2% of Standard Proctor Optimum. Density of compacted layers shall be determined by sand replacement method. Average compacted density shall be at least 95% of Standard Proctor Density. The number of tests to be conducted for determination of moisture content and density shall be as prescribed by the Engineer. Side slopes of embankments shall be formed along with the main

embankment. No side dumping shall be done for the formation of slopes. When required the width of each layer shall be constructed slightly in excess of required width and slopes trimmed to remove loose edge materials and completed to lines shown in drawings or as directed by the Engineer. Subgrades for road works shall be thoroughly wetted sufficiently in advance of placing of any base course and it shall be ensured that it is firm and moist for at least 50 mm below the surface. Should the subgrade for any reason be loose or have density less than required, it shall be recompacted and refinished. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or scaling. No traffic or hauling equipment shall be permitted to ply on finished subgrade and any damage caused to such portion shall be made good by the Contractor at his own cost.

2.18 Turfing

The slopes of embankment shall be dressed to line and slightly roughened to bond and hold a surface dressing consisting of 150 mm humus layer of soil. The entire surface shall then be covered with turf consisting of blocks or strips of grass of approved species. The sod shall include a net of roots and earth at least 75 mm thick. The sod shall be laid on slope in close contact and then tamped in place so as to close and fill the joints between blocks.

Immediately after placing the turf, slope shall be thoroughly wetted and kept wet for a sufficient period to assure plant growth. Watering shall be continued until the grass takes root firmly and the whole area presents a uniform appearance. In the event that the plant growth has not taken place within the period of maintenance such areas or patches shall be redone by the Contractor at his own cost.

3.0 ANTI-TERMITE TREATMENT

3.1 Scope

The scope of work includes setting up a chemical barrier against attack by subterranean termites while the building is under construction.

3.2 Execution

3.2.1 General

Unless otherwise specified all work shall in general be executed as specified in IS : 6313 Part-II -1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.2.2 Chemicals and rate of application

Chemical like chlorpyriphos 20% EC (Conforming to IS 8963 - 1978) in 1% emulsion shall be applied by pressure pumps, uniformly over the area treated. (1 part chemicals + 20 parts water = 1% emulsion).

3.2.2.1 Treatment of pits, trenches & basement excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300mm) for column pits, walls, trenches and basements shall be treated with emulsion @ 5 liters per sq.m. of surface area. Backfills around columns, walls, etc., shall be treated @ 7.5 liters per sq.m. of the vertical surface. Treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centers closed to the wall surface and spraying the emulsion in the specified dose.

3.2.2.2 Treatment of top surface of plinth filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crow-bars on the surface of compacted plinth fill. Emulsion at the rate of 5 litres per sq.m of surface shall be applied prior to laying soling or subgrade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

3.2.2.3 Treatment of doors, windows & soil surrounding pipes, Wastes and conduits.

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

All the wooden door/window frames on the ground floor of the buildings shall be treated with the insecticidal solution.

3.2.2.4 Treatment of expansion joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

3.3 Acceptance Criteria

The Contractor shall give a 10 year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the Owner.

4.0 CONCRETE PLAIN & REINFORCED

4.1 Scope

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives :

(a) The provision, at all locations on the site, of dense workable concrete, having the specified characteristic strength.

(b) The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the internal and external dimensions of structures as per drawings and maintaining the size, shape number and locations of reinforcements, inserts etc., as specified in the drawings providing the surface finish after stripping off the formwork to ensure the structural configurations as per drawings as well within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.

4.1.1 The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456-1978 "Code of Practice for Plain and Reinforced Concrete".

4.2 Materials

For materials, reference to Part - I (Materials) shall be made.

4.3 Grades of Concrete

The grades of concrete unless otherwise specified shall be in accordance with the following table. The grade of concrete to be used

in each section of work will be shown in the drawings or in the schedule of items :

Grade off Concrete	Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm^2)	Nominal Maximum Aggregate Size (mm)
M-5A	5	63
M-5B	5	40
M-7.5A	7.5	63
M-7.5B	7.5	40
M-10A	10	63
M-10B	10	40
M-10C	10	20
M-10D	10	12
M-15A	15	63
M-15B	15	40
M-15C	15	20
M-15D	15	12
M-20A	20	63
M-20B	20	40
M-20C	20	20
M-20D	20	12
M-25C	25	20
M-25D	25	12
M-30C	30	20
M-30D	30	12

Grade off Concrete	Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm^2)	Nominal Maximum Aggregate Size (mm)
M-35C	35	20
M-35D	35	12
M-40C	40	20
M-40D	40	12

Notes : A,B,C,D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 63mm, 40mm, 20mm & 12mm respectively.

Unless otherwise specified in the drawings or schedule of items the maximum nominal size of coarse aggregates for different grades of concrete shall be as under :

a)	For concreting in very narrow space or in very small thickness	12 mm
b)	For all reinforced concrete work except in massive foundations	20 mm
c)	For all ordinary plain concrete & massive reinforced foundations	40 mm & 63 mm

4.4 Mix Design

4.4.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to such proportions before he starts concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.

No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written authorisation for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is being carried out according to the approved proportions.

4.4.2 For the all major and important R.C. works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to I.S. 10262-1982 or any other approved standard methods.

4.4.3 The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

4.4.4 The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, the minimum cement content & maximum cement content of concrete shall be in accordance with Clause No. 8.2.4.1 & Clause No. 8.2.4.2 of I S 456 -2000 respectively.

4.5 Water/Cement Ratio

4.5.1 Where a particular water/cement ratio is stipulated in the design or drawing along with the characteristic grade of concrete the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water/cement ratio.

4.5.2 In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements, underground premises, tunnels, pump houses, exposed structures near sea side or deserts, prestressed structure, thin precast members etc. the water cement ratio shall be kept low and preferably not exceeding 0.45.

4.5.3 The water cement ratio, as achieved in the Mix Design, or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

4.6 Workability

4.6.1 The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & placing so that after compaction if becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

4.6.2 The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. During the finalisation of Trial Mixes, the relationship between compacting factor and slump test shall be established for each grade of concrete as well as for various levels of workability. The workability tests shall be carried out in accordance with IS:1199-1959.

4.6.3 Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content, in consistent with added water.

4.6.4 In cases where the cement content is to be limited to reduce the heat of hydration, and the water/cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

4.6.5 The usual limits of consistency for various types of structures are given below :

Limits of consistency

Degree of Workability	Slump in mm with Standard - Cone		Use for which concrete is suitable as per IS : 1199
	Minimum	Maximum	
Very low	0.0	25.0	Large mass concrete structure with heavy compaction equipment, roads and the like.
Low	25.0	50.0	Uncongested wide and shallow R.C.C structures
Medium	25.0	75.0	Deep but wide R.C.C structures with congestion of reinforcement and inserts
High	75.0	125.0	Very narrow and deep R.C.C structures with congestion due to reinforcement and inserts

Note : Not withstanding any thing mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer. With the

permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

4.7 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and Appendix A of IS: 456-1978 shall be taken as guideline for durability considerations.

4.8 Trial Mixes

4.8.1 After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.

4.8.2 Before starting the trial mixes, necessary preparatory works like sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents in the aggregates, shall be completed according to the I.S. Codes 383-1970 and 2386-1963.

4.8.3 Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

4.8.4 The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

4.8.5 Six numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality control at site. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.

4.8.6 Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and

subsequent testing of the test cubes obtained therefrom the design of the Approved Mix for that particular grade of concrete.

4.8.7 The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

4.9 Nominal Mix Concrete

4.9.1 Nominal mix concrete may be used for all concrete of Grade M-10 and below. If design mix concrete cannot be used for any reason for Grade M-15 & M-20, nominal mix concrete may be used with the permission of Engineer, Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20.

4.9.2 The proportioning of materials for nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I.S. 456-1978. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456-1978 shall also be taken into consideration.

4.10 Volumetric Mix Concrete

Where concrete is specified in volumetric proportions such as 1:4:8, 1:3:6, 1:2:4, 1:1 1/2:3, 1:1:2 etc., in the schedule of items, coarse and fine aggregates shall be measured by volume and cement by weight. The water cement ratio shall be within 0.45 to 0.70 depending upon the workability.

4.11 Batching of Concrete

4.11.1 Cement

Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly

4.11.2 Aggregates

4.11.3 For both Design Mix concrete and Nominal Mix concrete, the aggregates (coarse and fine) shall be batched by weight.

4.11.4 In particular cases, or where weigh-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates through out the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the

weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be made for bulking in accordance with I.S. 2386 (Part-III)-1963.

4.11.5 Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.

4.12 Water

4.12.1 Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank fitted to the mixer.

4.12.2 Adjustment of water due to moisture contents in coarse and fine aggregates

It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

4.12.3 Determination of moisture content in the aggregates

Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III)-1963. Where tests are not conducted, the amount of surface water may be estimated from the following table :

Aggregates	**Surface water carried by Aggregates**	
	% by weight	**Lit / m^3**
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel & stone chips**	1.25 - 2.5	20-40

** - Coarser the aggregate, less the water it will carry.

4.12.4 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi-liquid admixture may be measured by weight or volume.

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

Cement within plus or minus	2%	by weight.
Aggregate within plus or minus	5%	by weight.
Water within plus or minus	0.5%	by weight.

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for at least one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time from the time of adding water shall be in accordance with IS: 1791-1985 but in no case less than 2 minutes or at least 40 revolutions.

4.13.1.2 Hand mixing

When hand mixing is permitted by the Engineer it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing 10% extra cement shall be added to each batch at no extra cost to the Owner.

4.13.2 Transportation of concrete

4.13.2.1 Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by such means which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

4.13.2.2 Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily identifiable at the place of final deposit.

4.13.3 Actions before placement of concrete

4.13.3.1 Programme of works

At the beginning of every fortnight, the contractor shall give his detailed concreting programme for that fortnight to the Engineer. Such programmes, shall specify all information such as the locations where concrete is to be poured, type/grade of concrete, volume of concrete to be poured, number and Type of vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc.

4.13.3.2 Checking & approval

Before placement of concrete, the contractor shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer. To facilitate such checking, the contractor shall complete all his works according to the drawings and specifications well in advance before placement of concrete at least 36 hours for all major/important/complicated works and 24 hours for all minor/ordinary/simple works. The checks are purely in the interest of the work and to draw the contractor's attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the contractor from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

4.14 Preparatory Works/Surface Preparation

4.14.1 For concrete directly on earth foundation

4.14.1.1 Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without any extra cost to the Owner. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

4.14.1.2 The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any extra cost to the Owner.

4.14.2 For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and water-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted. For vertical construction joints a neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of freshly mixed mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix and applied immediately before placing of the concrete. On this surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.

4.14.3 (a) On vertical surfaces of masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of dimension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be cleaned thoroughly. Before the placement of concrete, the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

b) Over walls

Building paper over average 12mm thick cement sand bearing plaster of 1:4 mix with neat cement finish shall be provided at the bearings of slabs over walls as directed by the Engineer.

4.14.4 Inside the formwork (cleaning, surface preparation etc.,)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from all sort of dirts, grease/oil,

foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirts, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated with form oil or raw linseed oil material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be taken so that such oily material do not come in contact with the reinforcement.

4.15 Placing and Compaction of Concrete

4.15.1 The concrete shall be placed and compacted before setting commences & should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be over vibrated or under vibrated.No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. all inserts and embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.

4.15.2 Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

4.15.3 Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete.

4.15.4 Where plums are permitted in massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

4.15.5 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer.

4.15.6 The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

4.15.7 For members involving vertical placing of concrete (eg. columns, walls etc.,), each lift shall be deposited in horizontal layer extending the full width between shutterings and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction.

4.15.8 For member involving horizontal placing of concrete (e.g. slabs, beams etc.,) the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible.

4.15.9 Utmost care shall be taken to avoid the displacement of reinforcements/embedded parts or movement of formwork or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.

4.15.10 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable.

4.15.11 Should any unforeseen occurrence results in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor at his own cost.

4.15.12 The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedments, holes, openings etc., well within the accepted tolerance limit.

4.16 Construction Joint & Cold Joints

4.16.1 Construction joints

4.16.1.1 Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings.

4.16.1.2 Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guide lines :

(a) In Columns

(i) In case of Projection from basement slab, 300 mm from the top of base slab or 75 mm from the top of the haunches whichever is higher.

(ii) In framing of beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the top surface of the beam/slab or at the top surface of beam/Slab whichever facilitates formwork.

(iii) For columns under flat slabs 75 mm below the lowest soffit of the slab.

(b) In walls (horizontal construction joints)

(i)	Walls projecting from base slab	:	300 mm from top of base slab
(ii)	Walls supporting the suspended slab	:	75 mm from the lowest soffit of the slab

.

Note :

In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water-tight.

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint for simply supported beam shall be vertical and at the middle of the span ; in continuous beam, the same shall be at the point of minimum shear force.

(d) In suspended slabs

(i) In slab of small span, there shall be no construction joints.

(ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the right angles to the principal reinforcement.

(e) In walls (Vertical construction joint)

As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.

(f) In slabs resting on ground

(i) For Plain concrete

Concreting shall be done in alternate panels not exceeding 10 sq.m in area. The largest panel dimension shall be 5 m.

(ii) For nominally reinforced slab

The area of pour shall not exceed 40 sq.m and the maximum panel dimension shall not exceed 8m.

(i) For the basement slabs which act as structural member

There shall be no construction joint.

(g) In ribbed beam

The beams shall be cast monolithically with the slab in one continuous operation.

4.16.1.3 In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

4.16.1.4 The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures / embedments. All construction joints shall be made to form a tongue and groove joint.

4.16.2 Cold joint

An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold

joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it :

(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete along with the old concrete shall be vibrated systematically and thoroughly.

(b) In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on the cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep in to the layer of concrete.

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these specifications.

4.17 Requirements for Concreting in Special Cases

4.17.1 Concreting in deep lifts

Placing of concrete in lifts exceeding 2 M in columns and walls is in the category of deep lifts.

4.17.1.1 Before commencement of work, the contractor shall submit for the approval of the Engineer, the details of the methods he proposes to adopt for concreting.

4.17.1.2 The placement of concrete shall preferably be by tremie, chute or any other approved method.

4.17.1.3 In structures of heavy/complicated reinforcement or in complicated form works, the contractor shall provide sufficient number of windows in the form works as directed by the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

4.17.2 Concreting under water

When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with Clause 13.2 of IS: 456-1978.

4.17.3 Cold weather concreting

When conditions are such that the ambient temperature may be expected to be 4.5 C degree or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II)-1981.

4.17.4 Hot weather concreting

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I)-1975 and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree 'C'.

Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

4.18 Finishes to Exposed Surfaces of Concrete

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in both formed & unformed surfaces as and where required by the Engineer without any extra cost to the owner. Some common finishes are indicated below:

4.18.1 Surface which do not require plastering

Surface in contact with casings shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centerings, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if, in the opinion of the Engineer, such plastering is unavoidable then the thickness of plaster shall in no case exceeds 5 mm and the plastering shall be in cement and sand mortar.(1:3).

4.18.2 Exposed surfaces which need plastering

Surfaces of beams/columns flushing with the block work or other structures where intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.3 Surface for non-integral finish

Where a non-integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels and finished rough.

4.18.4 For monolithic finish

Where no more finishing course is to be applied as in the case of basement floor, industrial flooring or the screed concrete flooring etc, the concrete shall be completed and struck off at the specified levels and sloped with a screed, board and then floated with a wooden float. Steel troweling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface but not hard enough to prevent proper finishing. Troweling shall be such that the surface is flat, smooth and neatly finished.

4.19 Curing of Concrete

4.19.1 General

The purpose of curing is to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the contractor.

4.19.2 Different methods of curing

Any one of the following methods may be used for curing as approved by the Engineer.

(a) Curing by direct water.

(b) Curing by covering the concrete with absorbent material and kept damp.

4.19.3 Curing by direct water

This is done either by ponding or spraying water.

(a) Ponding

Ponding is widely used for curing slab and pavements. Earth bunds are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

(b) By spraying water

Curing is done by spraying water by suitable means at approved time intervals. While spraying, it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternate wetting and over drying shall be avoided.

Curing by spraying water shall be continued at least for 18 days after final setting.

4.19.4 Curing of concrete with absorbent material kept damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for at least 12 days after final setting.

4.20 Testing of Concrete

4.20.1 General

The Contractor shall carry out, entirely at his own cost, all sampling and testing in accordance with the relevant I.S. standards and as supplemented herein. The Contractor shall get all tests done in approved Laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

4.20.2 Consistency test (tests of fresh concrete)

4.20.2.1 At the place of deposition/pouring of the concrete, to control the consistency, slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with I.S. 1199-1959 as directed by the Engineer.

4.20.2.2 The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor

and the Engineer. That register shall be considered as the property of the Owner and shall be kept by the Contractor at site in safe custody.

4.20.2.3 The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 12% with the results in the respective design mix, in case of mix design concrete and with the values indicated in the table under clause 6.1 of IS: 456 in case of nominal mix concrete.

4.20.2.4 For any particular batch of concrete, if the results do not conform to the requirements as specified in 4.20.2.3 or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the Owner.

4.20.3 Strength test of concrete

4.20.3.1 While placing concrete, the Contractor shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be either according to clause 14.2 of IS: 456-1978 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516-1959. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

4.20.3.3 A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner.

(a) Reference to the specific structural member

(b) Mark on cubes

(c) The grade of concrete

(d) The mix of concrete

(e) Date and time of casting

(f) Crushing strength at 7 days

(g) Crushing strength at 28 days

(h) Any other information directed by the Engineer.

4.20.4 Acceptance criteria for test cubes

The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under clause 15 of IS: 456-1978.

4.20.5 Non-destructive tests on hardened concrete

4.20.5.1 If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under clause 15 of IS: 456-1978, non-destructive tests on hardened concrete like core test and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his own cost.

4.20.5.2 The core tests and load tests shall comply with the requirements of clause 16.3 and 16.5 of IS: 456-1978 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456-1978 shall be applicable.

4.20.6 Concrete below specified strength

In case of failure of test cubes to meet the specified requirements the Engineer may take one of the following actions:-

1) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at Contractor's expense.

2) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense and the resultant structures affected due to such rejection shall be made good at contractor's expense.

3) Modification/remedial measures if approved by the engineer to be carried out at contractor's expense.

4) Accept the work with reduction in the rate in appropriate item subject to the provisions of clause 15 of IS 456-1978 provided it is technically acceptable. The reduction in the rate shall be as given below :-

   i) When test strength of the sample is above 90% of the characteristic strength, payment shall be made 10% less than the contract rate.

   ii) When test strength of the sample is between 80-90% of the characteristic strength, payment shall be made 25% below than the contract rate.

4.20.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS: 456-1978 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant form work, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

4.21 Steel Reinforcement

4.21.1 Material

Material shall be as specified in the respective schedule of Items. The specifications of materials shall be as per Part-I.

4.21.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost of the owner.

4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502-1963 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456 -1978 "Code of Practice for Plain and Reinforced Concrete".

4.21.4 Welding of Reinforcement

Welding of mild steel reinforcement bars conforming to IS:432 (Part-I)-1982 shall be done in accordance with IS: 2751 -1979 "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be at least 3 mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more.

Welding of cold worked high strength deformed bars conforming to IS: 1786-1985 shall be done using electric arc welding process using low

hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxy-acetylene welding shall not be used.

Butt welding of bars upto 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars upto 32 mm diameter for horizontal splices shall be done either by single Vee-groove weld or double Vee-groove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxy-acetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0,65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is at least 1.62 times the area of bar being spliced.

More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located at least at a distance of 50 times the diameter of bar from bends.

Tests

Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751-1979. The number of tests will be as laid down in IS: 2751-1979 or such larger number as the Engineer may decide having regard to the circumstances.

4.21.5 Cleaning

All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.

4.21.7 Clear cover

Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456-1978.

4.21.8 Light structural work and embedded metallic parts, conduits

4.21.8.1 Fabrication of metallic parts & light structural works

Fabrication of all structural steel work shall be done in accordance with IS: 800 -1984 "Code of Practice for use of Structural Steel in General Building Construction". Workmanship shall match to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly inter-changeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimise site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened of flattened by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 -1969 "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814-1991 "Specification for covered electrodes for metal arc welding of mild steel shall be used.

4.21.8.2 Transportation and Storages

All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

4.21.8.3 Erection of light structural work

Erection of light structural work shall be carried out in accordance with the provisions of IS: 800-1984. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

4.21.8.4.1 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications.

Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged with suitable stoppers to prevent the ingress of water, grout, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, Unshapely profiles or other similar inserts are required to be placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary.

All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

4.21.8.4.2 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer free of cost to the Owner.

Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50mm beyond each side of the weld line shall be cleaned off.

4.22 Shuttering

4.22.1 General

All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a live load of 400 Kg/m2 in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of his responsibilities.

4.22.2 Material

The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant and shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or seasoned timber board. Where ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood which can be shaped correctly.

4.22.3 Fixing

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection or movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The form work shall be so designed that the sides are

independent of the soffits and the side forms can be removed easily without any damage or shock to the concrete.

4.22.4 Wrought shuttering

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface.

The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3 mm.

4.22.5 Rough shuttering

Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

4.22.6 Special provision

4.22.6.1 Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.

4.22.6.2 In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used.

4.22.6.3 Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct.

4.22.6.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar if so directed by the engineer.

4.22.7 Preparation for concreting

Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance

such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

4.22.8 Removing

4.22.8.1 Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction

4.22.8.2 Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

4.22.8.3 Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :-

i)	Walls, columns & vertical faces	24 to 48 hours as may be directed by the Engineer.
ii)	Bottom of slab upto 4.5 m span	7 days
iii)	Bottom of slab above 4.5 m span, bottom of beam and arch, rise upto 6 m span	14 days
iv)	Bottom of beam and arch rise over 6 m span	21 days

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc.,

4.22.8.4 Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

4.22.9 Contractor's responsibility

Any damage resulting from faulty preparation, premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

4.22.10 Irrecoverable shuttering

In cases where the shuttering cannot be removed without damaging the structure itself or where removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such shuttering shall be classified as irrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.

4.22.11 Metal Forms

Where permanently left-in-place metal forms or deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the requirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer, whose performance guarantee shall be obtained and submitted to the Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.

4.23 Damp Proof Course Concrete

4.23.1 Thickness

It shall be as specified in the drawings or in the items.

4.23.2 Mix

The grade of mix shall be as specified in the drawing or schedule of quantities. If nothing is specified, the mix shall be 1 part of cement : 1 1/2 part of coarse sand : 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer's specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5.

4.23.3 Preparation of base surface

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

4.23.4 Placing and compaction

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as

specified for the concrete in beams. The concrete shall be well compacted to make it dense.

4.23.5 Finishing

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.

4.23.6 Curing

The D.P. course shall be kept continuously moist at least 10 days.

4.24 Grout

4.24.1 Scope

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

4.24.2 Grouting under base plates

Grouting under base plates of equipments/structures shall be of cement mortar 1:2 for thickness upto 25 mm. For thickness exceeding 25 mm, concrete of grade specified in the drawing or minimum M-20 grade using 10 mm down graded aggregates shall be used. The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete, where so specified.

The grout shall either be "dry" concrete or mortar or "wet expanding" concrete or mortar as the Engineer may direct. A dry grout shall have a slump not exceeding 6 mm. It shall be rammed under the horizontal surface with the aid of suitable tools. A "wet expanding" grout shall have a slump of at least 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and in accordance to the Manufacturer's instructions.

4.24.3 Grouting the pockets/holes in concrete

Depending upon the size of the pockets/holes in the concrete, the mix of the grout shall be either of concrete or of cement sand mortars. Normally the grade of such concrete/mortar shall be M-20 unless specified otherwise. In filling the holes of foundation bolts and expanding admixture of approved type shall be used as per manufacturer's specification.

4.24.4 Workmanship

4.24.4.1 The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary, chipping shall be carried out on such surface to make it completely rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position. Before grouting the surface shall be thoroughly cleaned with compressed air/water jet.

4.24.4.2 Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

4.24.4.3 Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

4.24.4.4 The grout shall be placed within 30 minutes of being mixed. The grout shall be poured and then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly. Where the gap is very small or unapproachable for the placement of concrete, the Contractor shall grout by pressure grouting and in that case the mix may be of cement sand mortar of the appropriate grade but in any case the water cement ratio shall be as low as possible. Neither "Dry" grout (having slump 6mm or less) nor expanding wet grout shall be grouted with any type of vibrating machine

4.24.5 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist at least for 10 days.

4.25 Concreting in Water Retaining Structures

General requirements

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified herein before

in this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II)-1965 to make dense and impervious concrete. As specified herein before all the construction joints shall be provided with approved water bars. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as directed by the Engineer.

4.26 Application of Live Load

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out on the last concrete poured in structure.

4.27 Foam Concrete

This shall be of average 50mm thickness or as specified or as shown on the drawings. This may be laid in in-situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m2h/degree C. The weight of the insulating material shall be from 0.5 to 0.75 gm/cm3, strength not less than 5 Kg/sq.cm or (0.5N/sq.mm.). In general, the main ingredients of Foam Concretes are cement, fly ash and foaming agent and the work shall be carried on by specialised Agencies/Companies. Before starting the laying of foam concrete sample shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to take the usual work loads and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, sample batches of mix shall be kept for test if so desired by the Engineer.

5.0 MASONRY

5.1 General

This specification deals with masonry and allied works in foundation,

plinth and superstructure.

5.2 Materials

For specifications of materials Part-I shall be referred.

5.3 Selection of Mortars

Mortar for masonry shall conform generally to IS: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Cement Mortar

5.4.1 Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic metre. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

5.4.2 The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work.

If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonary platform, water shall be added and the mortar turned over and over, backward and forward several times.

5.4.3 Fresh mixed mortar, in case becoming stiff due to evaporation of water may be retempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only upto a maximum of 2 hours from the time of addition of cement in the mortar.

5.5 Brick Work

5.5.1 Storage and handling bricks

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. The supply of bricks shall be so arranged that as far as possible at least two days' requirement of bricks is available at site at any time. Bricks selected for different situations of work shall be stacked separately.

5.5.2 Soaking & Cleaning bricks

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

5.5.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212-1991 and got checked by the Engineer.

5.5.4 Laying of bricks

5.5.4.1 Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.5.4.2 Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

5.5.4.3 Walls coming in contact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of M.S. inserts or lugs used shall be measured and paid separately under relevant items). Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

5.5.4.4 Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to complete bond or as closers or around irregular openings.

5.5.4.5 Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging their edges.

5.5.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.5.4.7 Making of grooves, sleeves and chases shall be done, during the construction, to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.

5.5.4.8 Fixtures, plugs, frames,pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.5.4.9 Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

5.5.4.10 All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of one metre and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall. Toothing shall not be allowed in brick work, for raking back. The top layer just below the R.C.C slab or beam shall be laid with frogs down over a layer of mortar on full width.

5.5.4.11 Openings in brick work

Openings shall be made in brick work, which may be of any shape, size, at all levels, heights or depths, including round openings, as shown in the drawing or as directed by the Engineer, maintaining the necessary bond using a minimum of cut bricks. Openings in external face walls, the sills, jambs, soffits of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.5.4.12 All exposed brick work shall be rubbed down, thoroughly washed, cleaned and pointed as specified. Where face bricks of specific quality are used the same shall be rubbed with carborundum stone.

5.5.5 Half-brick masonry

5.5.5.1 Half-brick work shall be done in the same manner as for brick work except that all courses shall be laid in stretchers. Both faces shall be true to plane and the joints raked on both faces.

Where reinforcement is considered necessary or specified and shown in drawing, M.S. bars or hoop iron shall be provided as stipulated in the Schedule of Items or as directed by the engineer. The reinforcement shall be cleaned of rust and loose scale with a wire brush, and shall be laid straight on the mortar and lapped with the dowel bars provided in the column, securely anchoring them at their ends where the half-brick wall butts. The batching of mortar usually shall be in the proportion of 1:4 or as stipulated in the Schedule of Items. Half of the mortar for the joints shall first be laid and the other half laid after the reinforcement is laid in position, so that the reinforcement is fully embedded in position.

5.5.6 Brick on edge masonry

The work brick on edge masonry wall in superstructure shall be done in the same manner as mentioned for brick work except that it shall always be reinforced with wire mesh netting of approved variety as specified in the item and embedded in cement mortar at interval as specified in the Schedule of Items. The wire netting shall be continuously laid and securely anchored with the dowel bars provided & projecting from the walls/RCC structure or steel structures at their ends where brick on edge wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.5.7 Protection of brick work

The brick wall shall be protected and covered with gunny bags or

water proof sheets from the effects of inclement weather, rain, frost, etc., during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffits of openings are not damaged.

5.5.8 Curing

All brick works shall be kept moist for 10 days after laying.

5.5.9 Scaffolding

5.5.9.1 Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

5.5.9.2 Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one metre in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

5.5.9.3 If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees if any shall have to be borne by him.

5.5.9.4 All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer.

The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

5.6 Stone masonry

5.6.1 General

All aspects of the work shall be in conformity with the "Code of Practice for Construction of Stone Masonry, IS: 1597 (Part-I & II)-1992. Relevant clauses under brick work, such as setting out, making chases, openings, fixing frames and plugs, protection, curing, scaffolding etc., shall apply to stone masonry and concrete block masonary.

5.6.2 Mortar

The mortar used shall be as specified in the Schedule of Items or drawing.

5.6.3 Holes and Plugs

Holes in stone walls shall be left for water supply, plumbing, sanitation, electrification, etc., where shown on drawings or ordered by the Engineer as the work proceeds. These holes shall, on completion, be made good to match with the adjoining wall. The Contractor shall provide and fix wooden plugs, water supply piping and electric conduit pipes etc. where so specified.

5.6.4 Random rubble masonry

5.6.4.1 Laying

All stones shall be wetted and cleaned of all dust and loose materials before laying. Stones shall be laid on their natural beds, fitted carefully to the adjacent stones to form neat and close joints fully packed with mortar and chips and spalls of stone may also be used wherever necessary to avoid thick mortar bed or joints. Walls shall be carried to plumb or to the specified batter. Stones may be brought to level course at plinth, window sills and roof levels and the leveling shall be done with concrete comprising of 1 part of the mortar as used for the masonry and 2 parts of 20 mm down graded hard stone chips at no extra cost. Bond shall be provided by fitting in closely the adjacent stones and by using bond stones running through the thickness of wall in a line from the face to back with at least one bond stone, or a set of bond stones, for every 0.5 sq.m. of the wall surface. Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints.

5.6.4.2 Quoins

Quoins shall be of selected stones, neatly dressed with hammer or chisel to form the required angle and laid header and stretcher alternately. No quoin stone shall be smaller than 0.025cum (25dcum in volume and it shall also not be less than 300mm in length, 25% of them being not less than 500mm in length).

5.6.4.3 Joints

The stones shall be so laid that the joints are fully packed with mortar and chips and face joints shall not be more than 20 mm thick. When plastering or pointing is not required to be done, the joints shall be

struck flush and finished at the time of laying, otherwise the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.5 Coursed rubble masonry - First sort

5.6.5.1 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar, chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the quantity of stone masonry. The masonry in a structure shall be carried up regularly but where breaks are unavoidable, the joints shall be raked back at an angle not steeper than 45 degree. Toothing shall not be allowed.

5.6.5.2 Bond Stones

Bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.6.5.3 Quoins

The quoins, shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid stretchers and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10 cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

5.6.5.4 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.6 Coursed rubble masonry - Second sort

5.6.6.1 Laying

Shall be as specified in 5.6.5.1 except that the use of chips shall not exceed 15% of the quantity of stone masonry, and stone in each course need not be of the same height but more than two stones shall not be used in the height of a course.

5.6.6.2 Bond stone, quoins

Shall be as specified for first sort respectively.

5.6.6.3 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than 2 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.7 Hollow concrete block masonry

5.7.1 Construction of hollow concrete masonry shall be done in accordance with procedures laid down in IS: 2572-1963. General procedures for construction shall conform to IS: 2212-1991 except for the following :

5.7.2 Storage, handling and preparation

The blocks shall be stored in stable stacks over planks or other supports with sufficient care taken to prevent ingress or moisture.

Blocks shall be handled carefully to avoid cracking. All damaged units shall be rejected and removed from site.

Blocks need not be wetted before or during placement. Unless the climatic condition so require, the top and sides may be slightly wetted.

5.7.3 Mortars

Mortar for use in hollow concrete block masonry shall be made from cement, slaked lime and sand unless otherwise specified. The mix preparation shall be as recommended in Table-I of IS: 2572-1963. Preparation of mortar shall be in accordance with IS: 2250-1981.

5.7.4 Laying

Laying of block for first and subsequent courses and requirements of horizontal and vertical joints shall be as described in IS: 2572-1963. Use of hollow blocks in foundations shall be avoided. Use of blocks filled with sand and blocks filled with 1:3:6 concrete for foundation courses, plinths and basements shall be done with approval of Engineer. Closure blocks of superstructure shall have all openings battered with mortar. A course of solid concrete block masonry shall be provided under door and window openings or a 10 cm thick precast concrete sill block shall be provided under windows. This course shall extend at least 20 cm beyond the openings on either side. Solid blocks or hollow blocks filled with 1:3:6 concrete shall be used for jambs or fixing of hold fasts etc., Similarly solid blocks or U-shaped blocks filled with 1:3:6 concrete shall be used for roof course. They shall be finished smooth at top with 1:3 cement mortar and covered with a coat of crude oil, craft paper or oil paper for free roof movement.

5.7.5 Bond

Wherever two walls intersect, bond between at least 50% of the units intersecting shall be provided. If intersecting walls are laid separately pockets shall be left in the first wall at a maximum vertical spacing of 20 cm for the corresponding course of second wall to be built into these pockets.

Pilasters shall be of twice the thickness. Hollow blocks shall not be used for isolated piers unless they are filled with 1:3:6 concrete.

6.0 PLASTERING AND POINTING

6.1 Materials

The specification of materials shall conform to the requirements as specified in Part-I.

6.2 Plastering

6.2.1 General

Plastering shall be done in accordance with provisions of IS: 1661-1972. Mix proportions of mortar for plastering and thickness of plaster shall be as given either in the drawing, or as per Schedule of Items or as directed by the Engineer. For special plaster work, necessary admixtures shall be added to mortar in required proportion as per manufacturer's specifications or as specified herein. The thickness mentioned in the Schedule of Items shall be minimum thickness.

6.2.2 Preparation of surface

The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In masonry the joints shall be raked to a minimum depth of 12 mm and cleaned with wire brush. Concrete surfaces to be plastered shall be roughened and hacked to form key for plastering. All plastered surfaces shall be finished smooth with a wooden float in one plane and all internal angles shall be finished slightly rounded. If desired by the Engineer, any unevenness shall be rubbed down by carborundum stones. The surface to be plastered shall be wetted evenly before the application of plastering. Trimming of projections on brick/concrete surfaces wherever necessary shall be done.

For one coat plastering the plaster shall be laid slightly thicker than the specified thickness and the surface then leveled with flat wooden float to the required thickness. For two coat plaster work, the first coat (usually half of total thickness) shall be applied as detailed above except that the surface shall be left rough and keys formed for the application of second coat. The second coat shall be laid on with a wooden float to the specified thickness and shall be applied a day or two after the first coat has set, but has not dried up.

Cement mortar for plastering work shall be used within 30 minutes after adding water to cement and should be kept agitated at intervals of 20 minutes.

If specified cement punning shall be done over the plastered surface by sprinkling neat cement powder evenly on the surface and rubbed smoothly with a trowel to give a fine coating. The plaster shall be kept wet for at least seven days and protected from extreme temperature and weather during this period

The arises of doors and windows shall have richer mortar 1:3 in a width of 75 mm on either side or as required at respective location.

6.2.3 Concrete beams, slabs, columns etc. framing into masonry are to be plastered along with masonry walls with these edges wrapped with

chicken wire mesh of gauge 24. Overlapping of mesh shall be minimum 75 mm on either side of the edge of the concrete element. Minimum lap for chicken wire mesh shall be 50 mm.

6.3 Cement Pointing

6.3.1 Where shown on drawing, Schedule of Items, or as directed by the Engineer, exposed brick faces shall be cement rule pointed. The mortar shall be raked out of the joints to a depth of 12 mm. The dust shall be brushed out of the joints and the wall well wetted.

Unless otherwise specified the pointing shall be made with cement and sand mixed in proportion 1:3. The joints of the pointed work shall be neatly finished truly vertical and horizontal or as directed and the lines shall be kept wet till the cementing material has set and become hard. If required, the whole brick face shall be rubbed and polished with fine grade of carborundum stones. Particular care shall be taken to see that no brick face or brick edge is damaged during this work.

6.3.2 Flush pointing

The mortar shall be pressed into the joints and shall be finished flush and levelled. The edges shall be neatly trimmed with trowel and straight edges.

6.3.3 Ruled pointing

The joint shall be initially formed as for flush pointing and then, while mortar is still green, a groove of required shape and size shall be formed by running a forming tool straight along the centre line of the joint till a smooth and hard surface is obtained. The vertical joints shall also be finished in similar way. The pointing line shall be uniform in width and truly horizontal in case of floors and ceilings.

6.3.4 Cut or weather struck pointing

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 3mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

6.3.5 Raised and cut pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6mm raised and width 10mm or more as directed. The pointing shall be finished to a smooth but hard surface. the superfluous mortar then shall be cut off

from the edges of the lines and the surface of the masonry shall also be cleaned off all the mortar.

Curing

The pointing shall be kept wet for 7 days. During this period it shall be suitably protected from all damages.

6.3.6 Pointing on brick flooring

Specification for this shall be conforming to under sub head "Pointing".

6.3.7 Pointing on random rubble stone masonry

In such pointing, the mortar shall be simply struck off with a trowel and the work left showing the natural irregularities in line and surface of the stones themselves. Other specifications shall remain same as per para 8.3 under sub head "Pointing".

6.4 Rough Cast Concrete Facing

6.4.1 The surface shall be prepared as for Cement plaster and then 2 cm backing coat of cement sand mortar 1:3 shall be applied. Subsequently, when the backing coat is in plastic state, a top coat 12 mm average thick cement and stone chips mixture in proportion 1:3 (stone chips 10 mm size and below) shall be applied by dashing the mixture on top with trowel to produce uniform rough texture. The mix shall again be dashed over the vacant spaces if any. The surface shall afterwards be cured for 10 days. After curing, the surface shall be brushed with hard wire brush to remove loose chips from the surface. A coat of cement wash shall then be applied, the cost of which shall be included in the rate of the item.

6.4.2 Rendered sand faced cement plaster

The surface shall be prepared as for cement plaster. The backing coat shall be 12 mm thick of cement plaster proportion 1:4 (1 cement and 4 sand) and keys shall be formed on the surface. After curing this coat sufficiently, the finishing coat 6 mm thick consisting of grey cement and screened coarse sand to required gradation (1:3) shall be applied and finished to the desired te texture to the satisfaction of the Engineer. The surface afterwards shall be cured for 7 days.

6.4.3 Plaster moulding

Where specified, plaster moulding shall be strictly as per drawings and details, and shall run clean and true from proper templates and moulds, to the entire satisfaction of the Engineer. Rates shall include

for brick or concrete cores and for any necessary dabbing in cement mortar or brick or metal lath curing and final finish as desired. Where desired, all angles in internal moulding work shall be covered to a radius of 50 mm or as directed without any extra charges.

6.4.4 Floating coat with neat cement

When the plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth so that whole surface is covered with neat cement coating. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to cement.

6.4.5 Pebble dash plaster

Specification shall be same as that for rough cast concrete facing vide 8.4.1 except that pebbles or graded crushed stone, of size 10mm to 20mm or as specified/directed by the Engineer, shall be well washed and drained and then dashed/thrown wet on the plaster surfaces while it is still plastic, using strong whipping motion at right angles to the face of wall, pressed flat and filling uncover parts by hand so that finished surface represents homogeneous look. The finished surface shall be lightly tapped with a trowel to ensure good bond.

6.5 Punning with Lime or Plaster of Paris

6.5.1 Lime Punning

Lime punning shall be carried out with best quality approved lime. Lime shall be properly stirred, tempered with water to form a homogeneous mass and strained through fine cloth. The punning shall be laid and rubbed and troweled to an uniform smooth even finish using special trowels. Any unevenness shall be rubbed down with fine sand paper. The plaster must be dry before the lime punning is applied. The punning shall be kept wet for a period of 7 days. The lime paste shall be kept wet until use and no more quantity than can be consumed in 10 days shall be prepared at a time. No portion of the surface shall be leftout initially to be patched up later on.

6.5.2 Plaster of Paris punning

This shall be provided by using the best quality of plaster of Paris from approved manufacturer. Unless otherwise specified same procedure as for lime punning shall be followed for getting uniform smooth finish.

7.0 FLOORING, PAVING & FACING

7.1 Scope

Flooring, Paving and facing includes flooring, skirting and dado of various types encountered in plants, buildings, pavements etc. as described under respective heads. For the items which have not been covered up in this chapter completely or covered up only partly, specifications suggested by the manufacturers for the materials, surface preparation, workmanship and all other byeworks etc., shall be strictly followed. In addition to this the entire job will have to be carried out as per direction of the engineer, which shall be final.

7.2 Materials

Materials shall conform to Part-I of this series.

7.3 General

Flooring, skirting & dado may have to be done in discontinuous strips or areas to suit the needs of erection and commissioning of equipment. Flooring shall be done in close co-ordination with erection of equipment or other services and shall keep pace with the demands in respect of commissioning of individual equipment. No claims for extra shall be tenable for reasons of discontinuity of work or delay in having areas available for work.

Unless otherwise specifically included in the Schedule of Quantities or stated in the description of work, no extra shall be payable for works such as forming coves at internal angles, nosing at plinths, steps, window sills and stair treads, dishing in bath rooms, toilet & other places and cutting to line and fair finish to top edge of skirting and dado. Thickness mentioned shall be the minimum.

7.4 Sub-base

Flooring at ground level having sub-base of sand or earth as specified shall be laid in layers of 15 cm, watered and consolidated by rolling with hand roller or ramming with iron rammer and with butt ends of the crow bars. When filling reaches the required level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement later. The thickness of the sub-base shall be as specified either in the drawing or in the Schedule of Items.

7.5 Subgrade

The surface shall be brought to the desired level before subgrade is laid, loose pockets shall be filled up and whole surface shall be consolidated by tamping. Vegetable growth and other decomposed matter, rubbish etc., shall be removed.

7.5.1 Hard core subgrade

Where hardcore subgrade is specified, stone/slag boulders/laterite boulders shall be laid closely stacked together, the longer edge being laid vertically. All interstices shall be filled with smaller particles of the same material or with gravel or red earth. The top surface shall be spread with loose moorum sufficient to cover the gap and to achieve uniform top surface. The surface shall then be adequately watered and rolled by roller.

Hard core shall be laid to form the desired slope in the finished floor.

7.5.2 Brick Khoa subgrade

Over burnt bricks shall be used for getting brick khoa as per sizes described in Schedule of Items. The khoa shall be laid uniformly and rammed in dry and wet conditions so as to get a uniform compact surface.

7.6 Cement Concrete Flooring with Integral Finish

Cement concrete shall be mixed, laid, consolidated and cured as described in Chapter "Concrete". Laying of concrete shall be done in alternate panels. The size and division of panels shall be as per direction of Engineer. The mix or grade of concrete shall be as specified in Schedule of Items.

The finished surface may be rendered smooth by trowel finishing to provide an appearance of fine and smooth textured surface and in panels or in geometric pattern as specified in Schedule of Items or as directed by Engineer.

7.7 Concrete Flooring with Granolithic Finish (Artificial Stone Flooring)

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete. The subgrade shall be either brick khoa/lime concrete/cement concrete, as specified. Flooring shall be laid and finished according to IS : 5491-1967.

7.7.1 Thickness

Unless otherwise mentioned the thickness of flooring including topping shall be either 25 mm or 40 mm or 50 mm as shown on drawing/Schedule of Items. The net thickness of topping shall be 6 mm for 25 mm thick floor, 10 mm for 40 mm and 12 mm for 50mm thick floor. An additional allowance of 2mm in thickness of topping shall be made for cutting and grinding margin wherever polishing is specified in the item. The rate of the item will be inclusive of this.

7.7.2 Mix

For base or under bed course, the mix shall be 1:2:4 concrete, unless specified otherwise. The mix of the topping shall consist of 1 part cement :1 part coarse sand : 1 part coarse aggregated by volume or 1 part cement and 1 part stone chips. The coarse aggregate shall very hard like granite and well graded and size of chips shall be 3mm for 6mm topping & 6mm to 3mm for 10mm or more thick topping. Minimum quantity of water to get workability shall be added.

7.7.3 Laying

a) Laying of monolithic topping

The concrete base or underbed shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The surface shall remain sufficiently rough to take the finish.

To prevent construction cracks, the panels shall be divided in square or rectangular pattern. For floor finish of 40mm thickness or above, the maximum panel area shall be 2.5 sq.m. with none of the sides exceeding 2.5m, however for lesser thickness these shall be 1.5sq.m. and 2.5m respectively. The dividing strip may be aluminium or glass or as specified and shall have the same depth as that of floor. Within about 2 to 3 hours of laying the base while it is still fully 'green' the topping shall be laid evenly to proper thickness and grade. The topping shall be pressed firmly and rigorously to form full bond with the base/underbed.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly troweled to remove all marks and shall be left for sometime till moisture disappears from it. Fresh quantity of cement @ 2.2 Kg per sq.m. of the flooring shall be mixed to form a thick slurry and spread over the surface while concrete is still green. The cement slurry then shall be floated even & smooth. Polishing, if specified, shall be done with polishing machine and the portion where machine cannot be used manually to the satisfaction of the Engineer. If specified so the surface of the flooring shall be finished ribbed, chequered or

laid in slope without any extra cost unless specified so in the item. On completion, the floor shall be kept flooded with water for 10 days and shall be adequately protected before it is sufficiently hard.

(b) Laying of topping separately on hardened base

The sub base shall be laid as in clause 7.7.3. The surface of the base concrete shall be thoroughly brushed and cleaned free from all dirt, mortar droppings and laitance etc.. Where the surface has hardened too much, chipping or hacking of the surface may be necessary. The surface shall then be wetted with water for several hours and surplus water mopped. Neat cement slurry at 2.75Kg/sq.m. of surface shall be brushed into the clean surface. The topping then shall be laid as described in clause 7.9.3.

7.7.4 General

The junction of the floors with all plaster dado or skirting shall be rounded of with 1:1 cement sand mortar & polished, if specified or shown in drawing.

7.7.5 Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to use during this period.

7.7.6 Grinding & finishing

Where grinding is specified, it shall start only after the finish has fully set. The grinding shall be done with carborundum stone of No. 60, then No. 80 and then 120 as per the method as specified in in-situ mosaic flooring. After final polishing, the floor shall be rubbed with oxalic acid and then wax polished.

7.8 Dado & Skirting Work (Grey Cement Skirting/Dado)

A backing coat of 12 mm thick and 15 mm thick shall be applied on walls after proper dabbing of the surface for a finished thickness of 18 mm and 21 mm thick respectively, with cement plaster of proportion 1:4 (1 cement and 4 approved quality sand) or as specified. Over this a top coat 6mm/7mm thick consisting of one cement to one stone chips 3 mm nominal size shall be applied. If grinding and polishing

specified, the same shall be done as per granolithic flooring with carborundum stones.

7.8 Flooring & Facing with Redoxide of Iron (Red Artificial Stone Flooring)

It shall consist of an underbed or base course and topping over already laid & matured concrete subgrade.

7.9.1 Thickness

Unless otherwise specified the total thickness of the flooring shall be either 40 mm or 25 mm of which the topping shall not be less than 6 mm (net) for 25 mm thickness and 10 mm (net) for 40 mm thickness. The topping shall be of uniform thickness, the underbed may vary in thickness to provide necessary slopes. For vertical surfaces the total thickness shall be 18 mm, of which the topping thickness shall be 6 mm (net). Where grinding (cutting) & polishing is specified a minimum allowance of 2 mm shall be kept for cutting & polishing so that the net specified top thickness is achieved. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm or as shown in the drawing.

7.9.2 Mix

i) Course or base course

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 pert cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 or 4 parts coarse sand by volume as specified in the item.

ii) Topping course

For the topping white cement and red oxide of iron pigment powder shall be dry mixed thoroughly (generally 10:1 by weight) to produce the desired colour when laid. The mix shall then be prepared with 1 part white cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

7.9.3 Laying

The underbed shall be laid in panels of maximum area 2.5 sq.m. each and no side shall be more than 1.5m long. For outdoor locations the maximum area shall be 2.0 sq.m. or as specified. The forms for the

panels shall have perfectly aligned edges to the full depth of the total thickness of finish. Aluminium or glass dividing strips shall be used as forms. The underbed shall be laid compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'Green' but firm enough to receive the topping.The surface of the underbed shall be roughhead for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by troweling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg of the mixture shall be consumed/per sq.m. for horizontal surface, and 1.0 kg for vertical surface.

7.9.4 Grinding & polishing

Where grinding & polishing specified, the same shall be done 36 hours after laying when the surface has hardened sufficiently. It shall be polished with polishing stone, in sequence of different grades of carborundum stones (first No. 60, then No. 80 & then No.120) till a smooth shiny surface to the satisfaction of the Engineer is achieved. After final polishing, the finished areas shall be rubbed with oxalic acid and then wax polished.

7.10 Terrazzo Flooring & Facing

General

The terrazzo work shall be done by approved firm or specialists. Marble chips used for facing coat of terrazzo work shall be of best quality (from Dehradoon or other approved source) and of uniform tint and colour and shall be approved by the Engineer before using in the work. All terrazzo work shall be polished on completion followed by a final wax polish of approved quality.

Terrazzo work shall be done either cast-in-situ or with precast tiles as specified in the Schedule of Quantities Unless otherwise specified thickness for cast-in-situ terrazzo work shall be 25 mm including base course and for tiles 20 mm excluding mortar bed.

7.10.1 Cast-in-situ terrazzo flooring

It shall consist of an underbed and a topping laid over an already matured concrete subgrade.

7.10.1.1 Thickness

Unless specified otherwise, the total thickness of the finished flooring shall be either 25 mm or 40 mm of which the topping shall be minimum 6 mm (net) for 25 mm and minimum 10 mm net for 40 mm flooring. A minimum allowance of 2 mm in the topping shall be kept for grinding and polishing so as to achieve the minimum specified thickness of topping. All junctions of vertical with horizontal planes shall be rounded neatly to uniform radius of 25 mm or as shown in the drawings.

7.10.1.2 Mix

i) Underbed course

The underbed for floors and similar horizontal surface shall consist of a mix of 1 part cement, 2 parts sand and 4 parts stone chips by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only minimum water to be added to give a workable consistency.

ii) Topping

Topping shall consist of cement (grey or white) as specified with or without colour pigment, marble powder and marble chips. The proportion of cement and marble powder shall be 3 parts of cement to one part of marble powder by weight. The proportion shall be inclusive of any pigments added to the cement. The proportion to which pigments are mixed with grey or white cement to obtain various shades for the binder, shall be as specified in Table-I of IS : 2114-1984.

The proportion of marble chips and cement marble powder mix shall be 7 parts of marble chips to 4 parts of cement marble powder mix mixed by volume. Care shall be taken to ensure an even and uniform disposition of the marble chips.

7.10.1.3 Laying

i) Laying of underbed

The underbed shall be laid in panels in the same manner as that for artificial stone flooring. The panels shall not be more than 2 sq.m. in area of which no side shall be more than 2.0 m long. Cement slurry @ 2.75 kg/sq.m. shall be applied before laying over cement concrete/RCC surface/ plastered surface.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total

depth of underbed plus topping. In case of in-situ dado work, the sections shall not be more than 60 cm x 60 cm and the aluminium, glass or any other material strips provided similarly.

ii) Laying of topping

After laying, the underbed shall be leveled compacted and brought to proper grade with screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The terrazo surface shall be tamped, troweled and brought true to the required level by straight edge and steel floats in such a manner that maximum amount of marble chips come up and are spread uniformly over the surface and no part of the surface is left without the chips. Excessive troweling should be avoided in early stages lest too much cement may come up the surface leading to surface cracking and requiring more grinding to expose marble chip.

7.10.1.4 Curing

The surface shall be left dry for air curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for seven days.

7.10.1.5 Grinding & polishing

Grinding and polishing shall be done either by hand or by machine. In case of manual grinding, the process of grinding shall begin after 2 days while in case of machine grinding the process shall start after seven days after completion of laying. First grinding shall be done with carborundum stone of 60 grit size. The floor shall then be washed and cleaned to remove mud and grindings, a grout of cement and colouring pigment in same proportion of the topping shall be applied to cover the pin holes. The surface shall be cured for 5 to 7 days and then ground with machine fitted fine grit blocks (No. 120). The surface shall be again cleaned and repaired as mentioned above and shall be cured for 3 to 5 days. Finally the third grinding shall be done with machine fitted with fine grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible/ possible rubbing and polishing by hand shall be done in the same manner as specified for machine polishing except that carborundum of coarse grade (No. 60, 80 and 120) for first, second & final polishing. After the floor is polished to the satisfaction of the Engineer, it shall be rubbed with oxalic acid and finally wax polished with 'Mansion' or similar approved floor polish to the entire satisfaction of Engineer. For good result, wax polishing shall be applied on the surface with the help of soft linen over a clean and dry surface and then the polishing machine fitted with bobs shall be run over it. Clean saw dust shall be spread over the floor surface and the polishing machine again operated so as to remove excess wax and leave glossy surface. Floor shall not be left slippery.

7.10.2 Terrazzo cast-in-situ facing, skirting and dado

The work shall be carried out in the same manner as that for terrazzo cast-in-situ floors except that the base or bedding course shall consist of 1:3 cement mortar (1 cement & 3 medium sand) of 12 mm or 15 mm or 20 mm thickness for total thickness 18 mm or 21 mm or 26 mm respectively. As specified earlier, the bedding course shall be laid in panel (not more than 60 cm x 60 cm) divided by glass/ aluminium strips. The topping shall be of 6 mm thick finished and shall be laid when the backing plaster is still green. Special care shall be taken to see that the surface are properly cured.

7.10.3 Terrazzo tile finished flooring/facing

The work will consist of manufactured terrazzo tile and an underbed.

7.10.3.1 Thickness

Unless otherwise specified, the total (net) thickness including the underbed shall be 40 mm for flooring and other horizontal surface and 32 mm for vertical surfaces like dado/skirting. The necessary allowance for cutting and grinding shall be kept to have the specified finished thickness.

7.10.3.2 Tiles : Tterrazzo

The tiles shall, unless specifically permitted in special cases, be machine made under quality control in a shop and shall be subjected to minimum hydraulic pressure of 140 kg. per sq. cm.

The tiles shall be composed of a backing and topping. The finished thickness of upper layers shall not be less than 5mm for size of marble chips upto 6m size and not less than 6mm for size of marble chips upto 20mm size.

The ingredients for topping shall be same as cast-in-situ terrazzo. The thickness of the topping, as specified above, shall be net after grinding & polishing. First grinding shall be given to the tiles at the shop before delivery.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles.

7.10.3.3 Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 3/4 parts coarse sand mixed with sufficient water to form a stiff workable mass. The thickness of underbed for the flooring shall be 20mm unless otherwise specified. For skirting and dado and all vertical surface it shall be about 12 mm thick and composed of 1 part cement 3 parts coarse sand.

7.10.3.4 Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The base surface shall be roughened for better bond. Before laying the underbed, over the base/subgrade, a coat of cement slurry shall be applied over the sub-grade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or cement slurry applied at 4.4Kg of cement per sq.m. and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moistened allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed. If desired dividing strips as specified under Cl. 7.10.1.3 may be used for dividing the work into suitable panels.

7.10.3.5 Grinding and polishing

Procedure shall be same as in-situ terrazzo finished flooring. Grinding shall not commence earlier than 14 days after laying of tiles.

7.11 Glazed Tile Finished Flooring & Facing

This finish shall be composed of glazed earthen tiles with an underbed laid over a concrete or masonry base.

7.11.1 Thickness

Unless specified the total thickness shall be 21 mm for flooring & 18 mm for dado/skirting for the underbed.

The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

7.11.2 Tiles : Glazed

These shall conform to the requirement of IS : 777. The tiles shall be of earthenware, covered with glazed white or coloured, plain or with designs, of 149 mm x 149 mm or 99mm x 99mm nominal sizes and 5,6 & 7 mm thick unless otherwise specified. Specials like internal and external angles, beads, covers, cornices, corner pieces etc., shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform, and fractured section shall be fine grained in textures, dense and homogeneous.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

7.11.3 Mix : Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand mixed with sufficient water or any other mix if specified and shall be 12mm thick minimum or as specified.

7.11.4 Laying & finishing

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. Before laying the underbed, over the base/subgrade a coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The joints shall be practically invisible and filled with non-staining white

cement/white cement mixed with pigment for coloured tiles. Internal angles shall be provided with `specials'. Drains shall be provided with `specials'. The tiles shall be thoroughly cleaned after completion. The tiles shall be laid to the slope specified in the drawings and truly vertical on walls when used as skirting.

7.11.5 Curing & cleaning

After flush pointing the joints, the surface shall be cured for 7 days by keeping it wet. The surface shall be then cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

7.12 Marble Flooring

7.12.1 Thickness

Unless specified otherwise the underbed shall be average 20 mm for flooring and 12 mm thick for vertical surfaces. The slabs may be 20 mm, 25 mm, 30 mm or 40 mm thick as specified.

7.12.2 Marble slab

The slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws, angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of plus or minus 5 mm in dimensions and plus or minus 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm. The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

7.12.3 Mix : Underbed

The underbed, unless specified otherwise for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 4 parts coarse sand mixed with sufficient water to form a stiff workable mass and shall be on 20mm thick bed. For skirting and dado and all vertical surfaces it shall be 12 mm thick and composed of 1 part cement and 3 parts coarse sand.

7.12.4 Laying

The sides and top surface of the slabs shall be machine rubbed with coarse sand stone and washed clean before laying. The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry at 4.4 Kg of cement per sq.m. shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/ white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

7.12.5 Polishing, finishing

Fine chiseling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under terrazzo flooring. However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

7.13 Marble in Facia or Dado

Marble tiles of approved shade, variety, size and thickness as specified in the item shall be used. They shall be of selected quality, dense, uniform and homogeneous in texture and free from cracks or other structural defects. The exposed face shall have no unsightly stains, veins and defects. They shall have uniform milky white or coloured shade or patterns of colours approved by the Engineer before ordering the tiles. The surface shall be fine polished and sides machine cut, true to square.

When a single course of marble slab is to be fixed as in dado etc., the slabs shall be fixed as described below :

Mortar pads of 1:3 C.M. (1 cement : 3 coarse sand) of uniform width shall be stuck on to the wall at close intervals and the marble slabs shall be pressed on to them firmly. The remaining cavities if any shall then be filled with thin grout of cement mortar of the same proportion. The sound coming, on gently tapping of the slab, will indicate if there are hollows. When the hollow cannot be filled with grout and the finished slab continues to give a hollow sound on tapping, the slab shall be removed and reset. For the facia work where more than one course is required the marble slabs shall be of matching stand and veins to form architectural pattern as per drawings and shall be fixed in the same way as described above except for the horizontal joints of the slabs, where adjacent slabs shall be held together by a brass pin

passing through a hole drilled into the slabs. In addition, wrought iron/dowels shall be provided to anchor the slabs to the wall. The metal cramps shall be counter sunk into the joints of the slab and it shall be located about a metre apart subject to a minimum of one for each slab for each horizontal joint.

The facing shall be fixed truly in plumb and in perfect line or curves as shown on the plans. The courses and joints shall be as directed by the Engineer. The surface shall be protected from sun and rain and cured for 10 days and shall be finally polished with carborundum stones as for skirting & dado of cast-in-situ terrazzo.

7.14 Flooring/Paving with Hardener like Ironite

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'Green'.

7.14.1 Thickness

Unless otherwise specified in the Schedule of Items, the total thickness of the floor with metallic hardener finish shall be 40 mm or 50 mm of which the topping shall be 10 mm (net) for 40 mm & 12 mm (net) for 50 mm

7.14.2 Material (metallic hardener)

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the Engineer, actual samples shall be tested.

7.14.3 Mix

Unless otherwise specified, the mix for underbed shall be of 1:2:4 concrete and stone chips shall be 12 mm down grade. For topping the proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

7.14.4 Laying & finishing

The under bedding course of base course shall be laid as per specification of laying underbed for Red artificial stone flooring. The surface shall be roughened by wire brush as soon as possible. The

finish top coat shall be laid while the concrete base is still fairly 'green' within about 3 hours of laying of the later. The finish shall be of uniform and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smooth with steel trowel.

7.14.5 Curing

The finished floor shall be cured for 7 days by keeping it wet.

7.15 Chemical Resistant Tiles Flooring / Facing (Either of natural stone or prepared tiles)

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry. The Contractor shall get it done by specialised manufacturer & get guarantee of its performance.

7.15.1 Tiles

The chemical resistant tiles as detailed in the Schedule of Items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 kg/cm2. The surface shall be abrasion resistant and durable.

7.15.2 Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have same chemical resistant properties as that of tiles. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

7.16 Chemical Resistant in Situ Finished Flooring/Facing

Chemical resistant in situ finish shall be as called for in the Schedule of Items. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the owner in addition to his own guarantee.

7.17 Acceptance Criteria

The Contractors shall satisfy the Engineer specially for the workmanship of the following finished floor :

(a) Level, slope, plumb as the case may be

(c) Alignment of joints, dividing strip etc.

(d) Colour, texture

(e) Surface finish

(f) Thickness of joints including the workmanship in joints.

(g) Details at edges, junctions etc.

(h) Performance

(i) Precautions specified for durability.

(j) Effluent treatment plant

8.0 WOOD WORK

8.1 General

Wood work shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind. Rebates, roundings and mouldings as shown in drawings shall be made before assembling. Exposed work shall be finished smooth with well planed faces.

All assembly of shutters of doors, windows, ventilators and frames thereof shall be exactly at right angles. In the case of frames, the right angle shall be checked from the inside surfaces of the respective members.

All door and window frames shall be clamped together so as to be square and flat at the time of delivery. Door frames without sills shall be fitted with temporary stretchers.

Horns of frames and other parts that go into or butt against the masonry, shall be protected against moisture and decay with two coats of coal tar or other approved protective material.

All surfaces of the door, window and ventilator frames and shutters which are required to be painted ultimately shall be covered evenly by brush with a priming coat of approved primer. In the case of doors to be polished or varnished, a priming coat of approved polish or varnish shall be given before delivery. No primer shall be applied to the wood work until it has been inspected and passed by the Engineer.

8.2 Joinery

All heads, posts, transoms and mullions etc., of doors, windows and ventilators shall be made out of single pieces of timber only. The heads and post shall be through- tenoned into the mortices of the jamb posts to the full width of the latter and the thickness of the tenon shall be not less than 1.25 cm. The tenons shall be close fitting into the mortices and pinned with corrosion resisting metal pins not less than 8 mm diameter or with wood dowels not less than 10 mm diameter. The depth of rebate in frames for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm. Unless otherwise specified, all joints shall be mortice and tenon joints with the ends of the tenons exposed to view. Joints shall fit truly and fully without fillings. The contact surfaces of tenons and mortices shall be treated, before putting together, with an approved adhesive conforming to I.S :848-1974 and 851-1978.

8.3 Shrinkage & Tolerance

The arrangement, joining and fixing of all joinery work shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work.

The tolerance on overall dimensions shall be within the limits prescribed in IS : 1003 (Part 1 & 2)-1983 to 1991.

8.4 Fixing

Door and window frames shall generally be built in at the time the walls are constructed. Alternatively, where permitted by the Engineer, the frames may be subsequently fixed into prepared openings for which purpose holes to accommodate the holdfasts shall be left at the time of construction. Where the frames are subsequently fixed into prepared openings in the wall such openings should be 25 mm more than the overall width of the door, window or ventilator frame to allow minimum 12mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door care shall be taken to see that at least 6 mm space is left between the door and the finished floor. The M.S. clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 or (1:2:4 mix) with 20 mm down graded stone chips after holding the frame in proper position to the line, level and plumb.

The size of the concrete block shall be 250 x 125 x 85mm unless otherwise specified.

8.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with boiling coal tar or 2 coats of wood preservative treatment like hot solingnum or creosite oil etc. before fixing the frame in position.

8.6 Fittings

Unless otherwise specified, three holdfasts shall be fixed on each side of a door frame, one at the centre point, and the other two at 30 cm from the top and the bottom of the door frames. In the case of windows and ventilators, a pair on each side shall be fixed at quarter points of the frames. Unless otherwise specified the hold-fasts shall be of mild steel plate 40 x 3 x 225 mm long, fish tailed at one end and screwed to the frame in the formed rebates.

Generally, each door shutter shall be fixed to the frame with three hinges of approved manufacture, one at the centre and the other two approximately 24 cm from the top and bottom of the shutter. Each window shutter shall be fixed to its frame with two hinges at the quarter points.

Locks, handles, door closers, stoppers etc., shall be fitted as shown in drawing or described in the Schedule of Items.

8.7 Doors, windows & ventilators etc.

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003 (Part 1&2)-1983 to 1991 Table- III or as shown on the drawings. The work shall be carried out as per detailed drawing. The wooden members shall be planed, smooth and accurate. They shall be cut to the exact shape and size without patching or plugging of any kind. Mouldings, rebates, curves and roundings etc. shall be done as shown in the drawing before the pieces are assembled into the shutter.

The thickness of stiles and rails etc shall be as per IS: 1003 (Part 1&2)-1983 to 1991 unless otherwise specified in the item of works. These shall be properly and accurately mortised and tenoned. Rails which are more than 180mm in width shall have 2 tenons. Stiles and rails shall be made out of single piece upto 200mm in width. In case more than one piece of timber is used for members exceeding 200mm width, they shall be joined with a continuous tongued and grooved joint, glued together and reinforced with rust proof metal dowels or headless pins. The tenons shall pass clear through stiles. the stiles and rails shall have a 12mm groove, unless otherwise shown in the drawing, to receive the panel. In case of double shutters the rebate at the closing junction of the two shutters shall be as per clause 5.5 of IS:

1003-1991 or as shown in the drawing. Primer coat shall not be put before shutters are passed by the engineer.

8.8 Panelled Shutters

These shall conform to IS: 1003 (Part I)-1991. Timber panelled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, hard board or asbestos cement board.

Stiles, rails and panels in door shutters shall be of the same species of wood.

Timber panels shall be of minimum width of 150mm. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. No single panel shall exceed 0.5 m2 in area. Timber panels shall be fixed only with grooves but additional beadings may be provided either on one side or both sides.

Unless otherwise specified thickness of panel for 35mm thick shutter shall be 15mm and for 40mm and above thick shutter, it shall be 20mm. For 25mm thick shutter, panel thickness shall be 12mm.

Apart from timber panels other materials like plywood, Block board, particle board, Hard board and Asbestos cement may also be used for panelling purpose and shall be fixed with grooves or beading or both as per provisions made in IS:1003 (Part-1)-1991.

Timber suitable for manufacture of door shutter have been grouped under class a,b,c & d in Table 1 of IS: 1003 (Part-1)-1991.

8.9 Glazed Shutters

The openings for glazed shutters shall be rebated and moulded out of solid timber. Plain sheet glass for panels shall be of approved quality as specified. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass. Unless otherwise specified glass panes shall be fixed by means of moulded beads and suitable MS panel pins. A thin layer of putty shall be applied between glass panes and sash bars and also between glass panes & beading.

8.10 Flush Door Shutters

Unless otherwise specified, flush door shutters shall have a solid/cellular core, a teak wood frame, and shall be faced with approved quality of plywood on both faces. The core and stock shall

be made from well seasoned approved timber and treated with approved preservatives. The plywood faces shall be glued on to the solid/cellular core with waterproof glue under pressure and heat. The construction of flush doors shall be such that no difficulty should arise in fixing mortice locks, hydraulic door closers etc. The shutters shall be rebated in the case of the double leaf doors. Where specified flush doors shall be provided with vision panels, rectangular/ round or louvered.

If specified so, the flush door shall be solid block board core or solid particle board core construction. The workmanship and overall finish shall be of very high standard and shall conform to IS:2191 (Part 1&2)-1983 & 2202 (Part 1&2)-1983 to 1991. The shutters shall be procured from approved manufacturer bearing IS certification mark only.

8.11 Other types of shutters

8.11.1 Wooden hand rails

Wooden hand rails shall be of approved quality teak wood fixed to concrete or metal balustrade with concealed steel or metal lugs and bolts as per drg. Joints will be made with concealed crews and dowels. All bends, mitres, coves, moulds etc. will be strictly to proper profile and finally smoothened by sand paper. The hand rail shall be finished with wax or french polish or painting as per direction of the engineer.

8.11.2 Hardware fittings for door, windows & ventilators

All mortice or rim locks, latches, cabinet and wardrobe locks, hydraulic door closers, floor springs etc. shall be of Godrej, Everite make or of similar approved make. The rate shall include for all necessary screws, other adjuncts, fixing in position and is for the completed work. the finish shall be as specified in the schedule of quantities. Door, window and ventilator fittings shall be as per specifications already described. The rates for doors, windows and ventilator shutters shall include the cost of fixing the fittings, with the necessary screws to the shutters and the frame. The cost of fittings only shall be paid separately. Where specified in the schedule of quantities, the cost of fittings shall be included in the rates for doors, windows and ventilators shutters. In such case the contractor shall supply and fix the various fittings strictly to the standard laid down in the schedule of hardware fittings and no separate payment for this shall be made.

8.12 Inspection

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied until the wood work has been inspected and passed by the Engineer.

The Engineer shall have the option of rejecting any article or asking for replacement of any article found to be defective or not complying with the requirements of this specification and the relevant Schedule of Items.

9.0 METAL DOORS, WINDOWS AND ROLLING SHUTTERS

9.1 General

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall conform to IS:1038-1983 & IS : 1361-1978 as applicable.

9.1.1 Frames shall be constructed of sections which have been cut to length and mitred. They shall be morticed, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Flash butt welding or any other suitable method which gives the desired requirement, with mitred corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place. All frames shall be square and flat. Door thresholds shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

9.1.2 The Contractor shall first submit for the approval of the Engineer, the name and address of the manufacturer whose metal casements and doors and windows he intends to use, together with typical drawings and specifications, describing the details of construction for each type of door/window/ventilator etc.

9.1.3 All steel doors, windows and ventilators shall be either galvanised or painted. All steel surfaces shall first be thoroughly cleaned free of rust, scale or dirt and mill scale by pickling or similar process and then shall be painted with one coat of an approved primer conforming to IS : 102-1962 before despatch. Alternatively they may be galvanised by the "Hot Dip" zinc spray or electro- galvanizing process as described in IS : 1361-1978.

9.2 Fixing

Doors, windows and ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, as laid down in IS : 1081-1960. Holes to accommodate the fixing lugs are to be left or cut, and the casements fixed after all the rough masonry and plaster work have been finalised. The lugs of the

casement shall be jammed in cement concrete (15C Mark)/(1:2:4) mix after holding the casement in proper position, line and level.

The width of the clear unfinished opening in the wall should be 25 mm more than the overall width of the door frame to allow for plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 6 mm space is left between the door and the finished floor.

9.3 Fittings

Hardware shall be fixed as late as possible, preferably just before the final coat of paint is applied. It shall be fitted in a workmanlike manner, so that it may not work loose and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation. Where specified, doors shall be fitted with a three-way bolting device which can be operated from outside as well as inside, and a locking system, which can similarly be operated from either side. Solid steel bolt handles shall be provided, one on the outside and one on the inside of each shutter. In case of doors provided with a service door, the lock shall be fitted on the service door. All materials shall be the best procurable and shall be approved by the Engineer.

9.4 Normal Steel Plate Doors

Steel doors may be of the hinged type or sliding/ folding type, single shutter or double shutter, and of single-walled or double walled construction, as specified on the drawings or Schedule of Items. All doors shall be provided with a sturdy frame and hold fasts for fixing into the wall. Unless otherwise specified, the frame shall be prepared from mild steel angles of size not less than 65 x 65 x 6 mm electrically welded at the corners and the shutter shall be made from flat steel sheet of 18 gauge or 1.25mm thickness with a frame of mild steel angles not less than 50 x 50 x 6 mm all round, suitably braced. The whole shutter shall be of welded construction and shall be hung at the sides by means of three or four hinges as specified.

9.4.1 Double Plate flush door shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G or 1.25mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 20G or 0.99mm thick stiffeners, spot welded in position at not more than 150 mm on centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally

by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper level on lock stiles and rails and shall be reinforced at corners to prevent sagging or twisting. Pairs of double doors shall have meeting style edges bevelled or rebated. Where shown on drawing, or in the Schedule of Items, the doors shall be sound-deadened by filling the inside voids with mineral wool or other suitable approved materials. Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardwares where necessary. Any drilling and tapering required for surface hardware shall be done at site. Where shown in drawing, provisions, shall be made for fixing glazing, vision panels, louvres etc. Glazing mouldings shall be of 18G or 1.25mm thick steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvre blades shall be V or Z shaped sections.

9.4.2 Single sheet door shutters

Single sheet doors shall be made from best quality 18g/1mm mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semi-tubular edge and central stiffening rail which shall convey the lock and other fixture. The frames shall be made from best quality steel sections. Wherever required or shown on drawings, provision for fixing glass panes, louvres etc., shall be made.

The manufacturing shall done as specified in "Double Plate Flush Door Shutters".

9.5 Pressed Steel Doors

All pressed steel doors shall be obtained from an approved manufacturer. The frame and shutters shall be fabricated from cold rolled or pressed steel sections. Unless otherwise specified, the thickness of all sheets used for frames shall be not less than 5 mm. The shutters shall be made of sheet steel of 2 mm thickness for single shutter doors and double shutter doors with or without service door. The plates shall be adequately stiffened with suitably placed stiffeners

The double-walled door shutter shall consist of two plates each 2.5 mm thick, separated by a gap of 33 mm in between making an overall thickness of 38 mm or as shown in drawing. The plates shall be adequately stiffened by means of suitably spaced horizontal steel stiffeners.

9.6 Steel Windows, Sashes, Ventilators, etc.

These shall conform to IS : 1038-1983 and IS : 1361-1978 as appropriate and as shown in drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

9.6.1 Where composite unit openings are shown in drawings, the individual window units shall be joined together with requisite transoms and mullions. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown in drawings.

All welds at the corner of casement shall be done by flash butt welding process or any other suitable method which gives the desired requirement and dressed flush on all exposed and contact surfaces.

9.7 Collapsible Gate (Steel)

Mild steel collapsible gates shall be obtained from an approved manufacturer. These shall be of mid bar type made out of double channels each 20 x 10 x 2 mm with 20 x 5 mm diagonals and shall be top hung with roller bearings, and fitted with locking arrangement.

Collapsible gates under 3.0 metre height shall generally have 3 sets of lattices and those over 3.0 metre height, 4 sets of lattices. Guide tracks shall be fitted at the top and bottom, of T-iron 40 x 40 x 6 mm with 40 mm dia bearings in every fourth double channel

9.8 Steel Rolling Shutters and Grills

9.8.1 Unless otherwise specified the shutters shall conform IS:6248-1979. Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

9.8.2 Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods. End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the

torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.3 Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load. Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods.

9.8.3 End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation. Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.5 Manually operated shutters/grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 0.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 sqm in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank/handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule of Item or as desired by the Engineer.

9.8.6 Priming coat of shop coat

Shutters shall be painted with one coat of red lead or zinc chromate primer after they are inspected and found in order and acceptable. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

9.8.7 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc., shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with prevailing Indian Electricity Rules.

9.8.8 Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

9.8.8.1 Field inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

9.9 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

9.10 Aluminium Doors, Windows, Frames

9.10.1 Anodised tubular aluminium doors shall be of approved make and shall be of size and design as per relevant drawing. Unless otherwise specified, the door frame shall be of 101.4mm x 44.6mm and shutter of 50mm tubular extrusions, 3mm thick. The opening arrangement shall be single action or double action as shown in drawing with spring hinges in floor. The glazing shall be 5.5mm thick plain glass panes fixed with necessary gaskets and aluminium beading strip. The door shall be provided with one security lock. The shutters shall be provided with 1.6mm thick 300x150mm push plates and 1.6mm thick 300mm

wide kick plate of anodised aluminium for full width of door inside and outside.

The door frames shall be polished and anodized with approved colour. The average thickness of anodic coating shall not be less than 15 microns as per IS: 1868-1982. Door frame shall be provided with approved anchors @ 90 cm c/c maximum for fixing.

9.10.2 Aluminium windows

Aluminium windows and ventilators shall conform to IS:1948-1961 or equivalent as approved by the Engineer. Fixed frame shall be manufactured from aluminium alloy conforming to ISS-HE-9 WP. The fixtures like handles, stoppers, stays, etc., shall also be anodized aluminium and shall be of approved make. Glazing shall be 4mm thick plain glass and shall be fixed with glazing clips and metal putty. It shall conform to IS:1081-1960. Average anodizing coating to windows, ventilators and fixtures shall not be less than 15 microns as per IS : 1868 - 1982.

9.10.3 All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be shape fit type without visible screws and shall be of sizes to accommodate glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

10.0 GLAZING

10.1 General

Glazing shall be done with plain, frosted, ground glass or wired cast glass, laminated safety glass or toughened glass etc. as shown on drawings, described in the Schedule of Items or approved by the Engineer. The method of glazing adopted shall be such that movement of the structure, to which the securing is done, does not transmit strain to windows, doors or ventilators as the case may be. The work shall generally conform to IS:1081-1960 "Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators". The material for putty shall consist of whiting and linseed oil, raw-mixed in such proportion as to form a paste conforming to IS : 419-1967.

10.2 Doors, Windows and Ventilators

Windows and ventilators shall be designed for putty glazing fixed from outside and glazed doors for fixing from inside. In addition, spring type glazing clips shall be provided at intervals of 30 cm, or as shown otherwise on drawings or described in the Schedule of Items. These shall be inserted into holes drilled in the shutters or frames as the case may be.

All glazing shall be puttied to the shutters of frames with good quality putty in addition to glazing clips. Glass panes shall not be placed directly against the metal/timber. A thin layer of putty shall be even spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by means of teak wood beads for wooden shutters. Glass panes shall be set without springing & shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty etc. shall be smoothly finished to even lines. Figured glass shall be set with smooth side out. After completion of glazing work, all dirt stains, excess putty etc., shall be removed and the glass panes shall be left in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's cost.

10.3 Northlight Glazing

This shall consist of aluminium or steel glazing bars as shown on drawings or described in the Schedule of Item and be subject to approval of Engineer.The glazing parts shall be securely fixed in their frame and shall be weather-proof. All glazing shall be flashed to the surrounding so as to be weather-proof. Glass shall be fixed to the a astragals with glazing clips and putty.

11.0 WHITE WASHING, COLOUR WASHING AND PAINTING

11.1 Scope

This chapter deals with white washing, colour washing, distempering, cement washing, emulsion painting, silicate painting etc., to concrete and masonry surfaces and painting to the wood works and steel works. For the items which have not been completed or partly covered in this chapter, specifications suggested by the manufacturers for the materials, surfaces preparation, workmanship and all bye works shall be strictly followed and shall be carried out as per direction of the Engineer.

11.2 Materials

Materials shall conform to Part - I

11.3 White Washing, Colour Washing

11.3.1 General

Wherever scaffolding is required/necessary, it shall be erected on double support tied together by horizontal pieces, over which the scaffolding planks shall be fixed. No part of it shall rest on or touch the surface which is being washed/painted. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls. For white washing the ceiling, proper stage scaffolding shall be erected. The surface on which wash is to be applied shall be thoroughly brushed free from mortar droppings and foreign matter.

11.3.2 White Wash

The wash shall be prepared from fresh stone white lime of approved quality and shall be thoroughly slaked on the spot mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and then shall be screened through a clean coarse cloth. 4 Kg of gum dissolved in hot water shall be added to each cubic metre of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 Kg of lime. Indigo/ultramarine blue upto 3 gm per kg of lime dissolved in water shall then be added and wash stirred well. Water shall then be added at the rate of about 6 litres per kg of lime to produce a milky solution. The white wash shall be applied with approved brushes to the specified number of coats. The operation for each coat shall consist of stroke of brush given from the top downwards, another from the bottom upwards over the first stroke and similarly one stroke horizontally from the right and another from the left before it dries. The white washing on ceiling shall be done prior to that on walls.

Each coat shall be allowed to dry before the next one is applied and shall be subjected to inspection and approval by the Engineer. No portion of the surface shall be left out initially to be patched up later on.

The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed. Doors, windows, floors and such other parts of the building not to be white washed shall be protected from being splashed upon.

11.3.3 Colour Wash

A priming coat of white wash with lime shall be applied before applying two or more coats of the colour wash (as specified). Entire surface should represent a smooth and uniform finish. Sample of colour wash

shall be duly approved by the Engineer before application. Same specification as that of white wash shall be followed for colour wash also using necessary amount of colouring ingredient of approved tint.

11.3.4 White Washing with Whiting

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. 2 Kg of gum and 0.4 Kg of copper sulphate dissolved separately in hot water shall be added for every cum. of slurry which shall then be diluted with water to the consistency of milk so as to make wash ready for use. Other specification remains same as per white washing with lime.

11.4 Cement Primer Coat

The surface shall be thoroughly cleaned of dust, mortar, droppings etc., and shall be allowed to dry for at least 48 hours. It shall then be rubbed thoroughly be sand paper to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry. The cement primer shall preferably be applied by brushing and not by spraying. Horizontal strokes shall be given first and vertical strokes shall be applied immediately, afterwards. This entire operation will constitute one coat. The surface shall be finished as smooth as possible, leaving no brush marks.

11.5 Water-proof cement paint

The prepared surface shall be thoroughly wetted with clean water before water proof cement paint is applied. The paint shall be prepared strictly as per manufacturer's specifications, in the absence of which it shall be mixed in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. The paint shall be mixed in such quantities as can be used up within an hour of its mixing.

Paint shall be applied with brushes or spraying machine The solution shall be kept well stirred during the period of application. It shall be applied as far as possible on the surface which is on the shady side of the building so that direct heat of the sun on the surface is avoided. Painted surfaces shall be sprinkled with water 2 or 3 times a day. This shall be done between coats and for at least 2 days following the final

coat. The curing shall be started as soon as paint has hardened so as not to damage by sprinkling of water say about 12 hours after the application. A uniform shade should be obtained after application of paint. Cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper, varnish paint etc., and on gypsum, wood and metal surfaces.

11.6 Synthetic washable distemper

The surface shall be prepared as for Cement Primer Coat. A primer coat of cement or distemper primer shall be applied as specified in the description of the item. Unevenness in the plaster shall be made good by applying plaster of Paris putty mixed with distemper of the colour to be used on the entire surface including filling up the undulations. The surface shall then be rubbed down with a fine grade sand paper and made smooth. After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth, taking care not to rub the priming coat out. All loose particles shall be dusted off. One coat of distemper properly diluted with thinner, shall be applied with brushes/rollers in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied to obtain an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats. The brushes shall be of 15 cm. double bristled type. They shall be maintained in proper condition and those that are dirty or caked will not be allowed to be used. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc. Sufficient quantity of distemper shall be mixed to finish one room for applying one coat in one operation.

11.7 Dry Distemper

The surface shall be prepared in the same manner as for synthetic washable distemper. A primer coat using approved whiting shall be applied over the prepared surface. Distemper prepared as per manufacturer's direction shall be applied and each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be free from chalking when rubbed, even, uniform and shall show no brush marks.

11.8 Plastic emulsion paint

The surface on which plastic paint has to be laid must be thoroughly cleaned and prepared and all defects rectified and finally prepared in the same manner as for synthetic washable distemper. The surface shall be dry and rubbed smooth by means of sand paper to the satisfaction of the Engineer. One coat primer and two coats of plastic

emulsion paint are to be applied. The work is to be carried out under direct guidance and instructions from the manufacturers whose expert advise and supervision are to be made available in order to achieve the high grade finish. The painters employed for this work must be capable of producing the highest standard of workmanship required. If the finish is of doubtful nature, the contractor shall have to rectify at his own cost to the entire satisfaction of the Engineer.

11.9 Bitumen painting

Bitumen painting to concrete surface shall be done as follows :

(i) Hot application

The surface shall be cleaned of all mud etc., before painting. The honey-combs and other defects of concrete surfaces to be painted shall be rectified properly. Any projection of binding wire shall be cut to keep it 10 mm inside the concrete surface and then filled with mortar. Before application the surface shall be absolute dry.

Bitumen of standard quality as specified shall be heated to the temperature specified by the maker and then applied hot with brushes on the prepared surface. The surface shall be allowed to cool before applying the second coat.

(ii) Cold application

The surface shall be prepared in the same way as for hot application. The bitumen emulsion of approved quality shall be applied with special brushes. Where acid resistant treatment is specified such surface shall be covered with approved acid resisting coating to the satisfaction of the Engineer. Before the coating is applied, the surface shall be properly cleaned and prepared in the manner described above.

11.10 Tarring

(i) Timber surfaces in contact with earth/concrete/ plaster shall be treated with one coat of hot tar or as specified in schedule before fixing.

(ii) If required steel work in holdfasts and the like shall be treated as above and sanded in addition before being fixed in position.

11.11 Painting to Timber & Steel Surface

11.11.1 General

The priming coat for steel/wood work shall be applied after the surface has been prepared. After the priming coat has dried, all nails, screw holes and cracks shall be filled with putty and surface smoothened with sand paper.

All surfaces must be thoroughly dry before painting work is started and painting in exterior/exposed parts shall not be taken up in wet/humid or otherwise unfavourable weather.

All stains of paint to glasses, walls, fittings and fixtures etc. shall be cleaned thoroughly by applying required turpentine or thinner. The contractor's rate shall include all these.

11.11.2 Painting to timber

(i) Unless otherwise specified, all timber surfaces shall be treated with one priming coat, one under coat and one finishing coat. Under coat and finishing coat shall be synthetic enamel or as specified. Priming coat shall be of approved primer. In case the surface is to be polished or varnished, a priming coat as approved or specified shall be given. No primer shall be applied to wood work until it has been inspected and passed by the Engineer.

(ii) Polishing

The surface to be polished shall be prepared in the same manner as specified under painting.

(iii) French Spirit Polish

After preparation of the surface it will be well dusted and then the pores of the wood shall be filled up with a filler made of a paste of whiting in water or methylated spirit with a pigment if so required. The spirit polish shall be prepared by dissolving pure shellac in methylated spirit, @ 0.75 Kg of shellac to 5 litres of spirit, with the addition of pigment if so required.

The polish shall be applied with a pad consisting of cotton wool inside a clean white cloth. Several coats shall be applied with light sand papering from time to time and cleaning the dust before applying next coat except the final coat. The final coat of the polish shall be rubbed thoroughly until the wood feels perfectly dry when touched and gives a satisfactory smooth shining.

(iv) Wax Polishing

After preparation of surface wax polish will be applied. The polish shall be prepared by heating together 2 parts of pure bees wax and boiled linseed

oil each over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and one part of genuine turpentine is to be added and entire mixture shall be well stirred.

Polish shall be applied in the same manner as specified for spirit polish.

11.11.3 Painting to Steel Surface

11.11.3.1 General

All surfaces shall be thoroughly cleaned of all dirt, grease, rust and mill scale. Areas which become inaccessible after assembly shall be painted before assembly after cleaning the surfaces as described above. The surfaces shall be perfectly dry before painting.

Wherever shop primer painting is damaged, the surfaces shall be thoroughly cleaned and touched up with corresponding primer.

Site painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surface to be painted.

11.11.3.2 Steel Structures

Unless otherwise specified all structures shall be painted with two coats of primer. One coat shall be applied at shop and the second coat at site. All structures after erection shall be given two coats of finishing paint and shall be of synthetic enamel of approved colour. The under coat shall have different tint to distinguish from the finishing coat.

11.11.3.3 Galvanized Iron Sheets

All plain and CGI sheets requires surface pre-treatment or use of other patented primer to ensure adhesion of paint to zinc coated surfaces. Such pre-treatment shall be as per manufacturer's specifications. Where pre-treatment is adopted one coat of primer paint of suitable quality shall be applied. Unless otherwise specified the finishing coats shall consist of an under-coat of an aluminium paint having blue tint and a second coat of aluminium paint having aluminium colour.

11.11.3.4 Structures embedded

Exposed surfaces of embedded parts shall be given two coats of red lead graphite primer at shop and finished with two coats of anti-corrosive paint at site after embedment. Type of paint and procedure of painting shall be as per manufacturer's specification. Surfaces to be

field welded shall have no paint applied within 100 mm of the welding zone.

12.0 INTERNAL WATER SUPPPLY PLUMBING, DRAINAGE & SANITATION

12.1 Scope of Work

The work comprises supply, laying testing, commissioning etc. of water supply, plumbing, drainage & sanitation.

The work includes the following activities connected with the job :

i) Supply and delivery of all required pipes and other materials.

ii) Earthwork in excavation for trenches, pits/chambers/manholes etc.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the wall etc. and repairing them after pipe erection, construction of pipe supports, valve chambers, manholes, bedding and covering of pipe laying wherever required.

iv) Laying and jointing of pipe lines as specified in this chapter

v) Testing of pipe lines after laying as per standard tests specified in this chapter.

vi) Back filling of trenches after successful and satisfactory testing.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network.

ix) Safe custody of the pipes/materials/equipment/work and other obligation stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

12.1.1 Materials

The materials shall conform to Part-I of this series.

12.2 Water Supply & Plumbing

12.2.1 General

12.2.1.1 General Requirements

The Contractor shall lay all the pipes and fittings in the best workman like manner by skilled workmen and licensed plumbers in conformity with the regulations and requirements of the local appropriate authorities and to the satisfaction of the Engineer. Unless otherwise specified water supply works in buildings shall be carried out in accordance with IS:2065-1983 "Code of Practice for Water Supply in Buildings" & IS:2064-1993 "Code of practice for selection, installation and maintenance of sanitary appliances".

12.2.2 Installation

All works like earth work, masonry, concrete, steel work, cutting holes, chases in brick, concrete & RCC works, cutting of roads, repairs and rectifications associated directly with the installation of water supply system shall come under the scope of the contractor and shall be governed by the specification of the relevant chapter.

12.2.3 Laying

Before lowering down for laying in the trenches, the pipes shall be checked against crack by means of light hammering and for any other damage. All fixing shall be carefully aligned and spaced at a distance from the main structure to give reasonable all round access for maintenance and inspection and laid true to line plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface holder or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. If situation requires, pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer. Pipes embedded in floors and wall shall be securely bound so as not to allow any movement due to expansion and contraction. adequate width shall be provided to lay the pipes as per standard practice.

Excavation below the required level is not permitted. The contractor shall make good any excess excavation as directed by the Engineer.

Soft spots in the bottom of beds for pipe lines in rock shall be leveled with sand or soft soil or concrete as approved by the Engineer and the thickness of the layer shall not be less than 100mm.

12.2.4 Excavation for pipe lines in trenches

Excavation shall comply with chapter 2. The sides of pits and trenches shall be adequately supported at all times, except where otherwise directed by the Engineer.

12.2.5 Underground piping in and around building

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable, and as shown in the drawing and instructed by the Engineer. The thrust blocks shall be provided wherever required.

The size and depth of the trench shall be as approved by the Engineer. Backfilling in trenches shall be done with selected fine earth, unless otherwise permitted, in 150mm layers and carefully consolidated and well treated so that it does not set as a drainage channel. Special care shall be taken while filling in the vicinity of the pipe to avoid damages. Before backfilling the laid pipe shall be fully tested and approved.

12.2.6 Concealed piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the adjoining structure by making chases in walls/floors and these shall be secured by hooks and the chases filled with concrete 1:2:4 (1 cement, 2 sand and 4 aggregate). The contractor will rectify, if required the chases, openings and pipes, supplement and make good after laying and testing of the concealed pipelines.

12.2.7 GI.Piping

12.2.7.1 The pipes shall be fixed in longest lengths possible with all necessary bends, tees, couplings, reducing ockets, short piece, jamnut and tees etc. in perfect straight lines both vertically and horizontally.

12.2.7.2 All exposed GI pipes shall be fixed at least 15mm clear of wall face with holder bat clamps at suitable places not exceeding (2.5 metres) centre to centre. Where the pipes are laid in chases in walls as shown in the drawing, these shall be secured to walls by hooks. Chases in walls and floors shall be filled in with cement concrete 1:2:4. Where the pipes are to be run underground these may be laid at least 60 cm below ground level.

12.2.7.3 The joints of pipes and fittings shall be sealed with red lead paint and fine spun yarn. Joints must be perfectly water tight when put under maximum test pressure.

12.2.7.4 Unless otherwise specified the exposed portion of pipes and fittings shall be given two coats of approved synthetic enamel paint over a coat of approved priming. Pipes laid underground or concealed in walls/floors shall be treated with two coats of bituminous paint.

12.2.8 Jointing of pipes

The interior of all pipes and joints shall be cleaned before jointing commences. Jointing of pipes shall be done in such a manner as to render them completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, the general norms and recommended practices for different types of pipes are given below for guidance :

(a) Cast Iron

i) Spigot and socket joints :

Interior surface of bells and exterior surface of smooth ends of pipes shall be cleared of redundant insulating cover and other foreign materials particularly of oil, burning off materials from bells and smooth pipe ends. Sharp rises on interior bell surface shall be smoothed out.

Bells should be lined up, in compliance with direction of pipe. Laying work shall be started from lower points.

ii) Lead and Flanged Joint :

Lead joints shall be made as per Sl. 15.4.6.1 and flanged joints as per Sl. 15.4.6.2 of chapter 15.

b) Steel Pipes

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove burring from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer.

c) G.I Pipes

Threads shall be cut with, sharp tools, and before jointing all scale shall be removed from pipes by suitable means. The screw threads of the pipe shall be cleaned out and the joint made by screwing the fitting after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) Asbestos cement pipes

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

12.2.9 Precautions

a) All water supply pipes shall be so laid and so fixed and maintained as to be and remain completely water tight.

b) During installation open ends of each pipe shall be protected by suitable covers or plugs so that the ends, thread, sockets or spigot are not damaged and no foreign materials can make its way into the pipe line.

c) Due care should be taken to ensure that there shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting containing impure water or water liable to contamination or of an uncertain quality of water which has been used for any other purposes.

d) Fittings and fixtures liable to be stolen shall be fitted and fixed just before testing and handing over.

12.2.10 Painting

When mentioned in the schedule of item underground steel and cast iron pipes shall be treated with 2 coats of anticorrosive bituminous paint on the outside surface after cleaning the surface from soil, dust, moisture, rust, scales soot etc. When painting is to be done for pipes above ground, G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer over which at least 2 coats of paint of best quality and manufacture as approved by the Engineer shall be provided or as specified in the schedule of item.

12.2.11 Ferrule and stop cock box with chamber

Square cast iron surface box 15 cm square and 22.5 cm deep weighing not less than 4.54 Kg with hinged lid shall be provided in masonry chamber. Top of box shall be made flush with the finished level of the chamber. The chamber 25cm x 25cm inside shall be with half brick wall in cement mortar 1:4 over a cement bed concrete of 75mm thick in proportion 1:4:8 with stone chips. The inside wall faces shall be plastered with 12mm thick cement mortar 1:4 finished smooth with a floating coat of neat cement.

The exposed surfaces of cast iron box and cover shall be treated with two coats of bituminous paint.

12.2.12 Inspection, Testing and Acceptance

12.2.12.1 Pipes, fittings and fixtures before laying

All pipes, fittings and appliances shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be

inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

12.2.12.2 Testing of pipes after laying

General

a) The contractor shall ensure the safety of the pipe work under test and provide all necessary stoppers, testing apparatus etc. that are required for testing.

b) The contractor shall be responsible for any damage done to pipe work and ancillary work while testing and shall replace any pipe or fitting which does not satisfactorily withstand the test.

c) The contractor shall give written notice of the times at which tests are to take place. On completion of each test two copies of the complete records shall be given to the Engineer.

d) The work will not be considered complete until the tests are found satisfactory and a certificate issued by the Engineer.

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits and then tested under pressure. The test pressure shall be 6Kg/cm2 or double the maximum working pressure, whichever is greater The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or a large diameter, by a power driven test pump, provided that pump is not left unattended. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been re-calibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

12.2.12.3 Testing of service pipes and fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All pipings, fittings and appliance shall be checked for satisfactory support and protection from damage, corrosion and frost.

12.2.13 Storage Tank

12.2.13.1 Pressed steel tank

Pressed steel water storage tanks shall be of nominal size and capacity as mentioned in the Schedule of Item and fabricated with all flanges external / internal or bottom flange internal and side flanges external, as shown on drawings or schedule of items. Inlet, overflow, vent pipes and manholes shall be arranged and provided as shown in drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50mm above the bottom of the tank and there shall be 150mm free board at the top of the tank. The fabricator shall supply 5 prints of fabrication drawing to the Engineer for prior approval showing thickness of plates, method of jointing the plates. All supports, stays, gussets etc. Pads, cleats etc., required for supporting the tanks shall also be supplied by the manufacturer.

All tanks shall be supplied with mosquito-proof top with manhole not less than 450mm diameter. Tanks deeper than 1.00 Metre shall be provided with M.S. internal access ladder adjacent to the manhole. Meter level indicator shall be provided if asked for. Two coats of

anticorrosive paint over a suitable primer shall be applied to both internal a external surface of tanks. The paint shall be so selected as not to impart any taste or odour of water and be of lead free composition.

12.2.13.2 G.I. Water Tank

G.I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanized iron water storage tank shall be made of minimum 16 gauge galvanized iron sheet. Unless otherwise specified plain sheets shall be fixed at the corner to angle iron frames by means of 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised iron stays, one fixed to angle framing at topand two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. Lead shall be applied to the joints before rivetting.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks unless otherwise specified shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on drawing and 40 mm dia. G.I. overflow pipe and 25 mm washout with plug. If specified the rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve shall permit the entry of water when the tank is empty and disconnect the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hard rubber, 110 mm in diameter attached to an arm which is so pivoted that the end near the pivot close the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution. The ball valve shall be fixed to the tank in such a position that the body of the ball valve submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water in the tank below the lip of the over-flow pipe, and above the maximum water filled level shall be as per the standard norms for GI water tank.

12.2.13.3 Water reservoirs made of concrete or masonry shall be governed by the specification in the relevant chapter. It shall have, inlet, outlet,

overflow and wash out with plug and a top MS/CI cover as per schedule of items and drawings.

12.3 Drainage and Sanitation (Internal)

12.3.1 Scope

This section covers the layout and construction of drains for waste water, surface water and sewage together with all fittings and fixtures inclusive of ancillary works, such as connectins, manholes and inspection chambers used within and around the building and the connection to a public sewer upto treatment work, septic tank and soak pit. All sewerage and drainage works shall be executed in accordance with specifications given for different works. All sewerage and drainage works shall be executed by a licensed plumbing supervisor or a licensed plumber and in accordance with IS : 1742-1983 "Code of Practice for Building Drainage" unless otherwise specified.

12.3.1.1 Installation

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumbs, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and shall be located so as to allow easy maintenance.

All pipelines, fittings and fixtures shall be installed leakproof; when the works under scope of this specification are linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gasses.

12.3.2 Rainwater Downcomers

Rainwater downcomers shall be standard cast iron or asbestos cement pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paint over a coat of primer. Rain water downcomers shall run along and be secured to walls columns, etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clamp type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed. Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with

removable gratings. All horizontal pipes shall have a minimum fall of 1 in 100.

12.3.3 Gutter

The gutters shall be made of G.I. or A.C. Gutters shall be supplied by reputed specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. GI gutters shall have the edges strengthened by suitable means. The joints may be made by rivetting, bolting or soldering.

Unless specified otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no deflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated of MS brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater downcomers shall be made fully watertight and secured.

12.3.4 Soil and Drainage Pipes

12.3.4.1 Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

12.3.4.2 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and soil pipes be allowed to come close to water supply pipelines.

12.3.4.3 Laying

Each separate pipe shall be individually set for lines and levels. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or

sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 16 m apart. The excavation shall be boned in at least one in every 2 m. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

12.3.4.4 Support and protection on pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointings.

Where pipes are not bedded on concrete, the bed shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of sand or gravel as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 1 metre and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased surrounded with concrete as per IS:4127-1983.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipes, the sewer shall be bedded on concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched with concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

d) Where maximum water table is likely to rise above the top of the barrel the pipe sewers shall be completely encased/surrounded with 1:4:8 concrete with 20mm down aggregate as per IS:4127-1983.

Vitrified clay pipes shall be laid on a bed of 150mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The support shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

12.3.4.5 Entry into structures

For entry of the pipes lines into any building or structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. Where openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline, the openings and chases shall be mended.

12.3.4.6 Traps and Ventilating pipes

a) Pipes carrying the sewage from water closets and waste water and overflow water from baths, wash basins, sinks shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600mm above the outer covering of the roof top of the building or as shown on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

Connecting to existing sewer lines shall be through a manhole.

b) Sand Cast Iron Spigot and Socket pipe and fittings

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS:1729-1979. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior. of the pipes and fittings shall be clean

and smooth and painted inside and outside with Dr. Angus Smith's solution or other approved anticorrosive paint. Fittings shall include bends, offsets, branches of various types, junctions etc. as required for the work which shall be provided according to drawings and directions of the engineer.

The fittings shall be provided with access doors where so specified or directed by the engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3mm thick rubber insertion packing, and when closed and bolted they shall be watertight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

Fixing

The pipes and fittings shall be fixed to wall by means of MS holder bats clamp of approved type and steel bolts or by pipe nails, bobbins etc. as the case may be, keeping the pipe clear from the finished surface of the wall. The holder bat nails shall be fixed to the wall in wooden block. The soil pipe shall be supported at the foot upon a bed of cement concrete of proportion 1:3:6 and firmly attached to the wall.

The pipes shall be laid truly vertically or along the line as shown in the drawing. Connection between main pipe and branch pipe shall be made by using branches and bends with access door for cleaning.

All vertical soil waste, ventilating and anti-siphonage pipes shall be carried up above the roof and provided with suitable C.I. cowl on top.

Pipes outside the building shall be laid underground for which trenches shall be excavated as required for the work. The trenches shall be back-filled with excavated material after the drainage system has been tested and passed.

Jointing (Lead Caulked Joint)

Unless otherwise specified, the pipes and fittings shall be jointed with lead joints as described below :

The annular space between the socket and spigot will be first well packed in with tarred gasket or hemp yarn leaving 25mm from the lip of the socket for the lead. The joint may be leaded by using proper leading rings or if they are not available by wrapping a ring of hemp rope covered with clay round the pipe at the end of the socket, leaving a hole through which lead shall be poured in (for pipes with sockets facing a upwards 15mm high small clay band on socket edge may be used).

The lead shall be rendered thoroughly fluid and each joint filled in one pouring. Before caulking, the projecting lead shall be removed by flat chisels and then the joint caulked round with proper caulking tools and a hammer of 2 to 3 pounds in weight in such manner as to make the joint quite sound. After being well set up the joint is to be left flush neat and even with the socket.

Lead for caulking shall conform to IS:782-1978.

Painting

All the exposed CI pipes and fittings shall be painted to match the colour of the surroundings. The surface of the pipes and fittings to be painted shall be cleaned thoroughly and painted 2 coats with approved paint over and including 1 coat of approved primer. Pipes laid underground shall be painted with 2 coats of anti-corrosive paint.

12.3.4.7 Cutting of pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

12.3.4.8 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and man- holes shall be gas tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

(a) Sand Cast Iron Pipes

Jointing of cast iron pipe shall be done as described in Sl. No. 12.3.4.7(b).

(b) Concrete pipes

i) Spigot & Socket Joint

The opening of the joint shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool.

ii) Collar Joint

Joint shall be done by slipping the collar over and clear of the end of the pipe. The recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen. Care shall be taken that no off-set of the jute braiding shall be visible either outside or inside the pipe. The collar shall be then set up over the joint covering equally both the pipes and leaving an even caulking space all round. cement and sand mortar (1:1.5) shall then be well punched or pressed home with a caulking tool.

(c) Glazed stoneware pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the socket. The reminder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. When the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 degree with the barrel of the pipe. The newly made joints shall be protected, until set, from sun and rain and shall be covered with damp sacking or other suitable materials.

12.3.5 Trenches and other excavations

Excavation shall be carried out according to chapter-2, Earthwork.

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench. The spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work. Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement. All excavations shall be properly timbered, where necessary. Efficient arrangements for dewatering during excavation

and keeping it dry till back filling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the contractor from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken for packing with selected material in areas 300 mm around the pipe. At least 300 mm over the pipe shall also be filled with soft earth or sand.

Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All settlements shall be made good regularly to minimise inconvenience or traffic where applicable.

12.3.6 Installation of fittings & fixtures

12.3.6.1 General

All fittings & fixtures shall be laid out as per drawings and in proper line, level and shall be firmly secured to floors with screws and ditto fix and to walls with wall plugs and screws. Unless otherwise specified only C.P. Brass screws shall be used for fixing sanitary fittings to wall plugs and floors.

12.3.6.2 European pattern WC

Water closet shall be fixed with floor by means of 75 mm long, 6.5 mm diameter counter sunk bolts & nuts embedded in floor using rubber or fibre washers so as not to allow any lateral displacement.

12.3.6.3 Indian Patttern W.C.

The water closet pan shall be sunk into the floor and embedded in a cushion of average 150 mm cement concrete 1:4:8 (1 cement, 4 sand and 8 broken brick ballast of 40 mm size). The concrete shall be left about 125 mm below the top level of the pan so as to allow for flooring and its bed concrete. The joint between the pan and trap shall be made with C.M. 1:1 and joint between trap and CI soil and waste pipe to be made with lead. All the joints shall be leak proof. The WC floor

shall slope towards the pan. The foot rest shall be set in cement mortar 1:3 (1 cement : 3 sand).

The cast iron cistern, brackets and flush pipe etc. shall be painted with two coats of approved paint, over and including a coat of approved priming.

12.3.6.4 Wash basin

Wash basin shall be fixed to C.I./R.S. brackets fixed in cement mortar 1:3 (1 cement :3 sand). The brackets shall be fixed to approved wooden wall plugs with screws. C.P. brass trap and union shall be connected to waste pipe if specified.

12.3.6.5 Urinals

The urinal shall be fixed to the walls with C.P. Brass screws fixed to wooden wall plugs. Urinal partitions shall be fixed to walls by making chases in walls and grouting the same in 1:2:4 cement concrete.

12.3.6.6 Mirror

Fixed type mirror shall be screwed to wall plugs with CP brass screws and shall have a backing of asbestos or similar material as specification in the item.

Swivel type mirror shall be fixed with C.P. brackets which shall be fixed to wall plugs with CP brass screws

12.3.6.7 Soap tray / toilet paper holder

This shall be of flush mounting design and shall be housed in walls by making chases and grouting the same in cement mortar 1:3 unless otherwise specified. All other fittings shall be fixed with screw or as per manufacturer's specification

12.3.6.8 Towel rail & Toilet glass-shelf unit

This shall be fixed with CP Brass screws which shall be fixed to wall plugs.

12.3.6.9 Gully trap

This shall be fixed on 100 mm thick bed and encasement of size 600mm x 600mm x full height of trap shall be provided with cement concrete of proportion 1:4:8 with 40mm stone aggregate. The gully

outlet shall be jointed to the branch drain as specified or directed by the Engineer.

12.3.6.10 Masonry chamber for Gully Trap

After fixing and testing gully and branch drain, a brick masonry chamber 300mm x 300mm x 450mm deep or as specified (internal dimensions) in cement mortar 1:4 (1 cement and 4 sand) shall be built with half brick thick wall round the gully trap from the top of the concrete. The internal faces of the chamber shall be finished smooth with 15 mm thick cement plaster (1:4) and neat cement finish. Brick wall exposed to outside shall be finished with 12 mm thick cement plaster 1:4. P.C.C. (1:2:4) band 100 mm thick shall be provided over the brick work with suitable grooves for accommodating R.C.C. cover to be supplied as per drawing and made water tight by providing suitable beading in the band.

12.3.6.11 High level flushing cistern - (fixing flush pipe & cistern)

The W.C. pan shall be connected to the cistern by G.I. 32mm dia or 40mm (O.D) high density polythene flush pipe with holder clamp and brass coupling.

12.3.6.12 Low level flushing cistern

Unless otherwise specified, it shall be connected to the closet by means of 40mm dia white porcelain enameled flush bend using rubber adaptor joints.

12.3.7 Septic tank and effluent disposal

12.3.7.1 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawing. This item shall also include ventilating pipe of at least 100mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Generally ventilating pipe shall extend to a height of about 2 metres when the septic tank is at least 15 metres away from the nearest building and to a height of 2 metres above the top of building when it is located closer than 15 metres. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

12.3.7.2 Effluent disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority

approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed S.W pipes laid in a trench filled with broken bricks.

12.3.7.3 Soak Pit

Shall be complete as shown on drawing. In absence of a detailed drawing it shall consist of a 900mm dia pit 1000mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks with dry open joints backed with at least 75 mm of clean coarse aggregate. The lining above the inlet level shall be set in cement mortar (1:6). The pit shall be filled with brick bats. Inlet pipe shall be taken down to a depth of 900mm from the top as an anti-mosquito measure.

12.3.7.4 Open jointed S.W pipes

Minimum dia of the S.W pipes shall be 200mm nominal. The trench for laying the pipes shall be minimum 600x600mm. The joints of the pipes shall be left unsealed.

12.3.7.5 Commissioning septic tank

After the septic tank has been proved water-tight and the sewage system is checked, the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow dung may be introduced.

12.3.8 Manhole/Inspection chambers

Necessary excavation as required for the manhole shall be done true to dimensions and levels as shown in the drawing. The manhole chamber shall be built with brick work in C.M. 1:4 with minimum one brick thick on a base of 100mm thick cement concrete 1:4:8 with 40mm down aggregate or as specified. The concrete bed shall extend beyond the external face of brick work on all sides by at least 75mm . The thickness of wall shall be as indicated. The work shall be carefully built in English bond, the jointing faces of each brick being wall buttered with cement mortar before laying so as to ensure a full joint.

The inside of the walls shall be plastered with 15mm thick cement mortar 1:4 and finished with a floating coat of neat cement and outside shall be plastered with 12mm thick C.M. 1:4.

The channels and benching shall be done in cement concrete 1:2:4 with 20mm down stone aggregate and finished with 12mm thick

cement plaster in C.M. 1:3. The channels shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter the top edge shall be suitably rounded off. The Branch channels shall also be similarly constructed with respect to benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow of the main channel shall be given. The benching at the sides shall be carried up in a slope of 1 in 3.

All angles shall be rounded to 75mm radius with cement mortar 1:4 and shall be rendered smooth. The internal surfaces shall have a hard impervious finish obtained by using a steel trowel.

The manhole chamber shall be covered on top with RCC (1:2:4) slab with necessary reinforcement as per drawings. Unless otherwise specified circular type light duty M.H. cover with single seal weighting 25 kg. will be provided in each RCC cover.

12.3.9 Testing and acceptance

12.3.9.1 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

12.3.9.2 Testing of pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual test shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

12.3.9.3 Smoke Test

Soil, waste, vent and all other pipes, when above ground, shall be tested for gas tightness by a smoke test conducted under a pressure of 25mm water gauge and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

12.3.9.4 Water Test

For pipes other than cast iron Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the end of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in funnel which could be raised or lowered till required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following causes :

a) Absorption by pipes and joints.

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut and made good.

12.3.9.5 For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

12.3.9.5.1 For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end and;

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

12.3.9.6 Testing septic tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15mm.

12.3.9.7 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

13.0 EXTERNAL SEWERAGE & DRAINAGE

13.1 Scope of Work

The work comprises supply, laying, testing, commissioning etc., of sewerage & drainage network as specified.

The work includes the following activities connected with the job.

i) Supply and delivery of all required pipes and other materials including erection.

ii) Earth work in excavation for trenches and pits/ manholes.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the walls etc., and repairing them after pipe erection, construction of pipe supports, brick / concrete manholes, preparation of concrete bedding and covering for pipe laying wherever required etc.

iv) Laying and jointing of the pipelines as specified in this chapter

v) Testing of the pipelines after laying as per standard tests as specified in this chapter.

vi) Back filling of the trenches after successful and satisfactory completion of tests for the pipeline laid.

vii) Cleaning, painting/coating and wrapping etc of pipes and fittings etc.

viii) Commissioning of entire network laid.

ix) Safe custody of pipes/material/equipment/work and other obligations stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

xi) If specified, at road crossing the pipe shall be laid in encasing pipes, wrapped & coated M.S pipes shall be used as encasing pipes. The encasing pipe shall project beyond the berm or both sides of the road. The encasing pipe shall be supported on P.C.C saddles if the site condition warrants so.

13.2 Materials

The materials shall conform to part-I of this series. Sewerage net work in Township shall generally be of R.C.C/S.W.G pipes, R.C.C pipes being used normally for pipe sizes of 400mm dia and above. In plant area, at road crossings etc Cast Iron Pipes may be used.

13.3. Excavation of trenches & pits

Excavation shall be carried out according to Chapter of Earthwork.

Before starting earth work in excavation, temporary drainage arrangement shall be provided to prevent surface water entering the trenches and pits at the cost of Contractor.

Excavation of trenches and pits for pipelines shall be carried out in shortest possible time so as to avoid sinking of ground and consequent damage to the pipelines.

Excavation of trenches for pipelines and surface drains, shall be in exact accordance with the plans and section, alignment, levels and gradients as indicated on the drawings or as directed at site by the Engineer. The final bed must be dressed, levelled or trimmed to proper gradient and rammed with sprinkling of sand and got passed by the Engineer. No excavation shall be made below the specified levels without written permission of the Engineer. Should any excavation be taken below the specified level due to carelessness of the Contractor, he will fill in such excavation at his own expense as specified in clause 2.12.

13.4 Cast Iron Pipes

I.S 3114-1985 has to be followed in general for Laying and jointing of pipes unless otherwise specified.

13.4.1 Back filling

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top.

ZONE-"A" **From the bottom of the trenches to the level of the center line of the pipe.**

ZONE-"B" **From the level of the center line of the pipe to a level 300 mm above the top of the pipe.**

ZONE-"C" **From a level 300 mm above the top to the top of the trench.**

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer but back filling shall be done, at least from the bottom of the trench to the level of the center line of the pipe (ZONE "A") leaving 450 mm on either side of the joints uncovered, with earth till testing is completed. These joints should however be kept covered with mats, gunny, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage should be done to the pipeline. All back fill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetables or organic material, lumpy or foreign material, boulders, rocks or stones or other materials which in the opinion of the Engineer is unsuitable or deleterious. However, materials containing stones up to 20 cm as the greatest dimension may be used in Zone-"C" unless specified otherwise herein.

Backfilling in Zone-"A" shall be done by hand with sand, fine gravel or other approved material placed in layers of 80 mm and compacted by tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fitting and appurtenances simultaneously.

Backfilling in Zone-"B" shall be done by hand or approved mechanical methods. Special care being taken to avoid injuring or moving the pipes. The type of back fill materials to be used and the method of placing and consolidating shall be prescribed by the Engineer to suit individual locations.

Back filling in Zone-"C" shall be done by hand or approved mechanical methods. The type of back fill materials and method of filling shall be as prescribed by the Engineer.

Paving and metaling shall be reinstated in as good order as before removal and the Contractor shall do adequate ramming and watering of under layers to guard against subsequent settlement all at his cost.

13.4.2 Custody of pipes

The Contractor shall remain responsible for the safe custody of pipes, specials and other materials supplied by him/issued to him either free or on cost recoverable basis till these are laid installed, tested, back filled etc., and handed over to the Engineer.

The Contractor shall verify the conditions of the pipes, specials etc., at the time of receipt from sources and shall be responsible for all damages during handling, transporting, laying, installing, testing etc., and the cost of such damages shall be borne by the Contractor.

13.4.3 Erection/laying of pipelines

i) Erection of all equipment shall be carried out with highly skilled workers.

ii) The pipelines shall be laid and supported properly and it shall be deemed as a contractual obligation that the lines are not thrown out of alignment or lifted off during commissioning and subsequent operation.

13.4.4 Pipeline erection

All the underground pipelines shall be laid in accordance with IS : 3114-1985.

13.4.5. Handling of pipes & fittings

Unloading of pipes & fittings

While unloading, pipes shall not be dropped down from trucks on hard surface. This should be done with the help of a steadying rope and timber skids. Pipes should not be dragged, specially to the spigot end along hard surface.

Lowering of pipes & fittings

Proper implements, tools etc. shall be provided and used by the contractor while lowering pipes & fittings in the trenches and in no case these should be dropped. Pipes over 300mm dia shall be handled with the help of chain pulley blocks with tripod supports.

Detection of cracks in pipes and fittings

The pipes and fittings shall be inspected for defects and cracks by ringing with a light hammer preferably while suspended. Smearing the outside with chalk dust helps location of the crack. If doubt persists,

pouring a little Kerosene on the inside of the pipe at the suspected spot will confirm it as it will seep through.

Cleaning of pipes and fittings

All foreign materials shall be cleaned from the socket and spigot ends both from inside and outside. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being laid. When pipe laying is not in progress, the open ends of the pipe shall be closed suitably.

Cutting of pipe

The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat manner without damage to the pipe. Pipe cutting machine may be used for this purpose and in case it is not available, for large diameter pipes electric arc cutting method using a carbon or steel rod may be adopted. The pipes can be cut by using chisels also depending on the circumstances.

Permissible deflection at socket and spigot joints

Direction

On level ground the socket ends should face the upstream. When the line runs uphill the socket ends should face the upgrade.

Permissible deflection

In case it becomes necessary to deflect pipe from a straight either in the vertical or horizontal plane, due to obstructions or where long radius curve is permitted, the following norms shall be adhered to:- Lead joint 2.5 degrees Rubber joints

for nominal bore	80 to 300mm	5 degrees
for nominal bore	350 to 400mm	4 degrees
for nominal bore	450 to 750mm	3 degrees

Anchor and thrust blocks

Suitable concrete thrust blocks shall be installed, wherever the thrust is appreciable, specially at dead ends and bends. In case of unbalanced also this may be required. In case of steep gradients and under influence of temperature change also thrust blocks may be required for rigidly joined pipes.

It is advisable to avoid sharp bends above 45 degrees. In soft ground as far as possible two bends should not be put together and be separated by at least one length of straight pipe.

Anchor or thrust blocks shall be generally as per IS : 5330-1984 and thrust resistant design pressure shall be equal to the test pressure.

13.4.6 Pipe jointing

The type of jointing will be defined in the detailed working drawing and Schedule of items i.e. whether they should be (i) socket and spigot with molten lead or lead wool joint or (ii) flanged joint.

13.4.6.1 Socket & spigot joints

a) Molten lead joints

Unless otherwise specified, socket and spigot joints shall be done with molten lead.

The spigot shall be cleaned of the coating, carefully entered in the socket of the adjacent pipe by one or more laps of white hampen spun yarn, sufficient yarn only being driven into the socket to leave the depth of the lead specified. The proper depth of each joint shall be tested before running the lead by passing completely round it a wooden gauge, notched out to the correct depth of lead, the notch being held close up against the face of the socket. The pipes shall be carefully packed underneath so that they shall bear properly throughout their whole length.

The lead shall be carefully skinned of all scale when melted in a cast iron pot or patent melting machine. The joints must be perfectly dug before being run with lead. The pipes shall again be examined for line and level and the space left in the socket shall be filled in generally by pouring in melted lead. This may be done best by using proper loading rings or if these are not available, by wrapping a ring or hemp rope, covered with clay round the pipe at the end of the sockets leaving a hole into which lead shall be poured. For large pipes, it is also necessary to leave one or more air vents around lower half of the joints. The lead shall be rendered thoroughly fluid and each joint shall be filled at one pouring. If the pipe is too large for the joint to be filled from one ladle, two or more ladles shall be used. It is to be noted that the lead should be heated to such a temperature as will ensure that it flows completely around the joint. Overheating of lead shall be avoided.

After a section of convenient length has been laid, lead caulking shall be commenced. The lead shall be freed from the loading pipe outside the socket of the other pipe with a flat chisel, and

then caulked around 3 separate times, with proper caulking tools of increasing thickness and a hammer 2 to 3 kg in weight in such a manner as to make the joints sound and water tight. After being well and evenly set, the joint is to be left flush neat and even with the socket. The approximate weight of lead and spun yarn for different size of cast iron pipe socket and spigot joints, as per IS : 3114-1985 are given in the Table-I.

TABLE – I

QUANTITY OF LEAD AND SPUN YARN FOR DIFFERENT SIZES OF PIPES

Nominal **of pipe mm**	**Lead / Joint kg**
80	1.8
100	2.2
125	2.6
150	3.4
200	5.0
250	6.1
300	7.2
350	8.4
400	9.5
450	14.0
500	15.0
600	19.0
700	22.0
750	25.0
800	31.5
900	35.0
1000	41.0
1100	46.0
1200	50.0

1500	66.5

Note : The quantities of lead given are provisional and a variation of 20% is permissible either way.

b) Lead wool joint

In the event of the Engineer specifying or permitting the use of lead wool the joint shall be made as follows :

Hempen spun yarn shall be driven into the socket and thoroughly caulked with suitable caulking tools. Lead wool shall then be introduced and this caulking shall be repeated with each turn of lead wool under which the socket is full within 3 mm and the wool of the lead wool is compressed into dense mass. The joint shall then be finally pressed with finishing tool. The table giving the quantity of lead wool and yarn to be used in different sizes of pipes is given in the Table-2

TABLE – 2

Nominal Internal dia in mm	**Lead wool weight in kg**	**Spun yarn weight in kg**
80	1.30	0.17
100	1.70	0.23
150	2.41	0.34
175	2.89	0.37
200	3.37	0.57
225	3.63	0.64
250	4.11	0.74
300	4.82	0.82
350	6.04	1.17
375	6.52	1.25
400	7.00	1.33
450	9.64	1.84
500	10.86	1.99
600	12.79	2.83

Nominal Internal dia in mm	Lead wool weight in kg	Spun yarn weight in kg
750	15.68	3.52
825	17.12	3.88
900	18.80	4.25
1200	28.44	6.01

Note : Higher tolerance may be permitted under special circumstances depending upon site condition for quality of lead wool and spun yarn.

13.4.6.2 Flanged joints

Flanged joints should be made by painting the facing of the flanged with graphite or red lead freely. Packing should be of rubber insertion sheet or compressed fibre board and of approved thickness. The packing should be of full diameter of the flange with proper pipe hole and bolt holes cut out and even at both the inner and outer edges. All the bolts shall be tightened up evenly on all sides keeping the longi-tudinal axes of adjoining pipe in exactly the same straight line.

The interior of the pipe must be checked carefully so as to be free from all dust and other foreign matters as the work proceeds. For this purpose a disc plate or brush sufficiently long to pass two or more joints from the end of the pipe last laid shall be continuously drawn forward as the pipes are laid. The ends of the pipes must be securely protected preferably with wooden plugs during the process of the work. The pipes laid must not be made receptacles either for tools, cloth or any other material during progress of the work.

13.4.7 Inspection & testing

a) If required all materials shall be inspected by the Engineer before dispatch to site. All the tests shall be carried out in the manufacturer's works and necessary test certificates shall be furnished as proof of such testing. The Contractor shall intimate the Engineer at least two weeks in advance for any such inspection / testing. All facilities for inspection / testing including necessary test certificates shall be provided by the Contractor at his own cost.

b) After completion of erection all pipelines shall be inspected by the representative of the Contractor and the Engineer. Any discrepancy, defect pointed out during this inspection shall be

made good by the Contractor to the entire satisfaction of the Engineer without additional cost.

c) All pipes with valve and fittings shall be tested to 1.5 times maximum working pressure. The pressure should remain constant for a period of 8 hours. All arrangements for testing shall be done by the Contractor. Any defect found during testing shall be made good by the Contractor to the entire satisfaction of Engineer and the test shall be repeated till acceptable results are achieved. Any special tools, instrument or equipment required for these tests shall be provided by the Contractor for tests only.

d) All oils, lubricants and other consumables required during tests and trials of different equipment shall be supplied and arranged by the Contractor at his own cost.

13.4.8 Painting

i) All equipment, valves and other exposed steel parts shall be given a coat of red oxide, zinc chromate or red lead and two coats of final approved quality paint according to the colour scheme of the Purchaser.

ii) All the exposed pipes and fittings shall be painted with two coats of paints of approved quality.

13.4.9 Commissioning

After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and foreign materials.

The system shall be commissioned after all necessary tests have been conducted successfully. All lubricants, oils, and other consumables required for commissioning of the system shall be supplied by the Contractor at no extra cost. Commissioning of the equipment to be supplied, if any, by the Owner, shall be carried out by the Contractor under guidance of the representatives of the supplier of these equipment and Engineer. Any adjustment and/or changes/ rectifications that may be found necessary during commissioning of these equipment shall be carried out by the Contractor at his cost.

13.5. Stoneware Glazed Pipelines (S.W.G)

13.5.1 Back filling

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer, but back filling shall be done at least for a depth equal to the diameter of the pipe or 300 mm whichever is greater over the pipes leaving 450 mm on either side of the joints uncovered with earth till the testing is completed. These joints should however be kept covered with mats, gunny bags, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage is done to the pipelines. The first 300 mm of filling material immediately over and around the pipe should be of soft material free from clods and stones etc. The remainder of the filling materials shall be watered and rammed in layers not exceeding 250 mm at a time.

Paving and metalling shall be reinstated in as good order as before laying of the pipelines.

Unless otherwise required by the Engineer, there shall be a minimum cover of 700 mm over the pipes and at road crossing etc., it shall not be less than 900 mm.

13.5.2 Laying of pipes

The laying of the pipelines shall commence only after the levels of the bottom of the trench at various points have been checked by the Engineer. Cracked pipes whether at the socket or in the body shall be rejected. All SW pipes shall be fitted together on the surface of the ground to ensure a proper fit before they are lowered. The spigots and sockets shall be properly cleaned and brushed, if necessary & then lowered by hand to the bottom of the trench.

The pipes shall be carefully laid to the alignment, levels and gradients shown on the plans and sections, and great care shall be taken to prevent, sand, earth or other matter from entering the pipes during laying. As it is not permitted to rectify errors of grade by packing up underneath with earth, care should be taken in excavating and slight scraping, if necessary, done to bring to grade. The pipes between manholes shall be laid truly in straight lines without vertical or horizontal undulations.

Bedding, haunching or encasing of the pipes during laying shall be in accordance with IS : 4127-1983 and shall be done with cement concrete in proportion (1:4:8) to prevent ground water from entering the pipelines.

All inverts shall be laid from site rail fixed at the true levels, with proper boning rod. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor at his own expense.

The pipes shall be laid, sockets facing up the gradient, beginning at the lower end, and with the sockets, resting in the socket rest holes cut in the trench bottom. Each pipe shall be laid singly and no pipe shall be laid until the trench has been excavated to its required depth to a distance of twenty yards in front of the pipes to be laid.

No pipes of any description shall be covered until they have been passed by the Engineer.

13.5.3 Jointing of pipes

(a) Cement joint

The stoneware pipes shall be cement jointed normally. In case, if specified so, bituminous joints shall be used. In each joint, spun yarn soaked in neat cement slurry or gasket of tarred yarn shall be passed round the joint and inserted in it by means of suitable jointing tools. More skeins of spun yarn or gasket shall then be added and well rammed home. The yarn shall be moistened to avoid absorbing moisture from cement mortar.

The yarn should be so placed as to centre the spigot of one pipe within the socket of the other and shall prevent the jointing mortar penetrating inside the pipe where it might set and interfere with the flow of sewage.

Yarn or gasket (cemented or tarred) so rammed shall not occupy more than one-fourth of the depth of socket.

The cement shall be thoroughly mixed with medium sand in the proportion of 1:1 (1 cement : 1 sand) and then just enough water shall be added to make the mix plastic. On no account, the mortar shall be made soft or sloppy. The mix shall then be carefully inserted by hand into the joint.

Special care shall be taken for inserting the mortar into the portion of the joint underneath the pipe. When the cement mortar has been inserted, it shall be punched or caulked into the joint with wooden caulking tools, and more cement mortar shall be added until the space of the joint has been filled completely with tightly caulked cement. No fillet of cement shall be added.

No mortar which is older than 30 minutes shall be permitted for jointing. The cement mortar joints shall be cured at least for seven days before testing.

The inside of each pipe shall be carefully wiped out with a mop or scrapper sufficiently long to pass two joints from the end of the pipe and any projecting cement shall be removed.

All pipes entering the manholes should be set in cement mortar 1:3 and a completely watertight junction effected.

(b) Bituminous joints

If specified so this joint will be used. Asphalt and sand in the ratio of 1:7 shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

13.5.4 Testing of pipes

Testing of pipes shall be done wholly at contractor's expense inclusive of apparatus, provision of water etc., and/or as per IS : 4127-1983.

After cement has had time to set, the pipes shall be tested in lengths between manholes in the following 'manner'. In the lowest manhole a plug shall be inserted in the pipe. The disc in the pipe and at the upper manhole shall be fitted with a filling pipe with a right angle bend and an air cock. The length of pipe shall then be filled with water by means of the pipe connection on the upper disc. The air cock in the upper disc shall be kept open, while the pipeline is being filled to permit the escape of air.

When the pipes have been filled with water and air excluded, the air cock shall be shut and water shall be poured into a conical "Filler" attached to the testing and filling pipe of the disc in the upper manhole until water remains in the filler. The testing or filling pipe shall then be raised and fastened so that the height of the pipe is six feet, which will be the usual test pressure for stone ware pipe joints.

The test will be for an hour or such longer period as may be set by the Engineer. If the water level does not fall more than 25 mm in the length of 90 metre, the test may be considered satisfactory.

If it is found that certain pipe joints are leaking, the water shall be run off and joints recaulked with cement mortar and the test repeated till it is proved by the Contractor that the joints are leak-proof.

13.5.5 Concrete bedding, haunching & encasing

Unless otherwise specified in the Schedule of Quantities, all SW pipes shall be laid in accordance with IS: 4127-1983 As per site condition haunching or/and encasing of pipes with cement concrete may be

required as per clause 4.2 & 4.3 of IS 4127-1983. The concreting shall be done with 1:4:8 cement sand concrete.

Where sewers have less than 1.2 m cover at places of heavy traffic, these shall be surrounded with mass concrete if directed by the Engineer.

13.5.6 Handling of pipes

While unloading, pipes shall not be dropped from the trucks/carts on the ground. Timber skids and steadying rope should be used while unloading or lowering in trenches. To avoid damage specially to spigot end, pipes should not be dragged on the hard surface.

13.6 Manholes

All manholes shall be of the size and type as given in the Schedule and shall be provided as per drawing or as directed by the Engineer. All the manholes shall be circular or other shape as shown in drawing. The bed shall be in cement concrete of Mark-10B (or 1:3:6 mix) (Size of coarse aggregate 40 mm and down) of 100 mm thickness or as shown in the drawing and shall be projected out 75 mm from the outside face of the wall all round. or as shown in the drawing. The working part including channeling, benching etc., made of P.C.C. shall be of grade-15C (or 1:2:4 mix). All manholes shall be plastered inside with 1:3 cement plaster 20 mm thick and finished with a floating coat of neat cement unless otherwise specified.

Concrete used for precast RCC cover slabs shall be of grade 20C (or 1:1.5:3 mix)and shall be constructed as per drawing.

The top level of manholes shall be generally 100 mm above the surrounding ground levels or as directed by the Engineer. Channeling inside the manhole shall be done in smooth bends.

The end of pipe shall be neatly built in and finished in cement mortar 1:3.

Circular medium duty Cast iron water sealed manhole cover and frames, 560 mm dia (clear opening) and nominal weight 128 kg shall be provided for each manhole and shall be in accordance with IS:1726-1991 Manhole covers with double seals (Light duty) with wt. as specified in schedule of item shall be provided within compound near the buildings if specified so. If specified heavy duty cover and frames, either circular or double triangular type, shall be provided. Step irons shall be provided with two coats of bituminous paint and shall be as per drawing.

In cases where branch pipe sewers enter the manhole or main pipe sewer at a level more than 1m, from the main sewer, a drop connection shall be provided. The extra pipe length required for this connection will be paid under item for pipelines. No other extra payment will be allowed.

All exposed surfaces of cast iron frame and cover shall be painted with two coats of bituminous painting

13.7 Marker plates

Marker plate indicating the particular service installed shall be provided along the routes of pipes laid below ground. These shall be of mild steel, with the type of service and direction of flow, painted on it. The markers shall be set firmly in a concrete base and installed at all corners and turning points. Over straight runs markers shall be spaced at 100 m intervals generally.

14.0 ROAD WORK

14.1 General

Road works in general shall be constructed according to the requirements to the various specifications and codes of practices of the Indian Roads Congress.

Works such as earthwork, masonry, concreting and the like, wherever they occur in association with construction of roads, shall be governed by the respective specifications of these series.

14.2 Trenching and Preparation of Subgrade

The surface of the formation of width equal to that of soling coat shall first be cut to a depth below the proposed finished level equal to the combined depth of soling and wearing coat, (due allowance being made for consolidation), and dressed parallel to the finished profile. Any roots of bushes, trees etc., shall be taken out to the full depth and the cavities thus formed shall be filled up and rammed by the contractor at his cost.

In slushy soil or in areas where water logging is frequent, adequate arrangement shall be made for drainage of the area so that the sub-soil water level is kept as low as possible.

The sub-grade shall then be consolidated with a power road roller of 8-10 tonne capacity by rolling with minimum of 5 numbers of passes till it is densely consolidated to the satisfaction of the Engineer.

Surplus earth shall be disposed of as directed by the Engineer and the areas where it is disposed of shall be neatly dressed.

All undulations of the sub-grade surface that might develop due to rolling shall be made good with earth and sub-grade re-rolled.

14.3 Ash / Moorum Carpet

Wherever the ground is soft and slushy, ash carpet consisting of common boiler ash shall be laid to 5 cm thickness over the subgrade and then rolled. In firm ground no ash carpet is necessary and boulder soiling shall be laid directly over the sub-grade. If decided by the Engineer, a bed of moorum of specified thickness shall be provided for to form a sub-grade.

14.4.1 Boulder Soling

The width of the soling coat shall be 30cm (15cm on either side) more than that of the wearing coat. Its depth shall be 15cm in cutting and 23cm in filling and made up soil, unless otherwise specified in the schedule of quantities or shown in the drawing.

The edges of the soling shall be marked out by strings and stakes. Soling stone shall be hand packed and set on edge with greatest length across the road. This shall be laid closely in position on the sub-grade, firmly set with their broadest side downwards. The joints shall be staggered. All interstices between the stones shall be wedged in with locking smaller stones well driven into gaps to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of soling stones and shall not lag behind.

After packing, surface shall be checked with template of approved shape and high and low spots corrected by removing soling and re-packing. The top surface of the soling coat shall be perfectly true to camber and grade.

The soling shall then be thoroughly consolidated with power roller of 8-12 tonne weight depending upon the type of soling stones, starting at "edges" and working towards the centre. In case of super-elevated curve the rolling shall commence from the inside edge of the curve to the outside edge. The roller shall run over the same surface of soling at least 10 times or more till the soling coat is well consolidated to the satisfaction of the Engineer. The surface shall be checked by templates and any disturbance in grade or camber corrected after every rolling and finally consolidated. After that, at least 50mm thick

moorum shall be laid on top of soling coat and rolled with water to proper compaction so that the top surface seems smooth. The rate for soling coat shall be inclusive of the cost of the moorum as blinding materials for which no separate payment shall be made.

14.4.2 Laterite soling

In case of laterite soling the thickness of soling shall be as follows :

(i) For road width of 7m and above the sub-base shall consist of two layers of laterite stones 150mm maximum size. The sub-base shall be rolled to a thickness of 230mm after compaction.

(ii) For road width of 4m to 7m,the sub-base shall consist of one layer of laterite stone of 150mm maximum size consolidated to 115mm thick.

(iii) A layer of moorum,33.3 % in volume of laterite, shall be spread over the laterite to a uniform thickness and rolled with 8 tonne roller with constant watering until the mixture penetrates into the voids of laterite layer. Care shall be taken to maintain the camber and slopes.

Other steps for laying, compacting etc. of the laterite soling shall be same as given under clause 14.4.1 "Boulder soling".

14.5 Kerbs

Concrete or stone kerbs, where shown in drawings, shall be fixed in position after laying and consolidation of soling. They shall be fixed true to line and level and secured in position by approved means.

14.6 Water Bound Macadam Surfacing

The construction of water bound macadam shall be carried out according to IRC : 19-1981 "Standard Specification and Code of Practice for Water Bound Macadam".

14.7 Preparation of Base and Shoulders

The subgrade shall be reshaped to the required grade and camber. Where water bound macadam is to be laid over existing black top surface, 50 mm x 50 mm furrows shall be cut in the existing surface at 1 m intervals inclined 45 degree to the centre line of the carriageway, before laying of coarse aggregates. Necessary arrangements shall be made for the lateral confinement of aggregates by constructing shoulders in the form of two parallel mud walls 20 x 15cm which shall be made along the outer edges of the wearing course.

14.8 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly and evenly upon the prepared base in required quantities from stock piles along the roadside or directly from vehicles. In no case shall these be dumped in heaps directly on the base. The aggregates shall be spread to proper profile by using templates placed across the road about 6m apart. Where possible, mechanical devices shall be used to spread the aggregates uniformly.

The water bound macadam course shall be constructed in layers of not more than 75 mm thickness. However, the Engineer may permit courses of 100 mm compacted thickness to be constructed in a single layer. Each layer shall be tested by depth blocks. No segregation of large or fine particles shall be allowed.

14.9 Rolling

The coarse aggregates spread as described above shall be compacted to full width by rolling with either three wheel power roller of 6 to 10 tonnes capacity or an equivalent vibratory roller. The weight of roller shall depend on the type of coarse aggregate.

The rolling shall begin from edges and after the edges have been compacted, progress gradually towards the centre, parallel to the centre line of the road, uniformly lapping each preceding rear wheel track by one half width. On super elevated portions, rolling shall commence from the lower edge. Where screenings are to be applied, rolling shall be discontinued when the aggregates are partially compacted with sufficient voids to permit application of screenings. Where screenings are not to be applied, as in the case of crushable aggregates compaction shall be continued until the aggregates are thoroughly keyed, with no creeping of stones ahead of the roller. Slight sprinkling of water may be done during rolling, if necessary.

Rolling shall not be done when the subgrade is soft or yielding nor when it causes a wave like motion in the base course. If irregularities develop during rolling, and exceed 12 mm when tested with a 3m straight edge, the surface shall be loosened and aggregates added or removed before rolling again. The surface shall be checked by template for camber. In no case shall screenings be used to make up depressions.

14.10 Application of Screenings

After coarse aggregates have been rolled, screenings to fill the interstices shall be applied gradually over the surface in thin layers.

Dry rolling shall be done when the screenings are being spread, so that the jarring effect of roller causes them to settle into the voids of the coarse aggregates. Damp and wet screenings shall not be used and the spreading, rolling and brooming of screenings shall be taken up on sections which can be completed within one day's operation.

14.11 Sprinkling and Grouting

After application of screenings, the surface shall be copiously sprinkled with water, swept and rolled. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well blended and firmly set and a grout of screenings and water forms ahead of the wheels of the roller.

14.12 Application of Binding Material

After the application of screenings, approved binding material, where it is required to be used, shall be applied at a uniform and slow rate in two or more successive thin layers to a thickness of 2.5 cm. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with brooms, so as to fill the voids properly. This shall be followed by rolling with a 6-10 tonne roller, during which, water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry of binding material and water forms a wave ahead of the wheels of moving roller.

14.13 Setting and Drying

After final compaction the road shall be allowed to cure overnight. Next morning, hungry spots shall be filled with screenings or binding material, lightly sprinkled with water and rolled. No traffic shall be allowed till the macadam sets.

14.14 Surface Evenness

The surface evenness of completed water bound macadam course in longitudinal direction shall be within 12 mm when tested with a 3 m straight edge and in cross profile within 8 mm when checked with a template.

14.15 Bituminous Pavements

14.15.1 Bitumen premix carpet with seal coat

The consolidated thickness of this type of treatment shall be 2cm/2.5cm/4cm or as specified.

14.15.1.1 Surface preparation

Water bound macadam surface on which black topping is to be provided shall be thoroughly cleaned of dust, loose materials, caked mud and other foreign material with the help of wire brush, chisel, picks etc. Cleaning shall be such as to expose the stone metal to a depth of about 6mm without dislodging the interlock of the metal. All dust and other materials thus removed shall be thrown away at a suitable place as directed by the Engineer.

Any potholes, depressions and undulations found after cleaning shall be made good with premixed chippings, and well rammed.

14.15.1.2 Tack coat

Just before the application of tack coat, the surface shall be thoroughly cleaned by brooms and then by fanning with gunny bags.

Bitumen of specified grade heated to a temperature of 177 to 188 degree 'C' shall be spread on the prepared surface uniformly at the rate of 0.75 kg/sq.m. by means of sprayers. It shall be applied just ahead of and keeping pace with, laying of premix carpet.

14.15.1.3 Preparation of mix, laying & consolidation

The stone grit (aggregate) shall be surface dry and contain not more than 2% moisture before use. It shall be first screened of dust and measured in boxes and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion given in the table below. The aggregate shall be heated to facilitate mixing with the binder in cold weather, where so directed by the Engineer.

The binder heated in boilers, to a temperature of 149 to 177 degrees C or as specified for the grade used and maintained to that temperature, shall be drawn off from the boiler into a suitable container or in bucket gauged to show the weight of bitumen in it. This shall then be poured over the aggregate in the mixer at the correct rate of 64 Kg/cum of aggregate or as specified and mixing started and continued till aggregate is uniformly coated with bitumen.

Immediately after applying the tack coat, the hot mix shall be discharged from the mixer, carried to the road surface and spread to a thickness sufficient to achieve after consolidation the specified thickness. Rakes or drag spreaders shall be used for spreading the mixture.

When the premix has been laid for a length of 15-20 metres it shall be rolled. Rolling shall commence from edges and proceed towards the centre. The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. Any high spot or depression which become apparent shall be corrected by addition or removal of premix materials.

Further the prepared finished surface shall be protected from the traffic for 24 hrs or such period as may be specified by the Engineer.

14.15.1.4 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below, unless otherwise specified.

Sl. No.	Consolidated thickness of premix carpet	Stone chips (cum)	Sand (cum)	Tack coat (kg)	Binder Carpet (kg/cum)	Seal coat (kg/cum)
	Using Paving bitumen80/100 or 30/40 grade					
1.	Priming tack coat					
a)	on a water bound macadam surface			75		
b)	on an existing black top surface			65		
2.	Carpet					
	2 cm	2.4 (10 mm nominal size)			64	
	2.5 cm	3.0 (10 mm nominal size)			64	
	4.0 cm	4.8 (12 mm nominal size)			64	
3.	Seal Coat					
a)	Dry area (Premixed sand seal coat)		0.6			68
b)	Wet area (Liquid seal coat with chips		0.9			98

14.15.2 Seal coat

In dry areas where rainfall is under 150cm per year a premix sand seal coat shall be applied immediately after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen. The aggregates shall be dry and suitably heated to a temperature directed by Engineer before the same are placed in the mixer of suitable design. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with binder. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with premix materials, the surface shall be rolled with 6 to 8 tonne power roller. Rolling shall be continued till the premix material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

In wet areas where rainfall is above 150cm per year a liquid seal coat with chippings (not sand) shall be applied after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen and spread on the surface preferably using mechanical sprayers. Immediately following the application of the binder, stone chippings in a perfectly dry condition shall be uniformly spread on the surface. Immediately after the application of the cover material, the entire surface shall be rolled with 8-10 tonne road roller.

14.15.3 Surface dressing

The surface shall be prepared in the same way as that for premix carpet work as per 14.15.1.1. Depression or pot holes, if any, shall be repaired as indicated.

After the surface has been prepared and is in perfectly dry condition, bitumen heated in the same manner as for premix carpet, shall be sprayed over the surface preferably using mechanical sprayers. It shall be ensured that there is even and uniform distribution of bitumen on the surface. Spraying shall be carried out parallel to the centre line of the road.

Immediately following the application of bitumen, stone chippings in a perfectly dry condition, shall be uniformly and evenly spread as specified in the item, over the entire sprayed surface. Spreading may be done preferably by means of mechanical gritter. Finally the entire surface shall be broomed to ensure perfect uniform spreading.

The final surface shall be checked by means of camber board etc. The spread surface shall be rolled with 6 to 8 tonne roller till there is

sufficient boundage of chippings with bitumen. The finished surface shall be thrown open to traffic on the following day.

14.15.4 Premixed Bitumen Concrete

14.15.4.1 General

In this type of road carpet a mixture of sand and stone aggregate is used as aggregate producing a dense mixture. Seal coat is not necessary as the sand used in the mix works up to the surface and forms a seal by itself. The consolidated thickness of this type of treatment shall vary from 4cm to 7.5cm as specified.

14.15.4.2 Surface Preparation

Same as in para 14.15.1.1 above.

14.15.4.3 Tack Coat

Same as in para 14.15.1.2 above.

14.15.4.4 Preparation of Mix, Laying & Consolidation

Para 14.15.1.3 shall generally apply except that the mixing shall be done in two stages. The stone aggregate of the the correct specified size and in the proportion shown in the table above shall be fed into the mixer to which 2/3rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the stone metal is well coated, the sand in the specified proportion and the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

The premix shall be emptied on to wheel barrows or stretchers and carried to the site of work. It shall then be spread uniformly on the road surface with rakes or drag spreaders immediately after applying the tack coat to a thickness sufficient to achieve after consolidation the specified thickness. When the premix has been laid for a length of 15-20m it shall be rolled. Rolling shall commence from edges and proceed towards the centre.

The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. After preliminary rolling, all honeycombs, any high spot or depression which become apparent shall be corrected by addition or removal of premix materials. Camber and grade shall be checked at every stage to ensure correctness and any defect found shall be rectified.

14.15.4.5 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below unless otherwise specified.

BINDER

Sl. No.	Thickness of consolidated bitumen concrete surfacing	Tack coat (kg)	Hot Bitumen (cut back)/ Paving Bitumen 80 / 100 grade	
			Bitumen concrete	
			Stone aggregate (kg / cum)	Sand (kg / cum)
1.	4 cm, 5 cm, 6 cm & 7.5 cm	75	560	128

Aggregate

Sl.	Thickness of compacted bitumen concrete surfacing		Stone aggregate (cum / 100 sqm)	Coarse sand (cum / 100 Sq.m)
1.	4 cm	3.8	(12mm nominal size)	1.90
2.	5cm	4.8	(20mm nominal size)	2.40
3.	6cm	5.8	(60% 40mm nominal size) (40% 25mm nominal size)	2.90
4.	7.5 cm	7.3	(60% 50mm nominal size) (40% 40mm nominal size)	3.65

The nominal size of Coarse Aggregate herein shall mean as defined below:

Sl. No.	Nominal size of coarse aggregate	Designation of IS sieve through which the aggregate shall wholly pass	Designation of IS sieve through which the aggregate shall be retained
i)	40 mm	50 mm	25 mm
ii)	25 mm	40 mm	20 mm

iii)	20 mm	25 mm	12.5 mm
iv)	12 mm	20 mm	10 mm
v)	10 mm	12.5 mm	6.3 mm
vi)	6 mm	10 mm	2.36 mm

14.15.5 Surface evenness

The finished surface of premix carpet and bituminous concrete shall be tested with a straight edge 4.5 m long and any irregularity greater than 6mm shall be corrected.

14.16 Berms

Shoulders and berms shall be prepared as shown on the drawings. Work on making berms shall not lag more than 100 metres behind the water bound macadam consolidation. Suitable drains shall be cut on the berms so that the water bound macadam surface is kept drained till bituminous macadam is laid.

14.17 Kerbs

Kerbs shall be laid and set in place before completing the bituminous or concrete wearing surface as well as the wearing surface of footpath. Setting shall be done in mortar where so specified with Schedule of Items. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of footpath.

Where the road edge forms a curve, the kerbs shall follow such curve. Gaps shall be left as shown in drawings or as may be required to provide for drainage.

14.18 Bridges and Culverts

Bridges and culverts shall be constructed according to the specifications of Indian Roads Congress. Relevant chapters of earthwork, concrete, masonry etc., of these series shall apply.

14.19 Boulder Pitching

Wherever specified, boulder pitching shall be provided at the inlet and outlet of pipe culverts, or for embankments of bridges. The subgrade shall first be dressed to level or slight slope as indicated. The

transverse slope of the pitching shall be made strictly in accordance with the drawings or as directed by the Engineer.

14.20 Scarifying & Dismantling

Where a new carriage-way abuts or includes an existing carriage-way and the Engineer so directs, the surface of the latter shall be scarified, adjusted and reshaped to conform with the existing and new camber or crossfall. Materials from the existing road shall be used or disposed off as directed by the Engineer.

Where dismantling of the existing road has been specified, the various layers of the road viz., bituminous macadam, water-bound macadam and soling shall be scarified separately. Scarifying can be done either by hand picks, or by means of scarifiers fixed to the roller. When a roller is used for scarifying, crushing of the metal shall be avoided by moving the metal clear of roller wheels after the scarifier has passed over it. The loosened material shall then be combed by means of rakes to bring out most of the larger stone. If necessary, the larger stones thus collected shall be screened to separate fine particles if any.

The remaining metal shall then be removed and screened to recover reusable metal. Different grades of metal shall be stacked separately and measured.

14.21 Diversions

Where the construction of the road or culvert or bridge is in progress, the road shall be closed to traffic and a suitable diversion shall be provided for traffic by the Contractor, as directed by the Engineer.

The road shall be closed by the erection of barriers and suitable sign boards at both ends which shall be provided with lights at night. Both during night and during day, one man shall be posted at each barrier to suitably divert the traffic and to keep the light burning during the night.

15.0 WATERPROOFING TO ROOFS & WATERPROOFING PAINTS

15.1 Scope

This chapter deals with different types of waterproofing on roof.

15.2 Material

The materials shall conform to Part-I.

15.3 General Workmanship

The waterproofing to roofs being specialised works the Contractor shall get these done by specialised firms/agencies.

15.4 Painting with Hot Bitumen

The surface to be painted shall be thoroughly dried and then cleaned, with wire brushes and cotton or gunny cloth, of all loose materials and scales. The surface shall further be cleaned with a piece of cloth lightly soaked in kerosene oil. Bitumen shall be brought to the site in its original container and this shall not be removed from site till the painting job is completed. Before applying the main coatings of hot bitumen paints, one coat of bituminous primer shall be applied. The number of coats of hot bitumen shall either two coats or as specified in the Schedule of Items. The bitumen of approved quality (either of grade 80/100 or 30/40) or as specified shall be applied to the surface after heating it to the manufacturer's specifications. Care shall be taken to see that no blank patches are left and the quality of bitumen to be spread shall be as specified and shall be to the satisfaction of the Engineer.

15.5 Painting with Bitumen Emulsion

Before applying, the surface shall be cleaned thoroughly. Generally two coats of Bitumen Emulsion are provided over a coat of emulsion primer. Since the painting is with emulsion, the surface need not be made dry.

15.6 Waterproofing of Roof

15.6.1 With bitumen felt

Prior to laying the insulation, roof gradient shall be checked. If necessary, the roof shall be re-graded by screed to ensure everywhere a run off gradient of not less than 1 in 120. The screed shall consist of one part cement and four parts medium to coarse sand by volume. The screed shall be cured for 7 days. The surface shall then be cleaned of all foreign matter by wire brushing and dusting.

Waterproofing unless specified otherwise in drawings shall be the "heavy treatment type" with primer coat as described in IS : 1346-1991. The method of laying roofing treatment, surface finishing with pea gravels, special mode of treatment for drain outlets, projecting pipes, parapet walls, expansion joints, gutters, timber roofs etc., shall conform to IS : 1346-1991. The number of layers of felts shall be as specified

in the drawing or Schedule of Items. The bonding bituminous material shall be of grade 30/40 or as specified and the minimum quantity of hot bitumen to be applied, shall be 1.2 kg/m2. Unless specified otherwise, the bituminous felts shall be hessian bases of Type-3 Grade-2. Pea gravel finish may be substituted by a coat of bituminous aluminium paint, where so specified in the Schedule of Items.

The cement mortar used for filling the chases shall be of mix 1:4 and the cement concrete for fillets shall be of the same grade as the roof slab.

Where special surface finish with precast concrete or clay tiles is specified, it shall be in accordance with the relevant chapter of this series.

15.6.2 With bitumen mastic

The work shall be carried out generally in accordance with IS : 4365-1967 "Code of Practice for Application of Bitumen Mastic for Waterproofing of Roofs" or according to the manufacturer's specifications. The work shall be carried out by a firm of specialists in the trade.

The type of underlay or primer, thickness of application, surface finish etc., shall be as shown on drawing or described in the Schedule of Items. Bitumen melting shall be done in a mechanical mixer by gradually heating to about 200 degree 'C'. Coarse aggregate where required shall be added to the hot bitumen and stirred.

Each coat shall be spread evenly and uniformly by means of a float to the required thickness. Timber gauges shall be used to regulate the thickness. Particular care shall be taken to tuck the mastic into grooves on vertical surfaces, at joints, around pipes or other projections and at junction of adjoining bays.

15.6.3 Waterproofing of RCC roof with Lime concrete and Pressed clay titles.

Lime concrete shall consist of broken brick aggregates and lime. Proportion of brickbat coba shall be 2.5 parts of brick jelly to one part of lime. The brick jelly shall be hard, well burnt and of size varying from 12mm to 25mm.

The lime concrete is then laid over roof to slope to give specified thickness and in slope of 1 in 80 or as shown on the drawing for proper roof drainage as per roof drainage plan. The lime concrete is then to be beaten in the manner approved by the Engineer for 48 hours or as directed with hand beaters.

If the surface during the process of compaction becomes so uneven that water lodges in pools, the surface shall be pricked up, and fresh concrete

spread and consolidated as necessary to obtain an even surface.

The concrete shall then be cured by sprinkling water and allowed to harden for a period of not less than six days before laying the roof finish.

Roof shall be finally finished with one coarse of machine pressed clay titles 20 mm thick laid over a 12mm thick of 1:3 mix cement mortar mixed with 5% crude oil by weight of cement mixed in mortar. The pressed clay tiles shall be immersed in water for two hours before being used. The side joints of the tiles shall be more than 60 mm thick set full in mortar. Before the work dries up completely, the tile joints shall be raked out and pointed with cement mortar 1:3 mixed with crude oil which shall be 5% by mass of cement. The joints shall be well rubbed over with thin bar trowel and excess of mortar scrapped off until the surface of the pointing attains a black polish and becomes hard. As the work proceeds, it shall be kept thoroughly wetted until the mortar has set firm and hard. Watering shall be continued for three weeks after construction.

Lime concrete and tiles shall be taken up the parapet walls to a height of 150 mm or as shown in the drawing.

The specification of pressed clay titles shall be as given in IS:2690-1975 (Part-I). The specification of crude oil shall be as per IS:2119-1980.

The areas around drain pipes shall be properly finished with provision of adequate slope.

The contractor shall give guarantee for any/all types of waterproofing for a period of 7 years against bad of faulty material and construction and shall rectify the same at his own cost during the guaranteed period.

15.7 Waterproofing for Basement

15.7.1 The specification covers the requirements of waterproofing of basements, tunnels, ducts, pits, bunkers, etc.

The material used shall be bitumen felt type-3 of grade-2 conforming to IS : 1322-1982, together with the specified bonding material and primer.

Waterproofing shall be provided on the outside of walls and top of the floors and shall be carried 150 mm above ground level.

The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be :

i) For depths upto five metres below ground : 2 layers.

ii) For depths beyond five metres : 3 layers.

The method of laying the bitumen felts and workmanship shall in general conform to IS : 1609-1991.

Waterproofing work shall be taken in hand only when the sub-soil water level is at its lowest, the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed. For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps. In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area. Adequate arrangements shall be made to prevent the sides of excavation from slipping while the work is in progress.

The base concrete of mud-mat shall be rendered smooth by a 20 mm thick sand-cement plaster (6:1). Any sharp corner over which the waterproofing course is to be laid shall be eased out by means of cement mortar fillets 7.5 cm in radius.

The surface must be dry before the next operation is carried out. Blown bitumen conforming to IS : 702-1988 shall be applied hot over the prepared surface at the rate of 1.5 kg/m2 for the first layer and for every other subsequent layer(s). The laying of felt over the bitumen so applied shall always commence on the floor, and shall be carried to the walls only after treatment of the floor is complete. The minimum overlapping of joints at sides and ends of felts shall be 10 cm. Joints for subsequent layers of felt shall be staggered. All joints shall be completely sealed by blow lamp.

A protective flooring of either flat bricks in cement mortar 1:3 or 6 cm thick cement concrete type M15B or a coat of cement sand plaster (1:3) 4 cm thick shall be constructed over the waterproofing treatment to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way, the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall

surface shall be made smooth, where necessary with a coat of cement plaster 1:5, the felts shall be laid as for the floor ensuring that the surface to be treated is dry and then a protective brick wall, half-brick nominal thickness shall be built in cement mortar 1:6 over the projecting mud-mat, the space between the wall and felt being grouted with cement slurry. Sufficient care shall be taken to ensure a perfect bond between the waterproofing on the floor and that on the walls.

The treatment on the wall shall be carried 150 mm above the surface of ground and tucked into a grove 6.5 cm. wide and 7.5 cm deep, the chase being filled with cement mortar (1:4).

Where waterproofing is done to the roof of an underground structure, such as a tunnel, it shall be done in a similar way. The structural concrete shall be rendered smooth, hot bitumen and bitumen felts applied in the same way as for the floor and walls, and over this shall be laid a protective layer of cement concrete grade M10C, 7.5 cm thick.

15.7.2 With epoxy based emulsion

Over the mud-mat a 20 mm plaster is to be provided to make the surface even.

On the plastered surface of the mud-mat, three coats of epoxy based leakproof emulsion shall be applied with reasonable gap between each coat in order to permit sufficient drying time.

Precaution should be taken that during the process of rod binding if any damages happens it should be immediately rectified by making patch painting on the affected portion only and as such a complete vigilance is to be kept to rectify the defect.

After the rod binding is over the concreting should be done with high polymer based, chloride and sulphide free cement waterproofing additive/admixtures @ 2% by weight of cement all through the floor area and all through the vertically raised walls of four sides which shall remain underground upto a depth of 8 metre and above from ground level.

After the concreting and immediately after de-shuttering cleaning of the concrete surface on the external faces of the walls are to be done and then three coats of epoxy based leakproof emulsion shall be applied with a reasonable gap between the each coat before back filling. If the back filling is with hard material again a protective layer of plaster shall also be applied on the external faces of walls in order to avoid damages on the painted surface.

If the back filling is with soft sandy or alluvial soil there is no necessity for protective layer of plastering as mentioned above.

Epoxy based paint can be applied on the wet surface hence there shall be no stoppage of the normal progress of the project works.

15.8 Surface Application

Waterproofing done by surface application of bitumen based or epoxy based material shall conform strictly to the recommendations of the manufacturer. The work shall be carried out by a firm of specialists in the trade.

15.9 Guarantee

For the waterproofing on the roof as well as for underground basements the Contractor shall give guarantee in writing for the period of 7 to 10 years as specified in the Schedule of Item. For such guarantee the Contractor shall get guarantee from the manufacturer/specialised firms and forward the same to the Engineer. However, the Contractor shall be fully responsible for the serviceability of the waterproofing treatment throughout the guarantee period and any leakage during that guarantee period shall be stopped by the Contractor at no cost to the Owner and without disturbing working facility of the Owner.

15.10 Water proofing course with Fibre glass R.P. tissue

15.10.1 Scope

This section covers the furnishing of all labour, equipment and performing all operations necessary to complete to provide water proofing course of Fibre glass R.P. tissue all in accordance with the drawing and these specifications.

15.10.2 Terminology

For the purpose of these specifications the following definitions detailed hereinafter shall apply.

15.10.3 Preparation of surfaces

Surface to receive waterproofing shall be dry, free from dirt, loose particles and foreign materials. Projections which might puncture the

membrane shall be removed and voids and crevices shall be filled in prior to the start of work.

Adequate covering shall be provided during this work to avoid splashing or staining of the adjacent work and surfaces. Any work or surface splashed or stained shall be thoroughly cleaned to the satisfaction of the Engineer. Joints in the tissue felt in the different layers shall be staggered.

15.10.4 In built-up roofing

Application

i) Suitable slope shall be provided in the roof as per manufacturers specifications. Heat insulation may also be provided if necessary.

ii) Prime the plastered surface primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface and should be left till the time it is touch-dry.

iii) Apply first coat of hot bitumen @ 1.8 Kg/sqm.

iv) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

v) Apply second coat of hot bitumen @ 1.8 Kg/sqm.

vi) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry.

vii) Apply third coat of hot bitumen @ 1.8 Kg/sqm.

viii) Embed third layer of fibre glass RP tissue.

ix) Apply fourth coat of hot bitumen @ 1.8 Kg/sqm.

x) Finish with gravel grit @ 0.006 cum per sqm.

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.

15.10.5 Specification

Water proofing medium

i) By impregnation into the fibre glass reinforcement membrane forms a monolithic mass.

ii) Prevents the penetration of water/moisture.

iii) Acts as a top dressing.

Layer

A single thickness of fibre glass tissue impregnated with bituminous compound.

Multiple layer

2 or more layers of fibre glass tissue laid consecutively with overlapping joints and impregnation with bitumen.

Bitumen/primer

A liquid bitumen of low viscosity which penetrates into a prepared surface upon application.

Half-brick masonry shall be of approved quality 50 class brick work in cement mortar 1:4 (1cement : 4 sand). Plaster should be in cement mortar 1:4 (1cement : 4 sand). Sand should be fine sand conforming to IS 383

Application

Suitable slope may be provided in lean concrete, if necessary. Over this, 12mm thick plaster with cement mortar 1:4 (1cement : 4 coarse sand)is to be laid.

Prime the plastered surface with primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface & then should be left till the time it is touch dry.

Water proofing shall be as follows :-

i) Apply first coat of hot bitumen @ 2.4 Kg/sqm.

ii) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

iii) Apply second coat of hot bitumen @ 2.4 Kg/sqm.

iv) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry .

v) Apply third coat of hot bitumen @ 2.4 Kg/sqm.

vi) Embed third layer of fibre glass RP tissue after the surface of the second layer has become touch-dry.

vii) Apply fourth coat of hot bitumen @ 2.4 Kg/sqm.

viii) Embed fourth layer of fibre glass RP tissue after the surface of the third layer has become touch-dry.

ix) Apply fifth coat of hot bitumen @ 2.4 Kg/sqm.

x) A layer of 12mm thick fine sand is to be laid after completing the above operations. The layer of sand will not be applied on vertical walls.

The surface should be finished with half-brick masonry in cement mortar 1:4 (1cement : 4 coarse sand).

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.

General

The work will be carried out by specialists in the trade. Workers shall be provided with gum boots and hand gloves. There shall be no air pockets. Corners shall be treated flush without any air pockets or voids.

Measurement

The unit will include supply of materials, transport, preparation of surface, application of water proofing treatment, plastering, masonry work etc., as specified herein. The measurement of the item will be in square metres nearest to the second decimal of the concrete surface which is to be damp-proofed.

15.11 Water proofing course with P.V.C sheets/ membranes

15.11.1 Jointing

The adjacent lengths of the P.V.C sheets shall be jointed by giving an overlap of 25mm, one over another by sealing with the approved adhesive. A minimum width of the sheet, as specified in the item, shall be used without any joint. Jointing of the sheets, to the extent possible and practicable, shall be done at the site workshop.

15.11.2 Laying

i) Horizontal areas: The base concrete shall be rendered smooth by cement sand plaster 1:6 mix of 20mm thick unless otherwise specified. It shall be ensured that there are no sharped crivices, projections etc which may puncture and damage the sheet. P.V.C sheets shall then be evenly laid over the smooth rendered surface while it is green.

After laying of sheets a protective cover shall be laid over it. This cover may be of 1:6 cement sand mortar bed of thickness 20mm and above, flat brick/tile soling over cement sand mortar bed, any other suitable layer or thermal insulation cover as specified in the item. However care is to be taken that sheets do not get damaged while laying the protective cover. The horizontal layer of P.V.C sheets shall be carried over to a minimum of 150mm height and tucked in to the connecting vertical walls as in the case of roof parapets, if there is no provision of continuous laying of the sheets in the adjacent vertical surface.

ii) Vertical surfaces

On vertical concrete surfaces the P.V.C sheets shall be fixed along with the form work with the knobs projecting toward concrete. The sheets shall be clamped on the top of the form work to keep it in position. Concrete is then poured and knobs are locked in it. After the forms have been stripped off, all the tie bolt holes, cuts and other damages are sealed with additional patches of sheets as per manufacturer's specification.

In case good quality of soil, completely free from foreign materials like stone piece, hard lumps and rubbish etc, is available, it can be used directly as a back fill. Otherwise a half brick wall or any other measure as specified shall be provided as a protection barrier over the projecting base of the concrete/mud mat. The top edge of the sheet shall be tucked into a chase to be subsequently sealed with cement sand mortar of 1:4 mix.

In case of sheets being laid both on horizontal and adjacent vertical surfaces, the horizontal sheets shall be carried on the vertical portion as one monolithic layer.

15.11.3 Agency

The execution work including jointing, laying and testing etc. shall be done by a specialised agency duly approved by the Engineer.

15.11.4 Testing

After laying is complete, the sheets shall be tested by an Electronic Pin hole detector for pin holes, cuts and other damages etc. All such portions shall be patched suitably with additional sheets as directed and again test checked.

15.11.5 Expansion joints

All Expansion Joints etc of dimensions as specified, shall be filled up by Polymer Sealant of pourable grade as per manufacturer's specification on the P.V.C sheets locked in the joint.

15.11.6 Guarantee

The contractor shall guarantee the water tightness and leak proofing of the structure for a period of ten years after certified completion and handing over of the jobs by furnishing a free maintenance guarantee as per prescribed format and as specified.

15.12 Waterproofing with Non-Shrink Polymeric Waterproof Grouting Compound

15.12.1 Work Included

The Contractor shall furnish materials, labour, plant, equipment and tools to complete the work as specified and/or as shown in drawings.

15.12.2 Materials

Cement

Ordinary portland cement shall conform to IS : 269-1989 and portland blast furnace cement shall conform to IS : 455-1989.

Aggregates

All aggregates shall conform to IS : 383-1970 Fine aggregates shall be approved river or pit sand.

Cement waterproofing compound

All cement waterproofing compound shall conform to IS : 2645-1975 and shall be of approved quality.

Solvent less resin

High build polymeric surfacing which forms a thick resilient and flexible membrane on concrete with high resistance to oil and water.

Nozzle

15 mm dia threaded G.I. pipes of suitable length plugged at both ends.

Super plasticiser

High range water reducing admixture and integral cement waterproofer for concrete. Super plasticiser shall conform to ASTM C-194 Type F, IS: 9103-1979 & IS:2645-1975.

15.12.3 Waterproofing of underground structures

Waterproofing shall be carried out as per the approved manufacturer's specification and as stated below:

15.12.3.1 Raft

The sub-base (PCC) of the underground structure shall be cleaned of all dirts and kept dry by continuous pumping of water. 20 mm thick plaster with cement-sand mortar (1:3) mixed with approved cement waterproofing compound as per manufacturer's specification shall be laid on top of the sub-base. The plaster shall be finished smooth with a steel trowel.

The plastered surface shall then be painted with two (2) coats of approved solvent less resin to form a thick resilient and flexible resinous membrane over the plastered surface.

Threaded nozzles of 15 mm dia and of suitable length shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the whole raft, prior to casting of RCC raft. similar nozzles will also be placed along the construction joint, if any, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting clogged by

concrete. Similar nozzles shall also be post fixed at critical points, if required. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete which shall be at least M20 grade as defined by IS : 456-1978 and the water cement ratio of the concrete shall not exceed 0.45. Adequate precaution shall be taken to keep the nozzles vertical while concreting.

Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the instructions of the manufacturer. When the injection operation is over the nozzles shall be sealed with a sealing compound as per manufacturer's specification and instruction.

15.12.3.2 Vertical wall

15 mm dia threaded nozzle of suitable lengths shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the entire surface prior to concreting of the vertical wall. Similar nozzle are to be also fixed at construction joints, if any, y, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both the ends to avoid clogging of the nozzles by concrete. Similar nozzles shall also be post fixed at critical points, if required.

The concrete for the vertical wall shall be at least M20 grade as defined by IS:456-1978 having a maximum water cement ratio of 0.45. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete as per the manufacturer's specification. Adequate precaution shall be taken to keep the nozzles horizontal during concreting. The exterior surface of the concrete shall be plastered with 12 mm thick cement sand mortar (1:3) mixed with approved cement waterproofing compound conforming to manufacturer's specification. The plastered surface shall then be finished smooth with a neat coat of cement slurry and painted with two coats of approved solventless resin to form a thick resilient and flexible resinous membrane over the plastered surface. Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the manufacturer's specification and shall be sealed with a sealing compound as per manufacturer's specification and instruction.

16.0 MISCELLANEOUS

16.1 False ceiling

16.1.1 Scope

This chapter deals with the specification for various types of false ceiling as listed below :

a) Wooden ceiling (solid wood) and decorative ply.

b) Ceiling with insulating Building Board/Particle Boards etc.,

c) A.C. Sheet and ply wood ceiling.

d) Plaster of Paris (Gypsum Anhydrous) ceiling over wooden frame.

e) Plaster of paris (Gypsum Anhydrous) Tiles ceiling.

f) Wooden cover, fillets, beading for ceiling.

16.1.2 General

16.1.2.1 Materials

All materials shall be in accordance with the general specifications of materials, Part-I, Schedule of items and as shown in drawings.

Special finishing materials as specified in schedule of item shall be procured from the specified source and got fixed by employing skilled worker in the trade under direct supervision of the manufacturer.

16.1.3 Openings for installation of light fittings

Openings in the ceiling for installation of A/C grills, light fittings shall be provided as per drawings.

16.1.4 Recess for pelmet

Recess for the installation of pelmets shall be provided where shown in drawings along the windows/ doors.

16.1.5 Grills

Grills made of wooden, M.S., Aluminium, PVC or any other material as necessary shall be provided as indicated in the drawing.

16.1.6 Frame work

The type of frame to receive the ceiling material may be of wood, aluminium or M.S. as specified in the schedule of item and as mentioned in the drawing.

16.1.7 Wooden framing for false ceiling

Unless otherwise specified in schedule of items the wooden frame work shall be of following description :

The frame work for false ceiling shall be of approved quality teak wood scantlings, the runners shall be 75 x 50 mm size and shall be spaced at 1200 mm c/c and the battens shall be 50 x 50 mm size spaced at 600 mm c/c (approx) forming a grid of 600 x 600 mm or any other grid suitable for fixing the false ceiling material and its size. The runner and battens shall be joined by halving joint using counter sunk 6 mm bolt with washer of required length with soffit of runner and batten in perfect level. The heading joints between runners shall be made with lap joints using 2 nos. 6 mm dia counter sunk bolts with washer. Heading lap joints between battens shall be made with suitable size screws. The wall ends of the runner shall be embedded in the wall (50 mm deep) and shall be grouted with 1:2:4 cement concrete. The soffit of framework shall be made perfectly horizontal. The teak wood frames shall be treated with 2 coats of wood preservations treatment before fixing the tiles/boards as the case may be.

The main runners of frames shall be suspended by M.S. flat 40 x 3 mm /12mm dia M.S. round/T.S. hangers placed at 1200 mm c/c (approx), the top end of the hangers shall be hocked to R.C.C. reinforcement of slab or fixed to M.S. flat cleats installed in slab for the purpose or hooked to purlins of the trusses. The hangers may be twisted or ends of M.S. round/T.S. hanger flattened to allow for fixing the same with T.W. frame or M.S. cleats with bolts of suitable size.

For teak wood framings of shaped ceilings the spacings of frames and hangers levels of false ceiling etc., shall be required to obtain the shapes/drops and profile of the ceiling and to the requirement of ceiling material. The frames shall be locally adjusted to create openings of required sizes for installation of light fittings, grills of air conditioning system.

16.1.8 Metal framing

16.1.8.1 Galvanised pressed steel framing system

Galvanised pressed steel framing system for false ceiling shall be procured from reputed manufacturer and installed by specialist agencies under technical guidance of the manufacturer and strictly as per their specifications. Unless specified otherwise these shall consist of G.I. rectangular pipes at 900 mm c/c suspended by M.S. hanger fixed to R.C.C. slab with M.S. cleats and cross channels fixed to rectangular pipes at 450 mm c/c as per "Galvolock" system of M/s Eastern Interior Pvt Limited or equivalent. Ceiling materials shall be fixed to cross channels as per specifications of the manufacturer.

Framing shall be adjusted to provide openings for the light fittings and air-conditioning grills but these shall be supported independently and not on the framing.

16.1.8.2 Aluminium grid ceiling framing system

Framing for Aluminium grid false ceiling system shall be of reputed manufacturer Bestlok, Eezilock or equivalent. It shall consist of aluminium main tee and cross tee's suspended by adjustable hangers fixed to R.C.C. floor with cleats. The grid may be 600 x 600 mm, 1200 x 600 mm or as per drawings. Ceiling materials, shall be fixed to frames strictly as per manufacturers specification.

16.1.9 Fixing of Ceiling

16.1.9.1 Wooden ceiling with planks

These shall be of class of wood and thickness as specified in Schedule of items. Unless specified otherwise the width of the ceiling board shall be 100 mm to 150 mm and shall be planed true on the exposed surface. The maximum length of the finished board shall be 1800 mm. The boards/strips shall be joined with tongue and grove joints and heading joints in adjacent board of the same strip shall be square butt type neatly finished. These joints shall be staggered in alternate strip or line. The boards shall be fixed to T.W. battens by headless brass pins. Moulding beads at junctions with walls and other locations as per drawings shall be provided. Necessary opening for installation of light fittings and A/C grill shall be provided and junctions if required shall be finished with moulded beads.

The false ceiling shall finally be checked for line and level, sand papered and polished with colourless polish to achieve matt satin natural finish.

16.1.9.2 Decorative ply ceiling

These shall be with decorative selected group matched ply of Teak Ply, white cedar ply or any other approved class of veneer ply in strips, square or rectangular panel matching the ply of wall panelling, if any, in the same room and of thickness as per schedule of item and drawings. The strip ply, square/rectangular panels shall be fixed to T.W. framework with panel pins. Moulded beads of same wood as that of ply of matching shade shall be provided at junctions with walls and as specified in drawings.

Where specific pattern of grains and shade is required the ply cut into shapes as per design may be pasted on a backing ply with adhesive and such made panels shall be fixed to framing.

The ceiling shall be checked for line, and levels and exposed surfaces shall be sand papered and finally polished with colourless polish to achieve matt satin natural finish.

16.1.9.3 Ceiling with insulation board/particle boards

Insulation boards shall be of approved manufacturer, shade, design and thickness as specified in schedule of items and drawings. These may be plain, textured, perforated with natural finish or with white finished surface.

The boards shall be cut to suit the panel sizes of ceiling with special tools and by skilled workmen strictly as per manufacturers specifications. The board shall be fixed to T.W. frames with brass screws or as per manufacturers recommendation and in case of metal frames as per recommendations of the manufacturer of the ceiling system. The joints where exposed shall be of uniform thickness (3 mm to 6 mm) and pattern as shown in drawings.

The ceiling shall be checked for line and level and exposed surfaces prepared appropriately to receive the paint as specified in schedule of item and drawing.

16.2. Wooden partitions

16.2.1 Scope

All materials for the wooden partitions shall be of respective class as specified in the part (I) and as mentioned in schedule of items.

16.2.1.2 Frame work

Unless otherwise specified in the schedule of items, framing for partitions shall be made of approved quality teak wood scantlings of sizes as mentioned in schedule of items and drawing. The spacing of frames shall not exceed 1200 mm c/c in both direction. The joints of the frame shall be made as per standard joinery practice using standard adhesive as described in wood work chapter. The faces of the frames to receive ply/wooden board shall be true to line, level and plumb. The frames shall be firmly secured to walls, ceilings, floors by making chases and grouting the frames in 1:2:4 cement concrete or fixing the frames with metal clamps/flats screwed to above elements. The frame shall be treated with 2 coats of wood preservative. Where the panelling material is of decorative ply of 3.5 mm to 4 mm thickness,

commercial ply of 6 mm thickness shall be fixed to the frame work for backing purpose. Where sunk (coffered) panels are to be made, combination of single and double layers ply shall be used for backing to achieve level difference for sunk panels.

16.2.3 Boarding/facing for partition

a) Wooden plank/board

These shall be of class of wood and thickness as specified in the schedule of item and drawings. These shall be fixed to backing wooden frame work with counter sunk brass screws in pattern and designs, with groves, joints, beads, fillets, cover moulds as shown in drawings. The exposed surfaces shall be sand papered and polished as specified.

b) Decorative ply wood facing

These shall be with decorative teak wood/rose ply/white cedar 3.5 to 4 mm thickness of selected pieces with matching colour, texture and grains and shall be fixed to the backing ply with panel pins in pattern, design, with uniform width of joints, beads, fillets, cover mould as shown in drawings. The exposed surfaces shall be lightly sand papered finished with colourless polish to achieve matt satin finish.

c) Jolly pan (laminated) board

Where specified Jolly pan boards shall be fixed to teak wood frame work strictly as per manufacturer's specification. The boards after fixing shall be cleaned of all adhesives etc.

d) Formica facing

Formica facing shall be fixed to the backing ply with standard adhesive as described for panelling works.

16.3 Expansion and Isolation Joints

16.3.1 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it

is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved-laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval, for the method of forming the joints, should be obtained from the Engineer before starting the work.

16.3.2 Bitumen impregnated board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 (Part 1)-1983 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

16.3.3 Joint sealing strips

16.3.3.1 General

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water. The sealing strips will be either metallic like G.I., Aluminium or Copper, or Non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

16.3.3.2 Metal sealing strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U-shaped, Z-shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux. In case it is found that the joints cannot be made leak proof, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor without any

additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The Strips shall be strong, durable, without any rust or crease. At the joints, the overlapping should be for a minimum length of 50mm

b) Aluminium strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS : 737-1986. A minimum lap of 50 mm length is required at the joints.

c) Copper strips

The copper strips shall be minimum 18 SWG in thickness and 300 mm width.

It should be cleaned thoroughly before use so as to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

16.3.3.3 Non-metallic sealing strips

These will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

a) Plain

b) Central bulb

c) Dumb-bell or flattened ends

d) Ribbed and corrugated wings

e) V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The actual size and shape shall be as shown in drawings/Schedule of Items and or as directed by the Engineer.

The method of forming these joints, laps etc., shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber sealing strips

The minimum thickness of rubber sealing strips shall be 3 mm and the minimum width 100 mm. The material will be natural rubber and be resistant to corrosion, abrasion and attacks from the acids, alkalies and chemicals normally encountered in service. The physical properties will be generally as follows :

Specific Gravity : 1.1 to 1.15

Shore Hardness : 65A to 75A

Tensile Strength : 25 - 30 N/mm2

Maximum Safe Continuous
Temperature : 75 Degree 'C'

Ultimate Elongation : Not less than 350%

b) P.V.C. sealing strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows :

Specific Gravity : 1.3 to 1.35

Shore Hardness : 60A to 80A

Tensile Strength : 10 - 15 N/mm2

Maximum Safe Continuous Temperature : 70 Degree 'C'

Ultimate Elongation : Not less than 275%

16.3.4 Bitumen compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834-1984.

16.4 Barbed Wire Fencing

16.4.1 Materials

16.4.1.1 Galvanised barbed wire

Barbed wire shall be properly galvanised and shall be obtained from the approved manufacturer as specified in detail in Part-1.

16.4.1.2 Other materials

The specifications of materials, for angle iron posts, concrete works, plasters, if any, and for other works, shall conform to the requirements as specified in Part-I.

16.4.2 Workmanship

The work shall comprise of the following :

a) Excavation in ground of required dimensions with all sides vertical in any type of soil including soft rock and removing the soil and dressing it neatly.

b) Filling the holes in full with cement concrete 1:3:6 mix, well packed, after erecting the posts in correct line, level and plumb. In case of any post coming at local depression, the hole may not be of full depth but the depth of concrete will always be made 60 cm raising it above ground level with necessary shuttering.

c) Where the angle iron posts are specified in the item these shall be 50 mm x 75 mm x 6 mm unless mentioned otherwise. 10 mm dia holes with saw cuts for inserting the wires shall be made as per the spacings of barbed wire shown in drawing or as directed by the Engineer. The foot of the post shall be provided with base plate for anchorage. The spacing shall be 2.5 m or as per drawing. After inserting the wire into holes the socket is to be pressed back.

d) Straining bolts are to be provided 15 m apart from each row of wire for maintaining proper tension in the wire and without any sag or looseness.

e) Posts are to be painted as directed by the Engineer.

16.5 Chain link fencing

16.5.1 Scope

The work under this specification covers the supply and fixing of galvanised steel chain link fencing with galvanised steel posts chain link fabric.

16.5.2 Material

Galvanised steel chain link fabric and galvanised steel pipe posts shall be obtained from the approved manufacturer as specified in detail in Part - I .

16.5.3 Workmanship

The GI pipe posts shall be embedded in plain cement concrete not leaner than 1:4:8 foundations. The height of posts above top of foundations and spacing of post shall not be more than 3 m. The chain link fabric shall be fixed to the fencing posts with the help of stretcher galvanised bars (25 x 6 flats) which will be bolted to the lugs welded to the posts. The stretcher bars shall be provided in the lapping of fabric also.

SPECIFICATION FOR CIVIL WORKS

PART – III NORMS OF CEMENT CONSUMPTION

CONTENTS

GENERAL

For calculating the requirements of cement in various items of work the following standards will be adopted. Over the above theoretical quantity of cement, additional allowance upto plus or minus 3% shall also be allowed as certified by the engineer.

For items not covered in this standard, CPWD standards shall be followed or calculated as per uses/requirement in absence of standard norms. Cement required for enabling work and cement required for testing purposes will be taken into account for consumption purpose. However, in no case such quantity should exceed 5% of the total cement used in the work or as certified by the engineer based on actual observation whichever is less.

Sl.No.	Description of Item		Cement Requirement
MASONRY WORK			
1.	Random rubble masonry with	CM 1:4	1.255 quintals per cum
2.	Random rubble masonry with	CM 1:6	0.825 quintal per cum
3.	Coursed rubble masonry in	CM 1:6	0.75 quintal per cum
4.	Brick work in	CM 1:4	0.950 quintal per cum of BW
5.	Brick work in	CM 1:6	0.625 quintal per cum of BW
6.	Half brick work in	CM 1:3	1.43 quintals per 10 sqm of area
7.	Half brick work in	CM 1:4	1.06 quintals per 10 sqm of area
8.	75mm thick brick in	CM 1:4	0.65 quintal per 10 sqm of area
9.	75mm thick brick in	CM 1:3	0.81 quintal per 10 sqm of area
10.	Projected brick bands, Drip course etc. in CM 1:6 finished with 12mm thick cement plaster		0.165 quintal per 10 RM
11.	Half brick thick, Honey combed brick work in	CM 1:4	0.064 quintals per sqm
PLAIN/REINFORCED CONCRETE			
1.	RCC/PCC of nominal mix 1:5:10 complete (excluding finishing with CP)		1.30 quintals per cum of concrete
2.	RCC/PCC of nominal mix 1:4:8 complete (excluding finishing with CP)		1.70 quintals per cum of concrete
3.	RCC/PCC of nominal mix 1:3:6 complete (excluding finishing with CP)		2.23 quintals per cum of concrete
4.	RCC/PCC of nominal mix 1:2:4 complete (excluding finishing with CP)		3.18 quintals per cum of concrete

Controlled Concrete - Plain and Reinforced

5.	Concrete grade	(i)	M -5A	To be mutually agreed based on mix design to be prepared by contractor & approved by the Engineer plus wastage and all incidentals as decided.
		(ii)	M -5B	
		(iii)	M -7.5A	
		(iv)	M -7.5B	
6.	Concrete grade	(i)	M -10A	
		(ii)	M -10B	
		(iii)	M -10C	
7.	Concrete grade	(i)	M -15B	
		(ii)	M -15C	
		(iii)	M -15D	
8.	Concrete grade	(i)	M -20B	
		(ii)	M -20C	
		(iii)	M -20D	
9.	Concrete grade	(i)	M -25B	
		(ii)	M -25C	
		(iii)	M -25D	
10.	Concrete grade	(i)	M -30C	
		(ii)	M -30D	
11.	Applying cement slurry on RCC slab for receiving cement concrete flooring.			2.75 kg/sqm

FINISHING

1.	6mm thick C.P. 1:4	0.280 quintal per	10 sqm area
2.	10mm thick C.P. 1:5	0.370 quintal per	10 sqm area
3.	10mm thick C.P. 1:4	0.430 quintal per	10 sqm area
4.	10mm thick C.P. 1:6	0.300 quintal per	10 sqm area
5.	12mm thick C.P. 1:3	0.734 quintal per	10 sqm area

6.	12mm thick C.P. 1:4	0.547 quintal per	10 sqm area
7.	12mm thick C.P. 1:6	0.360 quintal per	10 sqm area
8.	15mm thick C.P. 1:4	0.655 quintal per	10 sqm area
9.	15mm thick C.P. 1:6	0.440 quintal per	10 sqm area
10.	20mm thick C.P. 1:4	0.850 quintal per	10 sqm area
11.	20mm thick C.P. 1:6	0.560 quintal per	10 sqm area
12.	12mm thick bearing plaster in CM 1:4 with neat cement finish	0.590 quintal per	10 sqm area
13.	Neat cement punning	0.200 quintal per	10 sqm area
14.	Flush or ruled or cut or weather pointing on brick work with CM 1:3	0.155 quintal per	10 sqm area
15	Flush or ruled or cut out or weather pointing on brick work with CM 1:2	0.200 quintal per	10 sqm area
16.	Raised and cut pointing on brick work with cement mortar 1:3	0.235 quintal per	10 sqm area
17.	Flush or ruled pointing on brick flooring with cement mortar 1:4	0.075 quintal per	10 sqm area
18.	Flush or ruled pointing on brick flooring with cement mortar 1:6	0.050 quintal per	10 sqm area

FLOORING

1.	Brick on edge flooring in cement mortar 1:4	1.100 quintal per	10 sqm area
2.	Brick on edge flooring in cement mortar 1:6	0.800 quintal per	10 sqm area
3.	25mm thick (IPS) cement concrete flooring 1:2:4 (1 cement : 2 sand : 4 graded stone chips 12mm nominal size) finished with a floating coat of neat cement.	1.020 quintal per	10 sqm area
4.	40mm thick (IPS) cement concrete flooring 1:2:4 with 20mm and down		

	stone chips finished with a floating coat of neat cement.	1.500 quintal per	10 sqm area
5.	25mm thick (IPS) flooring with base coat 19mm thick 1:2:4 using stone chips 10mm nominal size and 6mm topping coat 1:1 (1 cement : 1 stone chips 3mm size) with a floating coat of neat cement.	1.370 quintal per	10 sqm area
6.	40mm thick (IPS) flooring with base coat 30mm thick 1:2:4 using stone chips 10mm nominal size and10mm topping coat 1:1 (1 cement : 1 stone chips 3 to 6mm size) with a floating coat of neat cement.	2.320 quintal per	10 sqm area
	25mm thick cast-in-situ grey terrazzo flooring, under layer 19mm thick cement concrete 1:2:4 with 10mm nominal size chips and 6mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.	1.370 quintal per	10 sqm area
8.	40mm thick cast-in-situ grey terrazzo flooring, under layer 30mm thick cement concrete 1:2:4 with 10mm nominal size chips and10mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.	1.575 quintal per	10 sqm area
9.	40mm thick cast-in-situ terrazzo flooring, under layer 31mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 9mm thick with marble chips of size 4 to 7mm nominal size laid in cement marble powder mix 3:1 (3 cement : 1		

	marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.		
	a) Dark or light shade pigment with grey cement	1.583 quintal per	10 sqm area
	b) Light shade pigment or without any (grey cement) pigment with white cement	1.010 quintal per (grey cement) 0.580 quintal per (white cement)	10 sqm area 10 sqm area
	c) Medium shade pigment with 50% grey cement and 50% white cement	1.295 quintal per (grey cement) 0.290 quintal per (white cement)	10 sqm area 10 sqm area
10.	40mm thick cast-in-situ terrazzo flooring, under layer 28mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 12mm thick with marble chips of size 7 to 12mm nominal size laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 2:3 (2 cement marble powder mix : 3 marble chips) by volume.		
	a) Dark or light shade pigment with grey cement	1.705 quintal per	10 sqm area
	b) Light shade pigment or without any (grey cement) pigment with white cement	0.895 quintal per (grey cement) 0.810 quintal per (white cement)	10 sqm area 10 sqm area
	c) Medium shade pigment with 50% grey cement and 50% white cement	1.300 quintal per (grey cement) 0.405 quintal per (white cement)	10 sqm area 10 sqm area
	d) White cement without any pigment	0.895 quintal per (grey cement) 0.810 quintal per (white cement)	10 sqm area 10 sqm area

11.	Terrazzo cast-in-situ skirting and dado, top layer 6mm thick marble chips laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble : 7 marble chips) by volume.		
(A)	18mm thick with under layer 12mm thick cement plaster 1:3		
a)	Dark or light shade pigment with grey cement	1.490 quintal per	10 sqm area
b)	Light shade pigment or without any pigment with white cement.	1.090 quintal per (grey cement)	10 sqm area
		0.400 quintal per (white cement)	10 sqm area
c)	Medium shade pigment with 50% grey cement and 50% white cement	1.290 quintal per (grey cement)	10 sqm area
		0.200 quintal per (white cement)	10 sqm area
(B)	21mm thick, with under layer 15mm thick cement plaster 1:3		
a)	Dark or light shade pigment with grey cement	1.640 quintal per	10 sqm area
b)	Light shade pigment or without any pigment with white cement.	1.230 quintal per (grey cement)	10 sqm area
		0.400 quintal per (white cement)	10 sqm area
c)	Medium shade pigment with 50% grey cement and 50% white cement	1.430 quintal per (grey cement)	10 sqm area
		0.200 quintal per (white cement)	10 sqm area
12.	Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm laid in 25mm thick bed of lime mortar, jointed with neat cement slurry mixed with pigment		

a)	Dark shades using grey cement	0.88 quintal per	10 sqm area
b)	Light shade using white cement.	0.44 quintal per (grey cement)	10 sqm area
		0.44 quintal per (white cement)	10 sqm area
c)	Medium shade using 50% grey cement and 50% white cement	0.66 quintal per (grey cement)	10 sqm area
		0.22 quintal per (white cement)	10 sqm area
13.	Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm in skirting or on walls, laid on 12mm thick cement plaster 1:3 jointed with neat cement slurry		
a)	Dark shades using grey cement	1.395 quintal per	10 sqm area
b)	Light shade using white cement.	1.175 quintal per (grey cement)	10 sqm area
		0.22 quintal per (white cement)	10 sqm area
c)	Medium shade using 50% grey cement and 50% white cement	1.285 quintal per (grey cement)	10 sqm area
		0.11 quintal per (white cement)	10 sqm area
14.	White glazed tiles 5, 6 or 7 mm thick in flooring, skirting and dado on 12 mm thick cement plaster 1 : 3 in base and joined with white cement, slurry etc.	0.942 quintal per (grey cement)	10 sqm area
		0.25 quintal per (white cement)	10 sqm area
15.	Marble stone slab flooring over 20mm thick base of lime mortar 1:1:1 (1 lime : 1 surkhi : 1 sand) and jointed with white cement slurry etc.		
a)	20 mm thick / 30 mm thick / 40 mm thick	0.075 quintal per (white cement)	10 sqm area
16.	Marble stone slab flooring over 20mm thick base of cement mortar 1:4 &		

	jointed with white cement slurry etc.		
a)	20 mm thick	1.275 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
b)	30 mm thick	1.290 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
c)	40 mm thick	1.310 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
17.	Marble tiles 18 to 24 mm thick in risers of steps, skirting, dado, walls and pillars laid on 12mm thick cement mortar 1:3 (1 cement : 3 sand) and jointed with white cement slurry	1.16 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
18.	Extra for each additional thickness of 5 mm granolithic layer of 1:2:4 for flooring	0.016 quintal per	10 sqm of area
19	12mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.	0.800 quintal per	10 sqm of area
20	15mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.	0.995 quintal per	10 sqm of area
21.	19mm thick cement plaster skirting and dado with 12mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.	1.35 quintal per	10 sqm of area

22.	25mm thick cement plaster skirting and dado with 18mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.	1.85 quintal per	10 sqm of area

MISCELLANEOUS

1.	Marble work for wall lining (Veneer work) 1.8 to 2.4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust)	0.715 quintal per (grey cement) 0.170 quintal per (white cement)	10 sqm of area 10 sqm of area
2.	Marble work for wall lining (Veneer work) 4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust)	1.020 quintal per (grey cement) 0.170 quintal per (white cement)	10 sqm of area 10 sqm of area
3.	Grading roof for water proofing treatment with :-		
a)	CC 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size)	3.2 quintal per	cum of Concrete
b)	CM 1:3	5.1 quintal per	cum of mortar
c)	CM 1:4	3.8 quintal per	cum of mortar
4.	Providing and fixing MS fan clamps of standard shape and size in existing RCC slab including cutting chase and making good.	0.016 quintal	each
5.	Making plinth protection 50mm thick of CC 1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 20mm nominal size) over 75mm bed of dry brick ballast 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth.	1.1 quintal per	10 sqm of area

6.	Grouting with		
a)	CM 1:2	7.18 quintal per	cum
b)	CM 1:3	5.40 quintal per	cum
7.	DPC 25mm thick (1:2:4)	0.81 quintal per	10 sqm of area
8.	Making plinth protection with bricks on edge in CM 1:6 over 7.5cm bed of dry brick aggregate 40mm nominal size rammed, consolidated and grouted with fine sand and top of bricks pointed with CM 1:2.	0.86 quintal per	10 sqm of area
9.	Providing and fixing 25mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.05 quintal per	10 RM
10.	Providing and fixing 40mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.075 quintal per	10 RM
11.	Providing chases 75mm wide 50mm deep in walls for conduit pipe and filling the same with CC 1:3:6	0.075 quintal per	10 RM
12.	Fixing steel windows with 1:2:4 concrete blocks	0.40 quintal per	10 sqm of area
13.	Cement-sand mortar :		
a)	1:1(1cement :1sand)	10.2 quintals per	cum
b)	1:2(1cement : 2sand)	6.8 quintals per	cum
c)	1:3(1cement : 3sand)	5.1 quintals per	cum
d)	1:4(1cement : 4sand)	3.8 quintals per	cum
e)	1:5(1cement : 5sand)	3.1 quintals per	cum
f)	1:6(1cement : 6sand)	2.5 quintals per	cum

DRAINAGE/SANITARY & WATER SUPPLY INSTALLATIONS

1.	100mm dia AC rain water pipe I/c fittings with CM 1:2	0.725 quintal per	100 RM of pipe
2.	150mm dia AC rain water pipe I/c fittings with CM 1:2	0.82 quintal per	100 RM of pipe
3.	Fixing IWC pan with traps, pair of footrests, and flushing cistern complete	0.125 quintal	each
4.	Fixing EWC pan with trap and flushing cistern complete	0.01 quintal	each
5.	Fixing wash basin and kitchen sink	0.025 quintal	l each
6.	Fixing urinal cistern including pipes	0.025 quintal	each
7.	Fixing & finishing floor trap	0.015 quintal	each
8.	Fixing HCI pipes and specials, 100mm dia and 75mm dia including making good the walls	0.135 quintal per	10 RM of pipe
9.	Fixing GI pipes of all dia with clamps (for inside work only)	0.015 quintal per	10 RM of pipe
10.	Jointing glazed stoneware pipe with CM 1:1		
	a) 100 mm dia	2.17 quintals per	10 RM of pipe
	b) 150 mm dia	3.23 quintals per	10 RM of pipe
11.	Laying cement concrete 1:5:10 all round SW pipe including bed concrete as per standard design		
	a) 100mm dia SW pipe	19.24 quintals per	100 RM of pipe
	b) 150mm dia SW pipe	23.53 quintals per	100 RM of pipe

12.	Gully chamber as per specification.		0.385 quintal	each
13.	Stopcock chamber as per specification		0.185 quintal	each
14.	Inspection chambers as per specification			
	a)	600x600x600mm deep	1.43 quintals	each
	b)	750x600x600mm deep	1.435 quintals	each
	c)	900x900x600mm deep	1.885 quintals	each
15.	Extra depth of inspection chambers as per specification			
	a)	600x600mm	0.805 quintal per	RM of depth
	b)	750x600mm	1.295 quintal per	RM of depth
	c)	900x900mm	1.460 quintal per	RM of depth
	d)	1200x900mm	1.835 quintal per	RM of depth

SPECIFICATION FOR CIVIL WORKS

PART – IV DIMENSIONAL TOLERANCE

GENERAL

The materials used in construction shall, besides conforming to the specifications and standards mentioned, be the best of the existing kinds obtainable. Where a particular 'Brand' or 'Make' of material is specified such 'Brand' or 'Make' of material alone shall be used.

A high standard of workmanship and accuracy shall be achieved in all sections and parts of the work. The workmanship shall be in accordance with the latest and the best civil engineering practice.

The Contractor shall ensure that all sections of the work are carried out with utmost care to achieve the dimensions shown in drawings or specifications. Where special and close tolerances are required in any particular section of work, these will be shown in the drawing and such tolerances shall be met. In the absence of such specific mention in drawings the following dimensional deviations may be tolerated, provided they do not impair the appearance or render the particular section of work unacceptable to the purpose for which it is intended. Tolerance for materials and workmanship not covered in this part as mentioned hereinafter will be in accordance with the relevant IS code.

Description		**Permissible tolerance**
Building bricks, in length width and height	:	As per IS 1077 - 1992
Laterite stone, in length, width & height	:	Plus or minus 5 mm
<u>Natural building stone</u>		
a) For stones required in ashlar masonry :		
Length & Breadth	:	Plus or minus 5mm
Height	:	Plus or minus 3mm
b) For stones required other than in ashlar masonry :		
Length & Breadth	:	Plus 5mm, minus 10mm
Height	:	Plus 5mm, minus 5mm

Description		Permissible tolerance
Concrete and reinforced concrete pipes :		
Length	:	Plus or minus 1% of standard length
Internal diameter, upto 300 mm	:	Plus 3 mm Minus 1.5 mm
Cast iron spigot & socket pipes and fittings :		
Length of fittings	:	Plus or minus 10mm
Length of pipe	:	Plus or minus 20mm
Thickness	:	minus 1 mm
Internal dia of socket	:	Plus or minus 3 mm
Depth of socket	:	Plus or minus 10mm
External dia, upto 75 mm	:	Plus or minus 3mm
100 mm	:	Plus or minus 3.5mm
150 mm	:	Plus or minus 4mm
Stoneware pipes, in length		
upto 75 cm	:	Plus or minus 10mm
Upto 90 cm	:	Plus or minus 15mm
In thickness of barrel and socket not exceeding 450mm	:	Plus or minus 2mm
In thickness of barrel and socket between 500 to 600mm	:	Plus or minus 3mm
Glazed tiles, length of all 4 sides	:	Plus or minus 0.8mm
Individual dimensions and thickness	:	Plus or minus 0.5 mm

Description		Permissible tolerance
Metal doors, windows and ventilators - In overall dimension	:	Plus or minus 1.5 mm
Wooden doors, windows, ventilators Overall dimension of door, window, ventilators	:	Plus or minus 3 mm
All components of shutter except glazing bar		
Width	:	Plus or minus 3 mm
Thickness	:	Plus or minus 1 mm
Glazing bar, width & thickness	:	Plus or minus 1 mm

Mild steel tubes, tubulars and other wrought steel fittings

a)	Thickness			
	i)	butt welded light tubes	:	Plus not limited minus 8%
		medium and heavy tubes	:	plus not limited minus 10%
	ii)	seamless tubes	:	plus not limited minus 12.5%
b)	Weight			
i)	single tube (irrespective of the quantity)		:	+ 10% , - 8%
ii)	for quantity of less than 150m of one size		:	+ 10% , - 8%
iii)	for quantity of 150m and over of one size		:	+ 4% , - 4%

Earth work

Finished level of site levelling in hard rock	:	Plus or minus 50mm
Finished level of site levelling except for hard rock	:	Plus or minus 100 mm

Level of pits, trenches foundations	:	Plus or minus 50mm
Concrete & Reinforced concrete		
Footings, plan dimension	:	Plus 50 mm Minus 12 mm
Eccentricity	:	0.02 times the dimension of footing in the direction limited to 50 mm
Thickness	:	Plus or minus 0.05 times the specified thickness
Foundations		
Deviation of planes and lines of their intersection from vertical or inclination along full height	:	Plus or minus 20 mm
Deviation of horizontal plane from horizontal line		
for 1 m of the plane in any direction	:	Plus or minus 5mm
for the whole plane	:	Plus or minus 20mm
Sizes of cross section	:	Plus or minus 8mm
Surfaces of inserts to support loads	:	Plus or minus 5mm
Length of elements	:	Plus or minus 20 mm
Equipment foundations :		
Top level of bolt	:	Plus 20mm
Top level of foundation before grouting	:	Minus 20mm
Axes of anchor bolts in plan	:	Plus or minus 5mm

Axis of foundation in either direction	:	Plus or minus 10mm
Deviation in vertical line along height	:	Plus or minus 10mm
Sizes of pits in plan	:	Plus or minus 20 mm
Sizes of steps in plan	:	minus 20mm
Levels of steps, benches and pits	:	minus 20mm
Axes of inserts in plan	:	Plus or minus 10 mm
Basic dimensions in plan	:	Plus or minus 10mm
Deviation of horizontal plan from horizontal line		
for 1 m of plane in any direction	:	Plus or minus 5mm
for the whole plane	:	Plus or minus 20mm
Local deviations of top surface when checked with a 2 m long straight edge	:	Plus or minus 8mm

Buildings :

Surfaces when checked with a 2 m long straight edge	:	Plus or minus 8mm
Sizes of cross section	:	Plus 8mm Minus 0 mm
Length of elements	:	Plus or minus 20mm
Deviation from horizontal plane, for whole building	:	Plus or minus 10mm
Plumb in verticality	:	1 in 1000 of height
for columns supporting floor beams	:	Plus or minus 10mm
for framed columns linked with crane girders		

and beams	:	Plus or minus 10mm
Reinforced concrete walls	:	Length : Plus or minus 20mm
Flatness of surface when checked with a 2 m long straight edge	:	Plus or minus 8mm
Level of top surface to support assembled elements	:	Plus or minus 5mm
Deviation in planes and lines of intersection from vertical	:	Plus or minus 15mm
Size of cross section	:	Plus or minus 8mm

Placing of reinforcement :

Length of bar upto 75 cm long (Other than straight bars)	:	Plus 3 mm Minus 5 mm
75 - 150 cm long	:	Plus 5 mm Minus 10 mm
150 - 250 cm long	:	Plus 6 mm Minus 15 mm
250 cm long and above	:	Plus 7 mm Minus 25 mm
Straight bars, all lengths	:	Plus or minus 25 mm
Spacing of bars	:	Plus or minus 5 mm

Anchor bolts :

Shift in location in plan	:	Plus or minus 5 mm
Same, when bolts are located outside of structural columns	:	Plus or minus 10mm
Top level	:	Plus 20 mm
Threaded length	:	Plus 30 mm

	For Walls	**For Pillars**

Masonry

Width	:	Plus or minus 10 mm	Plus or minus 10 mm
Shift in axes	:	Plus or minus 10 mm	--- ---
Deviation in row from horizontal line for every 10m length	:	Plus or minus 15 mm	--- ---
Flatness of surface when checked with a 2 m long straight edge	:	Plus or minus 10 mm	Plus or minus 5 mm
Deviation in lines separating storeys Deviation of surface from vertical and and at angles and corners	:	Plus or minus 15 mm	Plus or minus 15 mm
for 1 storey	:	Plus or minus 10 mm	Plus or minus 10 mm
for whole building	:	Plus or minus 30 mm	Plus or minus 30 mm
Dimensions of openings for doors, windows etc	:	Plus 15 mm Minus 0 mm	
Flooring, skirting, dado and plastering	:		
Insitu concrete floor	:	4 mm	
Concrete tile and mosaic, in any 3 m length	:	3 mm	

in large open area	:	15 mm
wall tiling - surface should not vary from general plane by more than 1 in 200. Marble and such superior work, in any 2 m length	:	1.5 mm
in any row	:	3 mm
Plastered surfaces, flatness when checked with a 2 m long straight edge	:	3 mm
Vertical surfaces, upto 1 storey	:	5 mm
Over full heights	:	10 mm
Metallic Inserts on assembled components length and width	:	Plus or minus 3 mm

Road work

The levels of the sub-grade and different pavement courses should not vary from those calculated with reference to the longitudinal and cross-sections of the road as shown on the drawing beyond the tolerance given below :-

Sub-grade	:	plus or minus 25mm
Sub-base	:	plus or minus 20mm
Base	:	plus or minus 15mm
Wearing course	:	plus or minus 6mm

SPECIFICATION FOR CIVIL WORKS

PART – V METHOD OF MEASUREMENT

CONTENTS

1.0 GENERAL

1.1 The method of measurement of the various items of work shall be in accordance with IS : 1200 (Part 1 to 28) - 1971 to 1993 unless otherwise mentioned in this part or in the schedule of items or in preamble or in the specification.

1.2 If there is any contradiction in meaning between any portion of this part and that of IS :1200 (Part 1 to 28) - 1971 to 1993, the stipulation of this part shall prevail.

1.3 The descriptions and explanations given herein have as much forces as though they are incorporated into the description of the items themselves in the schedule of items.

2.0 EARTH WORK & SAND FILLING

2.1 General

2.1.1 Each dimension upto 25 m shall be measured to nearest 0.01 m and to nearest 0.1 m for dimensions over 25 m. Areas shall be worked out to the nearest 0.01 m2 and cubical contents to the nearest 0.01 m3.

2.1.2 Shoring and strutting shall not be measured separately unless otherwise specified.

2.1.3 Dewatering for earth work and sand filling work shall not be measured separately unless otherwise specified.

2.1.4 For classification of soils, relevant clauses of Technical specification (workmanship and other requirements) is to be followed.

2.2 Requirements for particular works

2.2.1 Site levelling

2.2.1.1 For site levelling levels shall be taken jointly before start & after completion of work and the quantity computed based on the levels. Measurements shall be made only for excavation and no separate measurement for filling shall be made except where earth, borrowed from elsewhere for site

levelling work, will be measured separately only for that borrowed portion of earth.

2.2.1.2 In cases where it is not possible or convenient to take measurements from excavated cuts or borrow pits, excavation shall be worked out from filling based on the levels to be taken before and after completion of works. Deduction of 10 percent will be made for voids, however for consolidated fills done through heavy mechanical means, the deduction for voids shall be 5% in place of 10%.

2.2.1.3 In exceptional cases where the quantity is measured on the lorry measurement, loose stacks, boxes or any other similar method with the approval of the Engineer the deduction for voids shall be 20 per cent from the actual quantity.

2.2.2 Excavation

2.2.2.1 Before commencing excavation of foundations for buildings and structures, the initial ground levels shall be jointly recorded. The depth of excavation and the calculation of lift shall be based on this. Normally the initial ground level shall be considered as the level of the site as handed over to the contractor. In case excavation is planned and approved to be taken up subsequent to terracing, the terrace level shall be treated as initial ground level.

2.2.2.2 Excavation of foundations, trenches, basements, pits etc., shall be measured to the dimensions shown in the excavation plan, if any, or of the lowest concrete or masonry course, as the case may be and the actual depth. Working space and slopes shall not be measured.

2.2.2.3 Excavation of rock shall be measured from stacks of excavated rock with a deduction of 50 per cent for voids or measured in the solid based on levels.

2.2.2.4 In case of following works, no measurement will be recorded for the excavation beyond drawing / specification.

(a) In work which will be covered externally with damp proof covering.

(b) In work which requires formwork.

(c) In work which requires workmen to operate from the outside and for guniting and post tensioned concrete, ground beams etc.

However, if there is a specific provision otherwise in the item/specification/preamble, for authorised working, it shall be measured accordingly. This working space may be 60 cm. measured from the face of the structure at lowest level, unless otherwise mentioned.

2.2.2.5 Surface Dressing

Trimming of natural ground, excavated surface and filled up area to remove vegetation and/or small in equalities not exceeding 15 cm deep shall be described as surface dressing and measured in square metres unless otherwise specified in the schedule of items/ preamble.

2.2.2.6 Lead

The distance for removal shall be measured over the shortest practicable route and not necessarily the route actually taken.

The description of the item shall include loading and unloading.

For the purpose of the measurement of the lead, the area excavated shall be divided in suitable block and for each block the distance from the centre of the block to the centre of the placed earth pertaining to this block shall be taken as lead.

2.2.3 Back filling/filling

2.2.3.1 In foundations, trenches, basements, pits, etc. and in other like areas, the measurements shall be the theoretical volume of the filling computed from drawings i.e. the volume measured under excavation minus the volume occupied by the structure and part filling if any, done otherwise.

2.2.3.2 In filling under floors the measurements shall be the theoretical volume as per drawings after deducting the part filling if any, done otherwise.

2.2.3.3 In embankments, the work shall commence only after recording jointly the initial ground levels and the measurements shall be made on the basis of finished cross section and initial ground levels. Where controlled compaction by mechanical compaction is done, 5% deduction for voids shall be made. In case controlled compaction by mechanical means is not done then deduction for voids shall be 10%.

2.2.3.4 Filling/Back filling shall not be measured separately for items of excavation, where filling/back-filling is a part of the composite item and as such is included in excavation item itself.

3.0 ANTI-TERMITE TREATMENT

Measurement shall be the plinth area of the ground floor of the building treated. Dimensions shall be measured to the nearest 0.01 m and area to nearest 0.01 m2.

4.0 CONCRETE (PLAIN & REINFORCED)

4.1 Concrete

4.1.1 Dimensions shall be measured to nearest 0.01 m except for the thickness of slab, which will be to nearest 0.005 m. Areas shall be worked out to nearest 0.01 m2 and cubic contents to nearest 0.01 m3.

4.1.2 The concrete shall be measured as per drawings except in the cases of approved variations which will be measured separately.

No deductions shall be made for the following :

i) Ends of dissimilar materials such as beams, rafters, purlins etc., upto 500 cm2 in cross section.

ii) Openings upto 0.1 m2 in area (In calculating area of an opening, the thickness of any separate lintel or sill shall be included in the height. No extra labour for forming such opening or voids shall be measured).

iii) Volume occupied by reinforcement or other embedments such as anchors, inserts, conduits or volume occupied by pipes, sheathing etc. not exceeding 100 sq. cm. each in cross sectional area or as specified.

iv) Small voids not exceeding 40 cm2 each in cross section.

v) Moulds, drip moulding, chamfer, splay, beds, grooves and rebates upto 10 cm in width or 15 cm in girth.

4.1.3 Columns shall be measured from top of column base to underside of first floor slab and from top of floor to underside of floor slab above thereafter. Beams shall be measured from face to face of columns and will include haunches. Depth of beam shall be measured from bottom of slab and in the case of inverted beams from top of slab. Chajjas and other cantilevers shall be measured from the face of the projection.Where vertical fins are combined with chajja, the latter shall be measured clear between fins. In case chajja is not combined with lintel, beam or slab, it shall be measured inclusive of bearing.

4.2 REINFORCEMENTS

4.2.1 Norms for Steel Consumption

The requirement of mild and high strength deformed bars for various works like reinforcement, guard bars, fan hooks etc. shall be calculated as mentioned below :

i) As per drawing including

(a) Authorised laps, bends, standard hooks and deviations etc.

(b) Spacer bars, chairs, hangers, supports, spacer blocks dowels etc. are to be considered for wastage only and not to be measured for payment purpose.

ii) Quantity upto 0.5% of (i) above towards unaccounted wastages, plus

iii) Quantity upto 3% of (i) above towards cut pieces, which shall be pieces below 2m. length. These cut pieces shall not be taken back even though steel has been issued by the client/owner.

4.2.2 Reinforcements shall be measured in lengths to the nearest 0.01 m for various diameters of bar and converted into weight in tonnes to the nearest kg. on the basis of standard weights as per IS : 1786-1986. No allowance shall be made in the weight for rolling margin.

4.2.3 Authorised laps, standard hooks, bends shall be measured.

4.2.4 Sapacer bars, chairs, hangers, supports, spacer blocks and unauthorised laps etc. shall not be measured unless otherwise specified.

4.2.5 Dowels neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured for payment.

4.2.6 Modification of already embedded reinforcement, if required due to faulty fabrication or placement, shall not be measured for payment.

4.2.7 The measurements of reinforcements (including authorised laps, hooks, bends) shall be taken only from Bar bending lists or from the drawings except in the cases of approved variations which will be measured as per 4.2.2.

4.2.8 Wire netting and fabric reinforcement shall be described (including meshes and wire/strands) and measured in square metre, unless otherwise specified in the schedule of item. Authorised laps shall be measured. Raking or circular cutting and waste shall be included in the description of item.

4.2.9 Hoop iron shall be fully described and measured in running metres unless otherwise specified in the schedule of item.

4.2.10 Binding wire for the reinforcement shall not be measured separately and shall be included in the item of reinforcement.

4.3 ADMIXTURE

Admixture will be measured separately as specified or on the basis of the requirement as approved by the Engineer.

4.4 FORMWORK

Each dimension shall be measured to the nearest 0.01 m and area to the nearest 0.01 sq.m.

4.4.1 Formwork shall be measured as the actual surface in contact with concrete and paid in sq.m. unless included in the rate for concrete in specific item of work.

4.4.2 All the measurements shall be computed from the drawings except in the cases of approved variations which will be measured separately.

4.4.3 Formwork shall not be measured separately for precast concrete work, grouting and damp proof course which shall be included in the concrete rates.

4.4.4 No measurement for formwork in construction joints shall be made.

4.4.5 Openings upto 0.1 sq.m. shall be neglected, as if non - existent, for the purpose of formwork measurement.

4.4.6 No extra measurement or payment shall be made for making the form work water proof or for supports, scaffolding, staging, centering, approaches etc.

4.4.7 No measurement shall be taken for the formwork in pockets, openings, chambers, chases etc., in concrete if the cross sectional area is less than or equal to 0.1 sq.m. in each case. If the cross section area of any opening exceeds 0.1 sq.m. the actual area of the formwork shall be measured for payment.

4.5 EMBEDDED PARTS

4.5.1 These shall be measured on the basis of standard theoretical weight of the complete insert according to the drawing/direction.

4.5.2 Embedded steel, which are the integral parts of the embedment according to drawing and are required for anchoring the embedded parts in concrete shall be measured on the basis of the theoretical standard weight. In case of anchor bolts the theoretical weights of the nuts, lock nuts, check nuts and washers shall be added in the measurement for payment.

4.5.3 All bye-works such as jigs, fixtures, templates and other arrangements which are not integral parts of the embedded parts, but necessary to secure those (embedded parts) in position shall not be measured for payment.

4.5.4 Anti-corrosive paint over the exposed surfaces and protection of the anchor bolts with grease tc., shall not be measured for payment.

4.5.5 Modification works necessary to rectify the mistake of already placed embedded parts shall not be measured.

4.6 GROUTING

4.6.1 Grouting shall be measured in volume except in the cases of grouting by special cement compound or epoxy compound which will be measured by number.

4.6.2 Measurement shall be computed from the drawings except in the cases of approved variations which shall be measured separately and subsequently added to or deducted from.

4.6.3 Necessary formwork shall not be measured for payment.

4.7 DAMP PROOF COARSE

4.7.1 Measurement shall be in sq.m. stating thickness and computed from the drawings except in the cases of approved variations which will be measured separately.

4.7.2 Necessary formwork shall not be measured for payment.

5.0 MASONRY

5.1 Dimensions shall be measured to nearest 0.01 m, areas to nearest 0.01 m2 and cubic contents to nearest 0.01 m3.

5.2 No deduction shall be made for :

(i) Ends of dissimilar materials such as joints, beams, posts, girders, trusses, lintels, purlins etc., upto 0.1 m2 in section.

ii) Openings upto 0.1 m2 in area.

(iii) Wall plates, bed plates, bearing of slab etc., thickness not exceeding 10 cm. and bearing not extending over the full thickness of wall.

(iv) Cement concrete blocks for holdfasts and the like.

(v) Iron fixtures such as pipes etc. upto 300 mm. dia. and hold fasts for doors and windows.

5.3 Dressed stonework such as in sills, cornices , column caps, copings etc., shall be measured as the smallest rectangular block from which the finished stone can be worked.

5.4 Honeycomb openings shall not be deducted from the area of honeycomb brickwork.

5.5 Brickwork of full brick width or more shall be measured in cu.m. while of thickness of half brick or less shall be measured in sq.m., unless otherwise specified.

5.6 Reinforcements for reinforced brick work shall be measured separately, unless otherwise specified and no deduction for reinforcement shall be made from brickwork.

6.0 PLASTERING & POINTING

6.1 All plastering and pointing shall be measured in sq.m. unless otherwise described. Dimensions shall be measured to nearest 0.01 m and areas to 0.1 sq.m.

6.2 Ceiling shall be measured between walls or partitions (dimensions before plastering) shall be taken. Measurement of wall plastering shall be taken between walls or partitions for length (dimension before plastering) and from top of floor or skirting to ceiling for height.

6.3 The methods of measurement including the deductions for openings etc., shall be according to the relevant part of IS : 1200 (Part 1 to 28) - 1971 to 1993.

7.0 WHITE WASHING, COLOUR WASHING, PAINTING & OTHER FINISHES.

The method of measurement shall be according to the relevant part of IS : 1200 (Part 13 & 15) - 1987.

8.0 FLOORING, PAVING & FACING WORKS

8.1 The work shall be measured as a complete finished item including necessary underbed, adhesives, dividing strips, joint sealing and necessary grinding, polishing and finishing where specified. The subgrade or the base course shall be measured separately against respective item unless otherwise specified.

8.2 All works shall be measured net, dimensions being measured to nearest 0.01 m and areas to nearest 0.01 sq.m. Any opening less than 0.1 sq.m. in area shall not be deducted nor any extra payment made for that.

8.3 Building paper or water proofing by bituminous felts/mastic asphalt treatment, where specified to be laid below floor, shall be measured separately for payment unless otherwise specified.

8.4 Laps and seams in sheet finishing (linoleum, cork, PVC, rubber & like) shall be deemed to be included in the item itself even if not described explicitly and shall not be measured and paid separately.

9.0 WOODWORK

9.1 All work shall be measured net for finished dimensions as fixed, that is no extra measurement or allowance shall be made for shape, joints, wastage etc. subject to specific provision made in the IS : 1200 (Part 21) - 1973 and for dimensions supplied beyond those specified in the drawing.

9.2 Wooden frame

rought, finished and fixed shall be measured net for overall length nearest to 0.01 m, width and thickness to the nearest 2mm or as specified in the drawing and cubic contents calculated in cubic metres to the nearest three places of decimals.

Wooden shutters of all types

Length and width of the shutters shall be measured net as fixed to the nearest cm. in closed position covering the rebates of the frame but excluding the gap between the shutter and the floor and the area calculated in square metre upto two places of decimal.

Over lap of two leaves of shutter shall not be measured separately.

Hand rails

Hand rails of finished width and depth as specified in the item shall be measured in running metres upto two places of decimal.

9.3 Painting and polishing, unless otherwise described in the schedule of items, shall be measured separately for payment.

9.4 Builder's hardware and fittings for doors windows and ventilators shall be measured separately, unless stated otherwise in the Schedule of Items. Hardware and fittings shall be measured according to IS : 1200 (Part-VII) - 1972.

9.5 Hold fasts for door, window and ventilator frames shall be measured separately.

9.6 Timber Partitions

This shall be measured in area calculated in sq. m. to the nearest two places of decimal.

9.7 Glazed shutters and glazed partitions (Wooden)

Glazed shutters/glazed partitions with wooden frames shall be measured as a single item in area calculated in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made.

9.8 Provision of making holes/opening/chases in masonry/ concrete flooring etc. for fixing and making good of the same shall not be measured separately for payment.

9.9 Bitumen painting or approved wood preservative of the timber surfaces in contact with masonry/concrete floor etc. shall not be measured for payment.

10.0 METAL DOORS, WINDOWS & VENTILATORS

10.1 Door, window and ventilator/louvers as fixed, shall be measured net as clear width between jambs and clear height between floor/sill and underside of lintel, but excluding the gap between door shutters and floor. Dimensions shall be calculated to the nearest 0.01 m., area calculated in sq.m. upto two places of decimal.

10.2 For MS collapsible shutter/gate, rolling shutter sliding folding door, length and breadth shall be measured to the nearest cm. for the clear area of opening as per drawing in which they are installed and calculated in sq.m. to the nearest two places of decimal.

10.3 M.S. Rolling grills, doors of steel plate, sliding door louvered ventilators, gates, grills, as fixed, shall be measured and computed to weight from the size as per drawing unless otherwise specified.

10.4 Glazed doors, windows, louvers, partitions (both steel and aluminium) shall be measured in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made for payment.

11.0 GLAZING

11.1 Glazing shall not be separately measured for doors, windows and ventilators unless otherwise specified.

11.2 North light and roof glazing shall be paid as the area from outside to outside of glazing including frames, to the nearest 0.01 sq.m.

11.3 Glazing, where shown in the schedule of items as a separate item, shall be measured from edge to edge of glass as fixed.

12.0 WATER SUPPLY, DRAINAGE, SEWERAGE & SANITATIONS

12.1 All the pipelines buried under soil/masonry/floors/ concrete, laid over/underground/along masonry/along under floor shall be measured in metres along the centreline together with fittings/specials upto two places of decimal against respective schedule of items for different diameter (the diameter as specified shall mean nominal bore except PVC pipe) unless otherwise specified.

12.2 All necessary earth work in trenches for laying pipe lines including dewatering, levelling and trimming to the gradient, sand filling in the trenches before laying the pipe, back filling either by sand or by approved borrowed soil after laying the pipe lines including necessary compaction by spraying water and levelling/dressing the same shall not be measured separately for payment unless otherwise specified.

12.3 All required specials, i.e. bends tees, shoes cowls, plug, elbows, unions, caps, checkout and the like excluding valves shall not be measured separately for payment unless otherwise specified.

12.4 All fixing and supporting arrangement of the pipes like the supports, saddles, brackets, clamps, cleats, covering the pipes with concrete in case of pipes laid over ground, special arrangement for supporting the pipe like

while coming out from the building to the trenches etc. shall not be measured separately for payment, unless otherwise specified.

12.5 All the arrangement in road crossing like cutting the road, diverting the road and drains, concealing the pipes with suitable approved measures, backfilling the area, covering and making good of the road with similar materials/design shall not be measured separately for payment, unless otherwise specified.

12.6 Septic tanks, inspection pits, manholes etc., shall be considered as a composite single item including excavation, dewatering, concrete, masonry, back filling, protection of other service lines and all the like works unless otherwise specified.

12.7 All the valves and all the bathroom/W.C./Kitchen fixures like bib tap, stop cock, shower, all sanitary wares, towel rails, mirrors etc., shall be measured separately under respective item in the schedule, unless otherwise specified.

13.0 WATER PROOFING, DAMP PROOFING

13.1 Water proofing for roofs

13.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.1.2 Measurement shall be made for the net covered area. No measurement shall be made for overlapping for end and side joints and for bends around/along the corners, ends and for special treatment around pipes, rain water gulleys, steel structure and the like etc. No deduction shall be made in the measurement for the opening of area less than 0.1 m2 each and no extra payment shall also be made for any special works made around such openings.

13.1.3 Water proofing treatment shall be considered as a single composite item including priming painting coat, water proofing felts, binding bituminous coats, top bituminous coat and pea size gravel or sand finishing etc.

13.1.4 For lime concrete terracing the consolidated thickness shall be considered for measurement.

13.2 For Water proofing treatment in basement

13.2.1 With bituminous felts

13.2.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. utp two places of decimal.

13.2.1.2 Measurement shall be made for the net covered area. Measurement shall be made from the drawing, except in certain special cases where it is impossible to compute from drawing and the measurement shall be made as executed. No measurement shall be made for overlaps, special measures around projected pipes, sealing the bends/rounds and in other cases, necessary projection/ overlap for the connection between vertical and horizontal junction etc.

13.2.1.3 Water proofing treatment shall be considered as a single composite item, including priming painting coat, water proofing felts, binding bituminous coats and top bituminous coat etc.

13.3 Mastic Treatment

13.3.1 Length and breadth shall be measured in metres upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.3.2 Measurement shall be made for the net covered area. No deduction in measurement shall be made for opening of area upto 0.1 sq.m. each and no extra payment shall be made for any special treatment around such openings. No measurement shall be made for extra payment for the special works necessary for junctions, corners, roundings, bends for the works around pipes and the like.

14.0 CEILING & LININGS

14.1 Dimensions shall be measured to the nearest 0.01 m., areas to be worked out to the nearest 0.01 sq.m.

14.2 Work formed to circular surfaces shall be measured separately unless otherwise specified.

14.3 All work unless otherwise described shall be measured as flat in sq.m.

14.4 No deduction in measurement shall be made for openings not exceeding 0.4 sq.m. and no extra measurement shall be made for forming such openings.

15.0 ROAD WORK

15.1 Dimensions shall be measured to nearest 0.01 m. Where the thickness is less than 20 cm., it shall be measured to nearest 0.005 m. Areas shall be worked out to nearest 0.01 sq.m. and cubic contents to the nearest 0.01 cu.m.

15.2 Where thickness is measured, it shall be the minimum thickness after compaction.

15.3 Cement concrete bases and roads shall be measured either in sq.m. or cu.m. as specified.

15.4 Unless otherwise specified, expansion and dummy joints shall be described and measured separately and given in running metres stating the thickness and depth of the joints.

SPECIFICATION FOR CIVIL WORKS

PART – VI SAFETY REQUIREMENTS FOR CONSTRUCTION WORKS

1.0 GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.

In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the Contractor and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work :

Indian Standard

4081 - 1986	Blasting & Drilling.
5916 - 1970	Construction with Hot Bituminous Materials.
4130 - 1991	Demolition of Buildings.
3764 - 1992	Excavation Work
5121 - 1969	Piling & Other Deep Foundations.
4014 - (P-II) - 1967	Scaffolding, Steel Tubular.
3696 - (P-I & P-II) 1987 to 1991	Scaffolds and Ladders.
6922 - 1973	Structures Subject to Underground Blasts.
4756 - 1978	Tunneling Work.
5499 - 1969	Underground Air-raid Shelters in Natural Soil.
4138 - 1977	Working in Compressed Air.
7293 - 1974	Working with Construction Machinery
8989 - 1978	Erection of Concrete Framed Structures.

2.0 BLASTING

2.1 Detonators and other explosive for blasting shall be taken to the blasting area in the original container or any separate non-metal container. This shall not be carried loose or mixed with other materials. Detonators and explosives must be kept separately.

2.2 No shot for blasting shall be fired except by persons licensed to do so.

2.3 Drilling shall not be resumed after a blast has been fired unless a thorough examination has been made to make sure that there is no unexploded charge.

2.4 Before firing a shot, sufficient warnings by means of whistling and/or otherwise shall be given to get men off the danger area. Blasting areas shall be cordoned off & red flags during day time and red lights during night time displayed prominently marking off the cordoned area.

2.5 All people except those who have actually to light the fuses must be removed to a safe distance of not less than 200 metres as a rule.

2.6 Wherever possible, blasting mats should be used.

2.7 Contractors doing blasting work must have licence and an approved magazine to store explosives.

2.8 Blasting operations shall be carried out during fixed hours of the day which shall be notified in writing.

2.9 Provisions in explosives Rules 1940 as amended from time to time, Indian Explosives Act 1844 (IV of 1884), and others shall be strictly followed.

3.0 EXCAVATIONS

3.1 Sides of all excavations must be sloped to a safe angle, not steeper than the angle of repose of the particular soil. If it is not possible to give a proper slope, the sides of the excavation where there is a danger of fall or dislodgement of earth or any material, shall be securely supported by timber or other type of shoring.

3.2 No excavation or earth work below the foundation level of an adjoining building shall be taken up unless adequate steps are taken to prevent damage to the existing structure or fall of any part.

3.3 Every accessible part of an excavation, pit or opening in the ground into which there is a danger of persons falling shall be suitably fenced with a barrier upto a height of one metre suitably placed from the edge of the excavation as far as practicable.

3.4 No material or load shall be placed or stacked near the edge of the excavation or opening in the ground. The excavated material shall not be placed within 1.5 m of the trench or half of the depth of the trench whichever is more.

3.5 Cutting shall be done from top to bottom. No undercutting of sides of excavation shall be allowed.

3.6 All narrow trenches 1.2 m or more depth, shall at all times be supplied with atleast one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of the trench to atleast one metre above the surface of the ground. The side of the trenches which are 1.5 m or more in depth shall be stepped back to give suitable slope, or securely held by planking, strutting and bracing so as to avoid the danger of side collapse.

3.7 Materials shall not be dumped against existing walls or partition to a height that may endanger the stability of the walls.

3.8 While withdrawing piled materials like loose earth, crushed stone, sand, etc., from the stock piles, no over hanging shall be allowed to be formed in the existing dump.

3.9 No material on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or public or any other agency at work.

4.0 DEMOLITION

4.1 On every demolition job, danger signs shall be conspicuously posted all round the structure and all doors, openings giving access to the structure shall be kept barricaded or marked except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for escape of workmen during any emergency.

4.2 During night, red lights shall be placed on or about all the barricades.

4.3 Where in any work of demolition it is imperative, because of danger existing to ensure that no unauthorised person shall enter the site of demolition outside working hours, a watchman should be employed. In addition to watching the site he shall also be responsible for maintaining all notices, lights and barricades.

4.4 All the necessary safety appliances as per IS ;4130 shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

4.5 The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure the same shall be got vacated to avoid any danger to human life.

4.6 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power line required for demolition work itself.

4.7 All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.

4.8 All the mains and meters of the building shall be removed or protected from damage.

4.9 If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored or braced suitably.

4.10 Walkways and passage ways shall be provided for the use of the workman who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.

4.11 All nails in any kind of lumber shall be withdrawn, hammered or bent over as soon as such lumber is removed from the structure being demolished, and placed in piles for future cleaning or burning.

4.12 All the roads and open area adjacent to the work site shall either be closed or suitably protected.

4.13 No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electricity charged.

4.14 All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

5.0 VEHICLE

5.1 No person shall board any vehicle or equipment when it is in motion.

5.2 Suitable blocks shall be placed against the wheels of a vehicle when it is used for tipping materials into excavation or a pit or over the edge of any embankment or earthwork to avoid the danger of its running over the edge.

5.3 All workers shall stand clear of the vehicle while it is dumping. If the material being dumped is very heavy or sticky, dump hooks shall be used or dumper shall be clamped to prevent any danger of its tripping.

5.4 Materials shall not be allowed to be loaded in a vehicle so as to project horizontally beyond the sides of the body of the vehicle. All materials projecting beyond the front or rear shall be indicated by a red flag in the day and with red light in the night.

5.5 Driver of the truck or any heavy vehicle shall not reverse it unless assisted by a signal man who shall have a clear view of the driver and the area beyond the truck during reversing operation.

5.6 Maximum speed of a heavy vehicle must not exceed 15 km. per hour.

6.0 SCAFFOLDING, GANGWAYS, LADDERS & SHUTTERING

6.1 For all work that cannot be done from the ground level or from part of any permanent structure or from other available means of support, soundly constructed scaffoldings of adequate strength shall be used as a safe means of access to places of work.

6.2 All scaffolding shall be securely supported or suspended and wherever necessary be properly braced to ensure stability.

6.3 Chains, ropes or other lifting materials used for the suspension of scaffoldings must be of adequate strength and shall be of tested quality.

6.4 All such chains and ropes used for the suspension of scaffoldings shall be properly fastened to safe anchorage points.

6.5 The platform of a suspended scaffolding shall be sufficiently wide. Suspended scaffolding shall have hand rail on 3 sides of about 1.0 m height.

6.6 All working platform and stages from which workers are liable to fall shall be of adequate width depending on the type of work done and closely boarded and planked.

6.7 Scaffolding or staging more than 3.5 m above the ground or floor, suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise secured atleast 1 m high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure. The platform shall also be provided with toe boards of atleast 150 mm high so placed as to prevent the fall of materials and tools from there.

6.8 All platforms or gangways, runways and the stairs shall be kept free from unnecessary obstructions, materials or junk.

6.9 Working platforms, gangways & stairways shall be so constructed that they shall not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.5 m above ground level or floor level they shall be closely boarded, shall be of adequate width and shall be suitably fenced.

6.10 Every opening in the floor of a building or in a working platform shall be provided with suitable fencing or railing whose minimum height shall be 1 m to prevent the fall of persons or materials.

6.11 Every ladder shall be securely fixed at top and bottom. A ladder more than 5 m long shall have a prop.

6.12 All ladders used shall be of good construction, sound materials and adequate strength. Ladders with defective or missing rungs shall not be brought into use. The spacing of rungs shall not exceed 30 cms and these shall be recessed atleast 12 mm into rails.

6.13 All ladders or rungs used for vertical height of more than 10 m shall have an intermediate landing. All such intermediate landings shall be provided with guard rails to a height of atleast 1 m.

6.14 Every ladder shall be securely placed so that it cannot move either at the top or at the bottom and it shall rise to a height of atleast 1.2 m above the place of landing.

6.15 No portable single ladder shall be over 8 m in length.

6.16 Spacing between the side rails of the ladder shall not be less than 300 mm for ladders upto 3 m in length. For longer lengths, this shall be increased at 6 mm for each additional 0.3 m of length.

6.17 Metal ladders must not be used for electrical work or near electric circuit of equipments.

6.18 All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

6.19 Unfinished scaffolding which is under construction shall be prominently marked as unsafe and any access points shall be closed.

6.20 All Planking and Decking on walkways and scaffolds should be adequately supported at each end of the plank and intermediately if necessary. Planks should not be allowed to cantilever beyond the last support but should be overlapped if necessary on to the next plant.

6.21 Shuttering

The above remarks shall be applicable for this also. Shuttering, particularly for slabs, should be treated as a scaffold. Unfinished shuttering should be marked as dangerous similarly the finished formwork should be adequately supported, care being taken to avoid trap door effects.

7.0 MOBILE LIFTING APPLIANCES

7.1 No mobile lifting appliances shall used on a sloping surface unless adequate precautions are taken to ensure stability.

7.2 Adequate precautions shall be taken to see that jib of the mobile crane does not come in contact with overhead electric transmission line.

7.3 Only one person shall give signals to the operator of mobile lifting appliances.

7.4 Maximum load to be lifted by lifting appliances shall be marked in a position where it can be clearly seen by the crane driver and the operator.

7.5 No load shall be raised, lowered or suspended from a chain or rope having a knot in any of the part.

7.6 No chain which is joined to another chain by means of bolt and nut shall be used for raising, lowering or suspending any load.

7.7 All chains, ropes and lifting gears shall be carefully examined and tested by a competent Maintenance Engineer atleast once in every quarter.

7.8 When the work is stopped or when the mobile lifting equipment is not in operation, the boom must be lowered to the horizontal position and tied securely in place to prevent accidental drop.

7.9 No person shall walk under a load which is swinging by a lifting equipment.

Guide rope must be attached to the load to prevent its swinging.

7.10 The foot blocks of the crane before starting work shall be securely supported and firmly anchored to prevent its movement in any direction.

7.11 Use of Hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards of condition.

7.11.1 These shall be of good mechanical construction, sound material and adequate strength and free from defect and shall be kept in good working order.

7.11.2 Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from patent defects.

7.11.3 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine or give signals to the operator.

7.11.4 In case of every hoisting machine and every chain ring hook shackle swivel and pulley block used in hoisting or lowering or as means of suspension the safe working load shall be ascertained by adequate means, every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working loading, each safe working load of the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing. Mobile cranes shall have the working load and the radius of jib for the load marked on it.

7.11.5 The top pulley for hoisting a load shall be opened monthly and the spindle inspected to see if any undue wear has taken place and for greasing.

7.11.6 In case of departmental machine, the safe working load shall be notified by the Engineer concerned. As regards contractor's machines the Contractor shall notify the safe working load of the machine to the Engineer whenever he brings any machinery to site of work and get it verified by the Engineer concerned.

7.12 Motors, gearing, transmission, electric wiring and other dangerous part of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce to the minimum, the risk of accidental descent of the load. Adequate precautions shall be taken to reduce to the minimum, risk of any part of a suspended load becoming accidentally displaced.

8.0 RIVETTING, WELDING & GAS CUTTING & STEEL ERECTION

8.1 Rivetting

8.1.1 Bolts covered with wet or slippery compounds shall not be used in fabricating structural work.

8.1.2 The rivet heater must keep the rivet heating equipment as near as possible to the place of work.

8.1.3 A pail of water shall always be kept ready for quenching fire when stopping rivetting work.

8.1.4 Hot rivet shall not be thrown across aisles and shaftways.

8.1.5 Metal buckets for catching hot rivets must have false wooden bottoms to prevent rivets from rebounding.

8.1.6 All rivets, bolts, nuts, and other tools must be kept in boxes and not left loose, (For any further safety measures relevant Indian Standards and safety specifications of structural section shall be referred to).

8.2 Welding & Gas Cutting

8.2.1 All cylinders must be used and stored in upright position only.

8.2.2 Cylinders must be stored away from open flames and other source of heat.

8.2.3 Oxygen cylinders must not be stored near other cylinders containing gas or oil, grease or other combustible materials.

8.2.4 While the cylinder is in use, the cylinder valve key or wrench must be placed on the valve spindle.

8.2.5 Before a cylinder is moved, the cylinder valve must be closed.

8.2.6 Gas cutting torches must be lighted by means of friction flames or similar other methods and not with matches.

8.2.7 When torches are being changed or welding stopped for some time valves for all cylinders must be closed.

8.2.8 The coloured lenses used for welding or gas cutting must be of proper shade for the work being done.

8.2.9 Suitable eye protection equipment such as goggles, hand shields etc., must be used by persons engaged in welding or gas cutting operations.

8.2.10 Before any heavy structural member is gas cut, make sure that it is cleared and supported by ropes, cables, chains or any other means to prevent its dropping or swinging.

8.2.11 Cylinder valves and connections are not to be lubricated. All oily or greasy substances must be kept away from cylinders.

8.2.12 Substantial and incombustible screen must be used below or near the welding operations, if there is a possibility of a spark falling on other workmen engaged in work closely.

8.2.13 All air pipe lines and air hoses must be frequently inspected. Air hoses shall not be used for dusting or for cooling purposes.

8.3 Steel Erection

8.3.1 All persons shall stand clear when a crane is sorting or shifting steel girders or other structural materials.

8.3.2 No person shall stand, walk or work beneath any suspended load.

8.3.3 Guide rope must be used for guiding lifting loads.

8.3.4 When guiding a beam or fabricated structure or erection it shall be so held that the employees hands do not get jammed against other objects.

8.3.5 Safety belts equipped with suitable life lines must be used by persons working at heights and standing on structural members. Life line must be tied to an independent support. For any further safety measures, for Structural Steel Works, IS : 7205 - 1974 shall be referred to.

9.0 SAFETY APPLIANCES

9.1 Workers employed on mixing asphaltic materials, cement and lime mortars, shall be provided with protective footwear and protective goggles.

9.2 Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes, shall be provided with protective goggles.

9.3 Those engaged in welding works shall be provided with welder's protective eye-shields.

9.4 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

9.5 When workers are employed in sewers and manholes which are in use, the Contractor shall ensure that the manhole covers are opened and chambers are ventilated atleast for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.

9.6 The Contractor shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting the following precautions shall be taken :

9.6.1 No paint containing lead or lead products shall be used except in the form of paste or ready made paint.

9.6.2 Suitable face mask should be supplied for use by them when paint is applied in the form of spray on a surface having lead paint dry rubbed and scraped.

9.6.3 Overalls shall be supplied by the Contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

9.7 The workers going into inspection chamber shall have gas masks, gum boots and rubber gloves while working inside. After coming out they shall have some disinfectant from the first aid box for proper washing

9.8 All necessary personnel safety equipment such as safety helmets, safety boots, safety belts, leather gloves for welders, clear glass safety goggles etc., as considered adequate by the engineer have to be kept available for the use of persons employed at the site of work and maintained in condition suitable for immediate use and Contractor shall take steps to ensure proper use of equipment by the workers.

9.9 All the persons entering the tunnel shall be provided with protective wear, such as helmets, steel toe safety shoe, gum boots or other suitable type of protective foot wear. In the case of steeply inclined tunnels and inshafts, safety belts shall also be provided.

9.10 Sign boards 1 x 1.5 m in size with the following wording shall be erected at the access to these areas. "CONSTRUCTION AREA, HELMET REQUIRED BEYOND THIS POINT"

9.11 No loose garments or ragged clothing shall be worn by the personnel engaged in tunneling operation.

9.12 A telephone system shall provided to ensure a positive and quick method of communication between all control location inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 m

9.13 Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning signals by any one of the following means.

9.13.1 By electrically operated bells, operated by battery/dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. The position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.

9.13.2 By the use of two field (magnet type) telephone.

9.13.3 Any other suitable arrangement like walkie-talkie.

9.14 Arrangement for rendering prompt and adequate first aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in-charge of the project. Depending upon the magnitude of the work the availability of an ambulance at a very short notice (at telephone call) shall be ensured.

9.15 First-aid arrangements commensurate with the degree of hazard and with the number of workers employed shall be maintained in a readily accessible place throughout the working hours. At least one experienced first-aid attendant with his distinguishing badge shall be available on each shift to take care of injured persons. Arrangements shall be made for calling the medical officer, when such a need may arise. It is recommended that foreman/assistant foreman/supervisor/ permanent workmen who are normally present at each working phase in each shift are given adequate training on first-aid methods to avoid employment of a separate attendant.

9.16 Stretchers and other equipment necessary to remove injured persons shall be provided at every shift.

9.17 Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.

10.0 ELECTRICAL

10.1 Only authorised persons shall handle or otherwise interfere with electrical equipment. Any person detecting electrical apparatus being handled by an unauthorised person or equipment in unsafe condition must report the matter to the Engineer concerned.

10.2 No person shall work on any live electric conductor or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf.

10.2.1 After isolating the equipment from the source of supply before the work begins, a sign 'DONT'T SWITCH ON' must be hung on or near the switch to avoid its being accidentally or inadvertently switched on when persons are working.

10.2.2 Take out the fuses and keep in safe custody.

10.2.3 The switch may be locked if locking arrangement exists.

10.2.4 Earth the equipment, before work, to discharge it and short the terminals as a precautionary measure against accidental switching ON.

10.2.5 After the work is finished take out Earthing and shorting link.

10.2.6 Remove all tools and materials from the site of work. Replace the fuses and unlock the switch.

10.2.7 The switch shall only be put 'ON' by the person who switched it 'OFF' or by the person authorised by him in writing.

10.3 When working on live equipment use one hand only whenever possible, it is advisable to keep the other hand behind the back. Shocks from hand to hand are most dangerous.

10.4 All persons handling electrical gear in elevated position must use safety belts. Even a slight shock may cause loss of balance and fall.

10.5 No one shall attempt to extinguish a fire on or near a live electrical apparatus with water. Water is a good conductor of electricity. Use extinguishers wherever provided. Use sand and blankets etc., if available.

10.6 No person shall use any part of electrical equipment for storing or hanging clothes, umbrellas or other articles. Serious accidents occur from this practice.

10.7 For attending the work on O.H. lines or equipment use wooden ladders. Metallic ladders shall not be used.

10.8 Use insulated tools and ensure the insulation is in proper condition periodically at least once in three months. Use rubber gloves wherever possible.

10.9 As far as possible verbal instructions shall be avoided in case of pre-arranged shut-down of electrical apparatus.

10.10 When workers are employed for electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

11.0 MISCELLANEOUS

11.1 The Contractor shall provide necessary fencing and lights to protect the public from accident.

11.2 Fire extinguishers adequate in number shall be kept by the Contractor at the site of works where there is risk of fire hazard.

11.3 Adequate washing facilities shall be provided near the place of work.

11.4 When the work is done near any place where there is risk of drowning, all necessary equipments shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions shall be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

11.5 These safety provisions shall be brought to the notice of all concerned by displaying on a Notice Board at a prominent place at the work spot. The persons responsible for compliance of the code shall be named therein by the Contractor.

11.6 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Engineer and Owner.

11.7 Not withstanding the above clauses there is nothing in those to exempt the Contractor from the operations of any other Act or Rule in force in the Republic of India.

11.8 All storage, handling and use of flammable liquids shall be under the supervision of qualified persons. Flammable liquid shall not be stored inside the tunnel

11.9 All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and 'NO SMOKING' signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.

11.10 All combustible materials shall be continuously removed from such areas where flammable liquids are stored, handled and processed. All spills of flammable liquids shall be cleared up immediately. Containers of flammable liquids shall be tightly capped.

12.0 REPORTING OF ACCIDENT

All accidents, major or minor must be reported immediately. The Contractor, will provide first aid to the injured person immediately and the injured person shall report to the first aid station along with the 'INJURED ON WORK' form duly filled in quintuplicate and submit to the Medical Officer of the First Aid Station".

Serious Injury

In case of serious injury, the following procedure shall be adopted by the Contractor :

1. Provide First Aid at his own First Aid Station.

2. Take the injured person to the Hospital along with the "INJURED ON WORK" form duly filled in.

3. Reporting the accident to the Owner/Engineer by the Contractor.

Fatal Accident

Fatal accident must be reported immediately to the Engineer/Owner as well as to the Police.

Penalty

Failure to observe the Safety Rules will make the Contractor liable to penalty by way of suspension of work, fine and termination of contract.

SPECIFICATION FOR CIVIL WORKS

ANNEXURE- A

LIST OF IS & IRC CODES REFERRED

ANNEXURE - A

LIST OF IS & IRC CODES REFERRED

IS 383 – 1970	:	Specification for coarse & fine aggregates from natural sources for concrete.
IS 2386 (Part 1 to 8) – 1963	:	Method of Test for aggregates for concrete
IS 456 – 2000	:	Code of practice for plain and reinforced concrete.
IS 712 - 1984	:	Specification for building limes.
IS 3182 – 1986	:	Specification for broken brick (burnt clay) fine aggregate for use in lime mortar.
IS 269 – 1989	:	Specification for 33 grade ordinary Portland Cement.
IS 455 – 1989	:	Code of practice for Portland Slag Cement.
IS 1489 – 1991	:	Specification for Portland Pozzolana Cement.
IS 8041 – 1990	:	Specification for rapid hardening Portland Cement.
IS 8112 – 1989	:	Specification for 43 grade ordinary Portland Cement.
IS 12269 – 1987	:	Specification for 53 grade ordinary Portland Cement.
IS 8043 – 1991.	:	Specification for Hydrophobic Portland Cement

IS 12330 – 1988	:	Specification for Sulphate resisting Portland Cement.
IS 6452 – 1989	:	Specification for high alumina cement for structural use.
IS 8042 – 1989	:	Specification for White Portland Cement.
IS 3535 – 1986	:	Methods of sampling Hydraulic Cement.
IS 4031 (Part 1 to 15) - 1988 to 1991	:	Methods of test for Hydraulic Cement.
IS 4032 – 1985	:	Method of Chemical Analysis of Hydraulic Cement.
IS 2645 – 1975	:	Specification for Integral Cement Waterproofing Compounds.
IS 1599 – 1985	:	Method of Bend Test.
IS 1608 – 1972	:	Method of Tensile Testing of Steel Products.
IS 6925 – 1973	:	Method of test for determination of Water Soluble Chlorides in concrete admixtures.
IS 432 – 1982	:	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS 1786 – 1985	:	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS 1566 – 1982	:	Specification for hard drawn steel wire fabric for concrete reinforcement.
IS 280 – 1978	:	Mild steel wire for general engineering

		purposes.
IS 2062 – 1992	:	Structural steel (Standard Quality).
IS 1161 – 1979	:	Steel Tubes for Structural purposes.
IS 5624 – 1970	:	Foundation bolts.
IS 1363 - (Part 1 to 3) - 1992	:	Hexagon Head bolts, screws, nuts.
IS 2016 – 1967	:	Plain washers.
IS 3063 – 1972	:	Single coil rectangular section spring washers.
IS 1239 (Part 1&2)-1990	:	Mild Steel Tubes and other wrought steel pipe fittings.
IS 1367 – 1980	:	Technical supply conditions for threaded steel fasteners.
IS 1030 – 1989	:	Carbon steel castings.
IS 3480 – 1966	:	Flexible steel conduit for electrical wiring.
IS 2667 – 1988	:	Fittings for rigid steel conduits for electrical wiring.
IS 9537 (Part 3) – 1983	:	Conduit for electrical installations - Rigid Plain conduits of insulating materiel.
IS 6946 – 1973	:	Flexible non-metallic conduits for electrical installations.
IS 3419 – 1989	:	Fittings for rigid non-metallic conduits.
IS 5913 – 1989	:	Methods of tests for Asbestos Cement Products.
IS 2098 – 1964	:	Specification for asbestos cement building

		boards.
IS 2096 – 1992	:	Specification for asbestos cement flat sheets.
IS 9537 (Part 2) – 1981	:	Conduit for electrical installations - Rigid steel conduits.
IS 2614 – 1969	:	Method for sampling of fasteners.
IS 1592 – 1989	:	Specification for asbestos cement pressure pipes.
IS 9627 – 1980	:	Specification for asbestos cement pressure pipe (Light duty).
IS 6908 – 1991	:	Specification for asbestos cement pipes and fittings for sewerage and drainage.
IS 1626 (Part 1 to 3) - 1980 to 1991	:	Specification for asbestos cement building pipes & pipe fittings and roofing fittings
IS 459 – 1992	:	Specification for unreinforced corrugated and semi corrugated asbestos cement sheets
IS 1077 – 1992	:	Specification for common burnt clay building bricks.
IS 3495 (Part 1 to 4) -1992	:	Method of Test for burnt clay building bricks.
IS 3620 – 1979	:	Specification for laterite stone block for masonry.
IS 1121- 1974	:	Method of test for determination of strength properties of natural building stone.
IS 1124 – 1974	:	Method of test for determination of water

		absorption Sp. Gr. etc. of building stones
IS 1125 – 1974	:	Method of test for determination of weathering of natural building stones.
IS 1126 – 1974	:	Method of test for determination of durability of building stone.
IS 1127 – 1970	:	Recommendation for dimensions and workmanship of natural building stones for masonry work.
IS 2185 (Part-1)-1979	:	Specification for concrete masonry unit Hollow and solid concrete blocks.
IS 2116 – 1980	:	Specification for sand for masonry mortar
IS 1542 – 1992	:	Specification for sand for plaster.
IS 2185 (Part-2)-1983	:	Specification for concrete masonry unit-Hollow and solid light weight concrete blocks.
IS 2185 (Part-3)-1984	:	Specification for concrete masonry unit - Auto claved Cellular Aerated concrete blocks.
IS 6041 – 1985	:	Code of practice for construction of Auto claved Cellular concrete block masonry.
IS 6441 (Part 1 to 9) - 1972 & 1973	:	Method of Test for Auto claved Concrete Products.
IS 3068 – 1986	:	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
IS 2114 – 1984	:	Code of practice for laying in-situ terrazo floor finish.

IS 460 (Part 1 to 3)-1985	:	Specification for Test Sieves.
IS 1237 – 1980	:	Specification for cement concrete flooring tiles.
IS 777 – 1988	:	Specification for glazed earthen ware wall tiles.
IS 1129 – 1972	:	Recommendation for dressing of natural building stone.
IS 1130 – 1969	:	Specification for Marble (blocks, slabs and tiles).
IS 809 – 1992	:	Specification for rubber flooring materials for general purposes.
IS 3462 – 1986	:	Specification for unbacked flexible PVC flooring.
IS 3461 – 1980	:	Specification for PVC asbestos floor tiles
IS 2818 – 1990	:	Indian Hessians.
IS 653 – 1992	:	Linoleum sheets and tiles.
IS 5389 – 1969	:	Code of practice for laying hard wood parquet and wood block flooring.
IS 210 – 1978	:	Grey Iron Castings.
IS 2114 – 1984	:	Code of practice for laying in-situ terrazzo finish.
IS 1198 – 1982	:	Code of practice for laying of linoleum flooring.
IS 1003 (Part-2)-1983	:	Specification for timber panelled & glazed shutters, windows and ventilator shutters.

IS 1141 – 1973	:	Code of practice for seasoning of timber.
IS 1003 (Part-1) - 1983 & 1991	:	Specification for timber panelled & glazed shutters - Door shutters.
IS 287 – 1973	:	Recommendation for maximum permissible moisture content of timber used for different purposes.
IS 2202 (Part-1) - 1983 & 1991	:	Specification for wooden flush door shutters (Solid core type).
IS 2191 (Part-1&2)-1983	:	Specification for wooden flush door shutters (cellular and hollow core type).
IS 3087 – 1985	:	Specification for wood particle boards (Medium density) for general purposes.
IS 3478 – 1966	:	Specification for high density wood particle boards.
IS 3097 – 1980	:	Specification for veneered particle boards
IS 303 – 1989	:	Specification for plywood for general purposes.
IS 1328 – 1982	:	Specification for veneered decorative plywood.
IS 205 – 1992	:	Specification for non-ferrous metal butt hinges.
IS 1341 – 1992	:	Specification for steel butt hinges.
IS 362 – 1991	:	Specification for parliament hinges.
IS 453 – 1973	:	Specification for double acting spring hinges.

IS 3818 – 1992	:	Specification for continuous (Piano) hinges.
IS 206 – 1992	:	Specification for Tee and Strap hinges.
IS 281 – 1991	:	Specification for mild steel sliding door bolts for use with padlocks.
IS 1019 – 1974	:	Specification for rim latches.
IS 2681 – 1979	:	Specification for non-ferrous metal sliding door bolts for use with padlocks.
IS 204 (Part 1&2)-1991&92	:	Specification for tower bolts - Ferrous and Non-ferrous metals.
IS 208 – 1987	:	Specification for door handles.
IS 2209 – 1976	:	Specification for mortice locks (vertical type).
IS 6607 – 1972	:	Specification for rebated mortice locks (vertical type).
IS 1823 – 1980	:	Specification for floor door stoppers.
IS 1837 – 1966	:	Specification for fan light pivots.
IS 207 – 1964	:	Gate and shutter hooks and eyes.
IS 6343 – 1982	:	Specification of door closers (peneumatically regulated) for light door weighing upto 40 Kg.
IS 8756 – 1978	:	Specification for ball catches for use in wooden Almirah.
IS 6315 – 1992	:	Specification for floor springs (hydraulically regulated) for heavy doors.
IS 7197 – 1974	:	Specification for Double action floor spring

		(without oil check) for heavy doors
IS 364 – 1993	:	Specification for fan light catch.
IS 3828 – 1966	:	Specification for ventilator chains.
IS 363 – 1976	:	Specification for hasp and staples.
IS 9899 – 1981	:	Specification for hat, coat and wardrobe hooks.
IS 729 – 1979	:	Specification for drawer locks, cup-board locks and box locks.
IS 3564 – 1986	:	Specification for door closers (Hydraulically regulated).
IS 4351 – 1976	:	Specification for steel door frames.
IS 419 – 1967	:	Putty for use on window frames.
IS 5187 – 1972	:	Specification for flush bolts.
IS 3847 – 1992	:	Specification for mortice night latches.
IS 4621 – 1975	:	Specification for indicating bolts.
IS 1038 – 1983	:	Specification for steel doors, windows and ventilators.
IS 1977 – 1975	:	Structural steel (ordinary quality).
IS 1361 – 1978	:	Specification for steel windows for industrial buildings.
IS 7452 – 1990	:	Hot rolled steel sections for doors, windows and ventilators.
IS 1948 – 1961	:	Specification for aluminium doors, windows and ventilators.

IS 1148 – 1982	:	Specification for hot rolled rivet bars for structural purposes.
IS 1949 – 1961	:	Specification for aluminium windows for industrial buildings.
IS 204 (Part 1) – 1992	:	Specification for tower bolts-non-ferrous metal.
IS 733 – 1983	:	Wrought aluminium and aluminium alloy bars, rods and sections (for general engineering purposes).
IS 6248 – 1979	:	Specification for metal rolling shutters and rolling grills.
IS 1081 – 1960	:	Code of practice for fixing and glazing of metal doors, windows and ventilators.
IS 2339 – 1963	:	Specification for Aluminium Paint for general purpose in dual containers.
IS 2835 – 1987	:	Flat Transparent sheet glass.
IS 5437 – 1969	:	Wired and figured glass.
IS 101 (Part 1 to 8) - 1964 to 1993	:	Method of sampling and test for paints, varnishes and related products.
IS 2074 – 1992	:	Ready mixed paint, air drying, red oxide zink chrome, priming.
IS 5410 – 1992	:	Cement paint, colour as required.
IS 427 – 1965	:	Distemper, dry, colour as required.
IS 428 – 1969	:	Distemper, oil emulsion, colour as required.
IS 348 – 1968	:	French polish.

IS 5411 (Part 1&2) - 1972 to 1974	:	Plastic emulsion paint.
IS 702 – 1988	:	Industrial Bitumen.
IS 73 – 1992	:	Paving Bitumen.
IS 217 – 1988	:	Cut Back Bitumen.
IS 454 – 1961	:	Specification for Digboi type cutback bitumen.
IS 5467 – 1986	:	Specification for shellac Wax.
IS 3384 – 1986	:	Specification for Bitumen primer for use in water proofing and damp proofing.
IS 290 – 1961	:	Specification for Coal Tar Black Paint.
IS 341 – 1973	:	Specification for Black Japan, Type A, B & C.
IS 1322 – 1982	:	Specification for bitumen felts for water proofing and damp proofing.
IS 218 – 1983	:	Specification for creosote oil for use as wood preservative.
IS 3037 – 1986	:	Specification for Bitumen mastic for use in water proofing of roofs.
IS 1580 – 1991	:	Specification for Bituminous compound for water proofing and caulking purposes.
IS 8542 – 1977	:	Specification for polish for wooden furniture paste.
IS 9862 – 1981	:	Ready mixed paint, brushing etc.
IS 782 – 1978	:	Specification for caulking lead.

IS 405 (Part 1&2) – 1992	:	Lead sheet and strips.
IS 5134 – 1977	:	Bitumen impregnated paper.
IS 2849 – 1983	:	Specification for non load bearing gypsum partition blocks.
IS 8591 – 1977	:	Specification for floor polish paste.
IS 2095 – 1982	:	Specification for gypsum plaster boards.
IS 77 – 1976	:	Specification for linseed oil, boiled for paints.
IS 533 – 1973	:	Gum Spirit of turpentine (oil of Turpentine).
IS 1504 – 1974	:	Bees Wax.
IS 3536 – 1966	:	Ready mixed paint, brushing, wood primer pink.
IS 8273 – 1984	:	Specification for gypsum plaster for use in the manufacture of fibrous plaster board.
IS 5871 – 1987	:	Specification for bitumen mastic for tanking and damp proofing.
IS 651 – 1992	:	Specification for salt glazed stoneware pipe and fittings.
IS 1729 – 1979	:	Sand cast iron spigot and socket soil pipe.
IS 771 (Part 1 to 7) - 1979 to 1985	:	Specification for glazed fire clay appliances.
IS 1230 – 1979	:	Cast iron rain water pipes and fittings.
IS 774 – 1984	:	Flushing cisterns for water closets and urinals.

IS 2548 (Part 1&2) – 1983	:	Specification for plastic seats and cover for water closet.
IS 1726 – 1991	:	Specification for cast iron manhole cover and frames.
IS 1239 (Part 1&2)-1990 to 1992	:	Mild steel Tubes and fittings.
IS 4984 – 1987	:	Specification for high density polyethylene pipes for potable water supplies: Sewerage and industrial effluents.
IS 2556 (Part 1 to 15) - 1972 to 1985	:	Specification for vitreous sanitary appliances (vitreous china).
IS 7328 – 1992	:	High density polyethylene materials.
IS 4985 – 1988	:	Specification for unplasticised PVC pipes for potable water supplies.
IS 3076 – 1985	:	Specification for low density polyethylene pipe for potable water supplies.
IS 9762 – 1981	:	Specification for polyethylene floats for ball valve.
IS 3395 – 1984	:	Code of practice for fire safety of industrial buildings.
IS 7834 (Part 1 to 8) – 1987	:	Specification for injection moulded PVC fittings with solvent cement joint for water supplies.
IS 8008 (Part 1 to 7) – 1976	:	Specification for injection moulded HDPE fittings for potable water supplies.
IS 8360 (Part 1 to 3) - 1977	:	Specification for fabricated high density

		polyethylene fittings for potable water.
IS 784 – 1978	:	Specification for prestressed concrete pipe.
IS 1703 – 1989	:	Specification for copper alloy float valves (horizontal plunger type) for water supply fittings.
IS 12234- 1988	:	Specification for plastic equilibrium float valve for cold water services.
IS 778 – 1984	:	Specification for copper alloy gate, globe and check valves for water works purposes.
IS 1536 – 1989	:	Centrifugally cast (spun) iron pressure pipes.
IS 1537 – 1976	:	Vertically cast iron pressure pipes for water, gas and sewage.
IS 1538 (Part 1 to 23) – 1976	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS 3589 – 1991	:	Electrically welded steel pipes for water, gas and sewage.
IS 781 – 1984	:	Specification for cast copper alloy screw down bib taps and stop valves for water services.
IS 1239 (Part 1&2) - 1990 to 1992	:	Mild steel tubes and fittings.
IS 779 – 1978	:	Specification for water meters.
IS 1795 – 1982	:	Specification for pillar taps for water supply purposes.

IS 1363 (Part 1 to 3) - 1992	:	Dimensions for screw thread run-outs and undercuts.
IS 2016 – 1967	:	Plain washers.
IS 638 – 1979	:	Sheet rubber jointing and rubber insertion jointing.
IS 4127 – 1983	:	Code of practice for laying of glazed stoneware pipes.
IS 458 – 1988	:	Specification for precast concrete pipes.
IRC 19 – 1981	:	Standard specification and code of practice for water Bound macadam.
IRC 29 – 1988	:	Tentative specification for 4 cm Asphaltic concrete surface course.
IRC 15 – 1981	:	Standard specification and code of practice for construction of concrete roads.
IS 6313 – 1981	:	Code of practice for antitermite measures in building.
IS 1054 – 1962	:	Dieldrin emulsifiable concentrates.
IS 1308 – 1984	:	Aldrin dusting powders.
IS 6439 – 1978	:	Hepta chlor emulsifiable concentrates.
IS 2632 – 1964	:	Crotonaldehyde.
IS 1791 – 1985	:	Specification for batch type concrete mixers.
IS 10262- 1982	:	Recommended guidelines for concrete mix design.
IS 7861 (Part 1) – 1975	:	Code of practice for extreme weather

		concreting - Recommended practice for hot weather concreting.
IS 1199 – 1959	:	Methods of sampling and analysis for concrete.
IS 516 – 1959	:	Method of test for strength of concrete.
IS 7861 (Part 2) – 1981	:	Code of practice for extreme weather concreting. Recommended practice for cold weather concreting.
IS 2502 – 1963	:	Code of practice for bending and fixing of bars for concrete reinforcement.
IS 2751 – 1979	:	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
IS 800 – 1984	:	Code of practice for general construction in steel and deformed bars.
IS 816 – 1969	:	Code of practice for use of metal arc welding.
IS 814 – 1991	:	Covered electrodes for manual metal arc.
IS 3370 (Part 1&2)-1965	:	Code of practice for concrete structures for the storage of liquids.
IS 2911 (Part 1 to 4) – 1979 to 1985	:	Code of practice for design and construction of pile foundations.
IS 1343 – 1980	:	Code of practice for prestressed concrete.
IS 1785 (Part 1&2)-1983	:	Specification for plane hard drawn steel wires for prestressed concrete.
IS 2250 – 1981	:	Code of practice for preparation and use of

		masonry mortars.
IS 1635 – 1992:	:	Code of practice for field slaking of building lime.
IS 2212 – 1991	:	Code of practice for brick work.
IS 1597 (Part 1&2)-1992	:	Code of practice for construction of stone masonry.
IS 4101 (Part 1 to 3) - 1967 to 1985	:	Code of practice for external facing and veneer.
IS 737 – 1986	:	Wrought aluminium and aluminium alloys, sheet and strips (for general engineering purposes).
IS 2572 – 1963	:	Code of practice for construction of hollow connect block masonry.
IS 1661 – 1972	:	Code of practice for application of cement finishes.
IS 5766 – 1970	:	Code of practice for laying of burnt clay brick flooring.
IS 5491 – 1969	:	Code of practice for laying of in-situ granolithic concrete flooring topping.
IS 3316 – 1974	:	Specification for structural granite.
IS 1196 – 1978	:	Code of practice for laying bitumen mastic flooring.
IS 1195 – 1978	:	Specification for bitumen mastic for flooring.
IS 3462 – 1986	:	Specification for unbacked flexible PVC flooring.

IS 1198 – 1982	:	Code of practice for laying fixing and maintenance of linoleum floor.
IS 848 – 1974	:	Specification for synthetic resin adhesive for plywood.
IS 4457 – 1982	:	Specification for ceramic unglazed vitreous acid resisting tiles.
IS 851 – 1978	:	Specification for synthetic resin adhesive for construction work (non structural) for wood.
IS 2202 (Part 1&2) - 1981 to 1991	:	Specification for wooden flush door shutters.
IS 102 – 1962	:	Ready mixed paint.
IS 1081 – 1960	:	Code of practice for fixing and glazing of metal doors.
IS 6248 – 1979	:	Specification for metal rolling shutters and rolling grills.
IS 1868 – 1982	:	Anodic coatings on aluminium and its alloys.
IS 2065 – 1983	:	Code of practice for water supply in buildings.
IS 2064 – 1993	:	Code of practice for selection, installation and maintenance of sanitary appliances.
IS 7634 (Part 1 to 3) – 1975	:	Code of practice for plastic pipes.
IS 1742 – 1983	:	Code of practice for building drainage.
IS 5330 – 1984	:	Criteria for design of anchor blocks for penstocks with expansion joints.

IS 3114 – 1985	:	Code of practice for laying of cast iron pipes.
IS 783 – 1985	:	Code of practice for laying of concrete pipes.
IRC-SP11- 1977	:	Hand book of quality control for construction of roads and run-ways.
IRC-63 – 1976	:	Tentative guidelines for use of low grade aggregates and soil aggregate mixtures in road pavement construction.
IRC-60 – 1976	:	Tentative guidelines for use of Lime Fly Ash Concrete as pavement base or sub-base.
IRC-74 – 1979	:	Tentative guidelines for use of Lean Cement Concrete and lean concrete Fly Ash Concrete as pavement base or sub-base.
IS 6509 – 1985	:	Code of practice for installation of joints in concrete pavement.
IS 1838 (Part 1) – 1983	:	Specification for performed filler for expansion joint in concrete pavements and structures.
IRC-43 – 1972	:	Recommended practice for Tools, Equipment and appliances for concrete pavement construction.
IRC-15 – 1970	:	Standard specifications and code of prac-tice for construction of concrete road.
IS 3036 – 1992	:	Code of practice for laying lime concrete for

		a water proofed roof finish.
IS 1346 – 1991	:	Code of practice for water proofing of roofs with bitumen felts.
IS 1609 – 1991	:	Code of practice for laying damp proofing treatment using bitumen felt.
IS 4365 – 1967	:	Code of practice for application of bitumen mastic for waterproofing of roofs.
IS 9103 – 1979	:	Specification for admixtures for concrete.
IS 2645 – 1975	:	Specification for integral cement water proofing compounds.
IS 1834 – 1984	:	Specification for hot applied sealing compound for joint in concrete.
IS 278 – 1978	:	Specification for Galvanized barbed wire for fencing.
IS 2721 – 1979	:	Specification for Galvanized steel chain link fabric.
IS 280 – 1978	:	Specification for Mild steel wire.
IS 4826 – 1979:		Specification for hot dipped galvanized coating on round steel wires.
IS 1200 (Part 1 to 28) - 1971 to 1993	:	Method of measurement of building and Civil Engineering Works.
IS 4081 – 1986	:	Safety code for blasting.
IS 5916 – 1970	:	Specification for cast iron gratings for drainage purposes.
IS 4130 – 1991	:	Safety Code for demolition of building.

IS 3764 – 1992	:	Safety code for excavation work.
IS 5121 – 1969	:	Safety code for piling.
IS 4014 (Part 2) – 1967	:	Code of practice for steel tubular scaffolding.
IS 3696 (Part 1&2) - 1987 to 1991	:	Safety code of scaffolds and ladders.
IS 6922 – 1973	:	Criteria for safety and design of structures subject to underground blast.
IS 5499 – 1969	:	Code of practice for construction of underground raid shelter.
IS 4138 – 1977	:	Safety code for working in compressed air.
IS 7293 – 1974	:	Safety code for working with construction machinery.
IS 8989 – 1978	:	Safety code for erection of concrete framed structures.
IS 4756 – 1978	:	Safety code for Tunneling work.
IS 7205 – 1974	:	Safety code for erection of structural steel works.

04.07 STRUCTURAL WORKS

04.07.01 General

This specification for Steel structural works furnished herein are intended as guidelines for execution of the works satisfying the Owner's requirements as also complying with all technical norms in totality. This specification shall apply to Design, Supply, fabrication, erection, painting of steel structures and cladding of structural buildings including supply of sheets and supply of paints in general on turnkey basis for North East Gas Grid (NEGG) Pipeline Project (Phase - I & Phase – II). for installation of a natural gas boosting station in order to maintain the required natural gas pressure in the downstream network for Natural gas compressor station.

04.07.01.01 Units

Structural steelwork under the scope of this specification shall consist of the units broadly described under the clause no. 04.07.05

04.07.01.02 List of Steel Structures

a) Columns (rolled section or built-up), column bracings , Beams
b) Crane Girder, Crane Walkway, Crane Rail , Rail Fixtures, Buffer Stops.
c) Monorail beams and supports
d) Roof Trusses, Roof Girders, Purlins, Roof panels, Roof hand rails, Sheeting Posts, Side runners, Louvers, Bracings, Sag angles, Sag rods,
e) Wind girders, Platforms, Walk-ways
f) Stairwell, Stairs, Ladders, Hand rails
g) Gutters and Down comers
h) Roof & Side Cladding with Colour Coated Galvalume Sheets, Polycarbonate Sheets as translucent sheets
i) Crane Maintenance Platform
j) Gable wall Cladding with Colour Coated Galvalume, Polycarbonate Sheets.

04.07.01.03 General Description of Structures

The following gives only general description of steel structural work . The structural work shall not be limited to these but shall be guided by Technological / Technical requirements and aspects for the total scope of work..

04.07.01.04 Description of Unit

The following gives only general description of structural work involved in for Natural gas compressor station. The structural work shall not be limited to these but shall be guided by technical/technological aspects for the total scope of work. Overall layout of natural gas compressor station with different units shall be as per relevant technological drawings.

04.07.01.05 Natural Gas Compressor Station

a) Gas Compressor Shed

This is a Steel structural building of approximately 100m length, 50m width and height of 15m having EOT crane of 15/5 m. This building is covered with Colour Coated galvalume sheet on all four side and roof shall be coved with the Sandwich panel made of colour coated sheet with appropriate insulated material as per technical specification.

b) Air Compressor Shed

This is steel structural shed of approximately length 10m, width 10m and height of 6m covered with colour coated sheet on roof and all four side.

c) Diesel Generator Shed:

This is steel structural shed of approximately length 12m, width 10m and height of 6m covered with colour coated sheet on roof and all four sides.

d) Lube Oil and HSD Storage shed

This is steel structural shed of approximately length 20m, width 20m covered with colour coated sheet on roof and all four side.

e) Fire Water Pump House

This is steel structural shed of approximately length 50m, width 12m, height 7.5m with 5T capacity pendent operated under slung crane. Building shall be covered with colour coated sheet on roof and all four sides.

f) Fire Tender House

This is steel structural shed of approximately length 24m, width 16m, height 6m with 16m wide and 6m Floor with RCC slab. Building shall be covered with colour coated sheet on roof and all four side above 1m from ground level.

g) Parking Shed

Parking sheds for car, scooter and bicycle shall be of steel structural building covered on roof with colour coated galvalume sheet. Tentative dimensions are as follows:

Car Parking Shed: Approximately length 35m, width 6m, height 2.8m.
Scooter Parking Shed: Approximately length 20m, width 4.5m, height 2.8m.
Bicycle Parking Shed: Approximately length 40m, width 4.5m, height 2.8m.

h) Mechanical Workshop

This is steel structural shed of approximately length 40m, width 25m, height 15m having EOT crane of 10/3 T. This shed shall be covered with colour coated sheet on roof and all four sides.

i) Store

This is steel structural shed of approximately length 30m, width 20m, height 11m with under slung crane of 5T capacity. This shed shall be covered with colour coated sheet on roof and all four sides.

j) Fire Water Tank

Fire Water Tanks Shall be of structural construction supported on ground. The dimensions of the tank shall be 24m dia x 16m height.

The above descriptions of steel structural works are indicative only and not limited only to as mentioned, if any other units are deemed necessary for completion of the Project those are to be supplied by the Bidder.

Successful Bidder shall also ensure the adequacy of the building parameters to suite equipment layout and technological requirement.

If the Bidder wants any deviation, he shall indicate the same and also the building parameters unit wise in his offer.

04.07.01.06 The work to be performed under this specification consists of design, engineering , supply, fabrication, erection and cladding, as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of all the above units, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

04.07.01.07 Supply of all materials including structural steel, roof cladding & side-cladding sheets, fasteners, paints, consumables like gas, electrodes etc. and all other materials as deemed necessary for proper completion of the work, are included in the scope of the Bidder.

04.07.01.08 The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Owner/Consultant. For all buildings and structures, necessary layout and details are to be developed by the Bidder keeping in view the statutory & functional requirements of the plant and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Bidder's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Owner .

04.07.02 Scope Of Work

04.07.02.01 The scope of work shall cover, but shall not be exclusively limited to, the following:

- Collection of all site related data & conducting site investigations,
- Design, preparation of all design drawings, fabrication drawings,
- Providing Estimated quantity of Steel structural work and crane rail in Tons, Roof sheeting, side sheeting and requirement of translucent sheets in Sqm.
- Obtaining Owner's/Consultant's approval on general arrangements and Design of structures

- Dismantling, retrieval, sorting and storing of any existing structures as directed by the owner, if dismantling is a part of the total work
- Supply of all materials viz, raw steel, sheeting for side cladding, and paints
- Supply of fasteners like bolts, nuts, washers etc
- Supply of consumables like electrodes for welding, gases for gas cutting etc
- Supply of plant & machinery, tools tackles instruments for fabrication and erection
- Providing facilities for testing of materials and conducting NDT
- Providing facilities for transport and handling
- Deploying requisite skilled and unskilled manpower
- Making arrangements for all services like approach to site, electricity, water etc.
- Fabrication of structures, their transport and proper storing at site
- Erection of structures, claddings, gutters, down pipes etc
- Application of paints at shop after fabrication and at site after erection
- Providing all reasonable facilities for inspection by Owner/Consultant
- Conducting NDT as stipulated by the Owner and making test results available to Owner / Consultant for evaluation
- Compliance with primary acceptance tests / inspection, liquidation of defects; compliance with final acceptance tests / inspection, liquidation of defects;
- Carrying out field-engineering decisions as desired by the Owner
- Preparation of "As Built" drawings for all the structures and hand over to the Owner the completed structural work to the Owner's full satisfaction.

- Any other work deemed incidental for the completion of the overall work but not included in the above detailed scope.

04.07.03 Design of Building Structures

04.07.03.01 Design considerations

a) General

i) Structures shall be designed such that they are economical and safe and meet the functional and service requirement of the technological process for which they are designed. The architectural planning of the building shall be based on technological requirements.

ii) The structures shall be designed conforming to the relevant safety regulations, Factory Acts, Electricity Rules and stipulations of Statutory bodies as applicable to the project and as per relevant Indian Codes of Practice or, any International Code approved by the Owner.

iii) Natural ventilation shall be provided ensuring that it does not permit rain water entry into the building. Scope of natural lighting shall be used to the maximum possible extent.

iv) Bidder shall submit the 6 copies of design drawings along with the design calculation & soft copy of staad input file for the approval of design drawings.

b) Design

i) Design of structures

Design of steel structures shall be done in accordance with IS:800-2007 or any equivalent international code of practice that may be acceptable to the Owner.

ii) Resonance in Structures

Structures supporting vibratory/reciprocating equipments shall be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency shall not lie within the range 0.7 to 1.5.

04.07.03.02 Loading Codes

a) All live loads shall be considered in accordance with IS:875(Part-2)-1987.

b) Wind loads shall be in accordance with IS:875(Part-3)-2015 and any other consideration specific to the site.

c) Seismic loads shall be in accordance with IS:1893- 2016.

d) Crane loading to be considered in design shall be as follows:

i) As per relevant clause of IS:800-2007.

ii) IS:875(Part-2)-1987 for conditions not covered in IS:800-2007. unless more severe loads have to be considered for technological/operational conditions.

e) Crane stopper shall be designed in accordance with clause 6.1.4 of IS:875 (Part-5)-1987.

f) In absence of any suitable provision for design loads, any other recognised code of practice may be followed subject to prior approval of the Owner.

04.07.04 Fabrication of Steel Structures

04.07.04.01 Drawings

The Bidder shall prepare fabrication drawings, erection drawings, bill of materials, drawing office despatch lists / shipping documents, schedule of bolts and nuts and as built drawings based on the approved design drawings. All drawing work shall be in metric system and all writing work shall be in English.

04.07.04.02 Material of Construction

i) All steel and other materials used for steelwork and in association with steelwork shall conform to appropriate Indian standards. Only tested materials shall be used unless written authority is obtained for the use of untested materials for certain secondary structural members.

Unless otherwise specified in the drawings

a) All rolled sections and plates up to & including 20 mm thickness shall conform to Grade "A" as per IS : 2062.

b) Plates of thickness above 20 mm and Plated structures subjected to dynamic loading shall conform to Grade "BR" as per IS: 2062.

ii) Steel sheets shall conform to IS : 1079.

iii) Steel tubes for structural purpose shall conform to IS : 1161 (of Grade Yst 240)

iv) Permanent Color coated (non-insulated) metal sheets shall be troughed (Minimum depth of trough= 28 mm & Maximum pitch of trough= 205 mm) zinc-aluminium alloy (55% Aluminium, 43.4% Zinc and 1.6% Silicon) coated, not less than 200 gm/sq m, having High Tensile sheet (Fy=550 MPa) of thickness commensurate with purlin spacing adopted, subject to a minimum Base Metal Thickness of 0.5 mm. The sheets shall meet the general requirement of IS: 15965 and shall conform to class 4 for the durability.

v) Polycarbonate sheet shall be 3 mm thick of matching profile with metal cladding profile confirming to IS:14443.

vi) Gutters shall be of copper bearing steel conforming to Grade "A" as per IS :2062.

vii) Crane Rails shall conform to IS : 3443.

viii) All black bolts, nuts and locknuts shall conform to IS : 1363 and IS : 1364 (for precision and semi precision hexagonal bolts) of property class 6.4 unless otherwise specified. Washers shall conform to IS : 6610

ix) All tapered washer shall be as per IS:5372 for channels, and IS:5374 for Joists. Spring washers shall conform to IS:3063.

x) Covered electrodes for arc welding shall conform to IS: 814.

xi) Certified mill test reports of materials used in the work shall be made available for inspection by the Owner / Consultant upon request.

04.07.04.03 Fabrication

i) Fabrication of all structural steelwork shall be in accordance with IS:800 and in conformity with various clauses of the Technical Specification.

ii) Wherever practicable and wherever perfect matching of parts is required at site, members shall be shop assembled before despatch to minimise site work. Parts not completely assembled in the shop shall be secured, to the extent possible, to prevent damage during despatch.

iii) The scope of work under fabrication includes, but not limited to, the following:

a) Preparation and supply of material indents, bolt lists, bought out items list, etc.

b) Procurement and collection of all material from supplier's temporary stockyards/stores, including loading, transportation, unloading and stacking and storing on skids or supports.

c) Procurement and collection of all consumables like bolts, nuts, washers, electrodes, paints, shims, packs, etc., including allowance for spares and wastage.

d) Preparation and submission of modification/rectification sketches, As-Built drawings, erection drawings, bill of materials, and shipping documents for approval of purchaser.

e) Cold straightening of section and plates, whenever they are bent and kinked.

f) Fabrication of all steel structural components covered under tender drawings, design drawings and generally described under the scope of the project.

g) Making arrangements for and conducting tests such as chemical analysis, physical and mechanical tests on raw materials where specified/as directed by purchaser

h) Control Assembly of steel structural components at shop, wherever required.

i) Preparation of steel structural surfaces for painting as provided in the specifications/drawings.

j) Application for one primer coat of painting at shop, as specified in the design drawing/specifications.

k) Loading, transportation from fabrication yard to site of erection and unloading of all steel structural components/units/assemblies.

l) Commissioning spare for each equipment for commissioning the system.

m) Preparation of design drawing, detailed engineering drawing, vendor data sheet/drawing, cable schedule/cable engineering and 'As built' drawings.

iv) Due to non availability of specified materials, suitable substitutions may be provided with the consent of purchaser. Such substitution shall be incorporated in the "As built" drawings.

All the items are to be cut as per requirements of the drawing. If joints are to be provided in any item in order to meet requirements of size and shape, cutting plan showing locations of joints shall be prepared for consideration of purchaser. Joints provided shall be incorporated in "As built" drawings.

Rolling and cutting tolerances shall be as per IS:1852-1985.

Only tested materials shall be used unless use of untested materials for certain secondary structural members is permitted by purchaser. If test certificate for the material is not available from the main producer, the following tests shall be carried out at the discretion of purchaser.

a) Chemical Composition
b) Mechanical Properties
c) Weldability test

04.07.04.04 Electrodes

Electrodes shall conform to IS:814-2004.

04.07.04.05 **S**toring of Materials

Materials shall be stored and stacked properly in supplier's temporary store ensuring that place is properly drained and is free from dirt. It shall be ensured that no damage is caused due to improper stacking.

04.07.04.06 **M**aterial Preparation

- Cut edges shall be finished smooth by grinding or machining wherever necessary. Sufficient allowance (3mm to 5mm) should be kept in the items in case machining is necessary.

- Cutting may be effected by gas cutting, shearing, cropping or sawing.

- Straightening and bending shall be done in cold condition as far as practicable.

- If required, straightening and bending may be done by application of heat between 900ºC and 1100ºC. Cooling down of the heated item shall be done slowly.

04.07.04.07 Drilling and Punching of Holes

- Drilling and punching of holes for bolts shall be done as per IS:800-2007,

- Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal.

- Holes for bolted connection should match well to permit easy entry of bolts. Gross mismatch of holes shall be avoided.

04.07.04.08 Assembly for Fabrication

- Fabrication of all structural steelwork shall be in accordance with IS:800 2007 and in conformity with various clauses of this Specification, unless otherwise specified in the drawings.

- Fabrication of structures shall preferably be taken up as per the sequence of erection.

- All erection units shall bear reference drawing no. at a prominent location on the structures for easy identification at site.

- Fabricated structures shall conform to tolerance as specified in this Specification and in IS:7215 1974. In case of contradiction, tolerance specified in this Specification shall prevail.

- All the components of structures shall be free from twist, bend, damage, etc.

- Splice joints shall generally be of full strength butt weld and wherever possible, shall be located at zones of minimum or substantially lesser stress.

- Splice joints of flange and web should preferably be staggered.

- Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads of nuts and bolts satisfactory bearing.

- The threaded portion of each bolt shall project through the nut at least by one thread.
- Permissible deviations from designed (true) geometrical form of the despatch elements shall be in accordance with IS:7215 1974.

04.07.04.09 Welding

a) The Tenderer shall work out welding procedure for considering the following factors:

i) Specification and thickness of steel.
ii) Specification of electrode or/and base wire.
iii) Welding process (manual arc welding, submerged arc welding).
iv) Type of structures to be welded (thickness of components meeting at a joint).
v) Sequence of welding.
vi) Weather condition.
vii) Inspection procedure to be followed
viii) Design requirements of the joints.

b) All metal arc welding shall be carried out as per IS:9595 1996.

c) Electrode shall conform to Clause no. 3.3 of this Specification.

d) Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due to any other reason shall not be used.

f) Recommendations of electrode manufacturer are to be strictly followed.

g) Welding surface shall be smooth, uniform, free from fins, tears notches or any other defect which may adversely affect welding.

h) For multi run weld deposit, the next run should be done only after thorough removal of slag and proper cleaning of surface.

i) Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method which does not cause grooving and other surface defects on the weld or on the parent metal.

j) Fillet welds shall not be stopped at corners but shall be returned round them.

k) Welding shall not be done under such weather conditions which might adversely affect the efficiency of the welding.

l) Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

04.07.04.10 Inspection & Testing

a) Purchaser/Inspector shall have free access at all times to those parts of Bidder's or his Sub bidder's works which are concerned with the fabrication of steel works and shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of relevant specification.

b) All gauges and templates, tools, apparatus, labour and assistance for checking shall be supplied by the bidder free of charge. Inspector may, at his discretion, check the test results obtained at the Bidder's works, by independent test at the Government Test House or elsewhere, and should the material so tested be found to be unsatisfactory, the cost of such test shall be borne by the Tenderer.

c) Tenderer shall make all necessary arrangements for stage inspection by Inspector during the fabrication at shop and incorporate all on the spot instructions/ changes conveyed in writing to the Tenderer.

d) Material improperly detailed or wrongly fabricated shall be reported to Inspector and shall be made good as directed. Minor misfits which can be remedied by moderate use of drift pins, and moderate amount of reaming and slight chipping may be corrected in that manner, if in the opinion Inspector, the strength or appearance of the structure will not be adversely affected. In the event Inspector directs otherwise, the items will be rejected and a completely new piece shall be fabricated. The cost of correcting errors shall be to the account of the Tenderer.

f) Purchaser/Inspector shall have the power:

i) To certify, before any structure is submitted for inspection, that the same is not in accordance with the contract, owing to the adoption of any unsatisfactory method of fabrication.

ii) To reject any structure as not being in accordance with Specification and drawings.

iii) To insist that no structure or parts of the structure once rejected is resubmitted for inspection/test, except in cases where Inspector considers the defects as rectifiable.

g) If, on rejection of structure by Inspector, the Tenderer fails to make satisfactory progress within the stipulated period, Inspector shall be at liberty to cancel the contract and fabricate or authorize the fabrication of the structures at any other place he chooses, at the risk and cost of the Tenderer, without prejudice to any action being taken in addition to terms of General Conditions of Contract.

h) Inspector's decision regarding rejection shall be final and binding on the Tenderer.

i) The Specifications prescribe various tests at specified intervals for ascertaining the quality of the work done. If the tests prove unsatisfactory, Inspector shall have liberty to order the Tenderer to re do the work, done in that period and/or to order such alterations and strengthening that may be necessary at the cost of the Tenderer and the tenderer shall be bound to carryout such orders failing which the rectification/redoing will be done by other agencies and the cost recovered from the Tenderer.

j) Notwithstanding any inspection at the fabrication yard, Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to specifications/drawings.

k) All rejected materials shall be removed from the site of fabrication by the Tenderer at his own cost and within the time stipulated by Inspector.

04.07.04.11 Control in Welding

The extent of quality control in respect of welds for structural elements shall be as follows and shall be conducted by the tenderer at his own cost:

a) Visual Examination All welds shall be 100% visually inspected to check the following:

i) Presence of undercuts
ii) Visually identifiable surface cracks in both welds and base metals
iii) Unfilled craters
iv) Improper weld profile and size
v) Excessive reinforcement in weld
vi) Surface porosity

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

b) Dye Penetration Test (DPT) This shall be carried out for all important fillet welds and groove welds to check the following:

i) Surface cracks
ii) Surface porosity

Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

c) Ultrasonic- testing: 100% for all Butt joints to detect the following

i) Cracks
ii) Lack of fusion
iii) Slag inclusions
iv) Gas porosity

Ultrasonic testing will be carried out in accordance with American National Standard ANSI/AWS DI-92 Chapter - 6: Part C. Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. will be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface will be prepared to make it suitable for carrying out ultrasonic examination.

d) Radiographic Testing (X-ray and & Gamma-Ray Examination)

This test will be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method will be decided by Purchaser to detect the following defects

i) Gas porosity
ii) Slag inclusions
iii) Lack of penetration
iv) Lack of fusion
v) Cracks

Radiographic testing will be conducted in accordance with American National Standard ANSI/AWSDI.1-92. Any surface irregularity like undercuts, craters pits etc. will be removed before conducting radiographic test. The length of weld to be tested will not be more than 0.75 x focal distance. The width of the radiographic film will be width of the welded joint plus 20 mm on either side of the weld.

The tenderer shall engage any reputed or Government test agency to carry out the tests. The third party shall carry out tests, give and interpret test results and recommend rectification measures necessary. Tenderer shall carry out the rectification work as recommended by the test agency to ensure defect free welding.

04.07.04.12 Acceptable Limits of Defects in Weld

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clause 8.15.1 American National Standard ANSI/AWS D1.1 96.

04.07.04.13 Rectification of Defects in Welds

In case of detection of defects in welds, the rectification of the same shall be done as follows :

i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.

ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

04.07.05 Erection of Steel Structures

04.07.05.01 Scope

The scope of work under erection includes in addition to provision of erection and transport equipments, tools and tackles, consumables, materials, labour and supervision, the following:

a) Storing and stacking at site of erection of all fabricated structural components/ units/assemblies till the time of erection.

b) Transportation of structures at site.

c) Receiving at site of structures including site handling /movement, unloading, storing and stacking at site of erection of technological structures such as bunkers and the related structures

d) All minor rectification / modification such as :

i) Removal of bends, kinks, twists, etc. for parts damaged during transportation and handling;
ii) Cutting chipping, filing, grinding, etc., if required, for preparation and finishing of site connections;
iii) Reaming for use of next higher size bolt for holes which do not register or which are damaged.
iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.

e) Other rectification work such as

i) Re-fabrication of parts, damaged beyond repair during transportation and handling or incorrectly fabricated.
ii) Fabrication of parts omitted during fabrication by oversight or subsequently found necessary.
iii) Plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.

f) Fabrication of minor items/missing items or such important items as directed by the Owner / Consultant.

g) Assembly at site of steel structural components wherever required including temporary supports and staging.

h) Making arrangements for and providing all facilities for conducting ultrasonic X-ray or gamma ray tests on welds; getting the tests conducted by reputed testing laboratories, making available test films/ graphs, reports and interpretation.

i) Rectifying at site, damaged portions of shop primer by cleaning and touch-up paint.

j) Erection of structures including making connections by bolts/high strength friction grip bolts / welding.

k) Alignment of all structures true to line, level plumb and dimensions within specified limits of tolerances as per IS :12843 "Tolerance for Erection of Steel Structures".

l) Application of second coat of primer paint and two coats of finishing paint at site after erection.

m) Grouting of all column bases after proper alignment of columns and only after obtaining clearance from Owner / Consultant.

o) Conducting preliminary acceptance and final acceptance tests.

p) Preparation of as built drawings, preparing of sketches/drawings to suit field engineering decisions, availability of material, convenience of fabrication, transportation and erection and changes during fabrication and erection.

All such works are subject to approval by the Owner / Consultant.

04.07.05.02 General Instructions for Erection

i) Erection shall be carried out in accordance with IS: 800 and other relevant standards referred to therein apart from this specification.

ii) The Contractor shall be responsible for checking the alignment and levels of foundations, correctness of foundation; centres of anchor bolts etc. well in advance of starting erection work and shall be responsible for any consequence for non compliance thereof. Discrepancies, if any, shall immediately be brought to the notice of the Purchaser. Any mistake subsequently found in alignment and levels of the structural

steelwork due to non verification of foundation before erection shall be corrected by the Contractor at his own expense.

iii) One set of reference axes and one bench mark level will be furnished to the Contractor. These shall be used for setting out of structures. Maintenance of such bench mark level shall be the responsibility of the Contractor.

iv) The Contractor at his own expenses shall provide measuring instruments for setting out, levelling and aligning steelwork. He shall provide one exclusive survey team for alignment of structural works.

v) For safe and accurate erection of structural steelwork, staging, temporary support, false-work etc. shall be erected as required.

vi) All erection works shall be done with the help of cranes, use of derrick is not envisaged.

vii) Erection should start preferably from braced bays

viii) The fabricated materials received at erection site shall be verified with respect of marking on the key plan/marking plan or shipping list.

ix) Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be painted in distinct colour for identification and the same shall be brought to the notice of the Purchaser.

x) The approved erection drawings and any approved arrangement drawing, specification or instruction accompanying them shall be followed in erecting structures.

xi) Erection work shall be taken up after receipt of clearance from the purchaser.

xii) For safety requirements during erection, provisions in IS: 7205 - 1974, IS: 7969 - 1975 and other relevant Indian standards shall be followed.

xiii) Erection shall be carried out with the help of maximum mechanisation possible.

xiv) Prior to commencement of erection, all the erection equipment, tools, tackles, ropes etc. shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary and frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipment, if any.

xv) Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment etc. Erected parts of the structures shall remain stable during all stages of erection when subjected to the action of wind, dead weight and erection forces etc. Specified sequence of erection of vertical and horizontal structural members shall be followed. Erected members shall be held securely in place by bolts ./ guy ropes etc to take care of dead load, wind load and erection load during all stages of erection, alignment, welding & painting.

xvi) All connections shall achieve free expansion and contraction of structures wherever provided.

xvii) No final bolting or welding of joints shall be done until the structure has been properly aligned. Structures shall be aligned true to plumb and level and shall be checked by using theodolite and a scheme shall be submitted for approval of the purchaser. Final welding / bolting shall be done only after obtaining approval of the alignment scheme from the purchaser.

xviii) Welding shall be carried out as specified in the Chapter "Welding of Steel Structures" in this specification.

xix) All erection bolts shall be retained in position or the holes shall be plug welded. No un used holes shall be left.

xx) For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

xxi) Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required, by deploying independent survey team. The final levelling and alignment shall be carried out immediately after completion of each section of a building using survey instruments.

xxii) All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

xxiii) The contractor shall manufacture, erect and provide false-work, staging temporary support etc. required for safe and accurate erection of structural steel work and shall be fully responsible for the adequacy of the same in strength for transferring temporary and erection loads.

xxiv) The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments etc. to purchaser for his inspection at any stage during erection.

xxv) All materials & consumables shall confirm to the material specification .

xxvi) Notwithstanding any assistance rendered to the Contractor by the Purchaser, if at any time during progress of the Work, any error should appear or rise therein, on being required to do so, Contractor at his own cost shall remove and amend the work as directed by the Purchaser.

xxvii) The contractor shall fully abide by the safety procedures and any accident whatsoever concerned to erection shall be full responsibility of the contractor.

04.07.05.03 Field Connections

i) The numbers of washers on permanent bolts shall be one for the bolt head side and one or two for the nut side.

ii) Where bolting is specified on the drawing, the bolts shall be tightened to the specified limit. The threaded portion of the each bolt shall project through the nut by at least three threads. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface. Minimum two bolts shall be provided at any bolted connection.

iii) To prevent loosening of nuts, spring washers or lock nuts shall be provided as specified in the design/shop drawings.

iv) All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structures.

v) All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.

vi) The mating surfaces shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.

vii) The mating surfaces shall be absolutely free from grease, lubricant, dust, rust etc. and shall be thoroughly cleaned before assembly.

viii) The nuts shall be tightened up-to the specified torque with the help of torque wrench or by half turn method with the help of pneumatic wrench lever.

ix) The direction of tightening of the nuts shall be from the middle toward the periphery of assembly.

x) After desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

04.07.05.04 Acceptance Standard of Welding

Acceptance standard of welding shall be as specified in "Welding of Structures" section of this specification.

04.07.05.05 Bedding and Grouting

i) Base plates shall be set to elevations shown on the drawings, supported aligned and levelled using steel wedges and shims or by other approved methods. Plates shall be levelled properly, positioned and the anchor bolts tightened.

ii) Pack plates below base plates should cover at least 50% area of the base plate unless noted otherwise and all such material shall be accounted as per special conditions of contract.

iii) The gap between the base plate and the foundation shall be pressure grouted by approved method, after thorough cleaning of the gap, duly checked by site Engineer. The concrete mix shall be minimum M30 or as per instruction / drawings and to be supplied by the CIVIL contractor. Such grouting shall be carried out strictly under the supervision of site Engineer.

iv) Bedding/grouting shall not be carried out until sufficient number of columns have been properly aligned, levelled and plumbed and sufficient number of girders, beams, trusses and bracings have been put in position & accepted by the purchaser.

04.07.05.06 Painting after Erection

The painting shall be as per "Surface preparation and painting of steel structures" section of this specification and instructions stated in the drawings.

04.07.05.07 Guidelines for Safe Erection Practice

a) DO'S

i) Carry out erection only after structures are thoroughly inspected and cleared.
ii) Start erection from braced bay.
iii) Ensure proper packing below the columns to have correct levels (to be checked by survey schemes).
iv) Ensure proper anchoring of column base by tightening of all anchor bolts.
v) Ensure that guying is done at 2/3rd height in 3 directions 120 degree apart.
vi) Ensure that guy ropes are fully tight and anchored. Size of the guy rope should be adequate to take loads.
vii) Provide temporary bracing wherever needed.
viii) Outstanding of flanges of beams /columns are to be protected against local bending at location of slinging during erection.
ix) Ensure that cross beam/bracings are erected only after the cleats/gussets are fully welded.
x) Do the welding of cross beams with cleats, only after ensuring all bolts are in position and are tightened fully.

(b) DON'TS

i) Don't leave the structures without proper guying in all directions till they are braced.
ii) Don't miss to anchor properly at the base of columns with anchor nuts fully tightened.
iii) Don't use manila ropes in place of steel ropes for guying.
iv) Don't support the cross beams with temporary jigs. Ensure all the bolts are provided and tightened.
v) Don't use bracings/tie members for fixing lifting tackles/diversion pulleys/cable trays to avoid damages due to erection loads.
vi) Avoid indiscriminate cutting/notching of erected and loaded structures.
vii) Don't use column bases for anchoring guy ropes of structures.

04.07.05.08 Acceptance of Work

Acceptance of erected steel structures shall be either after completion of erection of the whole building or in blocks.

04.07.06 Painting of Building Steel Structures

04.07.06.01 All steel structural work shall be painted as follows unless otherwise stated in the drawing / Technical Specification.

04.07.06.02 Surface preparation

The steel surface which is to be painted shall be cleaned of dirt and grease, and the heavier layers of rust shall be removed by chipping prior to actual surface preparation to a specified grade.

Following are the type and standards of surface preparation to be followed based on the requirement of a particular painting system or as specified in the design drawings.

Manual/Power tool cleaning :- Manual/Power tool cleaning shall be done as per Grade St-2 or St-3 of Swedish Standard Institution SIS 05 5900 or cl. 6.2.1.1 & 6.2.1.2 of IS : 1477 - 1987 (Part - 1).

Grade St-2 :- Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.

If no grade of surface preparation is specified, St-2 grade of preparation as per Swedish Standard shall be followed.

04.07.06.03 Paint System

i. Surface preparation :- St-2
ii. Primer paint :- Two coats of zinc phosphate in phenolic alkyd medium (35 microns/coat).
iii) Finishing paint :- Two coats of synthetic enamel (25 microns/coat) conforming to IS : 2932 - 1974.

All paints shall be of approved and shade as per Owner / Consultant's requirements.

04.07.06.04 Paint and Painting

Manufacture of paints, mixing of paints, etc. shall be generally according to the relevant IS codes of practice.

Generally compatibility between primer intermediate and finishing paint shall be certified by the paint manufacturer supplying the paints.

Guarantee period shall commerce from the date of completion of finishing coat of paint on entire structures. The guarantee period shall be indicated depending on the type of surface preparation and system of painting. To fulfill this obligations, the Bidder may obtain from the painting manufacturer, guarantee for the performance of paint/painted surfaces.

Application of paint shall be by spraying or brushing as per IS : 486-1983 and IS : 487-1985 and in uniform layers of 50% overlapping strokes by skilled painters. Painting shall not be done when the temperature is less than 5 degree C or more than 45 degree C and relative humidity is more than 85% unless manufacturer's recommendations permit. Also painting shall not be done in foggy weather. During application, paint agitation must be provided where such agitation is recommended by the manufacturer.

Painting shall be applied at painting manufacturer's recommended rates. The number of coats shall be such that minimum dry film thickness specified is achieved. the dry film thickness (DFT) of painted surfaces shall be checked with ELCOMETER or measuring gauges to ensure specified DFT.

All structures shall receive one coats of primer paint at shop after fabrication before despatch after surface preparation has been done as per requirements.

Unless otherwise specified all structures after erection shall be given one coat of primer and two coats of finishing paint of approved colour and quality. The under coat shall have different tint to distinguish the same from the finishing coat.
The proposed make, quality and shade of paint shall have the approval of Owner / Consultant

04.07.07 Cladding of Buildings With Sheets

04.07.07.01 Scope of Work

a) Preparation of drawings showing layout and size of sheets used, details of connections and flashings, bill materials.

b) Procurement and supply sheets as per material specifications for all gauges and sizes, flashings and fittings like corner pieces, apron pieces, ridges, along with all sheeting fixtures, self stiching screws, sealant tapes / adhesives, EPDM washers, fastners etc.

c) For any variation in profile of sheet with respect to material specified, in case of proven non availability, the tenderer shall submit design calculations of sheets along with manual and shall obtain prior approval of purchaser / consultant

d) Design calculations for sheeting fixtures shall be provided for review of purchaser / consultant.

e) Fixing of self tapping screws and desired anchor length in to purlin / runners shall be clearly indicated in the drawings .

f) Scheme for stitching of sheets / sealing the gaps, joints , unused holes shall also be indicated in the form of a manual / drawing.

g) Cutting and bending of sheets wherever required; drilling of holes all as per specification and drawings.

h) Procurement and supply of sheeting fixtures, self tapping screws, locking fixtures, sealant materials / tapes, stitch bolts as per recommendation of sheet manufacturer. However in case of Translucent sheets manufacturer's specification for fixing of sheets shall be followed.

i) Loading, transportation, unloading and delivery of sheeting material from place of procurement to erection site.

j) Provision of all tools, tackles, equipment, labour supervision and services required for the satisfactory completion of the work specified herein and on the drawings.

k) Erection in position sheets for roofing, walling, louvres; erection of all flashings, fittings like ridges, valleys, gutters, corners, apron etc. at all locations all work as per drawings and specifications.

l) All necessary flashings, ridging, capping, gable and corner trimming shall be made from sheets of same material quality.

m) Suitable Wind Ties (galvanised steel flats) shall be provided after fixing of sheets, at the free edge of sheeting.

04.07.07.02 Material

Material for sheeting shall be as described below:

Permanent Color coated (non-insulated) metal sheets shall be troughed (Minimum depth of trough= 28 mm & Maximum pitch of trough= 205 mm) zinc-aluminium alloy (55% Aluminium, 43.4% Zinc and 1.6% Silicon) coated, not less than 200 gm/sq m, having High Tensile sheet (Fy=550 MPa) of thickness commensurate with purlin spacing adopted, subject to a minimum Base Metal Thickness of 0.5 mm. The sheets shall meet the general requirement of IS: 15965 and shall conform to class 4 for the durability.

Polycarbonate sheet shall be 3 mm thick of matching profile with metal cladding profile confirming to IS:14443.

04.07.07.03 Fixing of Sheets

a) All fixing of the roof and side sheeting to purlins shall be by means of self tapping screws of tested quality as per manufacturer's recommendation.

b) All bolts shall pass through the crown of the corrugations for roof sheets and through trough corrugations for side sheets. Sheets are to be provided EPDM washers of approved quality. Fixing to the purlins shall be provided at alternate crowns / approximately at 400mm c/c.

c) All sheets shall be stitched together by self drilling stitching screws of specified dia and length as per sheet manufacturer's specification. In case of double side lap the pitch has to be staggered between alternative crowns. Washers of specified quality shall be placed under the head of the screw which shall always be on the outside the building.

d) Fixing of translucent sheets shall be as per manufacturer's specification.

e) All holes for sheeting and flashings are to be drilled at site with electric drill from the bottom side of the crown. The method of drilling shall be such that the material fits snugly together at laps to allow washers to have a good seating.

f) All the joints / overlaps, unused holes shall be properly sealed by using special sealing tapes / adhesives as per sheet manufacturer's specification.

g) All roofing shall be provided specified side lap and 230 mm end lap for roof slopes 15 degree and below. For roof slopes above 15 dergee end laps may be reduced to 150 mm. However minimum end lap of 150mm shall be ensured.

h) All side/gable end sides shall be provided with specified side lap and 100 mm end lap.

i) Overhang of sheets on the roof and side cladding shall not exceed 300 mm.

j) Erection is to be carried out with the lay of the side laps such that under the prevailing wind, rain is not driven into the lap. The sheets shall be laid so that side laps in any two consecutive rows are staggered.

k) Broken or otherwise damaged sheeting shall not be erected.

l) Cutting, framing and trimming of all openings required shall be carried out at site.

04.07.08 Quantities of Structural Items

The bidder shall indicate the estimated quantities of structural items of work ie fabrication/ erection tonnage, sheeting in sq.m etc. Bidder shall not make any additional claim if structural quantity of any items required for completion of entire package as per terms of contract exceed the quantity indicated by the bidder.

04.08 ARCHITECTURE

04.08.01 INTRODUCTION

Guwahati is the biggest city of the Indian state of Assam situated on the south bank of the Brahmaputra, the "Gateway to North East India".

04.08.01.01.01 Project Site

The architectural design shall aim to create a landmark office building for IGGL in India with all facilities and infrastructure. All buildings shall be sustainable, energy efficient and use space optimally.

04.08.02 MASTER PLANNING OF COMPRESSOR STATION

- The Master Plan reflects the strategic planning of the proposed buildings for the emerging needs in view of advances in oil sector. The objectives of Master Plan include integrated complex with zoning, taking into account the environment and attempts to minimize a building's resource consumption, waste generation, and overall ecological impact to within certain nationally acceptable limits / benchmarks.

- Self-sustaining integrated buildings.
- Functional utility of all spaces.
- Creating holistic environment for overall development.
- Integrating plant and official life.

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04.08.02.01 PROJECT COMPONENTS

The Site comprises of Administrative building, Control room building, Canteen, Parking sheds for 2 & 4 Wheeler, Biometric security building, Fire tender house, Gate complex, Guard room, Worker's rest and other ancillary requirements to make the site self-sufficient.

04.08.02.02 BUILDING DETAILS

SL. NO.	Building Name	No. of Floors	Nos./ Blocks	Built up area in sqm

1.	**ADMINISTRATIVE BUILDING**	**G+1**	**1**	**2907.00 sqm**
2.	**CONTROL ROOM BUILDING**	**G+2**	**1**	
3.	**CANTEEN**	**G+1**	**1**	**591.00 sqm**
4.	**PARKING**	**G**	**1**	**206.50 sqm**
5.	**FIRE TENDER HOUSE**	**G**	**1**	**413.95 sqm**
6.	**GATE COMPLEX**	**G**	**1**	**67.49 sqm**
7.	**GUARD ROOM**	**G**	**1**	**16.00 sqm**
8.	**WORKER'S REST**	**G+1**	**1**	**1286.00 sqm**
9.	**BIOMETRIC SECURITY BLOCK**	**G**	**1**	**197.00 sqm**
10.	**FIRE FIGHTING PUMP HOUSE**	**G**	**1**	
11.	**SWITCHGEAR BUILDING WITH SWITCHYARD**	**G**	**1**	

(All the buildings shall be designed for one extra floor keeping in view future provision)

Note:

1. All buildings as per requirement shall be designed & planned as per the need and requirement with respect to site conditions and shall be approved by client / consultant.

The above mentioned sizes are minimum, and are for tender purpose only. The final construction will be based on the approved drawing finalized during detailed engineering.

04.08.03 SCOPE OF WORK

04.08.03.01 The scope of work includes detailed architectural planning, structural design and design of all required services based on architectural conceptual planning done by client / consultant.

04.08.03.02 The bidder should provide design drawing(s) like Plumbing, Firefighting, Electrical and HVAC etc. and their integrated installation & commissioning. The drawings and schemes shall be got approved by client / consultant for the concerned project. CPWD Specifications, relevant IS codes of latest edition and other standard specifications suitable for modern Institution and latest technology will be followed in general except otherwise mentioned in bidding document.

04.08.03.03 The scope of work also includes Detailed interior drawings on the basis of enclosed layout that shall include but not limited to overall interior floor plans with cross sections, skin section of partitions, wall paneling, furniture layout drawings, reflected false ceiling plan incorporating lighting, ACVS, fire fighting and other necessary arrangements.

04.08.03.04 The scope of work also includes infrastructure works like roadwork, parking, pathways, external drainage, external development, landscaping, horticulture including electrical services, signage(s) etc. for complete project.

04.08.03.05 Obtaining mandatory approvals from local bodies/ State & Central authorities/ Municipal Corporation/ Town & Country Planning etc. is in scope of this contract. Approvals as per latest standards with up to date corrections slips, necessary Environmental Clearance from the appropriate authority, NOC from Fire Department, Environment Planning Dept., NOC from Airport Authority of India etc. and any other statutory approval / Central Licensing & Approving Authority etc. related to building, approval from authorities required for commencing the work, execution of work & services and handing over the assets after making them habitable in all aspects.

04.08.03.06 The cost of labour, material, tools and plants and machinery required for execution of the whole project as per Layout plan & detailed design and drawings to the approved, specifications etc. is within the scope of this work.

04.08.03.07 The scope of work includes obtaining minimum 3 STAR GRIHA rating for administration building and control room building. These buildings are to be planned as per

GRIHA norms. Necessary pre construction & post construction audit of the building shall be carried out by GRIHA and co-ordination; completion/compliance certificate shall be obtained from them. For this, the contractor shall engage a Green Building Consultant for facilitation of GRIHA rating.

04.08.03.08 Detailed working drawings, interior drawings, furniture layouts are to be submitted by bidder and approved by client / consultant.

04.08.03.09 The scope of work in the schedule shall be deemed to include unless otherwise stated, cost of all materials including wastage, loading, transportation and unloading, labour, tools and tackles, fuel consumable, scaffolding and other temporary works, all incidentals such as setting out, site drainage, offering sample for approval, cost of all tests, rectification of all defects, replacement of defective material and work, removal of debris etc., interruption of work required to accommodate the work of other agencies working in that area, site clearance after completion of work, working at all locations and levels and for all necessary leads and lifts etc.

04.08.03.10 Samples of the materials of approved make or otherwise shall be got approved from the Engineer-in-charge / consultant for the concerned project, before use in the work.

04.08.03.11 The building should be designed for barrier free and accessibility with harmonized guidelines and space standards for barrier free built environment as per hand book on "Barrier free and Accessibility" available on CPWD website and with available latest guidelines by Ministry of Urban Development, Govt. of India developed in February 2016 and modifications therein (if any).

04.08.03.12 Water Supply, Distribution and Drainage, Sanitary Services & Sewerage System

The building shall have toilet and drinking water facility and accordingly water supply, distribution and drainage, sanitary services as per National Building Code, Factory act and other referenced publication.

Drinking water provisions shall be provided within an enclosure separated from the toilets. Space for janitor shall be provided in the toilets. All service pipes showing on the external wall shall be suitably concealed or shall be provided within a shaft.

Buildings are to be connected with soak pits and septic tanks. Buildings are to be connected

with water supply lines of appropriate diameter so that water supply should be made to the buildings.

Buildings shall be provided with overhead tanks to store water.

04.08.03.13 Electrical Services

Refer Electrical Chapter (Chapter no: 05.00) in technical specification.

04.08.03.14 Site Development Works

(a) **Roads/ Pathways**: The road shall be constructed as per requirement and the drawings submitted by bidder shall be approved by client / consultant.

Storm Water drainage: Along Main Arterial Roads and Secondary Roads storm water drains shall be provided and shall be covered with Concrete Gratings with proper inlet for surface runoff.

(b) **Landscape and Horticulture:**

a. Survey, investigation, design & construction of Landscape works (both hard & soft soil strata) in and around the buildings & roads & services is in the scope of this tender.
b. Parking lot is proposed for all types of vehicles including two wheelers and four wheelers as per standard. Hard standing shall be provided(if required) in areas demarcated for open parking as marked in Site Layout.
c. Other Items which are not mentioned above but are essential considering functional requirements and according to modern concept of building.
d. Procurement and installation of all external signage.

Note:

1. All works have to be executed as per specifications provided in the bid document, CPWD Specifications 2018 Vol-I & Vol. II and relevant IS codes of latest edition (in case of difference if any, stringent / higher specification of the two shall be followed. In absence of CPWD Specification, IS Codes, MORTH Specifications, relevant IS codes of latest edition, Specifications, or sound engineering practices and other standard specifications suitable for

modern buildings and latest technology shall be adopted as per order of precedence defined in the contract.

2. The scope of works & specification are given in general but they are not exhaustive i.e. does not mention all the incidental works required to be carried out for complete execution of the work. The work shall be carried out, all in accordance with true intent and meaning of the specifications and the drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings and/ or described in the specifications, provided that the same can be reasonably inferred there from. There may be several incidental works, which are not mentioned in the contract document/specifications but will be necessary to complete the item in all respect. All these incidental works/ costs which are not mentioned, but are necessary to complete the work shall be deemed to have been included in the overall amount quoted by the contractor for various components of work. No adjustment of rates shall be made for any variation in quantum of incidental works due to variation/change in actual working drawings. Also , no adjustment of rates shall be made due to any change in incidental works or any other deviation in such element of work (which is incidental to the items of work and are necessary to complete such items in all respects) on account of the directions of Engineer-in-charge . Nothing extra shall be payable on this account.

3. In case, some of descriptions are missing in the scope of work or specifications in the bidding documents the same shall be executed as given in the CPWD Specifications, relevant IS codes of latest edition or according to sound engineering practices so as to make the building including related services fully functional. No claim what so ever may be entertained at later stage. All cost of providing and making buildings fully functional with services, landscape and horticulture works complete in all aspect unless specifically mentioned in the contract document are included in the cost tendered for this work.

04.08.03.15 Administration Building

- The Building is planned as Ground + 1 Floors R.C.C. Framed Structure having total area of 2907.00 sqm. (The total area is minimum and indicative and will be finalized during detail engineering). Building design shall envisage construction of additional floor over 1st floor.

- The building is quadrangle in shape and has 360 degree orientation of spaces. However to cut off heat gains OTS space is buffered in centre.

- **Floor wise facilities** are as follows:

Ground Floor	Entrance porch, Reception, waiting, UPS/Services, Personal & finanace deptt., Hall for 24persons, Officer's room, Doctor room, Library, Archive room, services, Driver's room, Toilets for male, Female & physically handicapped
First Floor	Plant Incharge room, Secretary to plant incharge, Ante room, toilet, Conference room, hall for 24persons, Meeting room, Hall for 26persons,Dining & recreation, Toilets for male, Female

- The Complete building will have provision of data networking, C.C.T.V., Lighting control system comprising pir sensor, daylight sensor etc. as required for ECBC compliant of building, roof mounted solar system. The building has 2 No. Lifts. The Conference Room will have the audio video conference system as well as video wall. Access control system will be provided in office incharge room or any other location as required. All arrangement of fire fighting, HVAC, etc will be done as per applicable norms.

04.08.03.16 Similarly, the brief description for other buildings (not exhaustive list) is given in the following table. Provisions regarding data networking, CCTV, lighting automation pir sensor, daylight sensor, IP based EPABX system, as mentioned for the administration building shall apply to the following buildings also. The list of provisions is not exhaustive. Other facilities mentioned elsewhere in the contract shall also have to be provided.

Sl. No.	**Building Name**	**Brief description**
1.	**CONTROL ROOM BUILDING**	• The building shall be U-shaped of R.C.C. construction having two floors • There shall be three bays in the building, two for accommodating Electrical equipment/facilities and third one for Control & Instrumentation equipment/facilities.

		• Tentative size of the three bays of the building is shown in the General Layout Drawing The roof/terrace of the building shall be utilized as a panoramic viewing deck which shall be enclosed with glass. The top of the viewing deck shall be enclosed with a structural glazed dome. *Further details are mentioned under the table.
2.	**CANTEEN**	The building shall be of RCC construction. The building shall be in G+1 configuration. The building shall have the following minimum facilities: 1. Recreation area with gents and ladies toilets. 2. Kitchen with wash counter. 3. Double height space with dining capacity for atleast 27 persons at ground floor, and dining space for atleast 11 executives at projected portion in upper slab area. 4. Atleast four rooms with staying provisions like bed, AC, attached toilet, pantry and balcony in each room.
3.	**PARKING**	A car parking of atleast 35m x 6m shall be constructed with appropriate structural shed. Scooter parking shed of atleast 20m x 4.5m shall be provided. Bicycle parking shed of 40m x 4.5m shall be constructed. The parking shall have structural shed and civil flooring.
4.	**FIRE TENDER HOUSE**	The building shall be of civil and structural configuration of minimum dimensions 24m x 16m. The building shall have the following civil rooms on one portion of the building (approx. area of 16m x 6m): driver's rest room, gents workers and change room, store, shower, gents toilet and ladies toilet. The remaining portion (approx. 16m x 18m) shall have structural construction.
5.	**GATE COMPLEX**	Structural gate has to be provided with necessary beautification by plantation etc.
6.	**GUARD ROOM**	The building shall be of RCC construction of minimum 4m

		x 3.5m. The building shall have a toilet and a storage room.
7.	**WORKER'S REST**	The building shall be of RCC construction, and in G+1 configuration. The building shall have toilets with bath facilities in ground floor as well as first floor area.
8.	**BIOMETRIC SECURITY BLOCK**	The building shall be of RCC construction, and of minimum 19m x 11m. The building shall have space for x-ray scanning, ladies search room, visitors waiting area, lobby, security office, security change room, pantry, toilets etc.
9.	**MECHANICAL WORKSHOP**	The building shall be a structural building with lean to shed running on one side along the length of the shop. The minimum dimension shall be 42m x 26m. The lean to bay shall have the following rooms: Store, hydraulic room, office room, planning room, MCC room, toilet. All rooms of lean to bay will have civil enclosures (civil walls and slab).
10.	**STORE**	The building shall have structural roof and structural columns. However, the walls shall be of civil construction. The area of the overall building shall be minimum 30m x 20m.
11.	**FIRE FIGHTING PUMP HOUSE**	The building shall have structural configuration and shall be single storey building. The dimensions may be taken from relevant portion in the technical specification.
12.	**SWITCHGEAR BUILDING WITH SWITCHYARD**	The building shall be of civil construction and shall be a single storey building. The dimensions may be taken from relevant portion in the technical specification.

*Details for the control building:

For the control building, toughened glass shall be used as shown in the tender drawing. The toughened glass shall be from +600 level upto the lintel level in the gallery area at ground floor. However, the cable cellar shall not have toughened glass.

At the first floor, toughened glass shall be from +600 level upto the lintel level in the gallery area and the outer wall of PLC equipment room, control room, shift in charge room, server room upto the lift portion. However, for the inside portion of the gallery, there shall be only

toughened glass. The wall between the equipment room and control room shall not have toughened glass. However, the toughened glass shall be used for the portion between engineering room, shift in charge room, server room, reception waiting and control room.
Similarly, for the second floor, the outer portion of the gallery, control room, viewing gallery, and conference room have toughened glass from +600 level upto the lintel. The portion between viewing gallery, conference and control room shall be only toughened glass. The inside portion of the gallery shall be only toughened glass.
The tender drawing of the control building may be referred for better understanding.

**The above mentioned sizes are minimum, and the drawings are just given for understanding. The final construction will take place based on the approved drawing finalized during detailed engineering.

04.08.03.17 EXTERNAL SERVICES

Following provisions shall be made in the project:

- Rainwater Harvesting
- External Water Supply
- Sewerage System (Drainage pipe)

04.08.03.18 SITE DEVELOPMENT

Following provisions have been made in the project for site Development:

- Micro Leveling of Land
- Cement concrete pavement with vacuum dewatered concrete
- Footpath with PCC base, 60 mm thick paver blocks and Kerb stone edging on one side
- Surface Drainage - open/covered drains for drainage system.
- Boring and submersible
- Horticulture Works

04.08.03.18.01 Circulation & Parking

The circulation and parking has been planned to keep the pedestrian character of the complex.

04.08.03.18.02 Pavers

The Interlocking pavers shall be provided in Pathways, roundabout, cycle track of 60mm thick factory made cement concrete interlocking paver block of M -30 grade made by block making machine with strong vibratory compaction, of approved size, design & shape, laid in required colour and pattern over and including 50mm thick compacted bed of coarsesand, filling the joints with fine sand etc. as per CPWD specification.

04.08.03.18.03 Signages

Signages with different sizes & material specifications are proposed for different locations. Signages will be made bilingual for all Internal, Site Way finding and Facade/Building. Bilingual signage shall be provided as per relevant local bylaws and Govt. norms.

Internal signages are to be provided in all the buildings.

Fire Signage as per relevant statutory norms shall also be provided in each buildings.

Emphasis will be given towards making the signages with modern look & feel with uniformity and longevity with low maintenance cost in future.

04.08.03.19 LANDSCAPING & HORTICULTURE WORKS

Objective

Main objective of the landscape theme is to create a pleasant outdoor environmental for staff and visitors to this prestigious complex, complementary to the character of the built form.

Landscape Irrigation Design

Irrigation to the plantation shall be done with the combination of modern irrigation techniques and manual irrigation methods, in line with the site conditions and local agro-climatic conditions and assist in conserving the landscapes besides saving water and ecology.

04.08.03.19.01 Design criteria

b. Buildings

The built form merges seamlessly with the landscape. The relationship is ensured by use of similar materials for the landscape palette corresponding to the building materials.

c. Main Entrances

The Site has main gate & pedestrian gate to facilitate smooth flow of traffic

d. Paths and Roads

There will be a consistency in the way paths and roads are presented that clearly identifies their use, whether these are direct routes, recreational routes, service routes.

e. Lighting and Security

Adequate lighting provision has been made to enhance safety and security. Parking areas, entrance and service roads, and also isolated or dark areas are clearly defined and lit.

f. Parking areas

Segregated parking spaces have been earmarked for Visitors and Staff .

04.08.03.19.02 Horticulture and Plantation:-

The Horticulture and Plantation works shall be carried out as per Technical Specifications and CPWD Guidelines & Specification.

a. Lawns –

The lawns area is to be developed.

b. Trees / shrubs Plantation –

- The peripheral plantation of trees along the roads, green belts and buildings shall be planted. The minimum height of individual variety of plants shall be as per CPWD guidelines for Horticulture & Landscaping. Tree guards for 50% plants/trees shall be provided as per directions of Engineer in Charge.
- Herbal Plants- The different varieties of herbal plants shall be planted. The minimum height of individual variety of plants shall be as per CPWD guidelines for Horticulture & Landscaping.
- Shrubs- The different variety of shrubs shrubs shall be planted. The minimum height of individual variety of shrubs shall be as per CPWD guidelines for Horticulture & Landscaping.
- Ground Covers -The different varieties of Ground Covers shall be planted. The minimum height of individual variety of Ground Cover shall be as per CPWD guidelines for Horticulture & Landscaping.
- Climbers -The different varieties of Climbers shall be planted.
- Roundabouts at different location, shall be constructed as per requirement.

c. Entrance Landscaping -. Landscaping at Main Entrance gates shall be completed.
d. Road Central verge – Trees and hedges are to be planted in the central verge of Roads

04.08.03.19.03 The contractor shall take instruction from the officer-in-charge regarding supply and stacking of material at site and execution of work etc. He shall bear all charge for storage and safe custody of materials.

04.08.03.19.04 The Scope of work include development of areas around the proposed buildings and shall be completed as per the specification and drawing approved by the Engineer-in-charge. Contractor has to do horticulture works as per approved landscaping plan including grassing, grass turfs, plantation of shrubs, plants, trees etc.

04.08.03.19.05 Grassing will be done with selection No.1 grass including supplying good earth if needed including watering and maintenance of the lawn for 30 days or more till the grass forms a thick lawn free from weeds and fit for mowing.

04.08.03.19.06 Grass turf will be provided with selection No.1 grass turf with earth 50mm to 60mm thickness on existing ground prepared with proper level and ramming with required tools wooden (Dhurmos) and then rolling the surface with light roller making the surface smooth.

04.08.03.19.07 Supplying & Plantation of trees at site will be done with healthy, well developed trees established at the site of following varieties including watering, removal of unserviceable materials etc in quantity as per approved Landscaping drawings.

04.08.03.19.08 Supplying & Plantation of Shrubs at site will be done with healthy, well developed shrubs established at the site of following varieties including watering, removal of unserviceable materials etc in quantity as per approved Landscaping drawings.

04.08.03.19.09 Supplying & Plantation of Hedging at site will be done with healthy, well developed plants established at the site of following varieties including watering, removal of unserviceable materials etc in quantity as per approved Landscaping drawings.

04.08.03.19.10 Soil testing for texture, nutrient level, water retaining capacity, PH value and other essential test for healthy growth of plants shall be conducted at-least 5 locations

where horticulture/ Landscaping works are to be done, from Agricultural University ICAR/Krishi Vigyan Kendra. Necessary recommendation for fertilizer requirement and water consumption requirement shall be made available from the laboratories.

04.08.03.19.11 **In general,** the quality of soil in construction area is not very conducive for growth of plants and grasses. Top good soil from the construction site shall be preserved for horticulture purposes. The soil not suitable for grasses and growth of trees shall be removed and good quality soil either from the preserved top soil or brought from outside the site shall be used for horticulture purpose. No extra payment shall be made for same. The agency will be responsible for healthy growth of plants, trees, shrubs and grasses during construction stage and maintenance upto one year.

04.08.03.19.12 **Manure and Fertilizers:** Cattle manure/ compost shall be well decayed (should be at least 6 months covered in dump), free from grits and any other unwanted materials. The contractor shall also provide and spread manure (cow dung manure/compost) for healthy growth the plants & trees under his maintenance. Depending upon requirement to maintained the nutrients level of the soil necessary application of chemical fertilizers (NPK) and other micro nutrients should be done.

04.08.03.19.13 Watering should be done in such a way that optimum level of moisture content for healthy growth of plants and trees is maintained, at no time moisture content should fall below the wilting point. Inadequate or excessive watering is to be avoided.

04.08.03.19.14 **Weeding and Hoeing**: The work includes maintaining areas close to the base of the trees and shrubs free from weeds within 300mm radius from the stem of the trees / 150mm radius from the stem of the plants. Weeding has to be carried out once in a month. All weeds are to be disposed off from the site with all leads and lifts.

04.08.03.19.15 **Pruning and Trimming:** All dead or injured twigs, water shoots, unwanted branches are to be removed. Trees, shrubs and ground cover should be pruned to maintain natural shape. The hedges and shrubs shall be given special shapes and sizes to give aesthetic appearance of the greenery at regular intervals.

04.08.03.19.16 **Pest and Disease control**: All trees/plants are to be inspected once in a month to determine any disease or pest infections. Once the infection is identified adequate control measures are to be taken.

04.08.03.19.17 The contractor shall have to arrange all required tools & plants & other stock items like fuel, irrigation pipe, broom, Bamboo, Sutli, Hessian cloth. Tokari etc. for the proper development & maintenance of garden feature. Repair cost of tools & plant items shall be borne by the contractor & nothing shall be paid extra on this account.

04.08.03.19.18 The Agency should ensure adequate malies having experience of Horticulture work are deployed. In case of any deficiency the Engineer- in- Charge can issue the necessary direction to increase the staff and Agency should abide by order of Engineer –in-Charge.

04.08.03.19.19 The contractor shall maintain the plants, hedges, trees, shrubs and lawns in good and healthy condition during construction period until handover of site. This will include Complete maintenance of the entire garden features of the garden area i.e. lawn, trees, shrubs, hedge, potted plants, flowers beds, creepers etc. and other garden feature including watering hoeing, making of plants basic manuring, trimming and cleaning of hedges / plants, Beds, spraying of insecticides, fungicides, weeding, mowing, and top dressing of lawn with good earth and manure and hedge clipping and removal of the garden waste, composting of green waste from plants, trees, lawn mowing, etc as per direction and satisfaction of the officer-in-charge.

04.08.03.19.20 Sample of grass may be got approved from the officer-in-charge, in case or regressing/relaying of grass.

04.08.03.19.21 In order to ensure the suitability of good earth supplied for horticulture purpose, lab test will be required for every 300 cum of good earth supplied.

04.08.03.19.22 Water has to be arranged by the agency himself for horticulture work and no separate payment shall be made for carrying and sprinkling of water.

04.08.03.19.23 In case of any causality of shrubs, trees or any other plants has been found during maintenance the Agency should replace the trees/ shrubs/ other plants of the same height and specification by another at his risk and cost and nothing extra shall be paid for the same in this regard.

04.08.03.19.24 In case, if it is observed that the maintenance is not healthy and to the

required standard, no payment shall be made of the specific area for the period over which the maintenance has been found to be neglected. The decision of the E-in-C shall be final and binding in this regard.

04.08.03.19.25 The required quantity of insecticides/ Pesticides will be arranged by the agency for proper maintenance (only during the maintenance period) if needed. No payment shall be made in this regard.

04.08.03.19.26 The rejected & substandard material should be removed from the site of work immediately; the Department shall not be responsible for any damage/ loss of rejected material.

04.08.03.20 GREEN BUILDING DESIGN & GRIHA 3-STAR RATING

04.08.03.20.01 The administration building and control buildings are to be designed and achieve for **3 star GRIHA Rated Building with the Involvement of a green building consultant (GRIHA certified)** having previous involvement with GRIHA project and shall involve in the project from beginning to the end of project.

04.08.03.20.02 The bidder has to develop a Green building Design Document as per TERI-GRIHA evaluation procedure in conjunction with ECBC norms and latest National Building Code and submit the same for achieving star rating.

04.08.03.20.03 Climate responsive Architecture with integration of daylight and electric light, thermal comfort, ventilation and highest performance standards for work space efficiency.

04.08.03.20.04 Use of low embodied energy materials and local/reused materials and consideration of green building principles.

04.08.03.20.05 Preserve top soil during construction, maintain its fertility (during construction phase) and use that preserved top soil for landscape post-construction.

04.08.03.20.06 Contractor shall Submit soil fertility test reports of site's top soil from an ICAR (Indian Council of Agricultural Research)-accredited laboratory

04.08.03.20.07 Increase total number of trees on site by 25% above the pre-construction phase OR Plant 4 trees for every 1 tree cut of the same native/naturalized species

04.08.03.20.08 Reduce landscape water demand by at least 40% from the GRIHA base case.

04.08.03.20.09 Water and solid waste management with waste water recycling, water conservation and rain water harvesting.

04.08.03.20.10 Rainwater harvesting for managing the rainwater runoff from roof and ground surfaces.

04.08.03.20.11 Contractor shall Submit potable water quality, treated waste water and captured rainwater quality test reports from various sources before and after treatment (if required) - from an NABL accredited laboratory on the quality of potable water.

04.08.03.20.12 Development of surroundings with indigenous vegetation and plantation.

04.08.03.20.13 Use of energy efficient glass, cladding materials, wall appropriate to the use of the building. The ratio of glass to wall shall vary depending the direction and as required for THREE STAR GRIHA certification.

04.08.03.20.14 All the fenestration shall meet the SHGC requirement of ECBC – 2007/ weighted façade average SHGC (for each orientation) meets SHGC requirements of ECBC 2007. Preferred value for SHGC is 0.25.

04.08.03.20.15 Window to Wall Ratio (WWR) and Skylight Roof Ratio (SRR) shall not exceed 60% and 5% respectively

04.08.03.20.16 VLT shall meet the requirement of ECBC 2007.

04.08.03.20.17 The contractor shall use only those materials which conform to the GRIHA Rating System criteria & procured within 500 kms from project site.

04.08.03.20.18 The contractor shall maintain proper record of all the materials/

equipment procured w.r.t. their source & specifications with details of their manufacturing and recycled content etc. and submits along with all supporting documents to the Client.

04.08.03.20.19 The contractor is required to adhere to the various environment friendly and GRIHA compliant aspects of construction as well as documentation w.r.t. use of Materials, Manpower, Machinery and other relevant mandatory requirements.

04.08.03.20.20 All sanitary and plumbing fixtures shall be of low flow category and shall reduce water demand through selection of low-flow fixtures by 70% below the GRIHA base case. Supportive documents, calculations and photographs shall be submitted by the contractor.

04.08.03.20.21 Use of low emitting materials, adhesives and sealants to reduce/avoid use of materials, which are irritating and naturally cause health problems to the construction workmen and occupants.

04.08.03.20.22 Limits of Low VOC content (grams of of VOC per litre) for (Interior/Exterior coatings, wood polish, Adhesives etc.) should be within the prescribed limit of GRIHA v2015 and supportive documents shall have to be produced

04.08.03.20.23 All the insulation used in building shall be CFC/HCFC free

04.08.03.20.24 All the fire suppression system and fire extinguisher installed in the building shall be Halon free

04.08.03.20.25 Artificial lighting design to fall within limits (lower and higher range limits) as recommended space/task specific lighting levels as per NBC and to meet a minimum uniformity ratio of 0.4

04.08.03.20.26 Demonstrate that project can achieve the thermal comfort requirements# of NBC

04.08.03.20.27 The indoor noise levels should be within the acceptable limits as specified in NBC and key noise source on site (like DG sets etc.) should have sufficient acoustic insulation as per NBC 2005 norms

04.08.03.20.28 Minimum 40% composition of building blocks/bricks by fly ash by volume, for 100% load bearing and non-load bearing masonry walls. Documents supporting the statement shall have to be produce.

04.08.03.20.29 Certify minimum 25% replacement of Ordinary Portland Cement (OPC) with fly ash in plaster/masonry mortar.

04.08.03.20.30 Project demonstrates that at least 50% of all materials (calculated by surface area) used for building interiors meets the GRIHA criterion low-impact material requirements. Documents in support shall be required.

04.08.03.20.31 Equipment LED/TFL, Unitary / Split air conditioner, ceiling fans, Geysers, UPS, Solid state inverters shall be of minimum 3 star BEE rating or equivalent performance in all buildings. All Equipment provided shall be energy efficient, motors shall be IE-2 / 3 class.

04.08.03.20.32 Bidder to provide Continuous monitoring of CO, Co2, Temperature, and Relative humidity, and installing digital display at each floor level of Admin and control building.

04.08.03.20.33 Project shall comply with following basic metering requirements of GRIHA.

- For the regular monitoring of project's energy consumption, Mandatory Basic digital meters shall be installed at the following point of source:

Energy

- Utility Grid
- On-Site renewable energy system
- Diesel Genset/ Gas – Genset (If any)
- Each Building Level

Water

- Municipal Supply (If any)
- Bore Well
- Captured Rain Water

- Each Building

- Extended Metering shall also be done at the following points:

Sub-meters shall be installed at the following points to monitor energy and water consumption respectively.

Energy

- Distributed Units (Split/Window AC) (If any)
- Lighting (Indoor and Outdoor)
- UPS
- Lifts and common areas

Water

- Irrigation

- Ensure the installation of smart metering system (one-way or two-way communicable system) which is capable of tracking energy and water consumption through a web-hosted portal for all installed meters.

- Also ensure sharing of monthly energy and water consumption data of the project by connecting with the GRIHA Online Benchmarking platform for 5 years.

All Energy meters that are installed to be of at least class 1 with Class 1 CT's/PT's, and should have an active RS-485 port, with industry standard Modbus protocol with publicly available register maps.
All Water/BTU meters should have an RS 485/RS232 port with publicly available/industry standard Protocol (Modbus,etc.) and register maps
All meters/CT should be calibrated by an authorized certified auditor at least every 2 years.
The metering and monitoring hardware and software should support compliance with the relevant requirements of "IS/ISO 50001 - Energy Management Systems - Requirements with Guidance for Use.

04.08.03.20.34 Air & Water pollution control measures including but not limited to:

- Provision of at least 3 meter high barricading around the construction area.
- Wheel washing facility at the vehicular entrance of the site
- Covering of fine aggregate and excavated earth on site with plastic/geotextile sheets

- Water sprinkling on fine aggregate (sand) and excavated earth
- Diesel gensets on site must have proper chimneys with their outlet facing away from the site.

04.08.03.20.35 Adopt strategies to reduce water use during construction like:

- Using gunny bags for curing and using ponding for curing
- Monitoring to avoid leaks and water wastage
- Use of additives to reduce water requirements during curing iv. Use of treated waste water/captured storm water

04.08.03.20.36 Implement waste management practices during construction including but not limited to:

- Allocation of separate waste storage spaces
- Safe disposal of waste
- Hiring of waste haulers
- Provide infrastructure (multi-coloured dustbins/different garbage chutes) to building occupants to ensure segregation of waste at source
- Provide dedicated, segregated and hygienic storage spaces in the project site to store different wastes before treatment /recycling
- Provide contractual tie-ups with waste recyclers for safe recycling for recyclable wastes like metal, paper, plastic, glass etc. Submit document highlighting tie-up with recyclers for ensuring safe recycling of recyclable wastes

04.08.03.20.37 **Photographs** during various stages of construction shall be taken by contractor and submitted to the Client, showing details of specific requirements/ measures being taken by the contractor and of activities during construction for documentary compliance of GRIHA and record to the Client

04.08.03.20.38 **Operation and Maintenance:**

The contractor shall organize the training and orientation programme between system supplier and O&M group of the institute.

The systems supplier shall provide the training to the core facility/ service group responsible for the O&M of the building systems after installation, on the operating instructions/dos and don'ts/ maintenance requirements for the specific system, as per GRIHA requirements.

Development of a fully documented O&M manual/ CD/ Multimedia /information brochure enlisting the best practices for O&M of the building's systems as per GRIHA requirements.
Development of a fully documented O&M manual/ CD/ Multimedia /information brochure enlisting the best practices for O&M of the building's systems as per GRIHA requirements shall be required.

04.08.03.20.39 O&M protocol shall be should be submitted for:

- Transformers, DG, HT & LT panels
- Solar PV systems

04.08.03.21 DESIGN PHILOSOPHY

The Buildings have been designed to provide associated facilities meeting the needs and comfort of employee. Some significant concepts that have been incorporated while designing and planning are listed below:

04.08.03.21.01 Each unit has been designed in a way that the building will look complete in itself.

04.08.03.21.02 The units cater for different functional requirements of user with creative indoor spaces, surroundings, better circulation and flexibility in space planning.

04.08.03.21.03 Integrated designs of electrical, mechanical and other services with structural system which should be planned with optimum cost, low maintenance and lowest consumption of energy and water.

04.08.03.21.04 Smooth horizontal and vertical movement.

04.08.03.21.05 Natural light to all the rooms has been externally provided.

04.08.03.21.06 Firefighting and detection system

04.08.03.21.07 Energy efficient Building

04.08.03.21.08 Planning and allocation of services as per the National Building Code-2016 and applicable bye-laws

04.08.03.21.09 Provision of solar panels

04.08.03.21.10 Climate responsive Architecture with integration of daylight and electric light, thermal comfort, ventilation.

04.08.03.21.11 Consideration of green building principles.

04.08.03.21.12 VRV/VRF system of air-conditioning and other systems mentioned elsewhere in the specification.

04.08.03.21.13 Water and solid waste management with waste water recycling, water conservation and rain water harvesting.

04.08.03.21.14 Development of surroundings with site terrain consideration, traffic circulation, indigenous vegetation and plantation.

04.08.03.21.15 The proposed blocks to be built should be based on efficient construction technologies for fast track and ease in construction. The buildings shall be RCC framed construction.

04.08.03.21.16 The floor to floor height of each storey shall be kept as 4.2m for Administration Building & control room building& 3.6M for other buildings shall be derived as per guidelines/Standards.

04.08.03.21.17 Preliminary Architectural drawings of each building are attached with this tender document. This has been approved in-principle by the client for cost estimate (preliminary estimate) purpose to enable bidder to quote judiciously.

04.08.03.21.18 The buildings are designed as differently-abled persons friendly and shall be constructed as per the latest norms, notifications & guidelines of Govt. of India / State Govt. / Statutory bodies.

04.08.03.21.19 The guidelines & regulation issued by National Disaster Management Authority should also be incorporated in the design of building which broadly covers safety aspect; evacuation plan etc. and these features shall be provided accordingly. Necessary inspection or certification shall also be the responsibility of the contractor.

04.08.03.21.20 IP Telephone, Intercom System including wiring facility for highly complicated mechanical, electrical and telecommunications systems is to be provided after approval from CPWD/client department.

04.08.03.21.21 Internal light fitting and LED Lights of standard specification shall be provided.

04.08.03.21.22 All plumbing and sanitary lines shall be located on exposed outer face of the building preferably in the ducts and shall be covered with Aluminium louvers of approved design & make matching with elevation. Adequate structural support system and provision for maintenance of services shall also be provided.

04.08.03.21.23 The external façade of the buildings should be as per architectural drawings enclosed with this tender.

04.08.03.21.24 Sufficient number and appropriate locations of Fire exits are to be provided in the buildings as per the NBC'2016 and NDMA guidelines.

04.08.03.22 REQUIREMENTS AND DELIVERABLES

04.08.03.22.01 Prepare detailed working drawings on the basis of schedules and specification of materials and workmanship, in sufficient detail. The drawings & documents shall include detailed site plan, detailed drawings for each buildings including floor plans, elevations, door & window schedules, finishing schedules, wall profiles, Staircases, ramp and lift details, details of important building parts / areas, landscape & horticulture details etc. As far as possible standards of quality performance requirement and descriptive names shall be used rather than specific products or brand names.

Drawings shall be adequately detailed and shall contain enough information to enable construction, full measurement, pricing and production of bill for payment.

04.08.03.22.02 List of Submittals:

The contractor shall submit the following during the execution of the project:

ARCHITECTURE:

- Floor plans, fully coordinated with all services/disciplines
- Elevations
- Sections
- Wall profiles / Skin Sections
- Doors & Window Elevations and sectional details
- Stairs/Ramps/Lifts details
- Details of building parts, areas
- Toilet details
- Kitchen & Pantry details
- Flooring pattern and details
- Dado details
- Roof flow, drainage system including rain water harvesting system underground tank and over head water tank
- Detailed design and drawings of all types of furniture and layout drawings as per the requirement of the client
- Any other detail required by the engineer in charge
- Finishing schedule , elevation treatment, fixtures, colour scheme of all buildings as approved by client / consultant.
- All furniture /equipments/fixtures/fittings for all buildings including rooms, labs, workshops, kitchens, lecture rooms, etc.
- Interior detail drawings including interiors treatments including 3D views
- Art work
- All drawings for approval from local authorities
- As-built drawings

SITE DEVELOPMENT:

- Site Development & Layout Plan
- Blow up of road junction / parking area and other such area as required. Longitudinal & cross section) for roads/ footpaths/ parking areas etc.
- Coordinated External services
- Landscape of areas around the buildings including garden light, façade lighting etc.
- Drawings of landscape blow up of critical areas / landscapes / plantscapes in detailed coordination with all external services
- Horticulture details
- Signage details

04.08.03.22.03 Any other details required for completion of the buildings/services.

04.08.03.22.04 All approved deviations and changes in drawings shall be recorded.

04.08.03.22.05 Inspect the works and attend meetings during execution to give clarifications, if any, and to modify the drawings as per the site/construction requirements.

04.08.03.22.06 Drawings are to be submitted in the scale mentioned below:

1	Site Plan & Landscape Drawings	Suitable Scale (Jointly agreed)
2	Floors + Roof Plans	1:100 scale
3	Elevations	1:100 scale
4	Sections	1:100 scale
5	Part Sections & Details, Schedule & Detail of Doors, Windows & Finishes, Toilet Details, Kitchen Details, Staircase/ Ramp/ Lift Details,	1:50, 1:25,1:10 or any other suitable scale (jointly agreed)

04.08.03.23 SCOPE OF SUPPLY

Contractor shall procure & supply to site all the materials including cement, reinforcing steel, steel sections/plates other masonry materials, admixtures & bonding agents, sealants, sand, etc. and any other construction material / item required to complete the civil works.

All costs towards testing/inspection of materials/goods shall be borne by the Contractor. No materials/items shall be supplied by the Owner.

04.08.03.24 SITE WORK

Complete construction work including supply of labour, construction materials, construction equipment, survey, tools & tackles, dismantling & modification/strengthening, supervision, testing etc. required to complete all the structures, foundations, finishes, steel inserts, painting, including site grading/earthwork in cutting & filling etc. as specified/applicable and required to complete the civil works in all respect.

04.08.03.25 SITE RECORDS

All works shall be recorded in appropriate Performa to be firmed up by the contractor in consultation with the Consultant. Where ever required reference to drawings and clauses of specification shall be recorded in the correspondence.

Records of cement and steel receipts, issue, and consumption shall be scrutinized from time to time by consultants and Owner. Statement of cement and steel receipts, statement of theoretical consumption and reconciliation accompany every bill. Records of spot levels jointly recorded before the start of the work shall form the basis of all measurements.

04.08.03.26 APPROVAL AND TESTS

A high standard of quality is required for all materials and workmanship in construction work. They shall be best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and timely supply.

All materials shall be subjected to inspection and testing. The Contractor shall submit samples for testing as may be required by the Consultant. Sampling and testing shall be carried out in accordance with relevant IS Standards.

Wherever IS codes are referred, they shall be latest edition/ publication as on date irrespective of the date of finalisation of the work.

04.08.03.27 REJECTION OF MATERIALS

Any material brought to site which, in the opinion of the Consultant is damaged, contaminated, deteriorated or does not comply with the requirement of this specification shall be rejected.

If the routine tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification or of IS codes as applicable, then that material shall be rejected.

The Contractor at his own cost shall remove from site any and all such rejected material within the time specified by the Consultant.

All enabling works e.g. construction water tank, fabrication yard, electricity, site stores & office, safety and security measures, coordination with other contractors working at site etc. shall be Contractor's responsibility.

Special permits to such as 'Hot Permit", "Fire Safety Permit" to work at project site, if required, shall be contractor's responsibility.)

04.08.03.28 GENERAL ARCHITECTURAL CONSIDERATIONS

04.08.03.28.01 FINISHING

The surfaces of brick work, RCC, CC etc. shall be treated and finished with Cement Plaster. The use of PP Cement shall be preferred or OPC with minimum 30% replacement with BIS-recommended waste by weight of cement shall be used. The cement plaster shall be provided as under:

- Internal wall faces: 12mm thickness (minimum) cement plaster
- External wall faces: 15mm thickness (minimum) cement plaster
- Ceiling and RCC works: 6mm thickness (minimum) cement plaster. In respect of RCC works, in continuation with the brick / fly ash work, plastering as per brick/fly ash work shall be continued over RCC works.
- The junction of RCC work and brick / fly ash walls shall be covered with 24 gauge chicken wire mesh fixed with screws/washers to avoid cracks in plaster work.
- Water proofing material in cement plaster work shall be mixed in proportion recommended by the manufacturers.
- The trenches / open drains: 15mm plaster finished with cement plaster 1:4 (1 cement: 4 fine sand) with floating coat of neat cement & adding of Water proof compound.
- Provide drip course/ groove in plastered surface or moulding to R.C.C. projections.

04.08.03.28.02 PAINTING

The plastered surfaces shall be finished as per the finishing schedule/ BOQ. This shall include Antibacterial Paint/textures paint and other paints as per finishing schedule. The ceiling area below where false ceiling is carried out shall be finished with white wash coat(s) as per requirement. The false ceiling, as required, shall also be finished as per the finishing schedule appended to the tender document.

All interior wall and ceiling finishes such as primers, paints, putty, etc. shall have low VOC content as per GRIHA norms and shall be lead free. Painting on doors, windows, Grills, MS work, structural steel, rolling shutters, railing and other members requiring painting and polishing etc., wherever required, shall be treated with primer coat and finished with painting/polishing of approved shade and manufacture, as per CPWD Specifications, to meet the functional requirements.

- All paint work on concrete and plaster surfaces shall include application of white cement based putty as base preparation, application of primer in compatibility with the

respective type of paint and painting with 2 or more coats of paint as per technical specifications.

- All paint work on structural components (excluding Stainless steel) shall include application of primer in compatibility with the respective type of paint and painting with 2 or more coats of paint as per technical specifications.
- The soffits of all projections, jambs, parapet walls terrace (in side) shall be finished with premium acrylic smooth exterior paint with silicone additives of approved shade and make.
- The wood work shall be painted / polished (melamine finish) as per requirements.
- All paints shall be Eco friendly paint with low Volatile Organic Compounds (not exceeding 50 g/L) of approved shade & make.
- For painting on steel work and ferrous metals, BS: 5493 and IS: 1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.
- For painting on wood work IS: 2338 shall be followed.
- Bitumen primer used in acid/alkali resistant treatment shall conform to IS: 158.

04.08.03.28.03 EXTERNAL FAÇADE TREATMENT

- Granite & Zinc cladding panels over aluminium framework at required locations as specified

- Texture paint - Weathercoat exterior Primer + High quality acrylic modified resin based TEXTURE PAINT of Dholpur/Red sand stone Pattern + top coating with Premium Acrylic Smooth exterior paint with Silicone additive.

- External Weather Protective Premium Acrylic Emulsion Paint over weathercoat primer on plastered surfaces. All exterior coatings shall have VOC content as per GRIHA norms.

- Aluminium louvers.

- ACP cladding at required locations.

04.08.03.28.04 RAILING AND GRILL WORK

- The open drains / channels in the machine room / plant room/cable trench shall be covered with the MS grill.

Railing:

- Stainless Steel railing shall be provided in staircases, front steps, front ramps and other locations etc. as specified in the finishing schedule, SS of Grade 304 made of Hollow tubes, channels, plates etc. in satin matt finish as per approved design.

04.08.03.28.05 FLOORING

- The flooring shall be as per the finishing schedules, BOQ, or as specified
- In order to keep the floor finish as per Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting. Alternatively, for maintaining the floor finish, grading with cement concrete with nominal mix 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 10mm nominal size) shall be provided.
- Protective layer to be provided for all types of flooring, during construction.
- The edges of steps in the staircases, counters, kitchen platform, window sills, facias and similar location shall be edge moulded as required. Staircase Tread should have Anti- Skid Grooves.
- The types of flooring shall be as per finishing schedule.
- All tiles shall be fixed using cement based high polymer modified quick set tile adhesive (water based) conforming to IS: 15477, using 5 kg adhesive per sq.m. of tile area with epoxy , in avg. 3mm thickness. The VOC of adhesives shall be less than 65 g/l as per GRIHA norms.
- The flooring work shall be carried out as per CPWD specification.
- The types of flooring as under:
- Concrete Flooring 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate) finished with a floating coat of neat cement
- Concrete Flooring with hardener
- Polished Kota Stone Flooring – 25 mm thick over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand).
- Polished Granite Flooring - 18mm thick gang saw cut mirror polished premoulded and prepolished) machine cut with joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, edge moulding and polishing to edge to give high

gloss finish.

- Vitrified Tile (Double Charged) Flooring of size 600mm X 600mm and thickness minimum 9mm conforming to IS:15622. Antiskid Ceramic Tile Flooring of size 300mm X 300mm with a recycle content of 35-55% of Group - IV classification, conforming to IS:13754.
- Fully vitrified unglazed porcelain tile (tac liner or tac button) size 300x300, 15mm thickness (Tile body 10mm thick plus profile 4.5mm thick) on ramps.
- Skirting/Dado
- Skirting in respect of above shall be of the same material and specifications and the height as specified.
- The dado work in the toilets/washroom/kitchen/pantry or as specified shall be with glazed/ digital ceramic wall tiles of size 300mm X 600mm and of height as specified with a recycle content of 35-55% of Group - IV classification, conforming to IS:13754.

04.08.03.28.06 DOOR & WINDOWS

The doors and windows shall be provided as per the requirements indicated in the finishing schedules and CPWD specifications. The various types of Doors and Windows shall be as under:

- **Wooden**

Flush doors with wooden frame: Laminated (factory Pressed), veneered, commercial ISI marked flush door shutters conforming to IS : 2202 (Part I) decorative type, core of block board construction with frame of 1st class hard wood and well matched teak 3 ply veneering with vertical grains or cross bands and face veneers on both faces of shutters.35 mm thick including ISI marked Stainless Steel butt hinges with necessary screws as per CPWD specification.

Flush doors with MS frame: Laminated (factory Pressed), veneered, commercial ISI marked flush door shutters conforming to IS : 2202 (Part I) decorative type, with pressed steel door frames conforming to IS: 4351, manufactured from commercial mild steel sheet of 1.60 mm thickness, including hinges, jamb, lock jamb, bead and if required angle threshold, as per CPWD specification.

Hardware: All hardware for doors and windows shall be of stainless steel or as specified.

- **Aluminum Works**

Doors, and partitions with Powder coated aluminum extruded built up standard tubular sections/ appropriate Z sections/built up sections and/or other sections with minimum thickness of powder coating 50 micron of approved make conforming to IS: 733 and IS: 1285 as per CPWD specification. Colour powder coating shall be minimum 50 microns. Aluminum extrusions shall be made from minimum 3mm thick (or as specified) heavy sections from environmentally compatible products containing minimum of 15 to 25 % of recycled content and shall be manufactured within 500 kms from project site as per GRIHA norms. A coat of bitumastic paint shall be done on the aluminium surfaces in contact with masonry / concrete and closing the gaps around the frame and the adjoining surface with approved silicone sealant with volatile organic compounds content less than 250 g/l on both faces to achieve watertightness. All fitting shall be of matching colour powder coated aluminium sections.

Hardware: All hardware for doors shall be of Powder coated aluminum matching with colour of aluminium sections. All hardware like heavy duty stainless steel butt hinges, pivots, approved door and windows handles, EPDM Gasket, PVC/Neoprene Gasket Lining, Stainless steel screws, mastic filling, weather strips, tower bolts,nuts, washers, rollers etc. shall be approved by EIC.

- **MS Works**

Doors frame: Powder coated Pressed Steel Door Frame (Mild Steel Sheet 1.6 mm thick) conforming to IS: 4351, manufactured from commercial mild steel sheet of 1.60 mm thickness, including hinges, jamb, lock jamb, bead and if required angle threshold, as per CPWD specification.

Windows: Powder coated Pressed Steel Frame (Mild Steel Sheet 1.6 mm thick) double rebate frame with 1 glass shutter and 1 mosquito net (SS wire gauge) shutter and MS grill in between.

Frame of 40x40x6mm angle iron and 1 mm thick MS sheet shutter with style & rails mumty room.

Hardware: All hardware for doors and windows shall be Powder coated MS or as specified.

M.S. Grill fabricated from MS flats, square or round bars etc. including priming coat with approved steel primer.

- **uPVC Windows**

uPVC 3 track sliding glazed windows (DGU) with toughened glass with minimum 6 mm thickness (As/GRIHA recommendation), with mosquito net (SS wire gauge) shutter and MS grill.

- **PVC Door**

30 mm thick door shutter made of solid PVC foam profile and PVC door frame with all necessary hardware.

- **Frameless toughened glass door**

12mm thick toughened frameless glass doors shall be provided with patch fittings and other hardware.

- **Rolling Shutter (Powder Coated)**

With mechanical operation system
With MS grill / without MS grill as required

- **Fire Check doors**

Fire Check doors of 120 minutes fire rating confirming to BS : 476 part 22 & IS : 3614 Part II . These doors shall be provided at all fire exit points, firefighting shafts, Service Duct and shafts. The fire doors shall be of Metal (M.S.), as specified. The fittings such as Mortise Lock, Flush Bolts, Automatic Door Closer, Pull Handle, Fire Rated Panic exit device shall also be of 120 minutes fire rating. Smoke Seals, Acoustic Seals shall also be provided.

- **Structural Glazing**

Designing, fabricating, testing, protection, installing and fixing in position semi (grid) unitized system of structural glazing at locations specified in drawings as per BOQ.

04.08.03.28.07 FALSE CEILING

The types of false ceiling shall be as per finishing schedule/ BOQ. However, these are brief as under:

- False ceiling with Light Weight Calcium Silicate False Ceiling Tiles
- False ceiling with Mineral Fiber Board Tiles
- Metal false ceiling
- False ceiling with gypsum board

04.08.03.28.08 PARTITIONS & PANELING

Wooden partitions and paneling shall be provided as per drawings and BOQ. The type of paneling shall be Acoustical wall paneling.

04.08.03.28.09 ROOF AND DRAINAGE

Roof drainage system will be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The roof gradient for the roof will not be less than 1 in 100. Roof System will be designed to handle design requirements for the specific site and will be in accordance to stipulations of IS:1742 and IS:2527. Roof drains will conduct water to storm drains through uPVC down take pipes. UPVC Rain water conform to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion Single socketed pipes.

04.08.03.28.10 WATERPROOFING

All exposed RCC roofs shall have waterproofing treatment of acrylic base flexible liquid applied Waterproof cum Insulation Membrane. The surface shall then be finished with crazy ceramic tiles.

04.08.03.29 TECHNICAL SPECIFICATION

04.08.03.29.01 REFERENCE

- The technical specification of ***CPWD SPECIFICATION 2018, VOLUME I & II*** would be applicable and referred.

04.08.03.29.02 GENERAL

- Samples and makes of each item shall be prepared for approval of client / consultant before commencement of work.

- The contractor shall prepare all the needed shop drawings /sample well in advance and get them approved before placing the order and execution of the item.

- Sequence of execution for work shall be suggested by the contractor for approval of client / consultant.

04.08.03.29.03 PARTICULAR SPECIFICATION

- **ZINC CLADDING**

Zinc Cladding system comprising of 0.8 mm Zinc sheet of Pre Patina Graphite Grey, to be fixed by Shiplap system/Proposed by consultants from the standard systems on Aluminium angle (vertical and horizontal support) with Aluminium runner, Screws, brackets and fixed on to M.S. Structure. Purlins as required to be provided on the MS Framework at a certain distance to be informed as per the fixing details. Provide exterior sealant with Dow Corning DC 789 /GE with all approved standard accessories and hardware. The material must be 100 % natural and recyclable with supporting certifications. No pigmentation can be used in the zinc for obtaining colours. The material must meet EN 998 criteria with TUV certifications. The contractor will design the system as per the prevalent site conditions and building elevation profiles. The system shall be designed to withstand a wind pressure not less than as specified by consultant. The system shall have insualtion material of 50mm with layered GI sheets in betwen top and bottom. There shall be a mesh below the sheets with heat reflecting membrane, Aluminium extrusions thickness shall not less than 2 mm & Shall be confirming to Alloy 6063-T5/T6. All screws used shall be only stainless steel of 304 grade and All Nuts, Bolts and washers & anchors shall be only stainless steel of 316 grade. Hilti /Fischer Make anchor.

Thickness: Coating thickness shall be minimum 80 µm and determined by TAIM standards.

No cracking/ flacking/blistering/chalking for minimum period of 5 Years shall be guaranteed. Humidity Resistance as per ISO & Salt Spray Test shall be as per ASTM shall be provided. The factory assembled louver fins of 165mm projection as per the length & 70mm width shall be fixed mechanically to the installation frame of Aluminium/MS provided by others in a module of 300mm C/C in varying length as per the site requirement to a maximum of 4mtrs.

04.09 GENERAL LAYOUT & TRANSPORTATION and FIRE PROTECTION SYSTEM:

04.09.01 GENERAL LAYOUT & TRANSPORTATION

04.09.01.01 INTRODUCTION

A compressor station comprising compressors and other auxiliary units is being set up at Barpalaha near Guwahati which will be used for compression of incoming natural gas for further transportation to Numaligarh refinery. The general layout of the proposed station will be developed keeping in the view the following factors.

- Most efficient use of land taking into consideration its shape and profile
- Smooth and uninterrupted flow of materials in accordance with the technological requirements
- Optimum lead for transport of material and for services lines
- Predominant wind direction
- Safety clearances and statutory provisions.

Hydrocarbon processing and handling plants are inherently hazardous. Today's trend of large and complex plants presents substantial risk potential. At times plants are modified to operate at higher capacities or efficiencies necessitating larger storage requirements than contemplated earlier. For these reasons, initial site analysis for the proposed new construction or addition should be done carefully while considering the space allocation to the various facilities. The Plant layout shall be designed as per OISD-226 & OISD-118.

04.09.01.02 PLANT LAYOUT PHILOSOPHY

Following philosophy should be adopted in layout of this installation;

a) Plant layout arrangement should follow the general route of raw material to process unit(s) as required. The entire area should be sub-divided into blocks.

b) Pedestrian pathways should be provided / marked alongside the primary traffic roads.

c) Alternative access shall be provided for each facility so that it can be approached for fire- fighting in the event of blockage on one route.

d) Road widths, gradient and turning radii at road junctions shall be designed to facilitate movement of the largest fire-fighting vehicle in the event of emergency.

e) Layout of the facilities shall be made to minimize truck traffic ingress in the plant.

f) Two road approaches from the highway / major road should be provided, one for employees and other for product / material movement. Both these approaches should be available for receipt of assistance in emergency.

g) Presence of ignition source shall always be contemplated at a sufficient distance from boundary wall of the installation.

h) Orientation of flares, furnaces & heaters, dusty operations (e.g. sulphur handling etc) and cooling towers should be decided based on prevailing wind direction to avoid travel of hydrocarbon vapour over sources of ignition.

i) Erection methods shall be studied for all types of equipment / structures. Towers, reactors, fired equipment etc should be located in such an area so to facilitate erection.

j) Maintenance requirements for each type of equipment shall be identified and considered.

k) For construction activities, area should be earmarked.

l) Future expansion should be assessed and space provision be made accordingly.

m) Suitable access/Approach of Paver Block/PCC shall be provided to each facility/unit from Main Road.

04.09.01.03 LAYOUT OF BLOCKS / FACILITIES

While preparing Plant layout, following aspects, as applicable shall be adhered to:

- Process units, utility requirements, storage tanks, and other pressurized storage vessels
- Product receipt / dispatch and mode of transport (rail, road and pipeline)
- Warehouses, storage areas for solid products such as petroleum coke, petroleum wax, sulfur, bitumen / asphalt etc and other open storage areas like scrap yards and dumping ground
- Chemical / Toxic chemicals storage, hazardous waste storage / disposal.
- Flares
- Service buildings, fire station and fire training ground
- Site topography including elevation, slope, and drainage
- Meteorological data,

- Seismic data
- Highest flood level in the area, water table, natural streams/ canals
- Approach roads to main plant areas
- Aviation considerations
- Risk to and from adjacent facilities
- Environmental considerations
- Statutory obligations

Note: An indicative plant layout is attached. The bidder shall develop the general layout drawing during the detail engineering.

General consideration for the layout of blocks / facilities

While locating the various facilities / blocks, the following should be considered:

(a) Layout of Blocks / facilities should be in sequential order of process flow.

(b) Process unit(s), solid storage, utilities, Effluent Treatment Plant (ETP) and approach roads should be located on high ground to avoid flooding.

(c) In case process units are operated in an integrated way and shutdowns are taken simultaneously, then it may be considered as a single block.

(d) Control room should be located in a non-hazardous area upwind of process plants / hydrocarbon storage and handling facilities. It shall not be located on a lower level than surrounding plants. There shall be no structure that would fall on the control room in case of a blast.

(e) Utility block(s) should preferably be located adjacent to unit blocks.

(f) Power generation facilities which also supply steam for process requirement should be located near the process unit block. When external power grid is interconnected with plant power generation facilities, either the power plant should be located at the side of the boundary wall or the external power transmission lines should be taken underground upto interconnection grid.

(g) Overhead power transmission lines shall not pass over the installation including the parking areas. Horizontal clearance shall be in line with the Indian Electricity Rules.

(h) High Tension (HT) sub-station(s) should be located close to major load centers.

(i) Low Tension (LT) sub-station should be located at load centers in such a way that the distance between distribution transformer and farthest motor is minimum.

(j) Cooling Towers should be located downwind of process equipment and substation so that fog developed will not cause corrosion or obstruct vision or short-circuiting.

(k) Separate collection system should be provided for different types of waste generated in the process plant such as oily water, caustic, acid effluents, fecal etc. Effluent Treatment Plant should be located minimum one block away from process unit area, downwind of process units and important areas considering odour & emission of volatile organic compound. This should be closer to disposal point by the side of the boundary and at lower grade to facilitate gravity flow of effluent.

(l) Flare should be located upwind of process units and the area around flare should be paved. For more details OISD-STD-106 on "Process Design and Operating Philosophies on Relief and Disposal systems" shall be referred.

(m) Main pipe racks / pipe track shall not be routed through process units. Overhead clearance for vehicles over roadways and railroads shall be provided (minimum 6m).

(n) Roads should be provided in a symmetric manner to serve all process areas requiring access for the operation, maintenance and firefighting. These roads should encircle the process blocks/ process units.

(o) Smoking booths should not be provided in the hydrocarbon industry. However, if required, these shall be located at minimum distance of 60 meters from any hydrocarbon source.

(p) Fire station, firewater storage & firewater pump house shall be located at a safe place away from hazardous areas. Fire station should be upwind of process units and hydrocarbon storage area with straight approach to process units / other critical areas.

04.09.01.04 LAYOUT OF PROCESS UNITS:

Equipment in process unit can be arranged in many ways. Safety, economy, operability, and ease of maintenance should be considered in locating each item within the unit. Adequate spacing between equipment will help in minimizing the spread of fire. Consideration should be given to access for firefighting.

(a) Process flow sequence and operating procedures should be thoroughly understood so that equipment arrangement in the plot plan is functional. Equipment should be arranged in logistic process sequence for optimum piping runs and operational and maintenance ease. Spacing between equipment shall be adequate for undertaking maintenance jobs.

(b) The unit pipe rack should be kept in the center, thereby splitting the unit into two or more areas of equipment. Pumps may be arranged in two rows close to and on either side of the pipe rack. Heat Exchangers and vessels should be grouped together forming outer rows on both sides of the rack.

(c) Heat exchangers should be located perpendicular to the pipe rack on the outer row to facilitate pulling of tube bundles with mobile crane or by other means. Shell and tube heat exchanger should have a longitudinal clearance of at least one-meter plus the length of removable bundles.

(d) Air fin coolers should be installed above the pipe rack / technological structures / independent structure.

(e) Vessels having large liquid hold-up should be installed at lower heights and preferably at grade. Adequate drainage should be provided around such vessels. Where process requirement dictates their installation above grade, these should be located in open area.

(f) Towers / columns should be located along the pipe rack towards open areas for unobstructed erection as well as maintenance of internals at grade. Tall towers requiring frequent operating attention at upper levels may be located at one place so that common connecting platform can be provided.

(l) Gas compressors should be located downwind from heaters so that leaked gases will not drift towards the heater. Gas compressors should have roofing and open from sides to avoid accumulation of heavier vapors/gases on the floor of compressor house. Compressor house should be located near the battery limits to facilitate ease in maintenance and operation. Drop out area should be provided for maintenance.

(p) Flare knock out drum for the process units should be located at battery limit of the unit.

(q) Blow down facilities / buried drum should be located at one corner of the plant farthest from furnace or any fired equipment and on the lee-ward side of the unit.

Vent from Blow down facility shall be minimum 6m above the highest equipment falling with in radius of 15 m from the vent stack.

(r) Operator's cabin may be provided in the process unit. The cabin should be located upwind side of the unit in non-hazardous area and away from draining / sampling facilities. The cabin should be for minimum occupancy of the shift operators of the respective facilities only.

(s) Stairways should be provided for the main access.

(t) Minimum headroom under vessels, pipes, cable racks, etc should be 2.1 meters.

(u) Equipment should be spaced to permit use of mobile equipment and power tools or servicing and maintaining equipment during turn around periods

Equipment spacing with in process units;

Minimum separation distances between various equipment within process units shall be as per Table-2 of OISD-118 & Table-III of OISD-226.

04.09.01.05 OVEREALL LAYOUT

The compressor station should be located considering following aspects:

(i) "Functional and pipeline hydraulic requirements".
(ii) Environmental consideration based on Environmental Impact Assessment (EIA) and Risk Analysis (RA) study for the pipeline and stations.
(iii) The HAZOP and risk analysis.
(iv) The availability of space for future augmentation of facilities.
(v) Approachability, water table and flood level and natural drainage.
(vi) Availability of electric power
In addition to above, compressor station should be located at such clear distances from adjacent property not under control of the pipeline owner / operator so as to minimize the hazard of communication of fire to the compressor station from structures on adjacent property.

The following aspects shall be considered while establishing station layout
i. Station equipment and their specification.
ii. P&I diagram for the station.
iii. Utility requirement.
iv. Flaring / cold venting requirements
v. Operation & maintenance philosophy of station equipment.
vi. Fire station & allied facility wherever required.
vii. Proximity to overhead power lines. Overhead power lines should not be allowed directly above station equipment / buildings.

viii. HT Pole structure, Transformers, Breaker and MCC room etc to be located in nonhazardous area.
ix. Requirement of space and access around the compressor shed / building and other equipment to permit the free movement of firefighting equipment.

04.09.01.06 SEPERATION DISTANCES

Inter-distances between various station facilities and utilities shall be as per OISD-226, ANNEXURE - III.

04.09.01.07 PROTECTION OF FACILITIES

Properly laid out roads around various facilities shall be provided within the installation area for smooth access of fire tenders etc. in case of emergency.

The boundary wall for the plant will be at least 3 M high with 0.6 M barbed wire on top (Construction of Boundary wall is not in the scope of Bidder). The contractor shall plan the General Layout accordingly.

Emergency exit with proper gate shall be provided in the earmarked zone wherever required.

The Preliminary General Layout for the Compressor station is attached with the Specification. Improvement of this may be carried out by the contractor in line with applicable codes & standards after prior Approval from MECON/IGGL.

04.09.02 FIRE PROTECTION SYSTEM:

04.09.01.01 INTRODUCTION

Compressor Station for Cross- country Pipeline consist natural gas compressor and its associated facilities besides other utilities besides in very compact area. When an accident occurs, it may develop into serious disaster with potential fire hazard. Therefore, it is of utmost importance that adequate fire protection measures should be provided for the

protection of life and property. The reciprocating compressors driven by electric motors form the backbone of each compressor station.

The entire system shall be designed as per the applicable national and international codes and engineering standards prevailing at the point of time, namely, OISD 226/116/117, API, ASME, ANSI, B31.3/16.5/16.29, etc. Other safety features namely, control system, interlocks etc., for safe operation as per good practice.

Fire Water Systems at the compressor station shall be designed as per OISD:226 and PNGRB guidelines. Any item, clause, equipment not specifically mention in this specification, but required as per OISD & PNGRB standards shall be considered to be included in the scope of Bidder.

04.09.01.02 SCOPE OF WORK

The work tendered in this package consists of Design, Supply, Installation, Testing and commissioning of Fire Protection system at IGGL Compressor station including Fire Water Pumps, Fire Water Tanks, MVWS System, HVWS system, Fire water piping network, Hydrants & monitors, Clean Agent system for Control Room Building, Fire Detection & Alarm System, Portable Fire Extinguishers, First Aid & Safety Equipment including all Associated Mechanical, Civil, Electrical, Structural & Instrumentation works.

The work being tendered is covered as indicated below:

	Fire Protection System at IGGL Compressor Station.	- Design , Supply, erection, testing & commissioning of aboveground/underground fire water piping network including valves, flanges & fittings, hydrants, monitors etc, internal coating of firewater pipes including all associated civil works, culverts, hume-pipes, supports, access platforms for hydrants, monitors, Deluge valves etc. - Design , Supply, erection, testing & commissioning of Main Fire Water Pumps (Diesel Engine Driven) & Jockey pumps, panels etc. including Civil, structural, Electrical & Instrumentation Works.

	Fire Protection System at IGGL Compressor Station.	- Design, Supply, Erection, Testing & Commissioning of medium velocity water spray system including Deluge Valves, spray nozzles, DV Panel and integration with water spray system, QBD, LEL Detectors etc. including all associated Civil, Electrical & Instrumentation Works. - Design, Supply, Erection, Testing & Commissioning of High velocity water spray system including Deluge Valves, spray nozzles, DV Panel and integration with water spray system, QBD, LEL Detectors, Linear heat sensing cables etc. including all associated Civil, Electrical & Instrumentation Works. - Design, Supply, Erection, Testing & Commissioning of fire water aboveground steel tank including all associated civil works. - Design, Supply, Erection, Testing & Commissioning of Clean Agent Fire Suppression system (Inert Gas , IG-541) for Control room building as per NFPA-2001, Latest edition. - Design, Supply, Erection, Testing & Commissioning of Fire Detection & Alarm system for Control Room Building , Admin Building, Workshop, Store, Canteen, Switch Gear Room as per NFPA, OISD & PNGRB Guidelines consisting of Fire Alarm Panels, Repeater panels, smoke detectors, Manual call points, Linear heat sensing cables for cable trenches etc. - Design, Supply, Erection, Testing & Commissioning of Fire Detection & Alarm System consisting of Manual call points etc at strategic operating locations in Plant. - Electric operated fire sirens with audible range of 1 km. Provision shall be made for continuous availability of power to this system during emergency shutdown. - Manual operated fire sirens shall be provided at strategic places. - Wet risers with landing valve, sprinkler system, hose reel, fire hose etc. as per norms & applicable code.

	Fire Protection System at IGGL Compressor Station.	- Portable Fire Extinguishers, First Aid & Safety Equipment as per OISD-226 & OISD-118 Guidelines. - Civil & structural works viz. pedestals, crossovers, monorail, Deluge valve houses etc. including supply of all materials. - Pressure Transmitters (3 Nos. minimum) for Fire Water Networks including associated cabling & Accessories. - Level Transmitters (one No. for Each fire Water Tank) along with associated cabling & accessories. - Pressure Gauges (Glycerin Filled) as per requirement at pump house, manifold & fire water ring main at prominent locations. - Pressure Safety Valve (2 nos.) in fire water ring main. - Design, supply, inspection, Testing of Foam cum Water Tender (Qty=1 No). However, Fire Tender house shall be designed to accommodate 3 Nos. Vehicles (FTV/ERV/EMV)

04.09.01.03 SYSTEM DESIGN

- The Fire water network shall be designed for 120% of Design Flow rate as per OISD Guidelines. Hydraulic analysis of Proposed Fire water network shall be carried out.

- Fire water system shall be designed to fight two major fires simultaneously anywhere in the installation.

- The fire water pumping requirement for medium velocity spray shall be calculated based on the spray rate given below or flow through two (2) nos. of fire water monitors (i.e.288 m3/hr) whichever is higher. Entire compressor area, Pig launching and receiving area, filter area, metering area and condensate collection area shall be covered with medium velocity water spray system.

- Spray rate for various areas shall be:-

a. Compressor area: 20.4 lpm/ m2 considering area based on outer foundation volume measurements (length x breadth)
b. Scraper area / Metering area /I filter area: 10.2 lpm/ m2 of area.
c. Other area: 3 lpm/m2 of area.

Note: The Pig Launcher & Receiver Area/metering & filtration system is not in the scope of bidder, However, the Fire protection system of Entire plant including pig launcher & receiver, Metering & Filtration area etc is in the scope of Bidder.

- The Fire water pressure system shall be designed for a minimum residual pressure of 7.0 kg /cm2 (g).
- A fire water ring main shall be provided all around perimeter of the compressor and delivery stations facilities with hydrants / monitors.
- There shall be minimum two (2) numbers of monitors located in such a way that it covers the compressors area, scrapper area and filter area. Fire hydrant network shall be in closed loops to ensure multidirectional flow in the system. Isolation valves shall be provided where the length of the pipe section is more than 300 mtr.

Fire Water Storage

Water requirement for firefighting shall be met through water storage tanks of steel construction. The effective capacity of the tanks above the level of suction point shall be minimum 4 hrs aggregate capacity of the pumps.

Fire Water Pumps

(i) Centrifugal fire water pumps shall be installed to meet the designed fire water flow rate and head. Pump shall have flooded suction.
(ii) Motor driven Jockey pump (not more than 10 M3 / Hr of water flow) shall be installed to maintain the fire network pressure at 7.0 Kg/Cm2 at farthest end of the network.
(iii) The fire water pumps including the stand by pumps shall be diesel driven.
(iv) A minimum of 50% stand by pump(s) (minimum one no) of the same type, capacity and head as the main pumps shall be provided.

(v) The fire water pumps shall be provided with automatic starting facilities.
The pump suction piping shall have Gate Valve, T/Y Type strainer, Pressure Gauge whereas the pump Delivery piping shall include gate isolation valve, Check Valve & Pressure gauge.

Fire Hydrant Network

The Fire Hydrant system shall be designed considering the following criteria.

(i) Fire water ring main shall be sized for 120% of the design water flow rate. Velocity of the water shall not exceed more than 5 m/s in the fire water ring main. In case of sea water service, the fire water main pipes shall be concrete / mortar lined internally or thermoplastic material.
(ii) Fire water steel pipe ring main shall be laid above ground at a height of 300 mm to 400 mm above finished ground level. Pipes made of composite material shall be laid underground.
(iii) The mains shall be supported at regular intervals not exceeding 6 mtrs. For pipeline size less than 150 mm diameter, support interval shall not be more than 3 m.
(iv) The steel pipe ring main shall be laid underground at the following places :
(a) Road crossings
(b) Where above ground piping is likely to cause obstruction to operation, vehicle movement and likely to get mechanical damage.
(v) Underground fire water mains shall have at least 1 mtr earth cushion in open ground and 1.5 mtrs under roads with concrete / steel encashment.
(vi) The underground fire water steel pipe network shall be provided with suitable coating / wrapping or concrete / masonry.
(vii) Double headed hydrants with two separate landing valves on 3" / 4" standpost shall be used. All hydrant outlets shall be 1.2 mtr above ground level.
(viii)Fire water monitors shall be provided with independent isolation valves.
(ix) Hose Box with 2 Nos. of hoses and a nozzle shall be provided at each hydrant points.
(x) The deluge valve shall be located at 15 mtrs. from the risk being protected. A fire wall shall be provided for the protection of the deluge valve and for operating personnel.
(xi) Fire Hydrants/ monitors shall be located at a minimum distance of 15 mtrs from the hazardous facility / equipment. Case of buildings this distance shall not be less than 2 mtr

and not more than 15 mtr from the face of building. Provisions of hydrants within the building shall be provided in accordance with IS: 3844.
(xii) At least one hydrant post shall be provided for every 30 mtr of external wall measurement or perimeter of the battery limit. Monitors shall be placed at 45 mtr interval.

Gate Valves shall be used in for isolation purpose in Fire Water network ring main. The Fire Water pipeline shall be internally coated as per attached Data sheet / Specifications.

Medium Velocity Sprinkler System

To meet the requirement of OISD 226 & PNGRB guidelines, Medium Velocity Water Spray System shall be provided Compressor House and associated facilities, Filter separator, Metering area, Piperack area, Gas turbine generator area, Scrapper launcher area, cable cellar and cable gallery areas etc. The Deluge valve shall have facility to actuate with QBDs with water pressurization, LEL activation, hydraulic & electrical actuation through control room. The DV shall be provided with Spare TOBV Connection, QBD & Spray Nozzles etc.

The medium velocity spray system provided at all critical areas shall have spray nozzles directed radially to the facilities intended for cooling at a distance of 0.6 mtr. from the surface of the equipment / facility. Only one type of spray nozzles shall be provided in a particular facility.

HVWS system for Transformers

High velocity water spray system shall be provided to extinguish fires involving transformers. The water spray system belongs to the category of fixed fire fighting installations. The purpose of providing water spray system is to guarantee sufficient exposure protection to equipments containing hazardous substances, flammable liquids by means of cooling their surfaces using devices like water spray nozzles, to reduce heat input from adjacent fire and limit the spread of flames.

The transformers shall be protected by auto actuated High velocity water spray system. The system shall be automatically actuated by a linear heat detection system, enabling to operate the deluge valve in line.

Each transformer shall be provided with separate high velocity water spray system network consisting of isolation valves, deluge valve assembly, manual bypass valves, strainers, drain valves, high velocity spray nozzles/projectors, deluge valve local control panels, DV & manual bye pass valve Houses etc.

10.2 LPM/m2 of the surface area of the entire transformer including the bottom surface, radiators, conservators etc. Minimum Pressure of 3.5 bars at hydraulically remotest sprayer & shall not be more than5 bars for any projector. The maximum velocity in feed pipe: 10 m/s.

The water spray system shall be provided with the deluge valve assembly actuated by linear heat detection system. Deluge systems shall be hydraulically balanced & capable to generate required pressure & flow to quench the fire. Valve will be sized for minimum pressure drop and at the maximum design flow rate. Deluge valve to be located minimum 15m away from the transformer. Deluge valve shall be located under a shed. Necessary sloping towards deluge valve end shall be provided. Material of construction of Deluge valves shall be of Cast Steel consisting Diaphragm Unit, Restriction check valve, Strainer, Pressure gauge with gauge valve, Emergency release station, Positive drain actuator, Swing check valve, Ball valve, Solenoid valve Drip valve, Alarm system, Priming connection, Detector pipe work manifold etc.

High Velocity water spray nozzles shall be provided in Brass construction. Nozzles on the rings shall be located at not less than 500 mm and not more than 800 mm from the transformer surface.

Clean Agent Fire Suppression System (Inert Gas High Pressure System)

Fire in strategically important places like computer rooms, control rooms, switch gear rooms, data storage rooms, server rooms, data storage archives, libraries, laboratories etc. is a serious hazard to highly precious and irretrievable items and properties. Occurrence of fire

besides leading to personnel injuries and property damage also leads to loss of productivity and precious time. The primary cause of fire may be due to short circuit / overheating of certain components somewhere in the areas. Fire suppression with water-based systems such as hydrant or sprinkler system can damage the assets permanently. Therefore for these costly & critical areas, the Fire Protection System envisaged calls for early detection of fire and quenching the same by flooding the area with gas based fire suppression system besides giving out an audio visual alarm. The design shall be strictly as per NFPA standard NFPA 2001. Depending upon the nature of the units to be protected from fire, fire protection systems viz. clean agent based Fire suppression system; automatic fire detection-cum-alarm system, portable fire extinguishers & fire fighting accessories shall be provided. However, fire suppression system shall be provided only in all the electrical rooms, Control / Scada rooms and Battery room as per Specification.

The suppression system shall provide for high-speed release of Gas based on the concept of total Flooding protection for enclosed areas with High Pressure clean agent gas (Inert Gas). A Uniform extinguishing concentration shall be as applicable and approved by NFPA 2001 of the gas for 70 deg F. The system discharge time shall be in accordance with NFPA standard 2001.

The Fire Suppression System shall include a detection and control system provision for both pre-alarm and automatic agent release.

The detection and control system that shall be used to trigger the Fire suppression shall employ cross zoning of Multi-criteria smoke detectors and other detectors. A single detector in one zone activated, shall cause in alarm signal to be generated. Another detector in the second zone activated, shall generate a pre-discharge signal and start the pre-discharge condition.

The discharge nozzles shall be located in the protected volume in compliance to the limitation with regard to the spacing, floor and ceiling covering etc. The nozzle locations shall be such that the uniform design concentration will be established in all parts of the protected volumes. The system as a whole along with equipments, components, flow calculation software etc. shall be approved by UL / FM / ULC / LPCB/VDS. The final number of the discharge nozzles shall be according to the OEM's patented and certified software, which shall also be certifiers such as UL / FM/LPCB/VDS.

The Gas shall be stored in seamless storage containers complying with the SMPV Rules set out by Chief Controller of Explosives, Nagpur, India. The Bidder shall be required to produce a NOC for the Chief Controller of Explosives, Nagpur for the storage containers against the cylinder identification numbers punched on them. Welded cylinders for agent storage will not be acceptable

The Gas shall be discharged through the operation of an Electric (solenoid) operated device or pneumatically operated device, which releases the agent through the pneumatic operated pressure valve. Systems that employ explosive or pyrotechnic devices for the discharge shall not be permitted.

The Gas discharge shall be activated by an output directly from the Gas Release control panel, which will activate the solenoid valve. Inert Gas (IG541) inert gas based Clean Agent System for Ceiling void, Room void & Floor void/cable trenches.

Clean Gas Fire Suppression System (Inert Gas based high pressure system) shall be considered complete with required accessories with main and standby bank (As per NFPA 2001 & UL Listed / FM / VDS / LPCB approved) with Pressure Switch with Locking Device, Discharge Nozzles designed to provide the proper flow rate and distribution of Clean Agent to total flood the hazard area: 180 deg. / 360 deg. (As per NFPA 2001 & UL Listed / FM / VDS / LPCB approved), ASTM A106 Gr. B Piping, fittings & supports, etc., Manifold fabricated from seamless pipe, A106 Gr. B having inlets with supports etc. with activation through intelligent addressable Fire Detection and Alarm System with panels, detectors, response indicators etc. all complete as per MECON TS No. MEC/TS/05/21/081J. The bidder shall include mandatory spares as described in PJS alongwith recommended list of spares required for 2 years trouble free operation.

The bidder must supply mandatory spares to be supplied with the Clean Agent system.

S. No.	Item	Quantity
1	Automatic and Manual release system	One of each type/size used in the systems supplied
2	Cylinder Valve with	One of each type / size used in the

	safety pressure relief device	systems supplied.
3	Clean Agent Nozzles	10% of total nozzles used in each size / type with minimum drill holes.
4	Clean Agent Release Push Buttons	10% of total used of each type etc. (Min, 2 nos)
5	Pressure Gauges	20 % (Subject to Minimum of 1) of each type, range, MOC, and rating, whichever is higher
6	Solenoid Valves	20% or Minimum 2 numbers of each type used
7	Panel Mounted Instruments	10% of Panel Mounted items like pushbuttons, lamps, switches
8	Pressure switches	10% or Minimum of 1, whichever is higher of each type, range
9	LHD Sensor Cable	20% or Minimum 2 numbers of each type used

Interlocking with A/C & Ventilation system

There will be interlocks to shut off the exhaust fans and simultaneous tripping of A/C and ventilation system. The fire signal from first detector will operate the audio-visual alarm whereas on confirmation of fire signal from the other detector the ventilation/air conditioning system shall be switched off automatically. Appropriate tripping relays and their contacts shall be provided by the tenderer for this purpose considering zone wise operation, partitions in cable gallery/ basement and number of fans/ system operating in the electrical rooms.

Potential free contacts (Relay modules) shall be made available for each zone for tripping of respective ventilation/air conditioning system. Location of above relay module shall be as finalized during detailed engineering stage. Tenderer to consider all accessories such as cabling/ wiring, contact multiplication etc required to achieve the system requirement. Contact of auxiliary relays shall be made available in relay auxiliary panel of the above mentioned places and shall be suitable to wire directly in MCC/starter panel control circuit. The relay modules shall be considered as part of fire alarm panel.

Automatic Addressable Fire Detection-Cum-Alarm System: Manual Push Button Type Fire Alarm System

Automatic fire detection-cum-alarm system shall be provided for service building, control room building, admin building, substation, Switch gear room etc. In addition to detection system, manual push button fire alarm system (manual call points) shall be provided for all the premises / bays within the scope of the Contractor. These areas shall be protected from Fire using State-of-the-art Automatic Smoke/ Heat Detection/ Alarm & Fire Control mechanism using Code of Practices approved by agencies such as Bureau of Indian Standards (BIS), British Standards Institute (BSI) or National Fire Protection Association (NFPA). Relevant certificate of approval shall be enclosed. The alarms need to be monitored on a 24 x 7 basis & logged for providing reports.

The Fire system shall deploy High Sensitivity Smoke/ Heat Detectors to allow swift detection of heat and/or smoke.

The fire alarm should be designed to cut power to air-conditioning system. Second alarm should cut all the power supply to the control room excluding supply to critical equipments and the fire suppression system should be triggered off after a pre-set time interval.

The fire detection & alarm system shall comprise of the following items / equipments:

- Automatic Fire Detectors and Accessories comprising of:
- Heat Detectors
- Ionization Type Smoke Detectors
- Photo Electric / Optical Type Smoke Detector
- Manual Break Glass Boxes / Manual Call Points (MCP)
- Response Indicators
- Exit Signs
- Hooters
- Flashing Lights
- Clean Agent Release And Inhibit Switches
- Any other item(s) required for the completeness of the system

Signal and control shall also be provided on main fire alarm control panel from as based fire extinguishing system.

Intelligent addressable Fire Detection and Alarm System as with fire alarm cum gas release panels, detectors, response indicators, cabling, cable trays, manual gas release switch, manual gas abort switch, hooter with flasher, manual call points etc. all complete as per MECON TS. Manual call points shall be installed at strategic operating locations.

Detection system for cable Trenches, below false flooring:

In cable trenches and below false floors, detection of fire shall be by a highly accurate & sensitive mechanism which can detect direct & indirect fire exposures.

LHS shall be used for detecting heat from a fire over its entire length. The sensor cable shall consist of a twisted pair of copper coated steel conductors covered by a temperature sensitive insulation. The LHS shall be UL/FM/LPCB/VDS approved and shall be designed for open area as well as proximity detection. LHS shall be compatible with any fire control panel that is capable of accepting contact closure type initiating devices.

Linear Heat Detection System shall be used for effective activation of a warning or alarm signal indicating a condition of excessive heat or fire. In this system, each discrete addressable LHS cable zone shall report an individual alarm to the addressable fire control panel. The detector should be capable of detecting fire even under harsh conditions. The response behavior of the detector shall be precisely adjustable to suit the environment & small temperature variations caused due to environmental fluctuations and shall not result in false alarms. The detector unit shall send fault signal when the LHS is damaged (Cut or damaged).

The detector specification shall be as follows:

- Rated Activation Temperature Tolerance : ± 5%
- Temperature Rating : 68 deg C
- Min. Installation operating temperature : 5`C
- Application : Indoor/Outdoor
- Outer Jacket Material : PVC
- Conductor Material : Tinned copper clad steel
- External Diameter Typical : 0.15" nominal (3.8 mm nominal)
- Conductor Diameter : 0.035" nominal (.89 mm nominal)
- Outer sheath Thickness : 0.020" nominal (0.5 mm nominal)
- Tensile Strength : 245K PSI/Conductor

- Bend Radius (Minimum) : 2.5 inches (63.5 mm)
- Weight nominal per length : 0.016 lbs/ft (24 grams/m)
- Conductor Resistance at 20 °C (max): 0.058 ohms/ft 2 conductor

The parameters as mentioned against each requirement are indicative and bidder has to submit the data sheet of LHS for approval of MECON during detailed engineering. The system shall operate on 230 VAC input and 24 VDC SMF Lead acid batteries for standby supply with battery backup of 48 hours in normal condition & 1 hour in case of fire condition.

04.09.01.04 FIRST AID & SAFETY EQUIPMENT included in scope of supply:

(i) Fire hoses – 2 nos. / per hose box / per hydrant – point- minimum 10 nos.
(ii) In addition to the nozzles provided in the hose boxes there shall be 1 set of spare nozzles for each category viz., Jet Nozzle with branch pipes, Fog Nozzle, Universal Nozzle, water curtain Nozzle and spray Nozzle
(iii) Minimum 2 Nos. or 25% spare hoses shall be stored.

First Aid and Safety Equipment

The following accessories / first aid items shall be provided.
a. Safety helmets-1 no. / Person (min 10 nos.).
b. Stretcher with blanket- 2 Nos.
c. First aid box- 1 nos.
d. Rubber hand gloves for electrical purpose- 2 nos.
e. Low temperature rubber hand gloves - 4 pairs.
f. Fire proximity suit- 1 no.
g. Resuscitator - 1 No.
h. Red / green flags – 2 nos. in each colour
i. Self-contained breathing apparatus with one spare cylinder (cap 30 min) – 1 set with spare cylinder.
j. Water jel blanket- 1 nos.
k. Portable Gas detectors – 2
l. Explosive meter – 1 No.
j. Windsock – Windsock shall be provided on an appropriately elevated structure like the control room /fire-water pump house in such a manner so as to avoid blind areas.

Inspection of firefighting equipment and system shall be carried out inline with OISD – STD-142.

04.09.01.05 FOAM CUM WATER TENDER (FTV):

The scope includes complete supply, mechanical design, engineering, materials, manufacturing, fabrication, assembly, quality assurance and quality control, inspection, testing, painting, documentation, certification, supply and shipment of all items, performance guarantee of complete package, in accordance with all referenced specifications, codes and standards for the Foam Cum Water Tender.

The chassis to be procured is of TATA/Eicher/ Ashok Leyland/Volvo/MAN of Euro IV standard, wheel base not less than 4700 mm, payload capacity of 16.2 tonnes or more with minm. engine capacity of 160BHP directly from TATA/Eicher/Ashok Leyland/Volvo/MAN or its Authorized Dealer and it should accommodate minimum 1 driver+1 officer+4 Firemen." It shall be the responsibility of the bidder to ensure selection of the chassis model to ensure optimum performance along with all components as per tender terms and conditions, specifications, other standards, norms and tests and no deviation is permitted on account of performance/testing.

04.09.01.06 TECHNICAL SPECIFICATION FOR PIPES, VALVES, SLUICE GATES & FITTINGS

T.S. for Pipes for hydrant system

Pipes and pipe fittings in general shall comply with the requirements of BIS codes and TAC norm. The pipes shall be manufactured / supplied as specified below:

i) Upto 150 mm nominal size - M.S ERW Black pipes conforming to IS-1239- 1984 Part-I (heavy grade) With Plain ends.

ii) 200 mm to 400 mm size - M.S. ERW Pipes conforming to IS-3589 -1973 but thickness as specified below

T.S. for Pipes and valves for Spray (MVWS) system

The material of construction and manufacturing standard of pipes, fittings, valves, fasteners, gaskets, etc. shall be as described in table-1 below:-

Table-1

Nominal pressure (PN) - 10 Kg/Cm^2
Test Pressure (PT) - 15 Kg/Cm^2

S. No.	Items	Nominal dia.(mm)	Specification
1.	Pipe	65 and below 80 100 to 150 200 to 250 250 and above	IS-1239 (Part-1) - '90 Heavy, IS-1239 (Part-1) - '90 Heavy, IS-1239 (Part-1) - '90 Heavy, IS-3589 Gr.410 ERW pipe commercial quality or equivalent. Thickness as specified.
2.	Pipe fittings		A 234 Gr. IS-1239/3589/2062
2.1	Screwed fittings	65 & below	IS-1239 (Part-1) - 90 Galvanised
2.2	Fabricated fittings		
	Bends	150 and above	Mitered bends with radius 1.5 DN from black pipe.
	Tees/Crosses	150 and above	Fabricated from black pipes by smithing.
	Reducers	150 and above	Fabricated from black pipes by taper cutting and welding.
3.	Bolting	All sizes	IS – 1367
4.	Gaskets	All sizes	Spiral wounded graphite filled gasket as per B 16.5, 150 #, ASTM A-105, CS Slip on,

S. No.	Items	Nominal dia.(mm)	Specification
			RF
5.	Flanges	All sizes	Slip on flanges to IS-6392 - `71 machined from Carbon Steel plates to IS-2002-`92 Gd. 2 with bore to suit pipe O.D.

Fittings shall be supplied as per IS: 1239-1992 Part II for pipes up to 150 mm dia and shall be fabricated from pipes/Factory made for dia 200 mm and above.

Technical specification for valves:

The valves & sluice gates shall be designed, manufactured and tested as per relevant Indian Standards or as per other International standards acceptable to the Purchaser and will be suitable for the duty conditions specified below. All underground valves will be provided with valve chambers with RCC covers. The size of chambers shall be suitable for easy maintenance of the valve. Complete civil work for this is in the contractor's scope.

Table-2

S. No.	Items	Nominal dia. (mm)	Specification
1.	Isolation	Below 50	Forged Carbon steel gate valve, screwed as per API – 602 standard, class 800 # ASTM A-105, trim 13% Cr, Bolt/Nut – B7/2H, Socket end threading as per ANSI B.16.11 Gasket SPW S.S. 304 with CAF Hand Wheel - Cast steel
		50 to 300	Cast Carbon Steel flanged gate valve as per standard API-600 class 150 # , Body & bonnet material ASTM A 216 Gr. WCB, Trim 13% Cr S.S, Spindle & Gland bush – A1S1 410. Hand wheel C.S, Gasket SW S.S-304 + LAF, flange drilled to ANSI – B.16.5 along with companion slip-on welded flange (without hub) drilled as per B.16.5 and gasket, Nut & bolt etc. Hand Wheel - C.S.

2.	Throttling	50 and below	Gunmetal globe valve, Screwed, as per IS-778-`84 Class-2

04.09.01.07 DESIGN CRITERIA

Codes and Standards:

All materials, equipments, piping, valves, fittings etc. dimensional standards, tolerance, prices of manufacture and testing procedure shall be in accordance with the latest revision of relevant Indian, British, American standards wherever applicable.

The material used and equipment supplied shall be new and the best of their kind and shall comply with the latest revisions of all relevant standards. The tenderer shall indicate in his tender the relevant standards to which the equipment, piping, fittings, etc. offered by him shall comply with. The latest revisions of applicable standards indicated in the technical specification shall be used for the design, manufacture, inspecting and testing of the items covered in this specification. The following codes and standards shall be considered for design: -

- OISD-226: Natural Gas Transmission & City Gas Distribution Network

- OISD-113: Classification of areas for electrical installations at hydrocarbon processing and handling facilities.

- OISD-118: Layout for oil and gas installation.

- OISD-163: Process control room safety.

- OISD – 179 & OISD – 226 & PNGRB.
- National Fire Protection Association, USA (NFPA) codes

- Standard for installation of centrifugal pumps (NFPA-20)

- Standard for water spray systems (NFPA- 15)

- Standard for sprinkler systems (INFPA-13)

- Code of acceptance tests for centrifugal, mixed flow and axial flow pumps IS: 9137-1978, BS-5316-latest edition, ISO-2548-1973

- Specification for cast iron check valves BS 5153-1991
- Landing valves IS:5290-1993
- Valve inspection & test IS:6157-1981
- Specification for inspection and test of steel valves BS:6755-1986
- Mild steel tubes, tubular and other wrought iron fittings IS:1239, Part-1-2001 & Part-2-1992
- Seamless or electrically welded steel pipes for water, gas and sewage IS:3589-1991
- Steel pipe flanges for water, oil, steam etc. IS:6392-1971
- Butt welded fittings ANSI B16.9
- Circular flanges for pipes, valves and fittings BS1560-latest editions
- Steel pipe flanges ANSI B 16.5
- Covered electrode for manual metal arc welding of carbon and carbon manganese steel IS:814-1991
- Approved tests for welding procedure IS: 7307 (Part-I)-1974
- Approved tests for welders working to approved welding procedures IS:7310(Part-I)-1974
- Specification for arc welding of carbon and carbon manganese steels BS:5135-1984
- Code of practice for coating & wrapping IS:10221
- Code of practice for radiographic testing IS:2595-1978
- Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes IS:4853-1982
- Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes IS:1182-1983
- Safety code for industrial radiographic practice IS:2598-1966

04.09.01.08 LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

A) **Mainline & Mechanical**

i) Pipes (1239/3589)

1. TISCO, Calcutta
2. Jindal Pipes, New Delhi
3. Ajanta Tubes, New Delhi
4. Gujrat Steel Tubes
5. Khandelwal

ii) Valve

a) **Globe Valves**

1) M/s BDK (New Delhi)
2) M/s Datre Corpn (Calcutta)
3) M/s KSB Pumps (New Delhi)
4) M/s L&T (New Delhi)
5) M/s Neco Schuber & Salzer Ltd. (New Delhi)
6) M/s Niton Valve (Mumbai)
7) M/s Ornate Valves (Mumbai)
8) M/s Panchavati Valves (Mumbai)
9) AV Valves Ltd.
10) BHEL (Trichy), India
11) Econo Valves Pvt Ltd, India
12) Fouress Engg (I) Ltd (Aurangabad)
13) Guru Industrial Valves Pvt Ltd
14) Leader Valves Ltd, India
15) NSSL Ltd. (Neco Schubert & SalzerLtd)
16) Oswal Industries Ltd, India
17) Petrochemical Engineering Enterprises, India
18) Sakhi Engineers Pvt Ltd
19) Shalimar Valves Pvt Ltd
20) Steel Strong Valves India Pvt Ltd, India

b) **Ball Valves**

1. Larsen & Toubro, Chennai
2. Virgo, Pune
3. Microfinish Valves, Hubli
4. Flow Chem, Ahmedabad

c) **Check Valves**

1. M/s Advance Valves Pvt. Ltd., Noida
2. M/s Aksons & Mechanical Enterprises, Mumbai
3. M/s Larsen & Toubro Limited (M/s Audco India Limited, Chennai)
4. M/s AV valves Ltd., Agra
5. M/s BDK engineering India Ltd., Hubli
6. M/s BHEL,OFE&OE Group, New Delhi
7. M/s Datre Coroportion Limited, Calcutta
8. M/s Leader Valves Ltd., Jalandhar
9. M/s Neco schubert &Salzer Ltd., New Delhi
10. M/s Niton Valves Industries (P) Ltd., Mumbai
11. M/s Precision Engg.Co., Mumbai
12. Econo Valves Pvt Ltd, India
13. Fouress Engg (I) Ltd (Aurangabad)
14. KSB Pumps Ltd (Coimbattore), India
15. NSSL Ltd. (Neco Schubert & SalzerLtd)
16. Oswal Industries Ltd, India
17. Panchvati Valves & Flanges Pvt Ltd, India
18. Petrochemical Engineering Enterprises, India
19. Sakhi Engineers Pvt Ltd
20. Shalimar Valves Pvt Ltd
21. Steel Strong Valves India Pvt Ltd, India

d) **Plug Valves**

1. M/s Breda Energia Sesto Industria Spa, Italy
2. M/s Fisher Sanmar Ltd., Chennai
3. M/s Larsen & Toubro Ltd., New Delhi
4. M/s Nordstrom Valves, USA
5. M/s Serck Audco Valves, UK
6. M/s Sumitomo Corporation India Pvt. Ltd., New Delhi
7. M/s Z Corporation, Korea

8. M/s Hawa Valves (India) Pvt. Ltd., Mumbai
9. M/s Steel Strong Valves India Pvt. Ltd., Navi Mumbai

iii) Flanges

1. M/s Aditya Forge Ltd., Vadodara
2. M/s Amforge Industries Ltd., Mumbai
3. M/s CD Engineering Co., Ghaziabad
4. M/s Echjay Forgings Pvt. Ltd. (Bombay), Mumbai
5. M/s Echjay Industries Ltd., Rajkot
6. M/s Forge & Forge Pvt. Ltd., Rajkot
7. M/s Golden Iron & Steel Works, New Delhi
8. M/s JK Forgings, New Delhi
9. M/s Metal Forgings Pvt. Ltd., Mumbai
10. M/s Perfect Marketings Pvt. Ltd., New Delhi
11. M/s Sky Forge, Faridabad
12. M/s S&G, Faridabad
13. Chaudhry Hammer Works Ltd, India
14. JAV Forgings (P) Ltd, India
15. Kunj Forgings Pvt Ltd, India
16. MS Fittings
17. R.N. Gupta & Co. Ltd, India
18. R.P. Engineering Pvt Ltd, India
19. Sanghvi Forgings & Engineering Ltd
20. Shri Ganesh Forgings Ltd., India
21. Uma Shankar Khandelwal & Co., India

iv) Fittings

1. M/s Commercial Supplying Agency, Mumbai
2. M/s Dee Development Engineers Ltd.
3. M/s Eby Industries, Mumbai
4. M/s Flash Forge Pvt. Ltd., Vishakhapatnam
5. M/s Gujarat Infra Pipes Pvt. Ltd., Vadodara
6. M/s M.S. Fittings Mfg. Co. Pvt. Ltd., Kolkata
7. M/s Stewarts & Lloyds of India Ltd., Kolkata
8. M/s Teekay Tubes Pvt. Ltd., Mumbai
9. M/s Pipe Fit,Baroda
10. M/s Sky Forge, Faridabad
11. M/s S&G, Faridabad

12. M/s Sawan Engineers, Baroda
13. Eby Fasteners, India
14. Leader Valves Ltd, India
15. R.N. Gupta & Co. Ltd, India
16. Exten Engg Pvt Ltd
17. Sivananda Pipe & Fittings Ltd
18. Tube Products Incorporated

v) Gaskets

1. IGP Engineers (P) Ltd., Madras
2. Madras Industrial Products, Madras
3. Dikson & Company, Bombay
4. Banco Products (P) Ltd., Vadodara
5. Goodrich Gaskets Pvt Ltd
6. Starflex Sealing India Pvt Ltd, India
7. Teekay Meta Flex Pvt Ltd
8. UNIKLINGER Ltd

vi) Fasteners

1. Nireka Engg. Co. (P) Ltd., Calcutta
2. Precision Taps & Dies, Bombay
3. AEP Company, Vithal Udyoug Nagar
4. Fix Fit Fasteners, Calcutta
5. Precision Engg. Industries, Baroda
6. Echjay Forgings Pvt. Ltd., Bombay
7. Capital Industries, Bombay
8. Boltmaster India Pvt Ltd, India
9. Deepak Fasteners Limited, India
10. Fasteners & Allied Products Pvt Ltd, India
11. Hardwin Fasteners Pvt Ltd, India
12. J.J. Industries, India
13. Multi Fasteners Pvt Ltd, India
14. Nexo Industries, India
15. Pacific Forging & Fasteners Pvt Ltd, India
16. Pioneer Nuts & Bolts Pvt Ltd, India
17. Precision Auto Engineers, India
18. President Engineering Works, India
19. Sandeep Engineering Works, India
20. Syndicate Engineering Industries, India

vii) Welding Electrodes

1. For Mainline – Lincoln make
2. For Terminal – Lincoln & D&H or equivalent

viii) Fire Fighting Equipments

a) Fire Extinguishers

1. Avon Services (Production & Agencies) Pvt. Ltd., Bombay
2. Kooverji Devshi & Co., Bombay
3. Zenith Fire Services, Bombay
4. Safex Fire Services, Bombay
5. Reliable (Fire Protection) India Ltd., Bombay
6. Brij Basi Hi
7. tech Udyog
8. Bharat Engg Works, India
9. Gunnebo India Ltd
10. Nitin Fire Protection Industries Ltd, India
11. Supremex Equipments, India
12. Vimal Fire Controls Pvt Ltd., India

b) Fire Hydrants, Monitors, Deluge Valve, Nozzles

1. Zenith
2. Minimax
3. Newage
4. HD Fire
5. Vijay Fire
6. Asco Strumech Pvt Ltd, India
7. Brij Basi Hi
8. tech Udyog
9. Gunnebo India Ltd
10. Nitin Fire Protection Pvt Ltd
11. Shah Bhogilal Jethamal & Brothers
12. Venus Pumps & Engineering Works

c) RRL Hose

1. Jayshree

2. Newage

d) Hoses

1. Ashit Sales Corporation, Bombay
2. Royal India Corporation, Bombay
3. Gayatri Industrial Corporation
4. Simplex Rubber Products Ltd., Ahmedabad
5. Zaverchand Marketing Pvt. Ltd., Baroda
6. Presidency Rubber Mill, Calcutta
7. The Cosmopolite, Calcutta
8. Simplex Rubber Products, Thane

e) Hose Delivery

1. Chhatarya Rubber & Chemical Industries,
2. Nitin Fire Protection Industries Ltd, India

f) Fire Hose Accessories

1. Asco Strumech Pvt Ltd
2. Brij Basi Hi-tech Udyog
3. Gunnebo India Ltd
4. Shah Bhogilal Jethamal & Brothers
5. Vimal Fire Controls Pvt Ltd., India

b) "T" TYPE STRAINER

1) M/s Gujarat Otofilt, Ahmedabad
2) M/s Genius Filters & Systems (P) Ltd., Vishakapatnam
3) M/s Delta Filters & Separators (P) Ltd., Navi mumbai
4) M/s Multitex Filters (P) Ltd., New Delhi
5) M/s Bhagwati Filters (P) Ltd., Ahmedabad
6) M/s Patel Filters Ltd., Ahmedabad
7) M/s Industrial Filtration Services
8) M/s Forum Filters & fabricators, Ankleshwar
9) M/s Filteration & Separation, Kalpavruksh
10) M/s Grand Prix Fab. (P) Ltd., New Delhi

B) **Instrumentation**

I) PRESSURE CONTROL VALVE

1) Fisher Xomox Sanmar Ltd.
2) Mil Controls Limited
3) Samson Controls Pvt. Ltd.
4) Forbes Marshall, Pune
5) Instrumentation Ltd. Palghat.
6) L & T
7) Virgo

II) L.E. L DETECTION SYSTEM

1) Crowcon Detection Instruments Ltd
2) Detection Instruments (I) Pvt Ltd
3) Detector Electronics Corporation
4) MSA – Mines safety appliances.
5) Oldham France S.A.

III) CONTROL AND SIGNAL CABLES

1) M/s ASSOCIATED CABLES
2) M/s ASSOCIATED FLEXIBLES
3) M/s DELTON Cables Ltd, India
4) M/s BROOK
5) M/s KEI Industries Ltd INDIA
6) M/s Suyog Electricals Ltd, India
7) M/s Thermo Cables Ltd
8) M/s Udey Pyrocables Pvt Ltd, India

IV) ZENER BARRIERS/ISOLATORS

1) M/s MTL
2) M/s P & F

V) RTDs

1) M/s General Instruments Ltd., Mumbai
2) M/s Nagman Sensors (Pvt.) Ltd.

3) M/s Pyro Electric, Goa

VI) PRESSURE TRANSMITTERS & DIFF PRESSURE TRANSMITTER

1) M/s Fisher Rosemount (Emerson)
2) M/s Yokogawa
3) M/s Fuji
4) M/s Honeywell

VII) PRESSURE GAUGES, D. P. GAUGES & TEMPERATURES GAUGES

1) M/s AN Instruments Pvt. Ltd., New Delhi
2) M/s General Instruments Ltd., Mumbai
3) M/s WIKA

VIII) SS VALVES, SS TUBE & SS TUBE FITTINGS

1) M/s Swagelok (USA)
2) M/s Parker (USA)
3) M/s Sandvik, Sweden

IX) JUNCTION BOXES AND CABLES GLANDS

1) M/s EX-PROTECTA
2) M/s FLAMEPROOF CONTROL GEARS
3) M/s BALIGA
4) M/s FLEXPRO ELECTRICALS

X) PUSH BUTTONS/LAMPS:

1) L&T
2) SIEMENS

XI) MCB'S:

1) HAVELL'S
2) INDO ASIAN
3) MDS

XII) RELAYS:

1) OEN
2) JYOTI

XIII) POWER SUPPLY UNIT:

1) ELNOVA
2) APLAB

XIV) CONTROL ROOM EQUIPMENT / CONTROL PANEL & ACCESSORIES

1) M/s Keltron Controls Ltd., Kerala
2) M/s RITTAL
3) M/s Pyrotech
4) M/s Positronics Pvt. Ltd.
5) M/s ABB Instruments Ltd., New Delhi
6) M/s Emerson Process Management (I) Pvt. Ltd.
7) M/s Rockwell Automation (I) Ltd., Ghaziabad
8) M/s Siemens Ltd.
9) M/s Tata Honeywell Ltd.

XV) INDICATORS/CONTROLLERS/RECORDERS

1) M/s ABB
2) M/s YBL
3) M/s EUROTHERN
4) M/s TATA HONEYWELL
5) M/s MASIBUS

XVI) ALARM ANNUNCIATOR

1) PROCON
2) IIC

XVII) PLC

1) M/s Siemens
2) M/s Yokogawa

3) M/s ABB
4) M/s Rockwell
5) M/s GE

XVIII LEVEL TRANSMITTERS cum GAUGES

1) M/s Emerson
2) M/s Yokogawa
3) M/s Fuji
4) M/s Honeywell
5) M/s SB Electronics
6) M/s LEVCON
7) M/s CHEMTROL

C) ELECTRICAL

Air Conditioner
1. O General
2. Daikin
3. Hitachi
4. Carrier
5. Voltas

Air Circuit Breaker
1. ABB
2. Siemens
3. Schneider
4. L&T
5. GE

Batteries (Lead Acid)
1. AMCO Batteries Ltd.
2. Exide Industries Ltd.
3. HBLNIFE Power System Ltd.
4. Amara Raja Batteries Ltd.

Batteries (Nickel Cadmium)
1. Amco Batteries Ltd.

2. HBLNIFE Power Systems Ltd.

Batteries Charger/DC-DC Converter

1. Amara Raja Power System(P)Ltd.
2. Chhabi Electricals Pvt. Ltd.
3. Caldyne Automatics Limited
4. HBL Nife Power Systems Ltd.

Cable – Fire Alarm & Communication Cables

1. Cords Cable Industries Ltd.
2. CMI
3. Delton cables Ltd.
4. ELKAY Telelinks
5. KEI Industries Ltd.
6. Reliance Engineers Ltd.

Cable – HT(XLPE)

1. Universal Cable Ltd.
2. KEI Industries Ltd.
3. NICCO Corporation Ltd.
4. Uniflex
5. Polycab.
6. Torrent cables Ltd.

c)

Cable – LT Power and Control

1. Cords Cable Industries Ltd.
2. Universal Cable Ltd.
3. KEI Industries Ltd.
4. Havells.
5. Uniflex
6. Industrial cables
7. NICCO
8. Polycab
9. Torrent

Cable – Gland

1. Baliga
2. Comet
3. Flexpro
4. Flameproof
5. FCG

6. Electro Werke
7. Dowels

Cable – Lugs

1. Dowels
2. Jainson
3. Hex

Cable – Tray

1. Ercon Composites
2. Yamuna Power & Infrastructure Ltd.

Cable Termination and Jointing Kit

1. CCI

2. Raychem
3. M-Seal

Ceiling/Exhaust/Pedestal Fans & Circulators

1. Bajaj Electricals Ltd.
2. Crompton Greaves Ltd.
3. Khaitan Electricals Ltd.
4. Havell's

Contractors – AC Power

1 Andrew Yule
2 ABB
3 BHEL
4 C&S
5 Havell's
6 L&T
7 Schneider
8 Siemens Ltd.
9 Telemechanique

Control Transformer

1. AE
2. Indushree
3. Intra Vidyut
4. Kalpa Electrikals
5. Transpower Industries Ltd.
6. Siemens

DG Set

1. Sterling and Wilson.
2. GD ankalesaria.
3. Deev Genset.
4. Jackson
5. Sudheer Gensets.
6. Power Engineering(India) Pvt Ltd.

Earthing Materials

1. Rukmani Electrical & Components Pvt Ltd.
2. Indiana Grating Pvt Ltd.

Flame proof LDB's/ JB,s/Control Station/ switches

7. FCG
8. Sudhir
9. Prompt Engineering Works
10. Flame Proof equipments pvt. Ltd.
11. Baliga Lighting Equipments Pvt. Ltd.
12. Flexpro Electricals Pvt. Ltd.

High Mast

1. Bajaj Electricals Limited
2. Crompton Greaves Limited.
3. Philips India Limited
4. Surya Roshani
5. Transrail

High Voltage PCC/ MCC panels

1. BHEL
2. Siemens
3. Tricolite Electrical Industries
4. Schneider
5. CGL
6. L&T

High Voltage Vacuum Circuit Breaker

1. ABB
2. SIEMENS

3. L&T
4. Schneider
5. CGL
6. BHEL

Indicating Lamps

1. Alstom Ltd.
2. BCH
3. L&T Ltd.
4. Siemens Ltd.
5. Vaishno Electricals

Indicating Meters

1. ABB
2. AMCO
3. AE
4. Alstom Ltd. (EE)
5. Conzerv/Schneider
6. Elecon Measurement Pvt. Ltd.
7. HPL Electric & Power Pvt. Ltd.
8. MECO Instruments Ltd.
9. Minilec
10. Rishabh Instruments Pvt. Ltd.
11. Trinity energy system
12. kaycee
13. Salzer

Lighting Fixtures

1. GE Lighting Pvt. Ltd.
2. Bajaj Electricals Ltd.
3. Crompton Greaves Ltd.
4. Philips India Ltd.

Lighting Fixtures - Flameproof

1. Bajaj Electricals Ltd.
2. Baliga Lighting Equipment Pvt. Ltd.
3. Crompton Greaves Ltd.
4. CEAG Flameproof Controlgear Pvt. Ltd.
5. Flexpro Electricals Pvt. Ltd.
6. Philips India Ltd.
7. Sudhir Switchgears Pvt. Ltd.

8. FCG.

Miniature Circuit Breakers (MCBs) and Lighting DB

1. ABB
2. Hagger
3. Havell's India Ltd.
4. Indo Asian Fusegear Ltd.
5. Legrand
6. MDS Switchgear Ltd.
7. Schneider
8. Siemens Ltd.
9. HPL

Motors

1. Siemens
2. ABB
3. CGL
4. Alstom
5. BHEL
6. WEG

Moulded Case Circuit Breaker (MCCBs)

1. ABB
2. Andrew yule
3. Larsen & Toubro
4. Schneider
5. Siemens
6. GE

Protection Relays – Thermal

1. BCH
2. L&T Ltd.
3. Siemens Ltd.
4. Telemenchanique & Controls (India) Ltd.

Low Voltage Distribution Board PDB/ MLDB/ LDB/SLDB

1. ABB
2. Siemens
3. BCH
4. Havells
5. C & S

6. L&T
7. Tricolite Electrical Industries Ltd.
8. Pyrotech Electronics Pvt. Ltd.
9. Vidyut Control India Pvt. Ltd.
10. Adroit Control Engineers (P) Ltd.
11. Risha Control Engineers Pvt. Ltd.

Low Voltage Power and Motor Control Center PMCC/MCC Panel

1. ABB
2. BCH
3. C & S
4. L&T
5. Siemens
6. GE.
7. Tricolite Electrical Industries.

Low Voltage Power and Motor Control Center PMCC/MCC Panel(Upto 1000Amp)

1. Siemens
2. ABB
3. BCH
4. C & S
5. L&T
6. Tricolite Electrical Industries Ltd.
7. Pyrotech Electronics Pvt. Ltd.
8. Vidyut Control India Pvt. Ltd.
9. Adroit Control Engineers (P) Ltd.

Low Voltage Power and Motor Control Center IMCC/VFD Panel

1. ABB
2. Rockwell Automation
3. L&T
4. Siemens
5. Tricolite Electrical Industries
6. GE

Push Buttons

1. BCH
2. Alstom Ltd.
3. L&T

4. Siemens Ltd.
5. Telemenchanique & Controls (India) Ltd.
6. Vaishno Electricals

Switches-Control

1. BCH
2. Easum Reyrolle Relays & Devices Ltd.
3. Alstom
4. Kaycee Industries Ltd.
5. L&T
6. Siemens Ltd.

Switches – 5/15A Piano/ Plate, Switch Socket

1. Anchor Electronics & Electricals Pvt. Ltd.
2. Kingal Electricals Pvt. Ltd.
3. North-West Switchgear Ltd.

Switch Socket Outlets (Industrial)

1. Alstom Ltd.
2. Best & Cromption Engineering Ltd.
3. BCH
4. Crompton Greaves Ltd.
5. Essen Engineering Company Pvt. Ltd.

Solar Modules

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL.

Solar Street Lighting

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL.

Terminals Blocks

1. Connectwell
2. Controls & Switchgear Co. Ltd.
3. Elmex Controls Pvt. Ltd.
4. Essen Engineering Co. Pvt. Ltd.

Tranformers

1. ABB
2. Andrew Yule
3. Alostom
4. BHEL
5. Bharat Bijlee
6. Crompton Greaves
7. EMCO Ltd.
8. Intra Vidyut
9. Indushree
10. Kirloskar
11. Transformers & Rectifiers (I) Ltd.
12. Voltamp

UPS System and Inverter

1. EMERSON
2. APLAB
3. KELTRON
4. HI-REL
5. DUBAS

VAIRIABLE FREQUENCY DRIVE

1. ABB
2. Schneider
3. Allan Bradley (Rockwell Automation)
4. Siemens
5. L&T (Yaskawa)
6. Ansaldo

NOTE:- Item/Vendor,which are not listed above,shall be subject to prior approval from Client/Consultant.

1) For procuring bought out items from vendors other than those listed above, the same may be acceptable subject to the following: -

a) The vendor/ supplier of bought out item(s) is a manufacturer/ supplier of said item(s) for intended services and the sizes being offered is in their regular manufacturing/

supply range.

b) The vendor / supplier should not be in the Holiday list of Client / MECON / other PSU.

c) Should have supplied at least one single random length (i.e. 5.5 meters to 6.5 meters) for item assorted pipes / tubes and minimum 01 (One) number for other item(s) (other than assorted pipes / tubes) of same or higher in terms of size and rating as required for intended services.

The bidder should enclose documentary evidences i.e. PO copies, Inspection Certificate etc. for the above, along with their bids.

2) For any other item(s) for which the vendor list is not provided, bidders can supply those item(s) from vendors/ suppliers who have earlier supplied same item(s) for the intended services in earlier projects and the item(s) offered is in their regular manufacturing/ supply range.

The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder, these documents shall required to be submitted by them within 30 days from date of Placement of Order for approval to CLIENT / MECON.

3) The details of vendors indicated in this list are based on the information available with MECON; Contractor shall verify capabilities of each vendor for producing the required quantity with. MECON does not guarantee any responsibility on the performance of the vendor. It is the contractor's responsibility to verify the correct status of vendor and quality control of each party and also to expedite the material in time.

THIRD PARTY INSPECTION AGENCY

Contractor shall appoint anyone of the following TPIA for inspection purpose, wherever required as per tender document. Contractor has to propose minimum 4 nos. of below listed agencies to be approved by CLIENT / MECON:

a) Lloyd Register of Industrial Services

b) Technische Ulierwachungs Verein(TUV)

c) Det Norske Veritas (DNV)

d) AB-Vincotte

e) Bureau Veritas

f) SGS

g) American Bureau Services

h) Velosi Certification Services

i)Certification Engineers International Limited(CEIL)

Apart from inspection by TPIA, inspection may also be performed by MECON / CLIENT's personnel.

STANDARD SPECIFICATION FOR MEDIUM VELOCITY WATER SPRAY SYSTEM

SPECIFICATION NO: MEC/TS/05/28/081/22

(OIL & GAS SBU)
MECON LIMITED
DELHI

1.0 SCOPE OF SUPPLY OF EQUIPMENT AND SERVICES

1.1 GENERAL

This specification lays down the broad technical specification for the medium velocity water spray system to be provided for various areas as specified in SOR, specifications.

For fluids flashing at below 65^{o} C (150^{o} F), extinguishments is always not possible or even desirable and for these, Medium Velocity Water Sprayers need to be installed to provide cooling, controlling the burning and/or exposure protection to protect processing blocks, processing equipments, structures, flammable liquid and gas vessel, piping and equipment LPG bottling plants, spot protection etc..

1.2 SCOPE

This specification covers design, supply, fabrication, erection, testing and commissioning complete with all mechanical and electrical items as elaborated in the following paragraphs. The system shall consist of the following as mechanical part of the system.

- Deluge valve assembly
- Piping for Water, pipe support, flanges etc.
- Sprinkler based detectors
- Medium velocity spray nozzles or sprayers
- Fittings and valves viz. sluice valve, non-return valve, float valve, drain valve etc.

2.0 DESCRIPTION OF THE SYSTEM

This is a special fixed pipe system connected to a reliable source of fire protection water supply and equipped with water spray nozzles for specific water discharge and distribution over the surface or area to be protected. The piping system is connected to the water supply through an automatically actuated Deluge Valve, which initiates flow of water. Automatic actuation is achieved by operation of automatic detecting equipment installed alongwith water spray nozzles. The system comprises of:

a) SPRAY NOZZLE

It is normally open water discharging device called Sprayers which, when supplied with water under pressure will distribute the water in a special, directional pattern peculiar to the particular device. These nozzles are made in a range of orifice sizes with varying discharge angles so that discharge can be controlled for optimum protection.

b) DELUGE VALVE

Deluge valve is quick opening valve, which admits water automatically to a system of projectors or sprayers and is operated by a system of detectors and/or sprinklers installed in the same areas as nozzles.

c) DETECTION SYSTEM

In case of water spray systems, detection systems are required for activating the Deluge system for spot protection (outdoors and indoors).

For the above protections, sprinklers are found in extensive application in view of their reliability. However the contractor can recommend / suggest other types of detection systems. The design of detection system by sprinklers varies from risk to risk in case of water spray systems and shall be governed in accordance with TAC guidelines for rules of water spray systems.

The system shall comprise water supply at high pressure, adequate number of spray nozzles and quartzoid bulb detectors to be located at strategic points, deluge valve, piping, audio-visual alarm system, control panel etc. Water shall be tapped from nearby sprinkler line. Water from static water tank shall be pumped to the system by means of the main pump to obtain the required minimum pressure at the remotest nozzle. Provision for 100% standby pump set to meet the emergency requirement shall be made. The delivery side of the pump shall be connected through a set of back pressure valves and stop valves to the Emulsifier System. These pumps shall have automatic starting facility, which will start the pumps whenever the delivery pressure drops below a preset valve.

High velocity water spray nozzles shall be installed all around the transformers. The number, spacing and discharge angles shall be so decided as to give effective coverage.

The quartzoid bulb heat detectors shall be placed on all sides of the transformer. The detectors shall be planned to be mounted on independent pipe line of compressed air. The heat sensing quartzoid bulb detectors shall shatter at 79 deg. C in case of a fire, creating a drop in the air pressure in the detector pipe line.

Under normal condition the system shall be kept in automatic mode. Due to leakage of water in the system, the water level in the tank shall fall resulting in pressure drop in the system. This shall actuate the pressure switch to start the pump. The jockey pump shall be automatically started by the actuation of level switch. When the water level rises beyond a preset level, the jockey pump shall be stopped automatically by the actuation of the level switch.

In case of fire, the temperature will rise and the gas inside the quartzoid bulb detector will expand to shatter the bulb. Water will then be released through the detector openings reducing the pressure rapidly. This will cause the deluge valve clack to get lifted by the hydraulic thrust on the downside of the deluge valve, which in turn shall allow water to get sprayed through the nozzles. This will result in rapid fall in pressure in the water line, which will actuate the pressure switch to start the main electrically driven pump. In case of power failure the pressure shall drop further to actuate the pressure switch for starting the standby pump.

3.0 EQUIPMENT DETAILS (MECHANICAL)

3.1 AUTOMATIC DELUGE VALVE

The deluge valve shall be a basically hydraulically operated water valve actuated by release of water in the detector pipe work. The deluge valve assembly shall be provided with `Y' type strainers in order to segregate foreign matter.

3.2 QUARTZOID BULB DETECTORS

Quartzoid bulb detectors shall be provided as heat sensing elements. The detectors shall be placed encompassing the entire surface of the transformer. The detectors shall be mounted on independent pipeline charged with water at pressure of about 4 kg/sq.cm. The heat sensing quartzoid bulb shall operate at 79 deg. C. Area covered by each detector shall not be more than 9.0 sq.m.

3.3 SPRAY NOZZLES

High velocity water spray nozzles shall be installed all around the transformer in such a manner that the entire surface of the transformers is encompassed for uniform spray of water. For this a piping cage shall be erected around the transformer. The number, spacing and discharge angles of the nozzles shall be so decided as to give effective coverage with an optimum discharge of water (11 l/sq.m/minute) to minimise the extent of damage to the equipment.

3.4 VALVES

All the valves shall be provided with matching flanges, bolts, nuts, gaskets, washers etc. Gate valves shall conform to the relevant class of IS: 780/ IS: 2906 while non-return valves shall be as per IS: 5312. All the valves shall be provided with proper support.

3.5 PIPES AND FITTINGS

Pipes upto DN 150 shall be ERW steel pipes as per IS: 1239 Part-I (medium) and pipes above DN 150 shall be ERW steel pipes as per IS: 3589. Pipe fittings such as bends, tees, reducers of size less than DN 150 shall be as per IS: 1239 Part-II and of sizes above DN 150 shall be fabricated. All the pipes shall be adequately supported.

The underground pipe shall be laid 1 m below the ground. The MS pipes to be laid underground shall have suitable coating and wrapping with 2 coats of coal tar, hot enamel paint and two wraps of reinforced fibre glass tissue or bitumenised Hessian.

The piping shall be capable of withstanding for two hours a pressure of 3.5 kg/sq.cm in excess of the maximum working pressure.

All the flanges shall be faced and have jointing of rubber insertion or asbestos compound. Wherever the underground pipes cross the road, suitable encasing pipes shall be provided.

The laying of pipes shall be included in the tenderer's scope of work.

STANDARD SPECIFICATION
FOR
DELUGE VALVE

SPECIFICATION NO: MEC/TS/05/28/081/08

(OIL & GAS SBU)
MECON LIMITED
DELHI

CONTENTS

1.0 SCOPE

This standard lays down requirements regarding construction, material, shape, and method of operation, performance and test of automatic deluge valve for fire water distribution.

2.0 CODES AND STANDARDS

The following codes and standards shall be followed for deluge valve:

1. Rules for automatic sprinkler installation published by TAC.
2. Applicable ISI codes
3. NFPA guidelines

3.0 DESIGN REQUIREMENT

3.1 An automatic deluge valve shall consist of following:

a) Deluge Valve unit
b) Diaphragm Unit
c) Integral Test and drain valve manifold
d) Alarm System
e) Priming Equipment
f) Installation stop valve with pressure guage and outlet valve
g) Detector pipe work manifold
h) Emergency release box
i) Solenoid valve system for remote actuation of deluge valve

3.2 Size and capacity of deluge valve shall be as under:

Size Inch(mm)	Rated Flow M3/hr	Working Pressure Kg/cm2 g.
2(50)	10 to 50	7.0 to 10.5
3 (75)	50 to 100	7.0 to 10.5
4(100)	100 to 200	7.0 to 10.5
6(150)	200 to 450	7.0 to 10.5
8(200)	450 to 1000	7.0 to 10.5

3.3 The deluge valve shall be provided with solenoid operated air release valve for remote operation. If deluge valve in located in hazardous area, alarm switch shall be intrinsically safe and flameproof.

4.0 MATERIAL OF CONSTRUCTION

4.1 For non saline water service, the material of construction shall be as follows:

Body	:	Cast Iron to Is 210 Gr. FG 200
Seat	:	Bronze
Clapper	:	Bronze
Clack	:	Graphite Iron
Diaphragm spindle & hinged pin	:	SS 304
Test and drain valve	:	Cast Iron
Installation stop valve & outlet valve	:	Cast Iron to Is:780 Class PN 1.6
Check Valve	:	IS:5312 Part-II
Diaphragm & Seat Rubber	:	Neoprine

4.2 For saline water service, aluminium bronze material shall be used in place of cast iron.

5.0 CONSTRUCTION AND PERFORMANCE

5.1 The deluge valve unit shall be provided with a clack to keep the valve close through a diaphragm unit.

5.2 The deluge valve shall also be fitted with an integral test and drain manifold. It shall consist of 50mm test and drain valve, air body drain valve and a drip valve.

5.3 The test valve shall allow water to flow through the deluge valve to drain during testing of deluge valve and to drain water from distribution pipe after fire. At open position the valve clack shall be held against its seating by an internal compression spring of sufficient strength to keep it in closed position till the pressure acting on underside of it does not exceed approx. 0.3 Kg/cm2. The clack will open at pressure exceeding 0.3 Kg/cm2.

5.4 The drain valve shall drain all the water from the deluge valve body and the outlet connections during maintenance of the deluge valve. The drain pipe work is to be designed to periodically check the rate of flow available in the system to satisfy the requirements appropriate to the hazard class for which the deluge valve is provided. Flow measurement shall be checked with differential pressure.

Water operated alarm motor gang shall be connected to the test and drain valve so that it gives an alarm as the deluge valve opens.

5.5 On detector pipe work manifold, test valve shall be provided at one end while on air

supply pipe one air pressure regulator, check valve and gate valve shall be provided. Both detector pipe work and air supply line shall be terminated with flanged ends. Piping shall be GI to IS 1239 medium grade. Instrument air shall be supplied at a specified pressure by the owner. Vendor shall supply suitable air pressure regulator.

In addition to above an electric pressure switch shall be provided to give alarm at "Low air pressure" and "fire condition". Low air pressure alarm shall be set at 1.7Kg/cm2 while for fire it shall be set at 0.7Kg/cm2. When fire occurs and deluge valve opens, the two alarms shall be given in rapid succession.

Provision for changing the set pressure of both the alarms shall also be provided. A test plunger shall be provided to test the alarm switches without disturbing the valves.

An additional low air pressure alarm shall be provided to indicate low-low air pressure at approx. 1.4 Kg/cm2. The alarm switches shall thus activate at low pressure of 1.7 Kg/cm2 and dangerously low pressure of 1.4 Kg/cm2 along with alarm to initiate warning of fire. Vendor shall confirm these set pressure based on inlet water supply pressure.

For manual remote operation of the valve, solenoid operated air release valve or gas based detection system activated valve shall be provided.

5.6 Installation stop valve and outlet valve above deluge valve shall be as per IS:780 class PN 1.6. In addition following provision shall be made:

Both the valve must be strapped (not chained) and padlocked in open position at all normal times. End flanges of both the valves shall be flat face, dimensions confirming to ANSI B 16.5 150 lb rating.

5.7 The deluge valve shall be tested for operation / opening at set pressure and operation of the alarms at set pressures.

5.8 For testing and setting of deluge valve, a priming valve and a vent shall be provided with deluge valve assembly. At all normal times and when testing the deluge valve according to various tests required, the body of the deluge valve shall remain full of water.

5.9 Pressure guage shall be fitted immediately above the deluge valve on water supply line. Another pressure guage shall be provided on detector pipe work manifold.

Pressure gauge shall be bourdon type and shall be weather proof to NEMA-4. Vendor shall specify the range of the pressure gauge and also submit detailed

specification / data sheet of the instrument.

5.10 The complete valve assembly shall be of good workmanship and furnish and shall be free from burrs and sharp edges. All waterways shall have smooth finish.

5.11 The deluge valve shall be tested for a test pressure of 25Kg/cm2.

6.0 INSPECTION AND MARKING

6.1 Owner / MECON shall have access at all reasonable times to the manufacturer's works where the deluge valve assembly are being manufactured or being tested.

6.2 Deluge valve assembly shall be clearly permanently marked with the purchaser's name, design and test pressure.

7.0 INFORMATION REQUIRED FROM VENDOR

7.1 The vendor shall furnish the following information alongwith the offer and for approval, prior to fabrication-

a) General arrangement of deluge valve assembly and elevation.
b) Constructional features of deluge valve assembly
c) Data sheet of the deluge valve
d) Initial setting procedure and details of deluge valve
e) Automatic and manual operational procedures
f) Periodic testing and safety procedures.

7.2 Following information shall be furnished by the vendor along with the supply of the deluge valve:

7.2.1 Instruction books for the guidance of the user including both the operating and normal maintenance procedures. The books shall include an itemised and illustrated part list / spare parts list giving reference no. of all the wearing parts.

7.2.2 Duly approved final drawings listed above in clause 7.1

STANDARD SPECIFICATION FOR GAS / CLEAN AGENT FLOODING SYSTEM

SPECIFICATION NO: MEC/TS/05/28/081/06

(OIL & GAS SBU)
MECON LIMITED
DELHI

1.0 SCOPE OF SUPPLY OF EQUIPMENT AND SERVICES

1.1 GENERAL

Fire in strategically important places like computer rooms, control rooms, switch gear rooms, data storage rooms, server rooms, museum, data storage archives, libraries, laboratories etc. is a serious hazard to highly precious and irretrievable items and properties. Occurrence of fire besides leading to personnel injuries and property damage also leads to loss of productivity and precious time. The primary cause of fire may be due to short circuit / overheating of certain components somewhere in the areas. Since most of the areas are unmanned and completely closed, fire inside is not visible and accessible from outside till it becomes too big, dangerous and unmanageable.

Fire suppression with conventional water-based systems such as hydrant or sprinkler system can damage the assets permanently. Therefore for these costly & critical areas, the Fire Protection System envisaged calls for early detection of fire and quenching the same by flooding the area with gas based fire suppression system besides giving out an audio visual alarm. The system considers and addresses possible Fire Hazards within the protected volume at the incipient stage and provide for highest degree of protection and minimum extinguishing time..

1.2 SCOPE

1.2.1 This specification for clean agent (environment friendly) based fire suppression system covers design, supply, fabrication, erection, testing and commissioning complete with all mechanical and electrical items as elaborated in the specification. The system shall consist of the following as mechanical / electrical / instrumentation / hardware / software part of the system.

- Gas agent
- Agent storage container with cylinder valve, pressure gauge
- Discharge Nozzle(s)
- Solenoid valve(s) and Pneumatic Actuator(s)
- Manual Release Valve / Manual Actuator(s) for discharging of gas in case automatic actuation fails

- Check valves
- Mounting brackets
- Discharge hoses
- Audio-visual Alarm Unit for indicating incidence of fire
- Manifolds and piping with fittings
- Inter-connecting Actuation hoses
- Electrical Cables from alarm initiating devices to the panels with required conduits as per the direction of purchaser / consultant.
- Gas Release Panel
- Detectors
- Any other item(s) required for the completeness of the system

1.2.2 The system shall have an interfacing with Main Fire Alarm & Control Panel of the plant. In case of fire in the concerned panel, indication & alarm should come in Main Fire Alarm & Control Panel.

2.0 REQUIREMENTS FROM VENDORS AND SPECIFIC TECHNICAL REQUIREMENTS

2.1 The Vendor shall be either Original Equipment Manufacturer (OEM) or any one of the approved International / National Distributor authorised and certified by the parent company for manufacture and / or marketing of their Fire Protection Systems.

2.2 The distributor shall have an established relationship with the OEM and they should hold the distributorship prior to submission of bid.

2.3 The Vendor should have received technical training on design, installation and commissioning of the systems from the principal and training certificate to this account from the principals should be submitted.

2.4 The OEM / Vendor shall give a certificate stating that their system as a whole along

with equipments, components, flow calculation software etc. is approved by UL / FM / ULC / LPCB.

2.5 The gas being used for the system shall have a Chief Controller of Explosives, Nagpur Certified filling station in India. The filling station should also be UL approved. The filling station should have Gas Chromatography facility to test the purity and chemical properties of the gas, if required.

2.6 The system flow calculation shall be carried out on certified software, suitable for the Seamless Steel Cylinder being offered for the project. Such system flow calculations shall also be approved by UL / FM / LPCB / ULC. The system flow calculation software developed The system flow calculation software developed for Welded Cylinder parameters, and subsequently modified to suit the Seamless Cylinder parameters, shall not be admissible unless the modifications too, are tested, certified and listed by UL / FM / LPCB/ULC.

2.7 The system shall UL/FM/LPCB/ULC certified technology that allows for a higher capacity to overcome frictional losses and allow for higher distances of the agent flow and also allow for better agent penetration in enclosed electronic equipments such as Server Racks/ Electrical Panels etc.

2.8 All system components shall be new and of current manufacture. These shall be installed in accordance with local codes. Systems containing components that have a dated life span and need periodical replacement shall not be acceptable.

2.9 The Vendor shall provide all documentation such as Cylinder Manufacturing Certificates,
Test and Inspection Certificates and Fill Density Certificates.

2.10 The tender drawings and Schedule of Quantities enclosed are for basic guidance of the Vendor. It shall be the responsibility of the individual Vendor to ensure the completeness of the gas flooding system as per area and volume of the protected risk.

2.11 The Contractor shall specifically prepare all the shop drawings. These drawings shall show the quantity, location, and marking of all system components included. The drawings shall also describe and indicate the routing of all piping, wiring for detectors and conduit layouts.

2.12 System electrical schematics and diagrams shall be provided, including a description of all interlock functions.

3.0 DESCRIPTION OF THE SYSTEM

3.1 Gas based flooding system (Clean Agent System) mainly consists of pressurized Gas

cylinder filled with clean gas (FM200 / NAF / HFC227/ Inert Gas / Halon replacement system etc.) and automatic detection (through smoke and heat detectors) and release of extinguishing media / suppression agent. The suppression system shall provide for high-speed release of Gas on the concept of total Flooding of the enclosed areas. A Uniform extinguishing concentration shall be maintained inside the protected area all over as applicable and approved by the manufacturer/NFPA 2001/UL/LPCB/ULC.

3.2 The temperature of gases considered for extinguishing shall be 70 deg F, or higher as recommended by the system / agent manufacturer.

Extinguishing Agent	Design Concentration v/v%	Design Concentration Kg/m3
FM 200 / HFC 125, 227 - NAF S125/ Inert Gas / Halon replacement (Environment Friendly)	8 or as per UL approval or as stipulated in NFPA 2001	As per NFPA 2001 stipultions

3.3 The system discharge time shall be 10 seconds or less or chemical based gases and 60-120 sec for inert gases, in accordance with NFPA standard 2001. Sub floor and the ceiling void to be included in the protected volume. Care should be taken to locate all agent storage containers as close to the protected area as possible to ensure complete liquid discharge of the suppression agent within 10 seconds.

3.4 The Fire Suppression System shall include a detection and control system provision for both pre-alarm and automatic agent release. The detection and control system that shall be used to trigger the Fire suppression shall employ cross zoning of Laser and Multi-criteria smoke detectors. A single detector in one zone activated, shall cause in alarm signal to be generated. Another detector in the second zone activated, shall generate a pre-discharge signal and start the pre-discharge condition.

3.5 The discharge nozzles shall be located in the protected volume in compliance to the limitation with regard to the spacing, floor and ceiling covering etc. The nozzle locations shall be such that the uniform design concentration will be established in all parts of the protected volumes. Aluminum / Brass Discharge nozzles shall be used to disperse the clean gas agent. The nozzles shall be brass / Aluminum with female threads and available in sizes as advised by the OEM system manufacturer. Each size shall come in two styles: 180° and 360° dispersion patterns. The nozzles provided shall be UL listed /LPC/ULC/Vds approved. The final number of the discharge nozzles shall be according to the OEM's patented and certified software, which shall also be UL / FM / LPCB / ULC approved.

3.6 In the event of fire, the signal through detectors reaches Gas Release Panel. The Gas discharge shall be activated by an output directly from the Gas Release Control Panel, which will activate the solenoid valve and the gas stored in the cylinder will get released through the discharge nozzles located in the protected volume. The Gas agent

is stored in the container as a liquid. The drop of pressure in the cylinder followed by reduction in the weight of the gas cylinder due to discharge of gas will activate an audio-visual alarm unit which will be interfaced / connected with the main fire control system.

3.7 The required gas quantity and size of the cylinder is selected based on the volume (Cu.M.) of the protected area. The gas should be environment friendly and should not leave any residue, has less refilling cost, local availability and no damage to protected equipment after fire suppression.

4.0 EQUIPMENT DETAILS

The main features of the system are:-

- Automatic Detection of Fire
- Automatic Flooding of Gas
- Activation of Audio Visual Alarm Unit
- Manual Release Valve option
- Indication & Alarm in main fire alarm & control panel

4.1 STORAGE CYLINDER ASSEMBLY

4.1.1 A self-activating pressure valve and a cyfen tube inside the cylinder shall be fitted to the cylinder through which the piping shall be connected. The valve shall contain a pressure regulator, to retain gas pressure in the cylinder.

4.1.2 In the event of detection by Smoke / Heat Detectors, the Control Panel will energise solenoid valve (electric operated) or pneumatically operated device which releases the agent through the pneumatic operated pressure valve.

4.1.3 The storage cylinders offered shall be Seamless type (UL listed), meant for exclusive use in the above gas systems, with FM/UL/LPCB/ULC component approval. Welded cylinders are not permitted.

4.1.4 The storage cylinders shall be made of Manganese steel DS658 using hot spinning process and heat-treated at 860`Centigrade for 30 minutes. These cylinders should have satisfactorily undergone air leakage test, bend test etc.

4.1.5 The cylinders should have concave bottom and neck threading to IS:3224-1979 14TPI Type-4.

4.1.6 The design drawings etc. including the cylinders shall be approved by CCOE, Nagpur.

4.1.7 The cylinders shall confirm to IS:7285 specifications, inspected and certified by BIS for permission for filling the gas.

4.1.8 The cylinders shall be individually numbered and subject to hydrostatic stretch test at a pressure of 250 Kg/Cm2 as required under rules 39 to 42 of the Gas Cylinder Rules 1981.

4.1.9 Gas storage cylinders shall be provided with a safety rupture disc. An increase in internal pressure due to high temperature shall rupture the safety disc and allow the content to vent before the rupture pressure of the container is reached. The contents shall not be vented through the discharge piping and nozzles.

4.1.10 Gas containers shall be equipped with a pressure gauge to display internal pressure. The gauge shall be an integral part of the container and shall be color-coded for fast referencing of pressure reading.

4.1.11 Flexibility in changing any cylinder in the bank shall be made available through proper system procedures. Non availability of any cylinder of the bank should not restrain from operating the bank.

4.2 MULTI-CRITERIA DETECTOR

4.2.1 The Multi-criteria detector shall have multi sensor, which combines optical, and heat detection along with microprocessor controls with analogue communications. The detectors shall have 2 auto learn sensitivity settings, 3 fixed photo thermal settings and thermal only detection mode, Twin LED for 360deg visibility.

4.2.2 The technical parameters for smoke and heat detector should be as follows:

Supply Voltage	:	9 to 33V
Average Quiescent Current at 24V	:	45µA
Average Quiescent Current at 9V	:	21µA
Alarm Current at 24V	:	52µA
Alarm Current at 9V	:	17µA
Alarm Indication	:	red LED
Normal Operating Temperature	:	-20 to +60°C
Max wind continuous	:	10 m/s

4.3 MANUAL RELEASE VALVE

4.3.1 The Manual Release Valve is intended for activation of the Gas system manually. The releasing of Gas Cylinder(s) shall also be possible through direct mechanical actuation, providing a means of discharge in the event of total electrical malfunction. It shall consist of a Ball valve actuator mechanism. The valve shall be operated by pulling out the locking pin and turning the knob to the "ON" position to actuate the system instantaneously.

4.3.2 The manual release device fitted on the Gas Cylinder(s) shall be of a manual lever type and a faceplate with clear instruction of how to mechanically activate the system. In all cases, gas cylinders shall be fitted with a manual mechanical operating facility that requires two-action actuation to prevent accidental actuation.

4.3.3 Manual Gas Discharge stations and Manual Abort Stations, in conformance to the requirements put forth in NFPA 2001 shall be provided.

4.3.4 Testing equipment for smoke and thermal detectors shall be provided by the contractor.

4.4 MASTER CONTROL UNIT / GAS RELEASE PANEL (GRP)

4.4.1 Master Control Unit / Gas Release Panel shall be Micro Controller based intelligent / Addressable control panel with battery charger and stand-by batteries located in control room. The PCB's controls, Displays, switches etc. shall be housed in this prefabricated anodised aluminium structure. It should be capable of monitoring the status of Solenoid valve and overall Gas flooding system in all the preset different zones on continuous basis.

4.4.2 The Panel shall have 2 x 40 character LCD display and have a capacity of 198 devices per loop .The panel should have LED indications for all zones, complete with internal sounder and alarm/fault indications The panel shall be capable of enhanced features such as inbuilt printer and auto dialer interface, by addition of extra cards/ field modules on the motherboard.

4.4.3 The system shall operate on 230V-AC and shall have battery backup for atleast 6 hours. GRP shall communicate with all the audio-visual alarm units once in every 70 Msec to understand their status. If there is any fault / fire condition sensed by the Smoke / Heat detector, the GRP will indicate zone area.

4.4.4 In case there is loss of gas in any Gas cylinder, the system shall give fault indication.

4.4.5 The GRP shall have LED indicators for power on, zone wise indication for fire, zone

wise indication for fault, bigger fire indication, test & isolate condition, Gas cylinder status, power backup status, charger on, battery low conditions etc.

4.4.6 It should also have switches for lamp / alarm test, buzzer mute, and power on and fire acknowledgement.

4.4.7 Release of Gas agent shall be accomplished by an electrical output from the Gas Release Panel to the solenoid valve and shall be in accordance with the requirements set forth in the current edition of the National Fire Protection Association Standard 2001.

4.5 AUDIO-VISUAL ALARM UNIT

4.5.1 The Audio-Visual Alarm Unit is located at the respective zones at convenient place near the panels fitted with Gas flooding system. This unit shall also be micro controller based and shall be housed in prefabricated anodised aluminium rack.

4.5.2 The unit shall monitor the status of all the Gas cylinders and the piping system installed inside the rooms to be protected. In case of fire, there shall be loud audio-visual alarm and the sound level shall be 100db.

4.5.3 The unit works on 24 V DC supply provided from the master control unit. It should have LED indication for power on, fault, Gas cylinder status, power backup status and also switches for lamp / alarm test, buzzer mute and fire acknowledgement. The AVA Unit shall respond to the Master Control Unit / Gas Release Panel based on the commands received.

4.6 POWER BACKUP WITH BATTERIES, CHARGER UNIT

4.6.1 The main control unit shall be provided with a power backup so that it is operational in case of 230V-AC power supply failure. The power backup shall not be less than four hours. Two nos. of 12 Volts maintenance free Batteries backup of Exide make connected in series (24V) shall be provided to the system.

4.6.2 Built in battery charging facility shall be provided using high quality charging IC's. The system shall continuously maintain the status of the battery. If the battery level becomes less than the predefined level of 20volt, the charging circuit will start charging the battery. At that time, charger on indication shall be displayed on the MCU.

4.6.3 In case the battery voltage becomes less than 18 volt, it should give a battery low indication and also charger on indication. When battery voltage reaches 27 volt, the

charger circuit shall display the fully charged indication. When the system works on emergency battery backup, the battery backup working indication should glow.

4.7 HARDWARE ITEMS (Brackets, Manifolds, Hoses, piping with fittings, Fasteners)

4.7.1 Standard fittings of reputed manufacturers should be used for completing the job. All the Major components of the Gas suppression system shall be supplied by one single manufacturer under the same brand name to the extent possible.

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4.8 ELECTRICAL CABLES

4.8.1 Electrical cables as per Indian Standard specification shall be used for inter connection of the master control unit to audio visual alarm unit, from audio visual alarm unit to various Gas / Clean agent cylinders. Cables shall be made up of 3 nos. twisted pair copper wire of 1.5 sq.mm. Cables shall be routed through M.S. conduit pipes, which shall be painted red.

4.9 WEIGHT MONITORING SYSTEM

4.9.1 The weight monitoring system shall be designed to monitor the weight of the Clean agent gas filled in the cylinders. It shall have load cell of high quality and precision with associated electronics and a cylindrical ring for holding the cylinder in place.

4.9.2 The load cell shall operate in the 5` Centigrade to 70` Centigrade range. The temp. affect on the span should not be more than 0.006% and the effect on tare shall be 0.008%. The safe overload provision is 200% of the rated capacity of 100 Kgs. The protection class code is IP-68. The system shall use beam type load cell.

4.9.3 In the event of reduction in the weight of the gas in the cylinder (either due to leakage or release of gas) beyond the preset limit (1.5Kg in the preset condition), the electronic circuitry provided in the unit shall activate the respective audio visual alarm unit and annunciates the occurrence of fault or fire.

5.0 TESTING

5.1 The Fire panel and Detectors will be tested as per the testing procedure of Intelligent Fire Alarm and Detection System.

5.2 The alarm will be generated from the fire alarm panel and the gas release panel should start the timer and the signal to valves.

5.3 The gas release panel will also be tested for its functioning of the manual override

and the manual discharge.

5.4 The valves will be removed from the cylinder and the actuation of valves will be tested for its performance.

5.5 The Vendor has to provide required quantity of colored nitrogen gas for testing the release of gas in each area.

5.6 The Vendor will provide testing with one cylinder of Gas for testing the complete system & quenching the fire. After testing the Vendor will refill and fix the cylinder in the main system at no additional cost.

5.7 Acceptance for the System installation, inclusive of the piping and requisite cabling shall be strictly in accordance with the installation acceptance guidelines as put forth in the NFPA 2001. The Vendor shall be required to carry out a simulation test [with the Electrical Solenoid on the Gas bank (/ Cylinder) disenabled / disengaged so as to prevent discharge of gas], and prove the functionality of the System.

6.0 REFILLING AND MAINTENANCE

In case of any leakage or accidental discharge of the agent, it should be possible to refill the cylinders in a UL Listed Filling Station or an UL Approved Alternate Manufacturing Location (AML) in India itself. The contractor should indicate the source of refilling and time that will be taken for refilling and replacement.

7.0 WARRANTY

System shall be warranted for parts and labour for a period of one (1) year from the date of commissioning of the system. The Contractor shall specify the maintenance to be performed during the warranty period to maintain warranty conditions.

8.0 CODES & STANDARDS, DESIGN CRITERIA

STANDARDS

8.1 All materials, equipments, piping, valves, fittings etc. dimensional standards, tolerance, prices of manufacture and testing procedure shall be in accordance with the latest revision of relevant Indian, British, American standards wherever applicable.

8.2 The material used and equipment supplied shall be new and the best of their kind and shall comply with the latest revisions of all relevant standards. The tenderer shall indicate in his tender the relevant standards to which the equipment, piping, fittings, etc. offered by him shall comply with. The latest revisions of applicable standards indicated in the technical specification shall be used for the design, manufacture,

inspecting and testing of the items covered in this specification. The following codes and standards shall be considered for design: -

a) UL: Underwriters Laboratory
b) FM: Factory Mutual
c) NFPA 2001 standard on Clean Agent Fire Extinguishing System;
d) SMPV Rules 1981, CCE Nagpur (for storage of cylinders)
e) Clean agent manufacturer's recommendation
f) Relevant OISD Standards
g) National Building Code of India
h) TAC Guidelines

DESIGN CRITERIA

FOR GAS BASED FIRE SUPPRESSION SYSTEM

System Design for the Control Room of size: As indicated in SOR

S.No.	Description	Calculation

1.	Overall Room Dimensions including all rooms to be protected approx. (Mtrs)	As indicated in SOR
2.	Total Volume (M3)	To be furnished by the Vendor
3.	Design Concentration (% by Volume)	6-8 or as recommended in NFPA 2001
4.	Design Concentration (Kg./M3)	As per NFPA 2001 stipulations
5.	Design Temperature	21 deg C
6.	Basic Gas quantity required (Kg.)	To be furnished by Vendor
7.	Adjusted Agent Gas quantity Required (Kg.)	To be furnished by Vendor

Annexure-I (For Gas Flooding system)

Technical data sheets details to be furnished by the vendor along with the Offer. (Data sheets shall be filled in separately for the Clean Agent System as per NFPA 2001/ISO 14520

1.0	Type of System Total flooding system (Mention name of agent & manufacturer).	
	Formula	
	Normal Charging Pressure (Bar)	
2.0	Design code/ standard to which design/ manufacture/ testing conforms (NFPA 2001/ISO 14520 (Latest)	
3.0	System designed to protect the largest or total risk in the building as specified.	
3.1	Risk Name	
3.2	Design Concentration	
3.2.1	Amount of gas required (Attach separate sheet, if required). (List out gas supplied, number of cylinders etc. for working and standby requirements risk wise).	
3.3	Gas cylinder details (Seamless)	
A	Manufacturer	
B	Design Code	
C	Capacity	
D	Gas holding Capacity (Kg)	
E	Total number supplied	
F	Approving agency	
G	Approval by CCoE (Yes/No)	
H	Working pressure (Bar)	
I	Design Pressure (Bar)	
3.4	Pipes, valves and fittings	
A	Materials for Construction	
	Pipes	
	Fittings	
	Valves	
B	Design Code	
	Pipes	
	Fittings	
	Valves	

	Type of Joints	
C	Hydraulic test pressure of manifold/ supply lines (Bar)	
d	Directional valve	
	i) Test Pressure (Bar)	
	ii) Approved by UL/FM (Yes / No)	
e	Discharge Nozzles	
	i) Number supplies	
	ii) Approved by UL/FM (Yes / No)	
f	Pressure switch	
	i) Approved by UL/FM (Yes / No)	
g	Pressure Gauge	
	i) Pressure Range	
	ii) Approved by UL/FM (Yes / No)	
h	Pressure Reducer	
	i) Approved by UL/FM (Yes / No)	
i	Cylinder Valve	
	i) Make	
	ii) Approved by UL/FM (Yes / No)	
j	Cylinder valve actuator	
	i) Approved by UL/FM (Yes / No)	
3.5	Operating Devices	
3.6.1	Signal from the Gas release control panel for shutting off the air handling unit and damper closing.	
3.6.2	Push Button Station	
	i) Type	
	ii) Manufacturer	
	iii) Model, numbers offered	
	iv) Overall dimensions	
3.6.3	Control cables	
	i) Manufacturer	
	ii) Code/ standard	
	iii) Type	
	iv) Size	
	v) Rating	
3.7	Main control panel	
	i) Manufacturer	
	ii) Mounting Detail	
	iii) Number of entries	

	iv) Sheet Thickness	
	v) Cable entry	
	vi) Total heat load predicted for air conditioning	
	vii) Nos. of AC/DC feeders and their rating	
3.7.1	Additional requirements for control panel	
a	Whether housing all the necessary printed card circuits, board cards, relays indicating lamps, push	
	buttons, switches, etc for the efficient operation of the system (Yes/No)	
b	Input power supply requirement for operation of panel (AC/DC volts)	
c	Panel signal Voltage (AC/DC volts)	
d	Type APM/ Capacity of the battery	
e	Interconnecting cabling between battery and panel	
f	Power supply unit incorporated in the panel (Yes/No).	
g	Audio visual alarm on panel provided for battery low conditions (Yes/No)	
h	Change over from AC Main supply to standby power supply fully automatic in either direction (Yes/No)	
i	Following push buttons provided	
	i) Alarm	
	ii) Reset	
	iii) Test (Yes/No)	
j	Audio visual indication for AC supply failure provided (Yes/No).	
k	Pilot lamp for system AON@supply failure provided (Yes/No)	
l	Dual tone hooter for fire / fault alarm provided and range of the same	
m	Painting (External / Internal)	
n	Low pressure alarm to indicate level	
4.0	Material of Construction selected in accordance with Specification (Yes/No)	
5.0	Inspection and Testing	
a	Visual inspection of installed system &	

	hazard area	
b	Check of labelling of devices	
c	Check for mechanical tightness of piping & associated equipments	
d	Non-destructive operational tests for all devices included	
e	Test with N2 gas for all risks (Yes/No)	
6.0	Confirmation regarding the size of cylinders room provided (Main + 100% standby) (Yes/No)	
7.0	100 % reserve cylinder with all accessories (YES/NO	
8.0	Battery back-up for 24 hrs (YES/NO)	

STANDARD SPECIFICATION
FOR
FIRE DETECTION
AND
ALARM SYSTEM

SPECIFICATION NO: MEC/TS/05/28/081/11

(OIL & GAS SBU)
MECON LIMITED
DELHI

CONTENTS

1.0 SCOPE

1.1 This specification covers the design, engineering, manufacture, testing, packing and supply of automatic and manual Fire Alarm System incorporating manual call points (break glass boxes), automatic detectors, release and inhibit switches for fire suppressant clean agent, data gathering, fire alarm and central fire alarm panels, conventional or computer aided (microprocessor based) mimic panels and associated equipments as specified hereunder and in data sheets / drawings.

2.0 CODES AND STANDARDS

2.1 The fire alarm system and the components used shall confirm to the latest edition of the following and also the other Indian and international Standards as applicable.

2.1.1	IS-5	Colours for ready mixed paints and enamels
2.1.2	IS-513	Specification for cold rolled low carbon steel sheets and trips.
2.1.3	IS-2175	Specification for heat sensitive fire detectors for use in automatic fire alarm system.
2.1.4	IS-2189	Code of practice for selection, installation and maintenance of automatic fire detection and alarm system.
2.1.5	IS-3700	Essential ratings and characteristics of semiconducting devices.
2.1.6	IS-3826 Part-I	Connectors for frequencies below 3 Mhz General requirements and tests.
2.1.7	IS-5469	Code of practice for the use of semi-conductor junction devices
2.1.8	IS-5780	Intrinsically safe electrical apparatus and circuits
2.1.9	IS-11360	Specification for smoke detectors for use in automatic

electrical fire alarm system.

2.1.10	BS-5839 Part-2	Specification for manual call points
2.1.11	NFPA 72	National Fire Protection Association
2.1.12	LPC	Loss Prevention Council Recommendation

2.2 Wherever the requirements of this specification are in conflict with any of the standards mentioned above, the requirements of this specification shall be binding.

2.3 In addition to the above, all equipment shall confirm to the provisions of Indian Electricity rules, Tariff Advisory Committee and other statutory regulations in force from time to time.

3.0 SITE CONDITIONS

3.1 All the equipments shall be suitable for the site conditions specified in the enquiry document / data sheets. If not specifically mentioned therein, a design ambient of 40`C and an altitude not exceeding 1000m above mean sea level shall be considered with a minimum temperature of 10`C for battery sizing.

4.0 GENERAL REQUIREMENTS

4.1 Unless otherwise specified in the enquiry documents, all the equipments shall be suitable for installation in safe, non-hazardous area and shall confirm to the recommendations of Tariff Advisory Committee.

Equipments to be located in hazardous areas shall have certification for use in such areas by the recognised testing and certification authorities, such as 'CMRI', Dhanbad, BASEEFA (UK), UL (USA) etc., or the relevant authorities of the country of origin. Equipment for hazardous areas shall be approved by CCE / DGMS / DGFASLI, as applicable, and all indigenous equipments shall be covered under a valid BIS licence.

4.2 **Power Supply**

The Fire Alarm System shall be suitable to receive the power supply as given below:

a) Voltage : 110V / 240V ± 6% (field selectable),
b) Frequency : 50Hz ± 3%, 1 phase

Further distribution shall be vendor's responsibility. Any voltage, other than the above shall be internally derived by the vendor within the system.

4.1.2 The battery back-up shall be capable of maintaining the system in normal operation for a period of not less than 48 hours after the failure of normal mains supply, after which sufficient capacity shall remain to provide full load operation for at least 30 minutes.

The full load shall be considered as the load caused by the operation of all alarm sounders operating simultaneously, operation of detectors in at least 25 percent of the zones and the operation of fault indicators.

The switch over from mains to batteries shall be automatic, in the event of a mains failure.

Ni-Cd / Lead Acid / Sealed maintenance free batteries, as specified in data sheets and suitable battery charger shall be provided for each system.

5.0 FIRE MONITORING AND ALARM PANEL

5.1 Fire sensed by the field equipments shall be monitored by Fire Alarm Panels located in plant control rooms. Fire Alarm panels can be either conventional type using digital electronic techniques or computer aided microprocessor based analogue addressable type, as specified in the enquiry documents / data sheets.

5.1.1 The conventional system shall generally comprise of the following equipments used in conjunction with conventional automatic fire alarm detectors and manual call points. Exact requirements shall be specified in enquiry documents data sheets.

a) Central Fire Alarm Panel with Mimic
b) Zonal Fire Alarm Panel
c) Repeat Alarm Panel / Annunciation Panel

5.1.2 Microprocessor based system shall generally comprise of the following equipments used in conjunction with analogue addressable automatic fire alarm detectors and manual call points. Exact requirements shall be specified in enquiry documents / data sheets.

a) Central Fire Alarm Panel / Central Processing Unit
b) Data Gathering cum Fire Alarm Panel (DGFAP)
c) Repeat Alarm Panel

5.2.2 **Addressable Fire Alarm System (PLC Based)**

5.2.1 **Central Fire Alarm Panel**

5.2.1.1 Central fire alarm panel shall gather information from various Zonal Alarm panels regarding the status of activation of detectors / manual call points etc. on an overall basis.

5.2.1.2 Central fire alarm panel shall house starter control(s) for siren(s), in order to generate an alarm audible in the entire plant in the event of fire.

5.2.1.3 If specified in the enquiry document / data sheets, the central fire alarm panel shall have provision for signals, alarms etc. as specified under clauses 5.2.5.1.

5.2.4 A mimic, unless otherwise specified in the enquiry document shall form an integral part of the central fire alarm panel and shall be located at the top of the panel. If separate, mimic panel shall either be wall mounting or free standing floor mounted type. Two nos. LEDs shall be provided for each zone on mimic panel. It shall derive the power supply from Fire Alarm panel. Mimic panel shall be illuminated through potential free contacts available in fire alarm panel.

LEDs on the mimic panel shall be arranged on a graphic mimic of the plant/area covered by the mimic panel. The LEDs shall be arranged on the basis of zones, unit wise, building wise, detector / manual call point wise or a combination of the above as described in the enquiry document/data sheets.

5.2.2 **Circuit Description and Operational Requirements**

5.2.2.1 The system shall be modular in construction to facilitate future extension/modification and shall include fire monitoring PCB, output relays, annunciatiors, indicating lamps, switches, push buttons etc.

5.2.2.2 Static components shall be mounted on plug-in type printed circuit boards (PCBs). PCBs for identical logic circuits shall be interchangeable. Connections to and from the PCBs shall be taken through gold plated edge connectors only. Plug and sockets of heavy duty type shall be used for PCBs. Card edge connecting pins shall not be acceptable. PCBs shall be coated with the antifungus chemicals on both sides and shall be suitable for tropical climate.

5.2.2.3 “Fail Safe” feature to signal the failure in the circuitry shall be incorporated in the logic circuit and operation of the alarm system shall be on opening normally closed field contact.

5.2.2.4 Test facility through common “Test” push button shall be provided for complete functional test of each group of logic circuits, audio and visual flasher circuit, lamps etc.

5.2.2.5 The annunciation circuit design shall ensure that momentary short circuit in the lamp circuit does not adversely affect the performance of the system. Visual and audible alarm circuits shall be independent i.e. the failure of one will not affect the other.

5.2.2.6 The circuit shall be so designed that silencing of the current alarm by ACCEPT push button shall not prevent initiation of fire alarm in case of subsequent ‘FIRE’ signal received from any other location.

5.2.2.7 The field contact wiring will be carried out by using multicore, copper conductor, PVC insulated and armoured cable which may be running close to power cables. Hence the logic circuitry shall be designed with sufficiently high signal-to noise ration to avoid spurious actuation due to noise induced in the field wiring because of proximity with power cables. Adequate noise filters and time delay shall be incorporated at the input stages to reduce the effect of the noise.

5.2.2.8 A minimum of two lamps shall be provided in parallel for each fire loop to increase the reliability of the visual alarm.

5.2.2.9 Fire alarm loop card shall be capable to receive the signal from break glass box, Heat, UV, IR, ionisation, optical type detector, heat sensing cable, linear beam detector and any combination thereof.

5.2.2.10 Whenever the fire is detected in any zone, both audible and visual (flashing) alarm shall be raised in the fire alarm panel indicating the corresponding location of fire zone. On pressing the 'ACCEPT' push button, the audible alarm shall stop and the lamp shall glow steadily. The panel shall be brought to normal condition by pressing 'RESET' push button (only after the field conditions are normalised). It shall be possible to manually initiate the audio alarm in addition to automatic operation.

If specified in the material requisition / data sheet, the system shall be provided with a siren to be located at a suitable location in the plant. The controls for the siren shall form an integral part of the Fire Alarm Panel. The starter for the siren shall be direct-on-line type, weather proof shall be in an IP-55 enclosure, suitable for outdoor installation. The enclosure shall be epoxy painted fire red, to shade 536 of IS-5.

5.2.3 Zonal Fire Alarm Panel

5.2.3.1 Zonal Fire Alarm Panel shall gather information from various detectors / manual call points connected to its loop. It shall monitor the status of detectors, cable faults etc.

Zonal Fire Alarm Panel shall have provision to annunciate the fire/fault signals received from the detector/manual call points connected to its loops. LEDs shall be provided for visual annunciation and electronic hooters as audible alarm.

5.2.3.2 Additionally LEDs shall be provided for power ON, fault, fire, multiple alarm indication etc. Push buttons shall be provided for alarm accept, hooter reset, LED test etc. Power ON switch shall be provided.

5.2.3.3 Zonal Fire Alarm Panel shall generate output contacts for signals to repeat alarm panels, central fire alarm panel etc. It shall generate potential free contacts for energisation of hooters, exit signs, tripping of owner's AHU and pressurisation system etc.

5.2.3.4 If specified in the enquiry document/data sheets, the zonal fire alarm panel shall have provision for the signals, alarms etc. as specified under clause 5.2.5.1

5.2.4 Repeat Alarm Panel

5.2.4.1 Repeat alarm panels shall generally be constructed as specified in clause 5.4 and shall be wall mounting type.

Repeat alarm panel shall receive signals from Central Fire Alarm Panel or Zonal Fire Alarm Panel shall have provision to annunciate the same using audio-visual annunciation. LEDs shall be provided for visual annunciation and electronic hooters as audible annunciation. Additionally LEDs shall be provided for power ON, fault, fire, multiple alarm indication etc. Push buttons shall be provided for alarm accepts and hooter reset, as well as, for LEDs test. Switch shall be provided for power ON.

5.2.4.2 Repeat alarm panels may either have

a) LEDs arranged in a matrix (rows and columns) along with text engraved alongside each LED indicating the zone where the fault/fire has occurred.

OR

b) LEDs arranged on a graphic mimic of the zones/areas covered by the repeat alarm panel.

5.2.4.3 Repeat alarm panels shall derive power from the associated fire alarm panel.

5.2.5 **Alarm, Signal and Control Requirements**

5.2.5.1 In addition to the initiation of fire alarm, zonal, central fire alarm panels shall have the facility for following status signals, status alarms and shutdown signals if specified in data sheets / drawings.

i. Automatic signal for release of clean agent/CO_2 release for protected area and release alarm in control room.

ii. Selector switches for primary or secondary clean agent/CO_2 supply for each skid / protected area.

iii. Manual push button for discharge of clean agent/CO_2 in each protected area (after alarm and 30 seconds time delay).

iv. Clean agent/CO_2 discharge inhibit push button for each protected area.

v. Deluge valve activation push buttons, deluge valve test push buttons and deluge valve activated status lamps.

vi. Shutdown signals to various air handling units relative to the zone of fire.

vii. Fire water pumps running indications.

viii. Fire water pumps start push buttons.

ix. Controls of sirens.

x. Repeat alarm signal to various control rooms.

xi. Repeat alarm signal to mimic panel.

xii. Repeat alarm signal to repeat alarm panel.

xiii. Status of Battery Conditions.

5.3 Computer Aided Fire Alarm System

The microprocessor based analogue addressable fire detection and alarm system shall be computer aided utilising distributed processing techniques. The system shall include the following as a minimum.

5.3.1 Central Fire Alarm Panel (CFAP)

5.3.1.1 The CFAP or central processing unit shall be a special purpose microprocessor operating under software program which shall provide central control and monitoring functions of the entire fire alarm system.

5.3.1.2 CFAP shall communicate with various Input / output devices, DGFAPs, repeat alarm panels, I/O multiplexer, mimic panels, industrial grade PCs, Visual Display Units (VDU), key boards, printers etc. located at central / various locations in the plant.

5.3.1.3 CFAP shall have the facility to scan the data received from the DGFAPs and shall send necessary information to the respective DGFAPs, repeat alarm panels, VDUs etc. through bi-directional communication network.

5.3.1.4 CFAP shall be modular in design and shall contain 100% redundant microprocessor based master unit, processing units, signalling module and power suppl unit. The CFAP shall serve as an interface and controller for connected PCs having graphics/text facility, located at central location and DGFAP panel(s) distributed in various control rooms.

5.3.1.5 CFAP shall be designed specifically for fire alarm and protection system applications and shall provide status, alarm, shutdown signals in predefined manners, initiate alarms, synchronise all activities, provide repeat alarms and other signals as specified.

5.3.1.6 The CFAP shall have non-volatile memory for reliability and shall permit reprogramming by authorised personnel.

5.3.1.7 The CFAP shall provide various event initiated programmes (EIP). EIP shall be initiatred by any of the following user defined parameters; day, time, alarm, return to normal, change of status and hardware failure.

The system shall provide multi levels of command priority to assure that high level commands are not overridden by lower level commands.

5.3.1.8 CFAP shall have the facility to display the affected area on the VDU and provide the instructions to suppress the cause. High resolution graphic software shall be provided for display. The graphics shall have many layers of penetration. The VDU shall either be touc screen type or menu driven using mouse/keyboard. However, instead of graphic display, VDU with only text display shall be provided, if specified in the data sheets.

5.3.1.9 Unless otherwise specified in the data sheet CFAP shall be designed to provide multicolour display on the VDU.

5.3.1.10 Suitable communication interface cards shall be provided in CFAP to interface with DGFAPs, repeat alarm panels etc.

5.3.1.11 PC shall be with a pentium or higher processor with a minimum 100MHZ clock rate, with 8GB hard disk, 3.5” floppy drive, CD drive, 512MB RAM, 64 KB cache memory, serial and parallel ports suitable for the devices connected. PC shall be complete with 101 key key-board with English language characters, 17” colour monitor with SVGA compatibility, non-glare screen with front mounted power switch, brightness/contrast control, horizontal/vertical position and size control etc. The monitor shall be on a swivel base.

5.3.1.12 Monitor screen shall have dedicated areas for the following functions:

- Alarms and returns to normal
- Menus, commands, reports and programming
- Time, day and date

5.3.1.13 Alarms and all other changes of status shall be displayed on the screen area reserved for this information. The following information shall be provided as a minimum:

- Condition of detector (Alarm / Trouble)
- Type of detector
- Location of detector and numerical system address
- Emergency instructions.

On receipt of alarm, an audible alarm shall sound and the condition and detector type shall flash until acknowledged by the operator. Return to normal shall also be annunciated and shall require operator acknowledgement.

5.3.1.14 The system shall have multiple levels of priority for displaying alarms. Should multiple alarms occur, the first received, highest priority alarm shall be displayed on the screen until acknowledged by the operator. Then the next highest priority alarm shall be displayed until acknowledged etc. Should a higher priority alarm occur, the higher priority alarm shall replace the lower priority alarm on the screen and the lower priority alarm shall be retained in memory and re-displayed after the higher priority alarm is acknowledged.

5.3.1.15 The system shall provide sufficient memory so that no alarm shall be lost. A message highlighted in reverse video, shall advise the operator when other unacknowledged alarms are present in the system.

5.3.1.16 The VDU keyboard shall use function keys with English descriptions to initiate all system functions. Typing abbreviations or using unlabeled or numerical function buttons is unacceptable. When a function key is pressed, the monitor shall lead the operator through the function by

asking him to choose one of several clearly defined options (menu penetration). When a specific detector must be addressed, a distinct numerical keypad shall be used to speedup and simplify the operation. On command from the operator, system reports either shall be displayed on the VDU screen or output on the printer, as desired by the operator.

5.3.1.17 Multiple levels of access to the system shall be provided for operators and supervisors via user defined passwords. The following functions shall be provided for each levels:

a) Operator level access functions
- Display system directory, definable by detector type
- Display status of an individual detector
- Manual command (alarm with an associated command i.e. secure / accesses / alarm – shall use the same system address for both functions)
- Report generation, definable by detector type. Reports shall be output on either the monitor or printer, as desired by the operator.

b) Supervisor Level Access Functions
- Reset time and date
- Holiday scheduling
- Enable / disable event initiated programmes, printouts, initiators.
- Enable / disable individual hardware points and system components.

5.3.1.18 Printer used in the system shall provide real time records of the system events and provide system reports on demand.

5.3.1.19 Printer shall be microprocessor controlled, high speed, read only (RO) type.

5.3.1.20 The system printer (PTR) shall be a letter quality dot-matrix printer, 132 character wide and shall have a 96 character set. The printer shall have a microprocessor controlled bi-directional logic seeking head. The printing speed shall not be less than 300 cps in draft mode.

5.3.1.21 The printer shall automatically record in English all alrams, troubles, acknowledgements, return to normal, manual commands, plus those automatic commands selected by the user.

5.3.1.22 Alarms shall be highlighted differently than other traffic and shall be recorded in English, including type, location, time, date and numerical address of alarm detector. Multiple alarms shall be recorded in the order received, regardless of alarm priority. If an alarm is received during the preparation of reports, the printer shall interrupt the report to record the alarm and afterwards resume the report automatically.

5.3.1.23 Automatic (EIP) commands shall be recorded automatically. All changes to system programming shall be recorded automatically.

5.3.1.24 Printer shall use fanfold paper and shall accomodate an original and two copies. Paper shall be tractor fed. Each page shall be automatically timed, dated and page numbered to detect unauthorised removal.

5.3.1.25 Printer shall be desk top unit and shall be styled to match the VDU.

5.3.1.26 The printer shall have an indicator to alert the operator that pape has run out.

5.3.1.27 The printer shall have a self test feature to verify printer operability even when off line.

5.3.1.28 To achieve 100% redundancy, 2PCs, VDUs, keyboards and printers shall be provided for communication with the 100% redundant central processing unit of the CFAP, if specified in the material requisition / data sheets.

5.3.1.29 The central processing unit, along with PCs and their peripherals shall be housed in a console type enclosure made out of minimum 16 guage CRCA sheets..

5.3.1.30 All cabling between the central processing unit, PCs and their peripherals shall be in the vendor's scope. Arrangements shall be made within the console enclosure for distribution of power supply to various equipments.

5.3.2 Data Gathering Cum Fire Alarm Panel (DGFAP)

5.3.2.1 The DGFAP shall act as a control and interface point between manual/automatic fire detectors and the CFAP.

The DGFAP shall be UL listed and FM approved, suitable for application in fire detection and alarm systems. Approvals from agencies other than UL/FM shall be subject to MECON review.

5.3.2.2 All manual/automatic fire detectors shall be connected to DGFAP. Input signals shall be processed by the DGFAP. It shall also have the facility to control all the input data received from different field devices. Field devices can be automatic fire detectors, break glass boxes, switches and process parameters.

5.3.2.3 The DGFAP shall have its own microprocessor and non-volatile memory.

5.3.2.4 The DGFAP shall have the facility to transfer all data to CFAP. It shall be possible to re-programme the operations at site. The DGFAP shall have the capability of stand alone operation in case of communication failure with the CFAP/other DGFAPs.

5.3.2.5 The DGFAP shall have at least the following facilities:

- External power supply with standby backup (Integral charger and battery may be accepted in case SMF batteries are specified in data sheets).
- Alarm and trouble / fault indications, through 2x40 character fluorescent alphanumeric display.
- Self diagnostic facility.
- Interface for data communication to other DGFAPs, CFAP, remote text or graphics displays, repeat alarm panels etc.
- Detector or loop disablement and restoration.
- Message, data storage in non-volatile memory.

- Change/examination of sensitivity of various detectors.
- Hooter with reset facility
- Battery low indication
- Hardwired potential free contacts for shutdown signals etc. as defined in clause 5.2.5.1

5.3.2.6 Simultaneous display of Fire and Fault indication on DGFAP shall be provided on the alpha-numeric display (LED type) with the action message that is to be taken by the operator.

5.3.2.7 All the data gathering panels shall have alarm verification capability.

5.3.2.8 DGFAP shall have repeating facility to remote area. Necessary hardware / software shall be provided for thsi purpose.

5.3.2.9 DGFAP shall provide indications for communication with the CFAP, as well as, alarm and trouble conditions in the sensor loops.

5.3.3 Repeat Alarm Panels

5.3.3.1 Repaet alarm panels shall be fabricated out of 16 gauge CRCA sheets. The panels shall have IP-41 enclosure protection as a minimum. The repeat alarm panel shall be suitable for wall mounting. Cable entry provision shall be from bottom by means of cable glands. The panels shall be epoxy painted fire red to shade 536 of IS-5.

5.3.3.2 Repeat alarm panel shall be capable to receive signals from either the CFAP or the DGFAP and shall have provision to annunciate the same using audio-visual annunciation.

5.3.3.3 Visual annunciation shall be by means of 2x40 character fluorescent display on the panel front. The display shall indicate the detector address, its location, action to be taken in case of fire etc. The display shall indicate the instances of fire and fault.

5.3.3.4 Electronic hooters shall be provided for audible annunciation.

5.3.3.5 Additionally LEDs shall be provided for power ON, fault, fire, multiple alarm indication etc. Push buttons shall be provided for alarm accept and hooter reset, as well as, for LED test. Switch shall be provided for power ON.

5.3.3.6 Repeat alarm panel shall derive power from the associated fire alarm panel.

5.3.4 **Data Highway**

5.3.4.1 Communication betwen CFAP, DGFAPs, repeater panels etc. shall be realised by means of data highway. Unless specified otherwise, data highway shall consist of 1.5mm^2 copper conductor, twisted pair, PVC insulated, PVC inner sheathed, overall screened and overall PVC sheathed cables. Data highway cables shall be 100% redundant, to ensure reliability of communication.

Wherever required, due to cable capacitance limitation, modems shall be employed for data highway communication. In such cases, modems shall be powered as well as located in the respective DGFAPS or CFAP.

5.3.4.2 Alternately, optical fibre cables, may be used as data highway. The fibres shall be as per latest CCITT recommendation for single mode optical fibres and shall be laid in slots/tubes filled-up with moisture resistant jelly. Polymer coated aluminium tape around the cable core shall provide a moisture barrier. Optical fibre cables shall have an inner polyethylene sheath with corrugated steel tape armouring and a polyethylene outer sheath.

5.4 **Panel Construction (Central Fire Alarm Panel, Zonal Fire Alarm Panel, Data Gathering cum Fire Alarm Panel, Repeat Alarm Panel etc.)**

5.4.1 Panel(s) shall be free standing/wall mounting type, made out of minimum 16 gauge CRCA sheets. Doors and covers shall be made out of 14 gauge CRCA sheets. The panel shall be naturally ventilated totally enclosed dust and verminproof with IP-41 enclosure as a minimum. The construction of

the panel enclosure shall be designed to allow for at least 10% expansion for future additions without involving any major modifications in the system. In general, these panels, shall generate/receive/display the required signals for Fire Alarm and Suppression systems.

5.4.2 **Equipment Mounting**

5.4.2.1 All apparatus, instruments and alarm facias mounted on the panel front shall be flush mounted type. The panel wiring shall not be terminated directly on the base connector of PCBs. It shall either be terminated through a separate terminal block or multipin connectors. Routine calibration and adjustments shall be accessible from the front of the panel without having to remove any wiring or causing loss of the panel function. In addition, total removal of the instrument(s) and replacement with a spare shall be possible from the front of the panel.

5.4.2.2 All annunciator components except the alarm horn and auxiliary contact relays (if used) shall be mounted integrally in a protective enclosure. Sufficient spare terminals shall be provided to accommodate all spare / future alarm points in the display. Access shall be provided to permit checking and / or changing the wiring at these terminal strips.

5.4.2.3 Lamps shall be capable for removal and replacement from the panel front via individual snap out windows or a swing out hinged door on which all windows are mounted.

5.4.2.4 There shall be separate hooters for faults/ malfunction and fire alarm having distinct audible tones.

5.4.2.5 Fluroscent lamp(s) shall be installed within the panel to provide adequate lighting for maintenance of equipments. Door interlock switch shall be provided for this purpose.

5.4.2.6 Cable entry shall be from bottom unless otherwise specified in the enquiry document / data sheet. A terminal strip shall be provided for incoming / outgoing cables. Supporting facilities shall be provided for clamping the cables.

5.4.3 Wiring and Terminals

5.4.3.1 Wiring within the panel shall be in slotted plastic raceways enclosed with cover. Interconnecting wiring shall be done with 1 sq. mm. Cross-section, copper conductor, PVC insulated, 660V wires. Power circuit wiring shall be with minimum 2.5 sq.mm. cross section, copper conductor. Panels shall be supplied completely pre-wired including spare points of modules / controllers etc. so that only field termination is required before energisation.

5.4.3.2 Cables shall be terminated on terminal blocks. Clamp type terminals shall be of spring-loaded, stacking type, mounted on rails. Terminals shall be sized to accept as a minimum 2.5 sq.mm. cross section conductors. Not more than one conductor shall be terminated on the outgoing side of each terminal. At least 20% spare terminals shall be provided in each panel.

5.4.3.3 Suitably sized terminals shall be provided for terminating main power supply cables.

5.4.4 Cable Glands

5.4.4.1 All the cable glands for outdoor application shall be weatherproof, nickel plated brass and double compression type, whereas those for indoor application shall be single compression type.

5.4.4.2 Cable glands for hazardous area equipment shall be flameproof, weatherproof and nickel plated brass double compression type.

5.4.5 Earthing

5.4.5.1 A common earth bar of minimum 25 x 3 mm copper or equivalent aluminium shall be provided throughout the length of the panel. All non current carrying metallic parts of the panel mounted equipment shall be earthed. All doors and movable parts shall be connected to the earth bus by flexible jumpers. 2Nos. earth lugs shall be provided outside the panel.

5.4.6 **Name Plates**

5.4.6.1 All name plates for panel shall be engraved out of 3 ply (black-white-black) lamicoid sheets or anodised aluminium. Back engraved perspex sheet nameplates will also be acceptable. Engraving shall be done with square groove cutters. Hard paper or self-adhesive plastic tape nameplates will not be acceptable.

5.4.6.2 All panels mounted equipments (e.g. lamps, push buttons, switches PCBs etc.) shall be provided with suitable nameplates.

5.4.6.3 Labels shall be provided for every component on the cards, connecting wires as well as for the terminals in the terminal strip inside the panel.

5.4.6.4 Special warning plates shall be provided on all removable covers or doors giving access to energised metallic parts above 24 volts.

5.4.7 **Painting**

5.4.7.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The undersurface shall be made free from all imperfection before undertaking the finishing coat.

5.4.7.2 After preparation of the undersurface, the panel shall be epoxy painted with two coats of final paint. Alternatively the panels may be powder coated. The colour shade of final paint shall be as specified in the data sheet. If not specified therein, the final paint shall be fire red, shade 536 of IS-5. The finished panels shall be dried in stoving oven in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust-corrosion. Moving elements shall be greased.

6.0 AUTOMATIC FIRE DETECTORS AND ACCESSORIES

6.1 General Specifications

6.1.1 All the detectors shall be plug-in type and shall have twist lock action fitting. An LED shall be incorporated which shall normally flicker indicating alertness and should turn steady when a fire is sensed, enabling immediate identification of the affected detector.

6.1.2 The mounting base of all type of detectors shall be identical. It should be possible to plug-in any type of detector at any location without changing the base and without distributing the external wiring. The detector housing shall be damage resistant made of polycarbonate or aluminium with plug-in housing base of universal type suitable for either surface or recess mounting. Junction boxes for detector mounting shall be complete with terminal block, etc. Additional terminals shall be provided to fit end of line resistance, wherever applicable.

6.1.3 The detectors, which employ a Radio Active source shall be such that the strength of the Radio Active material shall not exceed 1 micro curie.

6.1.4 It shall be possible to install all type of detectors (manual as well as automatic) in the same fire alarm circuit/loop.

6.1.5 All the detectors shall have inbuilt safety device to monitor the removal and pilferage of the detector.

6.1.6 All the detectors shall be on the approved list of Loss Prevention Council, Under Writers Laboratory (USA) / Factory Mutual (USA) / Tariff Advisory Committee.

6.1.7 All detectors shall be suitable for operation at DC power supply. All analogue addressable detectors shall be suitable for installation using fault tolerant wiring (class-A, style-6 wiring as per NFPA). Tapping shall not be permitted in the case of such wiring.

6.2 All automatic detectors for microprocessor based fire alarm system shall be analogue addressable type. The analogue addressable detectors shall be continuously monitored to measure any change in their sensitivity due to the environment (dirt, dust, temperature, humidity etc.). These detectors shall give an advance indication to the panel regarding the need for maintenance. The analogue reading sent by the detectors shall be sensed and if there is a rapid increase, an alarm shall be generated. However, if there is a gradual increase in the analogue reading, a maintenance alert shall be generated by the DGFAP. It shall be possible to generate maintenance reports from DGFAP.

6.3 All analogue addressable detectors shall preferably have the facility to set the addresses from the DGFAP. Alternately dip switches in the detector base shall be used for setting the detector address.

Manual call points/break glass boxes for microprocessor based fire alarm system shall be addressable type. Each device shall have its own address module which shall send a status signal to the DGFAP regarding its state of actuation.

6.4 **Heat Detectors**

6.4.1 Heat detectors shall be of dual thermistor (negative temperature coefficient resistor)/bimetallic/electro-pneumatic/thermo electric type, working on the two methods i.e. rate of rise and fixed temperature.

6.4.2 The rate of rise element shall be carefully calibrated to ignore any normal fluctuation in temperature, but to respond quickly when the temperature rise is 9`C or more per minute.

6.4.3 The fixed temperature feature should be entirely independent of the rate of rise element. The operating temperature of fixed temperature element should be factory set at 57`C ± 5`C.

6.4.4 The detector shall be self-restoring type ensuring repeated use and easy maintenance.

6.4.5 System should work on both parameters as a cross zoning feature, Also system shall be programmable type so that settings can be changed in accordance with site requirement.

6.5 Ionisation Type Smoke Detector

6.5.1 Smoke detector shall be solid state type, working on ionisation principle and shall preferably be of dual chamber and dual source type.

6.5.2 The radioactive source used in the detector shall not emit beta and gamma rays and the strength of Radioactive material shall not be more than 1 micro curie.

6.5.3 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion like wood, paper, ammonia processing paper, cloth, PVC, bakelite, nylon, foam, acrylic, thermocole, Photo film, nylon, polyester, painted sheets, Teflon, leather etc.

6.5.4 The sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure or permissible voltage variation. Its performance shall not be affected by an air current of 5 meter per second. It shall have an inbuilt arrangement such that puffs of smoke or hot air pockets do not inadvertently trigger the alarm. The detector shall be protected against dust accumulation / ingress. It shall have insect resistant screen to prevent nuisance alarms. All detectors shall be identical in construction, design and characteristics to facilitate easy replacement.

6.6 Smoke Detector With Aspirators

System Specifications

6.6.1 **General**

A Very Early Smoke Detection System shall be installed throughout the areas nominated on the drawings.

The system shall consist of highly sensitive LED-based smoke detectors with aspirators connected to networks of sampling pipes.

The detector shall be equipped with dedicated sensing devices for one or two channels and thus be able to identify instantly which pipe is carrying smoke. The detector should have a flow sensor which should be of twin thermal sensors and the maximum suction pressure should be 400 pa only.

The detector shall be easy configurable to the most widely used sampling pipe network topologies, as defined by NFPA 72.

When required, an optional display unit shall be provided to monitor each detector, and a PC based programming tool shall be supplied to configure the system.

6.6.2 Approvals

The very early smoke detection system must be tested according to the NFPA and bear the CE mark. It must be of a type submitted to, tested, approved, and/or listed by UL/FM/LPCB.

6.6.3 System Description

6.6.3.1 Design Requirements

Shall consist of aspiration unit one or two highly sensitive LED-based smoke detectors, each one forming an independent measuring device for the two pipe networks.

The detection unit shall be able to identify which sampling pipe is carrying smoke.

It shall be modular, with each detector optionally monitored by a display featuring LED bar graphs indicating the smoke density of each pipe network. The system shall be configured by a built-in programming device for standard configurations and a PC based Programmer for more demanding applications.

The system shall allow programming of:

- four smoke threshold alarm levels per pipe (sector);
- time delays;

- faults including airflow, detector, power, filter and network as well as an indication of the urgency of the fault;
- three (3), eight (8) or thirteen (13) configurable relay outputs for remote indication of alarm and fault conditions.

It shall consist of an air sampling pipe network to transport air to the detection system, supported by calculations from a computer-based design modelling tool.

Optional equipment may include SD card based event tracing and data logging, loop interface and/or a high level interface with the building fire alarm system.

Performance Requirements

- Shall be tested and approved according to NFPA-72 to cover upto 2,880 sq.m.
- Shall be approved to provide very early smoke detection and provide four output levels per channel / pipe network. These levels shall be programmable and able to be set at sensitivities ranging from 0.002 – 10% obs. / m.
- Shall report any fault on the unit by using configurable fault output relays or via addressable loop to a Fire Alarm Control Panel (FACP).
- Shall incorporate a flow sensor in each pipe and provide staged airflow faults.
- Suction Power shall be 400Pa.

6.6.4 **Submittals**

Product data and site drawings shall be submitted and shall include pipe layout, operational calculations and performance criteria.

6.6.5 Technology

Both Light Scattering and Particle Discrimination shall be utilised in this device as follows:

The Detection Chamber shall be of the mass Light Scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle discrimination method shall be employed for the purposes of preventing large particles from affecting the true smoke reading.

The Detection Chamber shall be specifically designed for aspirating systems providing smooth air flow for keeping dust contamination and noise dissipation at negligible level.

The detector shall use adaptive algorithms to adjust the sensitivity from that set during commissioning (auto learn mode).

6.6.6 Products

i) Detector Assembly

The unit shall be housed in a mounting box and shall be arranged in such a way that air is drawn from the fire risk and a sample passed through the Smoke Sensing Devices by the aspirator.

The system shall utilise the principle of sampling each of the two pipe networks (sectors) individually and simultaneously. If an alarm threshold level is reached an alarm is indicated and signalled.

The Smoke Sensing Device shall be LED-based type and shall have an obscuration sensitivity range of 0.002 – 10 % Obs. / m.

The Detector shall have four independent field programmable smoke alarm thresholds per pipe (sector) and a programmable time delay assigned to each threshold. The detector shall be suitable to ambient temperature at -30°C to 60°C.

The Detector shall also incorporate facilities to transmit the following faults and warnings

Smoke Sensing Device
Air flow
System
Communication
Power

Faults and Warnings: Warnings shall be considered as servicing or maintenance signals. Faults indicate the unit may not be able to detect smoke.

The detector shall have two separate sample pipe inlets (flow circuits) and must contain a flow sensor for each pipe inlet.

The aspirator shall be a purpose-designed air pump. It shall be capable of allowing for an aggregate pipe length up to 900m in total, (2 pipe runs per Smoke Sensing Device) with a transport time as appropriate NFPA-72 code dictates.

The Assembly must contain 3 relays for alarm and fault conditions. The relays shall be software programmable to the required functions. The relays must be rated at 1 AMP at 30 VDC. Additional 10 relays shall be offered as an option and shall be individually programmable to the desired function.

The Assembly shall be able to be surface mounted to a wall or recessed in the wall cavity (the unit may be inverted in either option).

As an option, the assembly shall have built-in event logging on a removable media (SD card). It shall store smoke levels, contamination / compensation levels, alarm and pre-alarm conditions, operator actions and faults. It shall be capable of storing up to 16 Mio events.

As an option, the assembly shall have built-in data logging on a removable media (SD card). It shall store smoke level, alarm threshold settings and contamination level at one (1) Second interval. Each detector (zone) shall be capable of logging data spanning a period of more than 80 days. Logged data should be recorded using Excel format (.xls) for easy processing.

The two sensing detectors should be independent of each other i.e. a SD can be used to cover more than one area or can provide redundancy in just one area.
The system should have very low fan raise level i.e. noise dissipation (typ.@ 1m) should only be 32 – 43dB.
The detection system should show the level of smoke in the room and should have three ranges of sensitivity.
Flow sensor should be of twin thermal type and the system should have networking capability with RS485.

6.6.7 Displays

A detector Display module located within the detector shall provide the following features at a minimum:

- Three independent LED indicators per zone for detector fault, system fault and fire alarm
- A Reset button for unlatching all latched alarm conditions.

When required, a smoke level display module may be located within the detector featuring a 2 x 10 segment bar graph display.

6.6.8 Programmers

- A programmer module located within the detector shall support the following features at a minimum:
-
- System configuration according to NFPA-72 pipe networks and response classes (A, B or C).
- Initiation of self setup cycle, to automatically configure the detector's alarm threshold settings to suit the current environment.
- Setting of date and time
- Viewing of the 99 most recently logged events
-
- Programming may be performed using a Windows® application running on a PC connected through a USB interface. It shall feature a multi-level password control to support the following features at a minimum:
-
- Viewing of the status of any device in the system.
- Adjustment of relative alarm thresholds for each pipe
- Software configuration for either 3, 7 or 12 relays
- Setting of day/night sensitivity thresholds.
- Initiation of adaptive learning algorithm, to automatically configure the detector's alarm threshold settings to suit the current environment.
- Programmable latching or non-latching relay operation.
- Programmable energised or de-energised relays.
- Programmable high and low flow settings for airflow supervision.
- Programmable aspirator speed control.

6.6.9 Application

- Detection Alarm Levels

- The LED based aspirating detection system shall have four (4) alarm thresholds per pipe (sector). The four alarm levels may be used as follows:

- Alarm Level1(Pre-Alarm)
  Alert someone and activate a visual and audible alarm in the fire risk area.
- Alarm Level 2 (Pre-Alarm)

Activate the electrical/electronic equipment shutdown relay and activate visual and audible alarms in the Security Office or other appropriate location.

- Alarm Level 3 (Pre-Alarm)
  Activate an alarm condition in the Fire Alarm Control Panel to call the Fire Brigade and activate all warning systems.
- Alarm Level 4 (Alarm)
  Activate evacuation action or shut down of systems.

6.6.10 Initial Detection Alarm Settings

- Initial settings for the alarm levels shall be determined by the requirements of the fire zone. However, the setting for Alarm Level 4 shall always appear as 100% on the bargraph scale. Default settings of the unit shall be:

- Alarm Level 1 30% of Alarm Level 4
- Alarm Level 2 50% of Alarm Level 4
- Alarm Level 3 70% of Alarm Level 4
- Alarm Level 4 0.13% Obs/m

- 6.6.11 Fault Alarms

- The Detector Fault relay shall be connected to the appropriate alarm zone on the Fire Alarm Control Panel in such a way that a detector fault would register a fault condition on the FACP. The warnings and isolate relays shall also be connected to the appropriate control system.

- 6.6.12 Power Supply and Batteries

- Power consumption of the device should be below 0.9 Watt (900 mW) under all circumstances (worst case with all LED lit).

- The system shall be powered from a regulated supply of nominally 24V DC. The battery charger and battery shall comply with the relevant Codes, Standards or Regulations. Typically 24 hours standby battery back up is required followed by 30 minutes in an alarm condition.

- Local Power Supply Standards that may apply: NFPA-72

6.6.13 Sampling Pipe Design

i) Sampling Pipe

The sampling pipe shall be smooth bore with an internal diameter of 25 mm. Normally, pipe with an outside diameter of 25 mm and internal diameter of 21 mm should be used.

The pipe material should be suitable for the environment in which it is installed, or should be the material as required by the specifying body.

All joints in the sampling pipe must be air tight and made by using solvent cement, except at entry to the detector.

All pipes should be supported at not less than 1.5 m centres, or that of the local codes or standards.

The far end of each trunk or branch pipe shall be fitted with an end cap.

ii) Sampling Holes

Sampling holes of appropriate size and spacing shall be drilled according to calculations by the engineering tool in compliance with the local code or standard.

Each sampling point shall be identified in accordance with Codes or Standards.

Consideration shall be given to the manufacturer's recommendations and standards in relation to the number of Sampling Points and the distance of the Sampling Points from the ceiling or roof structure and forced ventilation systems.

The Capillary Sampling Network

Where false ceilings are installed, the sampling pipe shall be installed above the ceiling, and Capillary Sampling Points shall be installed on the ceiling and connected by means of a capillary tube.

The Capillary tube shall terminate at a Ceiling Sampling Point specifically designed and approved by the manufacturer. The performance characteristics of the Sampling Points shall be taken into account during the system design.

6.6.14 Air Sampling Pipe Network Calculations

Air Sampling Pipe Network Calculations shall be provided by a sampling pipe aspiration modelling program such as PipeFlow. Pipenetwork calculations shall be supplied with the proposed pipe layout design.

6.6.15 Transport Time

The manufacturers recommended transport time (time taken for the smoke to enter the pipe and reach the detector) for the least favourable sampling point is 120 seconds or less.

6.7 Photo Electric / Optical Type Smoke Detector

6.7.1 Photo electric/optical type smoke detectors shall work on the principle of light scattering, utilising a light emitting diode. The sensitivity of the detector shall be preset by the supplier to suit the site conditions.

6.8 UV Flame Detector

6.8.1 UV flame detectors shall work on the principle of a vacuum photodiode tube to detect the UV radiation that is produced by a flame.

6.8.2 UV flame detectors shall react to ultraviolet rays of a flame. The detector shall not be actuated by artificial lights, sunlight incident through a window pane. False alarm check circuit shall be incorporated to prevent false due to intermittent flash or lightning.

6.9 IR Detectors

6.9.1 IR detectors shall work on the principle of a single wavelength infrared flame detector using one of several different photocell types to detect the infrared emissions in a single wave length band that are produced by a flame.

6.9.2 IR detectors shall react to the infrared rays of a flame. It should be sensitive enough to detect smoky fires in which flame is hardly recognisable. The detector should not react to extremely glaring artificial light or direct sunlight. The detector shall be completely solid state type.

6.10 **Linear Beam Detector**

6.10.1 The linear beam detector shall work on the principle of obscuration of infrared light beam by particles of smoke. The sensitivity shall be such as to enable operation at 30% to 50% obscuration.

6.10.2 Linear beam detector shall consist of separate transmitter and receiver. Linear beam detector shall be suitable for application in high roofed locations such as ware houses etc. The detector shall preferably be powered from the loop signal itself. However if external power supply is required the same shall be explicitly stated by the vendor and the supply shall be supplied from source with battery back-up as specified in clause 4.1.2.

6.11 **Heat Sensing Cables**

VOID

6.12 **Manual Break Glass Boxes**

6.12.1 The break glass box shall be fabricated out of 14 gauge cold rolled sheet steel. Alternately the break glass box may be made of die cast aluminium alloy such as LM6. It shall have IP-55 enclosure and weatherproof construction suitable for outdoor installation. The break glass box shall have a minimum dimension of 100x100x80mm.

6.12.2 The box shall be fabricated in such a way so that it can be mounted, flush to the wall or on the surface without any modification. Two nos. 19mm knock outs shall be provided at the bottom of the box to facilitate the cable/conduit entry. The glass shall cover at least 30cm^2 area and shall have a thickness not exceeding 2mm.

6.12.3 The break glass box shall have a push button element kept in pressed condition by a glass sheet fitted in the front of the box.

6.12.4 The break glass box enclosure shall be painted with fire red colour (shade 536 of IS-5) epoxy painting and an inscription “Break Glass in Case of

Fire", shall be painted in white letters or rivetted on the enclosure by a steel nameplate. A suitable nickel plated brass hammer, duly chained to the box with stainless steel chain shall be provided with each box for breaking the glass. Each box shall have a distinct identification number boldly painted on it.

6.12.5 If specified in the enquiry documents / data sheets, the break glass box shall have a suitably wired telephone hand set to facilitate communication between the break glass box and the central annunciation panel. In such a case the telephone hand set mounted on hook switch shall be provided in a separate lockable weather proof enclosure.

6.13 Response Indicator

6.13.1 If specified in the enquiry documents/data sheets, response indicators shall be provided in a weatherproof box which shall be suitable for wall mounting. The response indicators shall be connected to the detectors directly and shall be complete with terminal blocks suitable to accept cables with upto 2.5 sq.mm. copper conductor. In the normal state of detector, the LED shall flicker, but in the event the detector goes into alarm condition, the LED shall glow steadily. LEDs shall be red in colour with 5mm dia as a minimum.

6.13.2 Response indicators shall be employed only in case of non-addressable systems.

6.14 Exit Signs

6.14.1 Exit signs shall be fabricated out of 16 gauge cold rolled sheet steel. This shall be suitable for wall mounting or hanging from ceiling.

6.14.2 Fire Exit / No Fire Exit shall be displayed on opposite of the exit sign by means of 5mm dia. Red LEDs or back-lit text. It shall derive power from data gathering cum fire alarm panel and shall operate on DC power supply.

6.15 Hooters

6.15.1 The unit shall consist of solid state circuitry on a printed circuit board, a loudspeaker and a flashing lamp housed in a weatherproof dust tight, wall mounting type enclosure. The hooters shall, at least, have 102db(A) output measured at 1 meter distance. The nit shall derive power from the fire alarm panel and operate on DC power. In the event of fire, the hooter shall raise pulsating audio alarm and the lamp shall flash.

6.16 **Flashing Lights**

6.16.1 The unit shall consist of solid state circuitry on a printed circuit board and a red caped incandescent lamp and audio unit housed in a dust tight, wall / ceiling mounting type enclosure. It shall derive power from the data gathering cum fire alarm panel and operate on DC supply.

6.16.2 Flashing lights shall be installed in the enclosed areas where clean agent / CO_2 is to be dumped. In the event a signal for clean agent / CO_2 release is given, the lamp shall start blinking with a warning sound enabling operating personnel to evacuate the area. The audio unit (hooter) shall have 102 db (A) output measured at 1 meter distance.

6.17 **Clean Agent / CO_2 Release And Inhibit Switches**

6.17.1 This unit shall consist of pull type release and inhibit switches clean agent / CO_2 . The unit shall be fabricated out of 18 gauge cold rolled sheet suitable for wall mounting. Switches shall be pulled to release or inhibit clean agent / CO_2 .
Release switches shall have inscription:
"PULL TO RELEASE CLEAN AGENT / CO_2 "
And inhibit switches shall have inscription:
"PULL TO RELEASE CLEAN AGENT / CO_2 "

6.18 **Zener Barrier**

6.18.1 Zener barriers, located necessarily in unclassified/non hazardous areas, may be employed for wiring detectors/break glass boxes installed in

hazardous areas. These shall render the circuit beyond the zener barrier intrinsically safe.

6.18.2 Not more than 10 detectors shall be connected to one zener barrier. Zener barriers may be located either in the Zonal panel or DGFAP, if permitted by geographic proximity of detectors and zonal panel or DGFAP or may be located close to the detectors / manual call points.

6.18.3 Wherever zener barriers are provided, in safe area outside the zonal panel or DGFAP, they shall be housed in their own enclosure and shall be dust and vermin proof, weatherproof with IP-55 degree of protection as a minimum.

6.19 Short Circuit Isolator/Fault Isolator

6.19.1 Short circuit isolator/Fault isolator shall be installed, if specified in the enquiry document/data sheets.

Fault isolator shall be designed to provide short circuit protection to an analogue addressable detector loop. It shall be possible to wire the fault isolator at any point in the detector loop.

6.19.2 On occurrence of a fault (short circuit), the isolator shall cut power to all devices installed beyond the isolator in the loop.

6.19.3 The fault isolator shall have the capability to continuously check the faulted side of the loop to determine if the fault still exists. On rectification of the fault, the isolator shall automatically reset itself.

6.19.4 In case the fault isolator nearest to the fault does not activate first, the isolator shall query other isolators nearest to the short circuit and then de-activate/restore itself. The restoration shall continue along the loop until only the isolator closest to the fault is left activated.

6.19.5 The DGFAP panel shall be capable of accessing detectors/devices installed outside the zone covered by the fault isolator modules.

6.19.6 Fault isolator modules shall be housed in a dust and vermin proof, weather proof enclosure, with IP-55 degree of protection as a minimum.

6.20 **Sirens**

6.20.1 Sirens shall be industrial type with minimum 2.5km unidirectional range (i.e. 5km diametrical range) against the wind direction.

6.20.2 The decibel level of the siren shall, at least be, 132db(A) at 1 meter, to meet the audibility requirement for the above range. Unless otherwise specified, Sirens shall operate at 240V, 3ph. AC. Sirens shall be housed in weatherproof enclosure and shall be supplied along with direct-on-line starters. Power supply for sirens shall be derived from a source with battery back-up as specified in clause 4.1.2.

7.0 ADDITIONAL REQUIREMENTS FOR FIRE ALARM SYSTEM TO BE INSTALLED IN HAZARDOUS AREA

7.1 In general the CFAP, DGFAPs, Zonal fire alarm panels, mimic panels and repeat alarm panels shall be located in control room environment which is non-hazardous. However, if specified in the enquiry document/data sheets, the enclosure for the detectors, panels and other equipment shall have flameproof construction, conforming to IS-2148 and shall be suitable for installation in hazardous areas classified as Zone-1 and/or Zone-2, with gas group IIB or as specified in the material requisition/data sheet. All equipment for hazardous area installation shall be complete with cable glands as specified in clause 5.4.4.2.

7.2 Equipments which can not have flameproof construction shall be intrinsically safe in design and Zener barriers shall be provided to restrict the energy levels.

7.3 For analogue addressable fire alarm systems, manual call points, address interface units, automatic detectors etc. which are to be installed in hazardous area shall preferably have flame proof construction to permit the use of class-A, style-6 fault tolerant wiring as per NFPA-72, without employing T-tapping. As an alternative,intrinsically safe address interface

units, automatic detectors etc. may be permitted provided they are wired beyond zener barriers, located in non-hazardous area. Fire Alarm Circuit beyond zener barrier shall be "intrinsixcally safe" type confirming to IS-5780.

7.4 For conventional fire alarm systems, manual call points, automatic detectors etc. which are to be installed in hazardous area shall preferably have flameproof construction. As an alternative, intrinsically safe automatic detectors may be permitted provided they are wired beyond zener barriers, located in non-hazardous area and meet the requirements of IS-5780.

7.5 Manual call points shall, however, be in flameproof construction only for either of the above fire alarm systems.

8.0 SPECIFIC REQUIREMENTS FOR INTERFACE WITH CLEAN AGENT / CO_2 RELEASE SYSTEM

8.1 In the case of conventional fire alarm system, clean agent / CO_2 dumping area shall be divided at least into two zones for fire detection purposes. The detectors shall be installed in cross zoning manner. Signals for clean agent / CO_2 release shall be sent only when at least two zones have detected the fire. The blinking lights shall operate in the affected area. Two type of detectors in cross zones shall be provided in each dumping area.

On detection of fire (Min. two detectors), a signal from zonal Fire Alarm Panel shall be generated which shall open the valves for dumping clean agent / CO_2 .

8.2 In the case of analogue addressable fire alarm system, cross-zoning may not be necessary as the system shall be deemed to be capable of filtering out false alarms due to dust, dirt and other atmospheric changes. Signals for clean agent / CO_2 release shall be initiated on receipt of fire alarm from any detector in the protected area. The blinking lights shall operate in the affected area.

8.3 Clean agent / CO_2 can be released or inhibited by the "Clean Agent/ CO_2 " release and inhibit switch located outside the protected area or from the fire alarm panel. The contact for clean agent / CO_2 release alarm shall be taken from the pressure switch provided in the clean agent / CO_2 manifold. Provision in F.A. panel shall be kept to wire pressure switch contacts.

9.0 ENGINEERING REQUIREMENTS

9.1 The vendor shall perform basic and detailed engineering activities, unless specified otherwise in the material requisition/data sheets.

9.1.1 Conventional Fire Alarm System

9.1.1.1 For conventional fire alarm systems basic engineering shall include the development of block-diagram furnished by MECON/Owner.

9.1.1.2 The detailed engineering shall broadly include the preparation of MCP/detector layout drawings, based on MECON/Owner's building / plant layout drawings. Preparation of cable schedules, interconnection drawings, equipment installation drawings, sizing of various equipment such as batteries, battery chargers etc. preparation of G.A. drawings of various equipment.

9.1.2 Analogue Addressable Fire Alarm System

9.1.2.1 For microprocessor based analogue addressable fire alarm systems basic engineering shall include the development of block-diagram, finalising the requirement of maximum permissible lengths for data highway/detector loops, configuring the central fire alarm panel requirements etc.

9.1.2.2 The detailed engineering shall broadly include the preparation of MCP/detector laout drawings, based on MECON/Owner's building/plant layout drawings. Preparation of cable schedules, interconnection drawings, equipment installation drawings, sizing of various equipment such as batteries, battery charger, UPS etc. allocating addresses to various detectors and defining their sensitivity settings.

10.0 TESTING AND ACCEPTANCE

10.1 During fabrication, panel shall be subject to inspection by MECON/Owner or by any authorised representative, to assess the progress of work. The manufacturer shall furnish all necessary information concerning the supply to MECON/Owner's representative. MECON/Owner's representative shall be given free access in the manufacturer's works from time to time to inspect the progress of the work. Three weeks notice shall be given by the vendor to MECON/Owner for witnessing the final routine tests of complete assembly to ensure satisfactory working of all components.

10.2 All routine tests as specified by the applicable codes and standards shall be carried out at the manufacturer's work under his care and expense.

10.3 Type test certificates, from a recognised testing organisation, shall be furnished alongwith the bids. Type test certificates for hazardous area equipment shall also be furnished alongwith the bids.

10.4 Panels shall be tested for functional adequacy, at manufacturers works by simulation of fire/fault condition. Minimum testing shall include tests as specified in IS-2189 or as per the standards prevalent in the country of origin.

10.5 If specified in the enquiry document/data sheets, vendor shall conduct tests at site, after the entire fire alarm system is installed and inter connected by cables. These tests shall establish the operational correctness of the system i.e. all panels, detectors etc. Minimum testing shall included tests as specified at clause 11.2 of IS-2189.

11.0 PACKING AND DESPATCH

11.1 All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The panel shall be wrapped in polythene sheets before being placed in crates to prevent damage to finish. Crates shall have skid bottom for handling. Special

notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight' etc. shall be clearly marked on the package together with Tag nos. P.O. Nos. etc.

11.2 The equipment may be stored outdoors for long periods before erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature.

Technical Specification for Foam Cum Water Tender

CONTENTS

1. INTRODUCTION

ThisspecificationdescribestheminimumtechnicalrequirementsforFoam Cum Water Tender

NodeviationtothisspecificationispermittedwithoutthewrittenconsentofPURCHASERquotingthe clause number of thisspecification.

VENDOR shall in his offer either make a statement that the offered equipment is exactly as per the specificationorinaseparatechapterprovidedeviationsbyparagraphwithoutwhichhisoffermaybe considered incomplete and further correspondence be halted at the sole discretion of the PURCHASER.

The VENDOR shall be responsible for the design, materials, manufacturing, fabrication, assembly, painting, supply, quality assurance and quality control, inspection and testing, certification (as applicable),preparationforshipment,supplyofdocumentationforthecompletepackage,performanceguar anteeofcompletepackageandsitesupervisionduringpre-commissioningandcommissioningas described in this specification.

ThisspecificationdoesnotdictatethedetailedequipmentdesignrequirementsItisintendedthatthis responsibilityberetainedfullybytheVENDORsothatVENDOR'swarrantyremainsfullyinforceand is not affected by statementsherein.

Foam Cum Water Tender shall be complete including all ancillary equipment/items required to meet the design and environmental conditions as stated herein. Any additional part, equipment, material, etc., which are not specifically mentioned in this specification, but are required to make the supplied equipment/ item complete in all respect in accordance with the intent of this specification, statutory requirements, applicable codes/standards, good engineering practices and for safe and trouble-free operation, shall be deemed to be covered under the scope of this specification.

Ifnationaland/orlocalregulationsexistinwhichsomeoftherequirementsmaybemorestringentthan in this specification, the VENDOR shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards to safety, environmental,economicandlegalaspects,inallcasestheVENDORshallinformthePURCHASER of any deviation from the requirements of this specification which is considered to be necessary in ordertocomplywithnationaland/orlocalregulations.ThePURCHASERmaythendecidetonegotiate with the Authorities concerned with the object of obtaining agreement to follow this specification as closely aspossible.

Conflicts, Deviations andAmendments

The VENDOR shall notify the PURCHASER of any conflict between this requisition, the Codes, Standards and any other Specifications referenced herein. Resolution and/or interpretation precedenceshallbeobtainedfromthePURCHASERinwritingbeforeproceedingwiththeDesignor Manufacture.

In case of conflict, the order of Precedence shall be:

- PurchaseOrder
- This Specification / MaterialRequisition
- ProjectSpecifications
- Referenced Codes andStandards

VENDORExceptions

VENDOR's bid shall clearly state and list the exceptions/deviations under a separate section "exceptions/deviations"toSpecifications,referencedcodesandstandardsandalldocumentsreferred inthisspecification.Exceptionsmentionedelsewhereinthebidorimpliedinthebidshallbeinvalid.

VENDORSubmissions

The VENDOR's submissions shall provide sufficient data to allow the equipment to be evaluated againstthetotallifeoffieldcoststobeincurred.Inthisrespect,equipmentcapitalcost,costofspares and utility requirements shall be considered, as shall the cost of a proposed field life maintenance program.

The VENDOR shall submit full technical details of their standard equipment which best meets the requirements detailed herein. Aspects of the requirements that cannot be met shall be identified and the variances explained in a separate section under "exceptions/deviations" to bid document.

SUB- VENDORSubmissions

VENDOR shall be responsible for materials, engineering from their SUB-VENDORs. VENDOR shall be considered single point responsibility for the communication with their SUB-VENDORs.

VENDOR shall evaluate all his SUB-VENDOR offers and submit only one consolidated offer along withbid.TheconsolidatedoffershallconsistofoneSUB-VENDORoffereddataperitemwhichisfully or most technically compliant along with deviations (if any) in deviation list. Direct submission of multipleSUB-VENDORoffers,anddeviationsshallnotbeacceptedandVENDOR'sbidwillbeliable for rejection.

2. ABBREVIATIONS

ASME	:	American Society of MechanicalEngineers
AWS	:	American WeldingSociety
BS	:	BritishStandard
CMRI	:	Central Mining ResearchInstitute
FTV	:	Foam Cum Water Tender.
FLP	:	FlameProof
HPMV	:	High Pressure MercuryVapor
IEC	:	International Electro-technicalCommission
IS	:	IndianStandards
ISO	:	International Organization of Standardization
MR	:	Material Requisition
OISD	:	Oil Industry SafetyDirectorate
PESO	:	Petroleum and Explosives SafetyOrganization
P&ID	:	Piping & InstrumentationDiagram
PTO	:	Power TakeOff
SI	:	International System ofUnits
SS	:	StainlessSteel
VTA	:	VENDOR toAdvise

3. DEFINITIONS

COMPANY / PURCHASER	:	
CONTRACTOR	:	The party(s) which carry(s) out part of the design, procurement, installationandtestingoftheSystem(s)asspecifiedbytheENGINEER.
VENDOR	:	The party, which manufactures and/or supplies equipment, technical documents/drawings and services to perform the duties specified by PURCHASER/ ENGINEER.
SUB-VENDOR	:	The party, which manufactures and/or supplies equipment, technical documents/drawings and services to perform the duties specified by VENDOR.
WORK	:	Means all and any of the works and / or services specified in the Contract.
"SHALL"	:	Denotes mandatory action or requirement.
"SHOULD"	:	Denotes an action or requirement which is not mandatory but which is strongly recommended.

4. CODES ANDSTANDARDS

MechanicalEquipmentshallmeettherequirementsofthefollowingcodes,regulationsandstandards,as applicable, except as superseded herein. In cases where more than one code, regulation or standard apply to the same condition, the most stringent shall be followed. In the event of a conflict between the below mentioned codes &standards and project specifications or correspondence, the PURCHASER shallbeconsultedandaruling,inwriting,shallbeobtainedbeforeanyworkisstarted.

1 American Society of MechanicalEngineers

Standard No.	Standard Title
ASME B1.1, 2008	Unified Screw Threads
ASME B16.5, 2017	Pipe Flanges and Flanged Fittings (NPS ½" - 24")
ASME B16.11, 2016	Forged Fittings, Socket-Welding and Threaded
ASME B16.20, 2017	Metallic Gaskets - Pipe Flanges, Ring-Joint, Spiral-Wound & Jacketed
ASME B16.21, 2016	Non Metallic Flat Gaskets for Pipe Flanges
ASME B16.34, 2017	Valves - Flanged, Threaded, and Welding End
ASME B40.100, 2013	Pressure Gauges and Gauge Attachments
ASME B46.1, 2009	Surface Texture (Surface Roughness, Waviness and Lay)
ASME B18.2.2, 2015	Square and Hex Nuts
ASME Section II, 2017	Materials
ASME Section V, 2017	Non Destructive Examination
ASME Section VIII Div. 1, 2017	Boiler & Pressure Vessel Code - Rules for Construction of Pressure Vessels
ASME Section VIII Div. 2, 2017	Boiler & Pressure Vessel Code - Alternate Rules for Construction of Pressure Vessels
ASME Section IX, 2017	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Welding and Brazing Qualifications.

International Organization forStandardization

Standard No.	Standard Title
BS ISO 21940-11, 2016	Mechanicalvibration-Rotorbalancing-Part11:Proceduresand tolerances for rotors with rigidbehaviour

Standard No.	Standard Title
BS ISO 21940-14, 2016	Mechanical vibration - Rotor balancing - Part 14: Procedures for assessing balance errors
ISO 9001, 2015	Quality Management systems - Requirements

British Standards(BS)

Standard No.	Standard Title
BS EN 10204	Metallic materials. Types of inspection documents

International ElectrotechnicalCommission

Standard No.	Standard Title
IEC 60529, 2015	Degrees of Protection Provided by Enclosures (IP Code)

Oil Industry Safety Directorate

Standard No.	Standard Title
OISD-RP-110, 1999	Recommended Practices on Static Electricity
OISD-GDN-115, 2000	Guidelines on Fire Fighting, Equipment and Appliances
OISD-RP-126, 2007	Specific practices for installations and maintenance of rotating equipment
OISD-RP-149, 2013	Design Aspects For Safety In Electrical Systems
OISD-STD-119, 2008	Selection, Operation and Maintenance of Pumps
OISD-STD-123, 2008	Selection, Operation and Maintenance of Rotary Equipment Components
OISD-STD-125, 2007	Inspection and Maintenance of Mechanical Seals
OISD-STD-171, 1998	Preservation of Idle Static & Rotary Mechanical Equipment
OISD-STD-244, 2015	Storage and handling of Petroleum Products at depots and terminals including standalone crude oil storage facilities

Other Codes & Standards

Standard No.	Standard Title
AWS D1.1/ D1.1M, 2016	Structural Welding Code - Steel
EEMUA PUB NO 140, 2015	Noise Procedure Specification

Manufacturers Standardization Society(MSS)

Standard No.	Standard Title
MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components – Visual Method for Evaluation of Surface Irregularities

5. SCOPE OFWORK

5.1 General

All equipment shall be supplied in accordance with the requirements of this requisition and the reference documents listed in this requisition.

TheVENDORshallfurnishallcomponentsandancillaryequipmentnecessarytomaketheequipment complete, safe, maintainable and ready for trouble freeoperation.

5.2 Foam cum Water Tender VehicleList

The Number of FTV units shall be as indicated in SOR.:

5.3 Detailed Scope ofWork

Scopeofsupplyshallincludethecompletesupply, mechanicaldesign,engineering,materials,manufacturing, fabrication, assembly, quality assurance and quality control, inspection, testing, painting, documentation, certification, supply and shipment of all items, performance guarantee of complete packagelistedinthismaterialrequisition,inaccordancewithallreferencedspecifications,codesand standards for the Foam Cum Water Tender.

Anyitemsnotlistedinthisrequisitionbutconsiderednecessaryforsafeandsmoothoperationofthe equipment, shall be included by the VENDOR in their scope and complete details of all such items highlighting reasons for inclusion shall be furnished in thebid.

- Inspection,TestingandCertificationasperthisrequisition,codesandstandards.SUPPLIERshall identify all tests that will be carried out on the equipment at his works in the preliminary ITP and

shall be submitted with the bid;

- Supply of all special tools required for installation, testing, calibrating, servicing, maintaining and operating the equipment (To be included in baseprice);
- First fill of lubricants, hydraulic fluid andconsumables;
- Engineeringservices;

  This shall include, but not be limited to: -

  - Resolving engineering questions relating to equipment within the scope ofsupply;
  - Providing&co-ordinatingdetaileddesignofallequipment&componentswithinthescope ofsupply;
  - Ensuring that all equipment supplied shall meet the requirements of the specifications, design codes and engineering standards referencedherein;
  - Performing and co-ordinating all calculations, analysis etc., as specified in this specification and the reference specifications andstandards.
  - Reviewing all safety features and systems, which PURCHASER has specified and suggest in writing all revisions, additions, which VENDOR feelsnecessary.
  - Providing expediting services for the subcontracteditems
  - Attending COMPANY co-ordination meetings & kick-off meeting COMPANYpremises.
- Information and data as indicated in VENDOR Data RequirementList;
- Post warranty maintenance contract (PWMC) as specified in the commercial part ofthe tender;
- VENDOR shall incorporate PURCHASER comments without any cost implication to PURCHASER during detailengineering.
- Anythingnotmentionedinabovescopeofworkandrequiredforthesuccessfulerection& commissioning, operation of equipment shall also be in VENDOR's scope of supply without any cost implication to PURCHASER;
- VENDOR shall comply with the requirements of this requisition and attached specifications. Any deviationfromtherequirementsgivenshallbedetailedin"DeviationSchedule".Inabsenceof such a list, quotation shall be deemed to be in full compliance with this requisition.

Exclusions

Nil

6.0 TECHNICALREQUIREMENTS

6.1 Scope

Thisspecificationoutlinestheminimumrequirementsfordesign,engineering,procurementofboughtout items, packaging, assembly, inspection, testing at shop, performance and acceptance tests for FTV. The complete unit shall be manufactured, fabricated packaged and mounted on a vehiclechassis.

VENDOR shall invite proposals from different vehicle chassis manufacturers (to be procured along with
PTO);VENDORshallevaluate,selectandrecommendthesuitablemodelsofvehiclechassisalongwith technical details. VENDOR shall furnish information of selected Diesel Engine &Vehicle Chassis, from different manufacturers, in their bid which shall be suitable in terms of power &load requirements of quotedFTV.

VENDORshallcoordinatealltheactivitieswithvehiclechassismanufacturerandwithClientassociated with the selection, recommendation, procurement, inspection and taking delivery of vehicle chassis and transporting it to his factory/ shop for, manufacture, fabrication and packaging of FTV unit(s) as per the requirement ofrequisition.

VENDOR shall be responsible for supplying all equipment/ accessories and properly fixing them on the chassis as described in this specification. Schematic drawing of FTV with dimensions and ground clearancesofchassisshallgetapprovedfromRoadTransportOffices(RTO)ofrespectivestatesbefore commencement of manufacturingactivity.

VENDOR shall arrange permanent registration of FTV with local transport authority, of respective site location,beforehandingoverofthevehicletoclientatsite.Necessaryregistrationcharges,feeetc.shall be borne by the VENDOR. The vehicle shall be provided with All India Permit and shall be registered under 'EmergencyServices'.

Other details and requirements which are not covered under this requisition but may be necessary to complete the FTV tender and/or fulfill the operation/performance requirement shall be provided by the VENDOR, who will be responsible for the design and construction of the complete appliance to the full satisfaction of theclient.

6.2 SystemDescription

This specification covers the general requirements regarding materials, performance and acceptance tests for foam cum water tender to be used for firefighting. The scope of supply shall be inclusive of, but not limited to the following:

The foam cum water tender including all accessories shall be designed and manufactured as per BIS codes, OISD-115 and TAC's requirements wherever applicable and as per sound engineering practice.

All the equipment and accessories shall be fixed on the appliance in a compact and neat manner and shall be so placed that each part is easily and readily accessible for use and maintenance. The centre of gravity shall be kept as low as possible.

In case of any conflict between above specified standards & TAC requirements, the requirements of OISD-115 shall govern.

The foam/water tender shall include the following:

A centrifugal type fire pump of 4000 lpm discharge capacity at 8.5 kg/cm2 and conforming to TAC's requirements, wherever applicable.

A water tank of 3000 litres capacity.

A foam compound tank of 3000 litres capacity.

A foam proportioning system.

A power take-off unit for driving the pump.

A water cum foam monitor.

A manually operated foam transfer pump

A Hose Reel

Dry Powder Extinguishers. 8 Nos. of 9 kg capacity each.

A battery operated amplifier system.

Hand lines with foam making branches = 4 Nos.

An Extension ladder.

Piping, specials, necessary controls, hose lines and other accessories etc. complete.

SUPPLIER shall furnish information of Diesel Engine & Vehicle Chassis in their bid, which is suitable in terms of power, & load requirements of quoted Foam cum Water Tender. Supplier shall obtain specific approval from IGGL for the procurement of relevant model of the chassis of approved make and of technical specifications as mentioned elsewhere in this tender. SUPPLIER shall be responsible for supplying all equipment/accessories and properly fixing them on the chassis as described in this specification. Other details and requirements, which are not covered under this specification, but may be necessary to complete the Water cum foam tender and/or fulfil the operation/performance requirement shall be provided by the vendor, who will be responsible for the design and construction of the complete appliance to the full satisfaction of the IGGL. SUPPLIER shall be responsible for supplying all equipment / accessories and properly fixing them on the chassis as described in this specification. Other details and requirements which are not covered under this specification, but may be necessary to complete the foam/water tender and/or fulfil the operation/performance requirement shall be provided by the vendor, who will be responsible for the design and construction of the complete appliance to the full satisfaction of the IGGL. . It is in the scope of the bidder to take procure the chassis (of approved make and specifications) from the manufacturer, transport the chassis to its workshop incl. temporary registration, RTO tax, permits as required. No additional reimbursement shall be made by IGGL on this account.

The System component description is as per following clauses:

6.3 Drive System

The drive system for the Vacuum pump shall be through the vehicle Power Take Off (side PTO) by independentlyengagingordisengagingfortheVacuumpumpoperationbymeansofalevertobeinthe driver's

cabin. The output from the PTO shall be connected through an auxiliary propeller shaft to the Vacuum pump. The PTO can be actuated by operating the lever provided in the vehicle cabin or by operating a switch in the control panel. The actuation of the PTO shall be independent of the vehicle operation.

However,oncethePTOisengagedtotheVacuumpumpthebrakesofthechassis\shouldautomatically beappliedi.e.,therewillbenomovementofthevehicleoncethePTOisengaged.

PTO Engagement / Disengagement indication lamp shall be provided in Driver's Cabin at a suitable location to facilitate the indication for PTO Engagement/ Disengagement.

6.4 Vehicle Chassis

The Vehicle shall have water cooled diesel Engine and chassis complete with a spare wheel and maintenance tools, which is having rated pay load capacity exceeding requirements of Vacuum pump.

The Chassis shall have 6 x 2 power axle.

The complete unit shall be mounted on vehicle chassis along with factory fitted with side PTO. The engagement / disengagement lever of PTO shall be located at a convenient place in the driver's cabin.

PTO engagement & disengagement indication lamp shall be located inside the driver's cabin at suitable place for convenient operation.

NecessarySupportsforPTOunits,propellershaftcouplings,universaljointsetc.Forpowerinputtoand output from PTO unit should beprovided.

Vehicle shall be provided with robust steel bumper at the rear of vehicle.

The engine shall be complete with standard features and accessories. covering the following:

- Vehicle Chassis with standard sleeper cabin &PTO
- DieselEngine,Watercooledwithsuitabletransmissionunit,powerassistedunitandclutchetc.
- Power steeringsystem.
- HydraulicserviceBrake,ParkingBrakeandFail-SafeBrake(ifany)Heavydutyframeandfueltank.
- Leaf spring suspension with shock-absorbers at frontaxle.
- Wheels complete with rim, tube andtyre.
- Spare wheel complete with rim, tube andtyre.
- Vehicle'selectricalsystemcompletewithstandardlightingarrangementswithcontrolsatdashboard and battery starting system withBattery.
- Truck should have good climbingfeatures.

6.5 **Pump**

The foam tender shall be mounted with one centrifugal type, double stage pump. The pump shall be capable of discharging minimum 4000 lpm at 8.5 Kg/cm2. The suction of pump shall be from hydrant

discharge outlets under pressure or from the water tank of the tender.

The pump shall be capable of discharging not less than 150% of the rated capacity at a head not less than 65% of the rated head. The shut off head of the pump should not exceed 120% of the rated head for the pumps.

Pump shall be suitably mounted on the rear / midship on the chassis and shall be accessible and readily removable for repair and maintenance. The pump should have its control panel installed suitably.

The pump shall be of rigid construction and shall be made of gunmetal/ any suitable light alloy, compatible with firefighting water and foam compound with stainless steel grade 304 shaft shall be suitable for use with saline water. The pump impeller shaft shall be fitted with antifriction bearings. The pump impeller neck rings and impeller rings shall be renewable types and the gland shall be self-adjusting type. A drain plug shall be provided at the bottom of the casing.

Primer: The pump shall be fitted with an automatic water ring /reciprocating primer. It shall be capable of lifting water at least from a depth of 7.0 m at a rate of not less than 30 cm per second. It shall be of such design as would not lead to its mechanical failure, would be easy in maintenance and would work satisfactorily even if it has been left dry for a long period.

There shall be four delivery points on either side having standard gun metal instantaneous female coupling with screw from the water tank in normal condition.

The delivery outlet of the pump shall be connected to the monitor and 4 numbers of screwed 63 mm female instantaneous couplings in accordance with IS: 903 – 1975. The monitor and other 63 mm female coupling outlets shall be fitted with lever-operated ball valves.

The pump shall have one suction inlet on each side of the appliance. Each inlet shall be provided with two suction collecting heads to facilitate the pump suction to be connected to two 63mm hydrant discharge outlets with that help of hoses. The pump shall be able to take the suction from the water tank in normal condition. Suction line shall be provided with strainers, which shall be removable easily.

Suction lines shall be provided with strainers, which shall be removable easily.

The Engine compartment of chassis/fire Tender shall be protected with FDSS(Fire Detection & Suppression system)as per AIS:135 Std. The system shall be reusable, robost, one time installation.

6.6 Power Take Off Unit

A power take off unit of suitable gear ratio to match the engine & pump characteristics shall be provided. A separate lever in the main cabin should engage the PTO. Necessary supports for PTO units, propeller shaft couplings, universal joints etc. for power input to and output from PTO unit shall be provided. The drive assembly components (shaft, couplings etc.) shall be dynamically balanced. The details of the PTO such as its make, name of manufacturer etc. supported with catalogue/drawing shall be submitted along with the offer.

6.7 Water Tank

Water tank of 3000 litres capacity shall be suitably mounted on the chassis. It shall be fabricated out of

stainless steel grade 304/316 sheets; of minimum 5 mm thickness for bottom and 4 mm for sides, top & baffles. The gas tungsten arc welding (GTAW) with ER 309 MOL electrode or equivalent and 100% radiography shall be followed. Tank made of MS shall be epoxy coated. The tank should have adequate MS / SS angle reinforcement.

It shall be provided with a baffles across to prevent surge while the vehicle is accelerating, cornering and braking and shall be so designed and mounted as to bring the centre of gravity as low as possible in the chassis. The baffles shall be provided with flanged 450 mm diameter manholes.

It shall be rectangular / elliptical in shape and the mounting of the tank shall be flexible type to prevent the tank distortion due to the chassis flexion. The mounting should permit full contents of the tank to flow into the pump.

An inspection manhole of not less than 450 mm size shall be provided on top, with a hinged or removable cover and shall be marked 'WATER".

Suitable eyes shall be provided on the shell of the tank to enable it to be lifted off the vehicle for repairs / replacement as necessary.

A cleaning hole of 250 mm diameter flanged type shall be provided at the bottom of the tank. The cleaning hole shall be clearly approachable from bottom of chassis and fitted with a 25 mm diameter drain pipe with a valve and plug connection and shall be taken down to a point well below the chassis without reducing the effective ground clearance.

The tank shall be fitted with overflow pipes of suitable diameter to prevent pressure build up when connected to the hydrants and the discharge end shall be taken below the chassis without reducing the effective ground clearance.

150 mm / 200 mm water filling pipe on each side of the vehicle shall be provided for water tank filling, fitted with 2/3 numbers of 63 mm instantaneous male couplings incorporating a strainer, NRV (Non Return Valve) and lever operated ball valves near the pump control panels.

A water level indicator of the graduated glass tube with isolating cock valve (suitably protected) type or other suitable type shall be provided close to the control panel. It is suggested to have an illuminated level indication at control panel indicating full, 3/4, 1/2, 1/4 and empty.

The complete tank shall be painted externally after fabrication.

The tank shall be connected to the pump through a pipeline fitted with inverted stainless steel strainer and lever operated ball valves.

All the piping shall be subjected to a hydraulic test pressure of 18 Kg/cm2 for a minimum 30 minutes

All piping / fittings, internals, bolts and nuts of the tanks shall be of MS/stainless steel grade 304/316, to minimise galvanic corrosion.

Water tank shall be tested for leakage period of 24 hours.

The tank shall be provided with a breather valve / vent.

6.8 Foam tank

Foam Compound tank of 3000 litre capacity shall be mounted on the chassis. It shall be fabricated out

of stainless steel grade 304/316 plates of minimum 5 mm thickness for bottom and 4 mm thickness for sides & top. All external surface shall be suitably treated to resist atmospheric corrosion and painted.

The foam tank shall be of rigid type rectangular / elliptical in shape with welded construction. The gas tungsten arc welding (GTAW) with ER 309 MOL electrode or equivalent 100% radiography is required.

The foam tank shall be suitably baffled to prevent the surges while the vehicle is accelerating, cornering and braking and shall be so designed and mounted as to bring the centre of gravity as low as possible in the chassis. The baffles should have flanged man ways of 450 mm dia.

The tank shall be fitted with a sludge trap have a cleaning hole of 250 mm diameter and 25 mm drain pipe with a valve and plug incorporated in it. The cleaning hole shall be flanged type and easily accessible from the beneath of the vehicle. The bottom of the tank should have a slight slope towards the sludge trap.

The tank shall have 2 nos. of filling orifices of not less than 150 mm dia with a removable strainer fitted to it. The filler cap shall be clearly marked 'FOAM'.

The tank shall have one line on either side of 75 mm diameter with interconnection male coupling and level operated ball valve.

The tank shall have minimum 1 no. of 450 mm diameter inspection manhole with hinged or removable covers. The manhole cover shall be marked 'FOAM' at the top.

The tank shall be provided with a breather valve to enable automatic venting of the foam compound tank when the foam compound is drawn from it or when the tank in being filled.

The draw off line shall be connected to the foam compound proportioner / indicator and pump and shall be 40 mm above the bottom of the foam tank.

A foam solution transfer pump of rotary type of minimum discharge capacity of 192 lpm at head of 3.0 meters with necessary piping etc. shall be provided on the appliance to transfer foam compound from drum to the foam compound tank. The pump shall be manually operated.

Provision shall also be made for drawing foam compound direct from an external source through a pick-up while producing foam.

The draw-off pipe shall be fitted with removable strainer of S.S. material.

The draw off tube shall be connected to the foam compound proportioner and shall be 40mm above the bottom of the foam tank. The draw off tube shall have a non- return valve in addition to the main control valve. The draw off pipe shall he fitted with removable strainer of suitable material. Necessary foam piping shall be provided for foam monitor.

One extra auxiliary foam compound pick up connection inlet of which shall be on the suction side of the pump shall be provided to enable foam compound to be induced into the pump from the open foam supply. A pick-up tube with strainer shall be also provided for foam monitor.

Foam tank shall be tested for leakage period of minm. 24 Hrs.

6.9 Foam Compound Proportioner

Around the pump proportioner with variable setting selector valve (to induce 3 to 6% of foam

compound) shall be provided between the foam compound tank and pump. It shall be designed for operation by water under pump pressure. The proportioner shall be so installed that it should not be liable to mechanical or other damage. The selector valve should have four settings beginning with 'On' or 'Off' position. Each upward setting will result into an equal increase in the foam compound flow rate. The linkages for this purpose shall be as simple as possible to avoid distortion due to chassis flexion. It shall be very reliable and should not require frequent calibration checks.

6.10 Water Cum Foam Monitors (UL Listed/FM Approved).

There shall be one roof mounted water-cum-foam aspirating / non aspirating monitor of minimum 2580 lpm capacity and 60 m horizontal water throw at 7.0 Kg/sq.cm. The monitor shall be capable of traversing through 360 degree in a horizontal plane and 900 up and 150 down in the vertical plane. The monitor and hand-lines shall be tested separately and in combination for delivering foam and water throw at rated capacity and range; within the pump capacity. The water cum foam monitor shall be UL Listed/FM Approved.

6.11 Hand Lines

Four hand lines each capable of delivering 2400 litres per minute of generated foam (Exp. ratio- 8) at a minimum pressure of 7 kg/cm2 shall be provided. Each hand line shall terminate into a foam making branch pipe of aluminium alloy arid fitted with 63mm male instantaneous connection. The hoses for the hand lines shall be of 30M length and 63mm dia and shall be of reinforced rubber line type conforming to IS: 636. It shall be possible to operate the monitor and hand line simultaneously.

6.12 Hose Reel

One first-aid hose reel shall be provided and mounted so as to be accessible for use from either side of the appliance. Swivelling guide rollers shall be fitted, where necessary, to prevent tubing from kinking. Hose reel shall hold not less than 60m of 19mm bore tubing hose in convenient lengths, terminating in a dual purpose shut-off nozzle. Crops foot coupling shall be used to join together the lengths of hose and to couple one end of the hose to the hose reel and the other to the shut off nozzle. The tubing shall conform to IS: 5132- 1969. The reel shall be provided with friction brakes to prevent over-run of tubing without affecting easy run of the reel. Plumbing between the pump and hose reel shall hayed clean and unobstructed water way of not less than 25mm in throughput without any restriction. The working pressure of the tubing shall not be less than 1.5 kg/cm2 and shall be of 60m long. Flow to the reels shall be controlled by manually operated ball type valves located suitably for ease in operation. Hose Reel shall be RRL Hoses.

6.13 Dry Powder Extinguisher

8 Nos. Dry powder extinguishers of 9kg capacity each shall be placed suitably on the appliance. The extinguishers shall have approved make conforming to IS: 15683. The dry powder shall conform to IS: 4308.

6.14 Body Work (shall comply with requirements given in OISD-115)

Enclosed accommodation shall be provided for two men in front compartment including driver. Both the seats shall be independent. The driver's seat shall be adjustable. The rear compartment of driver's cabin should have one removable seat for full width of cab for crew members. All seats should have foam cushion and shall be covered with Rexene. Two doors on either side shall be fitted with safety

glasses and winding type regulators. The cab floor shall be provided with rubber mating. One roof light shall be provided in the driver's cabin. Dual type visors and external rear view mirrors shall be fitted to the cab.

The rear removable seat should have box type arrangement to accommodate batteries and other important equipment. Six numbers of hooks shall be provided above the rear seat at suitable height for hanging helmets.

The entire structure of appliance including that of drivers cabin shall be a welded structure made from anticorrosion treated M.S. pressed sections and channels structural steel (IS : 2062) with minimum 2 mm or 3 mm thickness aluminium sheet panelling outside.

Sufficient number of lockers for storage of all equipment shall be provided with external access. The height shall be not more than 1.67 m so as to be accessible from ground level. The bottom of all the lockers shall be of chequeredaluminium plate of 4 mm thickness fitted on the base frames to avoid bending of the plates. Sides of the lockers shall be of 2 mm aluminium plate with suitable stiffener. The top of lockers should have roof there by providing a working platform for access to tank tops and also the roof mounted monitors.

All the lockers shall be fitted with internal lighting with proper guards and suitably located

'ON-OFF' switch. A master switch for isolating the locker lighting circuit should also be fitted in the driver's cab.

All the lockers shall have snap coupling belt fasteners to keep equipment in its place and order. All the lockers and other compartments shall be suitably provided with heavy-duty doors. All the lockers should have self-draining of all wash down water.

Grab rails and non-slip steps shall be provided to give access to the roof of the appliance and for easy and speedy removal and mounted of ladders.

No part of the bodywork shall reduce the ground clearance to less than 36 cm or increase the overall width more than 2.42 m. The highest part of the appliance with the ladder and monitor mounted on it's should not exceed 3.6 m from ground level. The construction of superstructure should not reduce the angles of approach and departure below 30 degrees.

Stability: The stability of the appliance when under fully equipped and loaded condition shall be such that if the surface on which the appliance stands is tilted to either side, the point at which over turning occurs is beyond an angle of 27 degrees.

A suitable space shall be provided to keep 10 lengths of 63mm size fire hose each of 30m length.

A 7.50m long aluminium two-piece extension ladder shall be mounted on suitable gallows fitted with rollers and designed to facilitate easy and quick removal of the ladder by one man from the rear of the appliance. The ladder in general shall conform to IS: 4571.

6.15 Control Panel

Adequately illuminated pump operating control panels shall be provided suitably. The control panel should include the following:

Throttle control for the engine.

Pump pressure gauge calibrated to 25 kg/cm2.

Hydrant connection for water tank filling pipes.

Delivery outlets of the pump along with the control levers.

Control for using the auxiliary foam compound pick-up tube;

Operating instruction plate; and flushing out instruction plate.

Compound gauge as per IS: 951.

Suction inlet of pump.

Water tank contents gauges (calibrated)

Foam tank contents gauge calibration in liters.

Pump suction – water tank isolating valve control.

Foam tank isolating valve control.Foamproportioner valve control.

Delivery outlets of the pump along with the control levers.

The monitor valve control.

Engine cooling water temperature.

Illuminated water tank level indication.

Illuminated foam tank level indication.

System schematic etched in brass plate. All levers, switches, valves, inlets / outlets, gauges etc. shall bear identification on brass plate duly riveted.

Foam pickup tube valve assembly

Engine oil pressure gauge

Priming pump engagement lever

Lighting for control panel illumination

Digital flow meter for foam monitor

Valve control for hose reel

The dashboard panel in the driver's cabin should have:

Engine Oil Temperature Gauge

Engine Oil Pressure Gauge

Ammeter battery charging rate.

Air pressure gauge for the braking systems.

Fuel tank contents gauge calibrated in liters.

Odometer calibrated in KM.

Speedometer calibrated in KM/hr.

Siren switch

Ignition switch.

Engine cooling water temperature gauge.

Master switch for batteries.

In addition to the above, other items may also be provided that may be considered essential.

6.16 Accessories

Foam Tender shall be provided with the following accessories in addition to those normally fitted to the chassis. All the accessories shall be suitably fixed in position, shall be kept in position, or shall be kept in lockers or other suitable place on the tender.

1 No. Electrically operated siren to be mounted externally.

2 No. Fog lamps powered by the battery of the appliance shall be low mounted in front of the appliance.

4 No. Reversing lights four numbers – suitably situated to assist reversing.

2 Set. Blinker type traffic indicators.

1 Set. Twin amber blinker lights cabin roof mounted.

1 Set. Search light with 100 meters length of cable with tripod etc., complete

1 No. An adjustable spot light

2 No. Portable inspection lamp with brackets to be clamped to the battery

1 Set. All tools required for normal routine maintenance of the appliance, which are not included with the kit of the chassis

1 No. Removable Spark arrestor fitted to the exhaust of the engine

1 No. A trickle charger 250 AC supply for self-charging of battery being charged. It shall be fitted in the driver's cabin.

Wind screen wipers (Electrically operated of approved design) if not provided with the chassis.

1 No. Hydraulic jack – 25 tones capacity

1 No. Oil feeder.

1 No. Grease gun.

1 No. First Aid Box.

Public address system: Battery operated with a control panel in driver's cabin shall be provided. One loud speaker shall be mounted on driver's cabin roof and shall be capable of rotation in all directions. The range shall be 1 km in still air and 500 m in noisy areas.

2 No. Suction hoses and fittings

6.17 Equipment for Tender

10 No. Fire hoses 63 mm

Fire extinguishers

Nozzles & branches

Foam making branch-line

6 No. Mechanical foam generator 2400 lpm (foam)

Adaptor

4 Nos. Devilling breaching made out of Gun metal (IS : 5131 – 1969) each having two 63mm female instantaneous type outlets

2 Nos Collecting breaching made out of Gun metal (IS : 905 – 1968) (One 140mm outlet with round female threads and 2 female instantaneous type inlets).

1 No. Lug spanner (IS : 903 – 1971)

1 No. Fireman's Axe (IS:5505 – 1999)

1 No. Nylon rope, 50 mm circumference, 30 m long (IS : 9048 – 1960)

1 No. Ladders : 7.5 m long aluminium two Piece extension ladder (IS : 4571)

1 No. Breather Apparatus

1 No. Fire Proximity Suit

8 Lengths. Armoured suction hose of suitable 140 mm dia. Complete with rounded threaded coupling 2.5 m long Each confirming to IS 2410

1 Set. Sunvisor

1 No. Manually operated fire bell

6.18 Painting& Marking

The entire appliance shall be painted in 'Fire Red' paint of shade No.536 of IS: 5-1961 (yellow colour optional) and thickness of 0.15 to 0.20 mm using double coat spray painting on the outside.

Also, on either side of the appliance, monogram shall be painted. The lettering of 'FOAM TENDER' shall be written in golden yellow colour at suitable places.

The driver's compartment shall be laminated and the inside of lockers shall be painted cream. Lockers shall be finished in shadow board painting to show the position of each piece of equipment.

The chassis and wheel arches shall be painted black.

Water piping shall be painted red, foam compound piping yellow and water / foam solution in red & yellow stripes.

Two coats of anticorrosion paint and one coat of zinc phosphate primer shall be applied before painting.

The appliance shall be clearly and permanently marked with the following, preferably on a metal plate attached in the driver's cabin and also near pump operating control panels;

a) Manufacturer's name or trade mark;

Year of manufacturer

Capacity of pump in Ipm water tank in liters and foam tank in liters

Engine and chassis number

Pump number

6.19 Acceptance Tests

Following tests shall be carried out before commissioning the vehicle:

The design of tender shall be such that it will not affect the Chassis characteristics as specified by the chassis manufacturer such as break efficiency etc. with appliance fully loaded.

Road tests to check chassis, manufacturer's rating for acceleration, maximum speed, braking efficiency and turning circle with appliance fully loaded.

The stability of the appliance shall be such that when under fully equipped and laden condition, if the surface on which the appliance stands is tilted to either side, the point at which over turning occurs is not passed at an angle of 27 degree from horizontal.

When the vehicle is brought to a stop in 9 m when travelling at 32 KM/hr. fully loaded and manned on pavement without any adverse effect on mounted equipment.

Pump test to check pump manufacturer's rated output at varying pump pressure for a continuous period of 4 hours. During this test, the temperature of engine should not exceed the rated temperature and that of lubricating oil 79 Degree Celcius.

The priming device shall be tested within a vertical lift of 7.0M measured from water level to the centre second of suction eye of the pump at a rate of not less than 30cm per second.

Foam Monitor and hand-lines Test : Monitor performance for rated flow and throw shall be tested.

Foam making equipment shall be applied to check the induction ratio of foam compound, total foam discharge rate and expansion ratio of foam production using the foam compound available in India as per IS:951.

AII the piping shall be subject to a hydrostatic test pressure of 18.0 kg/cm2 for a period of minimum 30 minutes.

Foam tank and water tank shall be tested for leakage. The tanks shall be kept full with water and shall be observed for 24 hours for leakage.

6.20 Instruction(s) Book

A set of illustrated books along with as built drawing, flow diagram, general assembly & cross sectional drawing for pump, drawings of PTO, line diagram for electrical circuits for foam tender for guidance, including operating and normal maintenance procedures for the appliance, shall be kept. The test certificates and original manuals of all the bought out items shall be kept. The books should include an item-wise and illustrated spare parts lists giving reference number to all wearing parts with a view to ensure that adequate number of such spare parts are made easily available, when necessary. It should

also include as built line diagrams showing all piping work connecting, water tank, foam tank, foam proportioning system and pump. All inspection and testing records including calibration and hydro-testing certificates shall be included in manual.

6.21 Spares

A complete set of recommended spare parts for foam monitors, foam proportioner, pump, battery charger etc. shall shall be kept with tender. The spares shall be recommended by the vendor for 2 years trouble free operation.

6.22 Inspections

Inspections shall shall be carried out for various materials / quality of work at various stages of procurement / fabrication / body building of the Foam Tender. Vehicle should confirm to Motor Vehicle Act 1988 and Motor Vehicles Rules thereunder.

6.23 Information Required From Supplier

The SUPPLIER shall furnish the following information along with the offer and for approval prior to fabrication (and those included in vendors drawing and data equipment).

Flow diagram of the appliance (indicating the sizes of pipes).

Plan and elevation of the appliance showing various equipment.

Pump characteristic and performance curves with the pump working on hydrant and the water tank, with manufacturer's catalogues and Model No. etc.

Line diagram showing all piping and valves etc.

Line diagram of all electrical circuits

Catalogues for all bought out items with Model No.

The test certificates and original manuals of all the bought out items shall be kept.

The books should include an item wise and illustrated spare parts lists giving reference number to all wearing parts with a view to ensure that adequate number of such spare parts are made easily available, when necessary. It should also include as built line diagrams showing all piping work connecting, water tank, foam tank, foam proportioning system and pump. All inspection and testing records including calibration and hydro testing certificates shall be included in manual.

Following information shall be furnished by the SUPPLIER along with the appliance.

Operating and maintenance manual 6 sets

Final drawings as described above 6 sets

Original I Transparencies incorporating the as built information shall be got signed by inspection Engineer before submitting to IGGL for records.

Allaboveequipment,unitsandcomponentsshallbemountedonvehiclechassis,fullyassembled,piped, wired, tested and painted for severe corrosiveenvironment.

7.0 QUALITY ASSURANCE, INSPECTION &TESTING

7.1 QualityAssurance

VENDORshalloperateaqualitysystemsatisfyingtheapplicableprovisionsofISO9000(series).The effectivenessofthequalitysystemandtheVENDOR'scompliancewithitshallbesubjecttomonitoring by PURCHASER and in addition, may be audited following an agreed period ofnotice.

TheVENDORshallsubmitaqualitycontrolprogramforPURCHASERreviewatthetimeofoffer.The VENDOR shall provide facilities for and cooperate with PURCHASER and statutory authority inspectors during manufacturing, assembly andtesting.

7.2 Factory Inspection andTesting

VENDORshallsubmitforreviewandapprovalbythePURCHASERanInspectionandTestPlan(ITP) covering all relevant components, completed equipment andsystems.

VENDORshallprovidePURCHASERwithreasonableaccesstotheirandtheirSUB-VENDOR'splant facilities in order to verify that equipment is manufactured and tested asspecified.

A detailed test procedure of shop tests shall be submitted at least one (1) month in advance of any testing and shall be approved by the PURCHASER.

Allinstrumentsusedforconductingtestsshallbecalibratedbeforethetestsandcalibrationcertificates shall be furnished at the time oftesting.

Thevarioustestscarriedoutasdescribedinthissectionshallbeproperlyrecordedandplotted.Such documentsdulysignedbyVENDOR'sinspectorsandthethird-partyinspectors,shallbesubmittedto PURCHASER

Material certificates and test certificates shall be supplied along with the equipment. Inspection documents for tank plates and nozzles material shall meet the requirements of this requisition.

VENDORshallprovideweeklyreportsduringprocurementandfabricationphasesindicatingprogress status.

100% UT & 100% MPI/ DPI will be carried out on parent materials, lifting lugs &lifting aids material. All welds on lifting lugs &lifting aids shall be subject to a 100% MPI test both before/after the load test.

AlltheacceptancetestsshallbecarriedoutbyPURCHASER/Thirdpartyinspectionagency for each FTV without any extracost:

The complete unit shall be trial assembled and dimensionally checked prior to shipment. This activity shall be witnessed by the PURCHASER and/or hisrepresentative.

8.0 SURFACE PREPARATION ANDPAINTING

All equipment, exposed steelwork, piping and all items within the package shall be prepared and

painted in accordance with Project Specification for External Painting & Protective Coating.

The vehicle with cabin and tank etc. shall be painted with “Fire Red” paint of shade no. 536 of IS:5-1961 on the outside with "IGGL" logo painted in blue colour and name "INDRADHANUSH GAS GRID LIMITED" in Hindi and English on both sides of the vehicle. The driving compartment and inside of cabin shall be painted in Grey. The chassis and wheel bars are to be painted with synthetic enamel black. Pipes to be painted in blue colour. The system should have the following marks at conspicuous location:

i) The manufacturer's name ortrademark.

ii) Year of manufacture.

iii) ControlPanel:Thecontrolpanelshallbemadefrom10SWGCRCsheetandshallhavegreycolor finish. All controls in the panel shall be identified withnameplates.

All the exterior / exposed surfaces of the cabin / vehicle shall be treated for rust proofing than finally with high gloss finish. All the logos and lettering shall be printed with computer generated stencils.

9.0 SPARE PARTS AND SPECIALTOOLS

9.1 Spares

Erection, Pre-Commissioning & Commissioningspares

VENDOR shall provide and include in its scope of supply for each vehicle the recommended spares parts for the equipment, instruments, valves etc. within his package to cover the Erection, Pre-Commissioning & Commissioning of the FTV.

If,however,anyadditionalspareisconsumedduringErection,Pre-Commissioning&Commissioning over and above the included Erection, Pre-Commissioning & Commissioning spares, the same shall beprovidedbytheVENDORatnoextracosttoPURCHASERatthetimeoferection&commissioning.

Spares for two years Normaloperation

VENDOR shall furnish for each vehicle an itemised list of recommended spares with unit prices for two years normal & continuous operation of the complete package (including Mechanical, Electrical and Instrumentation spares) required.

Original Equipment manufacturer's recommendations shall be followed by the VENDOR in the preparationofrecommendedsparepartslist.AllsparepartsfurnishedbyVENDORshallbewrapped andpackagedtopreservethepackageundernormalconditionsofstorageanticipatedatprojectsite.

Thesamepartsshallbetaggedbystainlesssteeltagsandcodedsothatlateridentificationastotheir intended equipment usage will be facilitated. All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment in accordance with the instructions from PURCHASER. Packing lists shall be furnished complete and in detail so that parts can be handled withoutuncrating

9.2 SpecialTools

The VENDOR shall supply one (1) set of special tools & tackles for each vehicle required for the erection and/or maintenance of the equipment including all ancillary equipment.

Special Tools & Tackles means all such tools / tackles those are specific to the erection and/or maintenance of the supplied equipment/package, and are normally not expected to be available in a plant workshop, but without which it would be difficult or time-consuming to do erection and/or maintenance of the supplied equipment/package.

The VENDOR shall identify the special tools required with Bid. Special tools shall be itemized and submitted for review. Special tools shall be itemized and submitted for review.

10.0 GUARANTEE ANDWARRANTY

The VENDOR shall guarantee that all equipment and its internals/ accessories within his scope of supplyshallmeettheperformancerequirementsasstatedinthisrequisition,specificationsandother applicable documents when operating under the specified design and operatingconditions.

The VENDOR shall be responsible for Mechanical Guarantee for the Equipment.

The VENDOR shall warrantee the mechanical design, material, workmanship and performance requirements as stated in this specification continuously for all conditions stated, for the time mentioned in the Tender.

Ifduringthemechanicalwarrantyperiod,anypartoftheequipmentprovesdefectives,VENDORshall replace such defective parts at their own cost andexpenses.

The VENDOR shall guarantee that all work will be performed in accordance with good and sound engineering and construction practices and within the requirements of this specification. The equipment, accessories and all the materials supplied by the VENDOR shall be free from defects, shall be suitable for the use for which they are intended and shall perform in accordance with the requirements of this specification.

The VENDOR shall agree to promptly correct, at his own cost at site, all the defects and mal-performanceoftheequipmentand/ortheaccessoriessuppliedbyVENDORtocomplywithobligation expressedorimpliedundertheTenderandtoextendthewarrantyperiodforthedurationrequiredto remedy suchdefects.

The VENDOR shall assume full responsibility for the proprietary equipment and component supplied by him, and his SUB-VENDOR, incorporated in the package are in accordance with this requisition.

TheVENDORshallguaranteethestabilityofthematerialofconstructionforthedutiesrequired,even if the PURCHASER has specified the type and the grade of material to beused.

11.0 TRAINING

VENDORshallprovideO&MtrainingtoPURCHASER'sOperationsandMaintenancepersonnel.This

trainingshallbeprovidedforthePackagesuppliedincludinganySUB-VENDOREquipmentincluded in thepackage

TheVENDORshallarrangeforatrainingofPURCHASER'sengineersatsiteforEquipment/Package supplied. The training shall cover the design, operation, and maintenance aspects by the representative of respective manufacturer and for a minimum of 5 working days for a group of 10 engineers.

Fire Water Network Erection Welding, Testing & Painting

SPECIFICATION NO: MEC/TS/05/28/081/12

(OIL & GAS SBU)
MECON LIMITED
DELHI

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1.0 Specifications for erection

1.1 Erection of Equipment

Major activities involved in erection, testing & commissioning are enumerated below. However, any other activity not mentioned but required for total work execution shall be included in the scope of work of the Tenderer.

i) Receiving of equipment/ material, unpacking, storage, transporting the same to respective erection site.

ii) Safe custody of equipment/ material from time of receipt till these are installed and handed over.

iii) Cleaning, flushing and lubricating equipment / material before assembly, erection and testing. Servicing, greasing, packing the supplied valves as required by Owner / MECON

iv) Checking of foundation levels, centre lines, orientation, locations etc.

v) Assembling, coupling, fitting, fixing, jointing, aligning various sections of equipment etc. by welding /bolting etc. as per the drawings.

vi) Servicing of anchor bolts.

vii) Supply and fabrication of liner plates, shim plates.

viii) Installing the equipment on foundation /structures/ platforms / walls/ columns as the case may be in proper orientation.

ix) Construction of civil pedestals for supporting the pipelines and construction of foundations for structural columns of pipe bridge

x) Fixing and grouting of anchor bolts and base frame for pumps including supply of non-shrink grouting mix.

xi) Supply, assembly, positioning, fixing of all accessories (platform, ladder, internals) on the main equipment.

xii) Providing temporary supports, scaffolding, staging etc for supporting equipment, pipes etc as required during the construction, installation, and erection or testing. Removing the same after the completion of the job and keeping the area clean. Wooden ladders are not acceptable. Tenderer shall use metallic ladders only.

xiii) Protecting properly all installed and uninstalled equipment/ material from theft, damage, pilferage and becoming a hazard to life and property. Protecting nozzles, flanges, machined parts, open pipe ends etc. by covering them with plastic pipe caps/ flange caps, wooden blanks, etc.

xiv) Cleaning of equipment (internal & external) before testing.

xv) Testing of pipelines, equipment as per the requirement, specifications and standards.

xvi) Draining, emptying and cleaning the pipelines, equipment after testing and painting providing necessary drain points.

xvii) Opening/closing manholes/ nozzles etc. as required during pre-commissioning.

xviii) The following jobs are also included under Tenderer's scope of work for pumps, motors (Fixing, aligning etc of equipment shall be done only by skilled millwright fitter who will be approved by Owner/MECON before commencement of such work in case felt necessary).

- Servicing of coupling, stuffing box, and bearings.

1.2 Erection of Fire Fighting Pipeline

The handling, laying and welding of pipelines shall be carried out conforming to relevant codes / standards unless otherwise stated in the specification given below.

There may be variation between dimensions shown in drawings and actually existing at site due to minor variations in the location of equipment, inserts, structures, etc. To take care of these variations "Field welds" shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicated in the drawings may be left on one side of the pipe at each of the field welds. During erection, the pipe end with extra length at each field weld, shall be cut to obtain the actual dimension occurring at site. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Tenderer to provide adequate number of field welds. In any case no extra claims will be entertained from the Tenderer on this account. Wherever errors / omissions occur in drawings and Bills of materials, it shall be the Tenderer's responsibility to notify the Engineer-in-charge prior to fabrication or erection.

Based on the site conditions, the routing of pipelines shown in the drawings may require modification. The Tenderer shall execute the work under his scope of work accordingly as directed by the Engineer in charge.

The measurement for laying of pipelines shall be based on measurement along the centre line of the pipeline, inclusive of fittings but exclusive of items such as valves, strainers, etc.

The anti-corrosive treatment to the pipes to be laid underground shall be provided as specified in 11.00.

1.3 Erection of pipe above ground

Fire fighting pipelines shall be routed and located as per final approved piping drawings keeping in view the piping specifications. No deviations from the arrangement shown shall be permitted without the written consent of Owner / MECON.

In general, pipelines shall be routed above ground. However, where road crossing is

involved as indicated in the layout drawing, the pipelines shall be routed under ground.

Pipelines shall be routed in a pipe bridge at about 6.5m height between the pump house and Tank lorry-filling gantry. At the Tank lorry-filling gantry, the pipelines shall be laid at around 5m level supported from building structures.

All pipe work shall be designed with sufficient flexibility to prevent development of undesirable forces or movements at the point of connection to equipment at anchorage or due to thermal expansion. Flexibility shall be provided by change of direction or by use of bends, loops or offsets.

Location and design of pipe supports shown in approved arrangement drawings/ support drawings should be strictly adhered to. Pipe supports i.e. restraints, such as guides, stops, anchors must be made in such a manner that they will not contribute to the over stressing of a line, while protecting a weaker or more sensitive component. e.g. pump.

Flanged joint shall be used for connections to vessels, equipment, flanged valves and road crossings and also on suitable straight lengths of pipelines at strategic points to facilitate erection and subsequent maintenance work.

While fitting/ welding of matching flanges care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled up together without inducing any stress at the pipes and equipment nozzles.

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Boltholes of the flanges shall straddle the normal centerlines unless different orientation is shown in the drawing.

Steel to cast iron flange joints shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate parallel and lateral alignment.

Flanged connections at the pumps, fittings, accessories, etc. shall be made in such a way as not to induce any stress due to misalignment, excessive gap etc. The final tightening shall be carried out when the machines are aligned completely and specifically authorised by Engineer-in-Charge. Temporary protection covers shall be provided at all flanged connections of pumps, until the piping is finally connected.

Pipelines shall be laid sloping towards drainage points.

The Tenderer shall maintain slopes specified for various lines in the drawing. Corrective action shall be taken by the Tenderer in consultation with Engineer-in-charge wherever the Tenderer is not able to maintain the specified slope.

Vents and drains shall be provided on each line at the highest and lowest points respectively to release the trapped air during hydraulic testing and to drain out the test fluid after testing. These openings shall be plugged and welded after the test.

After the piping is erected in final position, it shall be cleaned, tested for tightness and kept

dry as described in the specification.

All valves shall be provided with the operating handle/ lever/ wrench within easy reach. Where ever necessary, operating platforms shall be provided.

Installation of line mounted equipment / items like filters, strainers sight glasses, etc., including their supporting arrangements shall form part of piping erection work and no separate payment shall be made for this work.

The Tenderer shall provide all required supports, anchors, saddles, hangers, rollers, clamps, u-bolts, guides, spring supports, sway bracings, vibration dampers etc for aligning and controlling the pipe work. Supports shall prevent, under operating conditions, excessive stresses and excessive vibration of supporting elements from possible resonance with imposed vibrations.

Wherever additional flange joints/valve fittings are required, the same shall be provided after taking approval of the Engineer – in-charge.

All suitable hoisting tackles/ equipment should be used for speedy and safe handling of pipes while laying the pipes on supports, specifically in case of surface coated pipes. Such tackles/ equipment shall be provided with cushioning material to avoid damage to the lining / coating of the pipes.

The inside of the pipes shall be cleaned of stones, sand, dirt, oil, grease etc. thoroughly before laying. The cleaning process shall include removal of foreign matter such as scale, sand, weld spatter, cutting chips etc. by wire brushes, cleaning tools etc and blowing out with compressed air and / or flushing out with ordinary water.

1.4 Buried Pipe

All buried pipe work shall be laid with earth cover sufficient to avoid damage from pressure of vibration caused by surface traffic. Minimum earth covering over the pipe shall be 1200 mm from the finished ground level area in areas subject to temporary loads and 1000 mm from finished ground level in areas not subject to temporary loads. Where the buried depth is less than these limits, permission from the Engineer-in-charge shall be taken. All buried pipelines shall be provided with anti corrosion wrapping and coating as specified.

The excavation of trenches shall be so carried out that the digging of trenches does not go far ahead of the pipe laying operations, so as to prevent risk of landslide. All work shall be so organised that trench digging, pipe laying, testing and back filling of trenches follow one another closely.

All buried pipes shall be hydro tested before wrapping and coating.

Where loose earth is met during excavation or where trench is very deep, sidewalls shall be shored properly with timber or other means.

The trench shall be excavated to proper width (min. for single pipe 800mm) and depth. In

case of pipeline passing through existing RCC/ asphalt driveway, Tenderer shall refill the excavated driveway and bring it to its original finish. No additional claim for such work will be entertained.

All underground pipelines crossing rail tracks or roads shall be through culverts or RCC non pressure pipes of the approximate class as indicated in the drawings to suit the site conditions.

It should be ensured that while laying the pipes no foreign materials like stones, sand, gunny bags, bits of welding rods, muck, weld materials etc. are left inside the laid pipes. The Tenderer should ensure that the coating / wrapping of the pipes are not damaged while drawing the pipes through RCC pipes. If there is any damage, it shall be rectified by the Tenderer at his cost.

At the end of each day of work, the free ends of the laid pipes must be kept properly sealed.

Special care shall be taken to place the pipes in the trenches. If any damages are caused during laying/ residual welding of pipes in trenches, floating of pipes in water in trenches, it shall be the Tenderer's responsibility to get them repaired and no claim whatsoever on this account will be entertained by MECON/ OWNER.

On completion of testing and painting of pipelines, the trenches shall be filled as per specification. The entire responsibility lies with the Tenderer for taking care of the pipes including lining/ coating of the pipes.

1.5 Pipe Sleeves

Pipe sleeves shall be provided for pipes passing through foundations, walls, floors, roofs etc., they shall be of sufficient size to permit the passage of flanges or fittings assembled with the line. The annular space at the ends between the sleeve and the pipe shall be sealed with cement concrete.

All required operating platforms, valve stands, access ladders, handrails, pipe crossovers etc shall be erected after the piping has been installed. Structural steelwork in connection with those items shall conform to the relevant Indian Standards for structural steel work.

2.0 Welding

All pipe work shall be of butt weld construction. Flanged joints shall also be provided to match the connecting ends of equipment, valves or where specified. Where specific equipment-piping connection necessitates several joints, unions shall also be provided. Only qualified welders proficient in welding in the vertical and overhead positions shall be allowed to weld these pipelines. Preferably welders with proficiency certificate from Govt. Test House or equivalent recognised authority should be put on the job. It shall be Tenderer's

responsibility to arrange for and bear all costs towards testing of welders.

The following steps shall be taken besides controlling quality in general, to make effective control in carrying out welding:

Welding procedure (PQR & WPS) shall be prepared in line with ASME SEC. IX and tests shall be carried out to qualify the procedures. Number of procedures will depend on variables like positions of welding, thickness range, etc. Once a welding procedure is qualified, strict adherence to it shall be made during actual welding.

Welders employed shall be qualified as per ASME SEC. IX. MECON / OWNER will have the right to check/ witness the certificate(s) / test(s) before and / or during execution of work.

Makes of welding consumables such as electrodes, filler wires, argon, etc. shall be approved by MECON / OWNER before they are used. Such consumables are, however, subject to qualifying initial check tests as per ASME codes.

The Tenderer shall submit batch test certificates, from the electrode manufacturers, giving details of physical and chemical tests carried out by them, for each batch of electrodes to be used.

Guidelines for acceptance of weld defects detected by radiographic / ultrasonic tests, wherever applicable, shall be governed by ASME SEC.VIII, Div-I.

All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers shall be kept in holding oven at temperatures recommended by the electrode manufacturer. “Out of the oven time” for electrodes, before they are consumed, shall not exceed the limits recommended by the electrode manufacturer. The electrode shall be handled with care to avoid any damage to the flux covering.

All low hydrogen type of electrodes shall be rebaked at 350°C for 1-hour minimum and stored in ovens kept at 80-100°C before use. Recommendation of the electrode manufacturer shall be followed if available.

The electrodes, filler wire and flux used shall be free from rust, oil, grease, earth and other foreign matter, which affect the quality of welding.

Welder’s qualification test report as per IS: 817, electrode and material test certificate from manufacturer shall be furnished.

Welding process shall be manual shielded metal arc process. Standard quality line up jigs and fixtures should be used to ensure sound welds. The cutting of pipes and welding shall conform to specifications and to the satisfaction of MECON/ OWNER site engineers.

Welding shall not be performed when surfaces to be welded are wet, when rain is falling on such surfaces or during the period of high winds unless the welder and the works are shielded in an approved manner.

Joint preparation for welding shall be so as to leave a smooth finished profile free of cavities

and conforming to standard practice. Edges shall be cleaned of paint, rust, scale, slag, dirt and other foreign matter before welding.

The throat thickness of the tack welds shall be similar to that of the initial root to be deposited in the groove and where necessary the extremities of the tack welds shall be dressed by grinding, chipping and flame gauging to facilitate proper fusion when they are incorporated in the initial root run. Bridge tacks (above the weld) shall be removed.

All slag and scales etc. shall be removed from the surfaces of each completed bead before depositing the next bead.

The finished weld shall present a smooth bright and shiny surface of constant width and uniformly spaced ripples. The welds shall be free from slag pockets, porosity, undercutting, incomplete penetration and fusion and other weld defects.

The weld protrusions, spatter etc., on the weld surface and adjacent area shall be removed so as to leave the surface smooth and clean.

The weld shall not project beyond the plain surface in butt weld by more than 2mm.

All valves, flanges, risers, bends and other fittings shall be in perfect plumb and care shall be taken to align the pipelines and bends properly to keep the symmetry of the pipeline layout.

To maintain the specified alignment and gap during welding the pipes shall be securely held in position by technical means, tack welding or by welding on bridge pieces. Electrodes or filler rods used for tack welding shall be of the same quality as those for completing the first run of the weld. Welding electrodes used shall have approval from OWNER/MECON. The following make of electrodes are acceptable:

- Advani Oerlikon,
- Philips,
- D & H Sechron,
- GEE,
- Esab,
- Honavar Electrode Ltd.,
- Mailam.

Any other reputed make with the approval of OWNER /MECON

Welding Electrodes for wall thickness up to 14mm shall be 6013 AWS and for wall thickness more than 14mm the electrode shall conform to 7018 AWS.

For root welding of pipe joints, the electrodes shall be 6010 AWS

All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the container shall be kept in holding ovens at temperature recommended by the manufacturer.

2.1 Visual Inspection

Inspection of all welds shall be carried out as per the latest editions of the applicable codes and specifications. All finished welds shall be visually inspected for parallel and axial alignment of the work, excessive reinforcement, concavity of welds, shrinkage cracks, inadequate penetration, unrepaired burn-through, under cuts, dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/code.

2.2 Preparation of pipe ends

For pipes intended to be in axial alignment, the plane of the pipe ends shall be square with the axis of the pipe.

The pipes, which were intentionally out of the axial alignment, the plane of the joint shall bisect the angle between adjacent pipes.

All tack welded butt joint assemblies shall be inspected to ensure root gap alignment, quality of tack welds, their root penetration section and cleaning and freedom from crack. Any substandard tack weld shall be cut out and remade up to the standard before starting the welding.

2.3 MS pipe joints

The ends of pipe 4.5mm and under in wall thickness need not to be bevelled. The ends of all pipes over 4.5mm wall thickness shall be bevelled to an angle of 30 degree for electric arc welding and to an angle 37-1/2 degree for gas welding. Where bevel is made with a cutting torch, the cut edge shall be mechanically cleaned to remove all scale, oxides and irregular edges.

In aligning the ends of pipe for welding, a space at the root of the joint about 1.5mm wide shall be allowed before tack welding. Where chill rings are used spacing up to 4.5mm should be allowed.

A wire spacer of suitable diameter may be used for maintaining the weld root opening while tacking, but it must be removed after tack welding and before laying the root bead.

For pipes of wall thickness 5 mm and above, the ends to be welded shall be secured in position with the aid of couplers, yokes and 'C' clamps, to maintain perfect alignment. Yokes shall be detached after the completion of weld, without causing any surface irregularity on the pipe. Any irregularity caused on the pipe surface must be suitably repaired to the satisfaction of the Engineer –in – charge.

Tack welds, for maintaining the alignment, of pipe joints shall be made only by qualified welders using approved WPS. Since the tack welds become part of the final weldment they shall be executed carefully and shall be free from defects. Defective tack welds must be

removed prior to the actual welding of the joints.

While practical aligning, clamps should be used and the ends shall be tack welded to retain their position during welding. The number of tack welds shall be not less than:

3 tacks - for pipe sizes smaller than 50mm NB.

4 tacks - for pipe sizes more than 50mm NB upto 300mm NB.

6 tacks - for pipe sizes more than 350mm NB.

The tack welds shall be approximately 25mm long and well fused along with sides of end to the bottom of "V" or groove.

Welding shall commence only after approval of fit-up by the Engineer – in – charge.

3.0 Welding Techniques

3.1 Root Pass

Root pass shall be made with electrodes / filler wires recommended in the welding specification chart. For fillet welding, root welding shall be done with consumables recommended for filler passes. The preferred size of the electrodes is 2.5mm diameter (12 SWG) but in any case not greater than 3.25mm (10 SWG).

Upward technique shall be adopted for welding pipe held fixed with its axis horizontal.

The root pass of butt joints should be executed so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall be as per applicable code. It shall be limited to 3mm maximum, when the applicable code does not place any restriction.

Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart should be adopted only after obtaining express approval of the Engineer – in – charge.

Welding shall be uninterrupted.

While the welding is in progress care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.

Peening shall not be used.

3.2 Joint Completion

Joint shall be completed using the class of electrodes, recommended in the welding specification chart. Size of the electrode shall not exceed 4mm in diameter for stainless steel and alloy steels used for low temperature applications.

Two weld beads shall not be started at the same point in different layers.

Butt joint shall be completed with a cover layer that would ensure good fusion at the joint edges and a gradual notch free surface.

Each weld joint shall have a workmanship like finish. Weld identification mark shall be stamped clearly at each joint, just adjacent to the weld. Metal stamping shall not be used on thin pipe having wall thickness less than 3.5mm. Suitable paint shall be used on thin wall pipes for identification.

Rust preventive / protective painting shall be done after the weld joint has been approved.

The weld shall be thoroughly fused to both sides of the "V" or groove and through the bottom of the joint. The pipes shall be welded with three runs of weld. There shall be good fusion between each run and scale shall be thoroughly removed from the surface of each bead or layer of scaling or moderately peeling before the next one is applied. In the event of any cracks occurring, tack welds shall be chipped out before welding is continued. Special care shall be exercised to remelt the tack welds to fuse them with the weld.

Where the pipe can be turned, all welding shall be carried out in the down hand position.

The finished weld shall be uniform and of smooth finish. There shall be no overlapping or excessive undercutting of the pipe at the edge of the weld.

3.3 Repairs of welds

Defects ascertained, through the inspection methods, which are beyond acceptable limits shall be removed after the joint is completely radiographed by the process of chipping and grinding.

When the entire joint is judged unacceptable, the welding shall be completely cut and edges suitably prepared as per required alignment tolerances. The rewelded joint shall again be examined following standard practices.

No repair shall be carried out without prior permission of the Owner's inspector.

Repairs and / or rework of defective welds shall be done in time to avoid difficulties in meeting the construction schedules.

3.4 Riser and Branch Connections

The end of the riser or branch connection and the opening in the line or header shall be prepared by gas cutting or machining along templates lines to ensure accurate cutting and proper fit up. After gas cutting the edge forming the pipes, opening shall be beveled so as to permit welding completely around the joint for connections. Any rough gas cut edges shall be cleaned and or removed by chipping or other mechanical means. The riser may be fitted inside the opening in the header, or set in top. In the latter case the branch shall be beveled for welding. It is preferable to have the riser at least one size smaller than the header but risers of the same sizes as the header are permitted. The use of welding toes in

such case is recommended.

After beveling the work shall be assembled and checked as regards matching of ends, uniformity of spacing and bevel angle and any defects noted shall be corrected prior to welding.

The joint shall be tack welded in a manner similar to that required for 'Pipe line joint'.

Where the riser is set in, the weld shall be thoroughly fused to both the beveled edge of the header and to the sidewalls of the riser. Where the branch or riser is beveled for setting on top of the opening care shall be exercised to penetrate well, metal shall be fused through at the root. Where the riser is placed on top of the header it should be back welded on the inside, wherever possible.

All set in connections shall be prepared so that the ends are at least flush with the inside wall of the header.

In the case of an off set riser subjected to excessive stresses, knee braces gaskets shall be used.

3.5 Supports

Cement concrete/ brick masonry pedestal supports with metal inserts shall be provided for yard piping by the civil works Tenderer. Sliding contact between the support and the pipe is achieved by providing 25mm dia MS rod supplied and erected by the Tenderer. This rod shall be welded to the insert plate. If the level of the top of the rod does not match the required level, proper level of the bottom of the pipe is achieved by raising the rod by means of packing plates between the rod and insert plate. After leveling, the packing plate is welded to the insert and the rod in turn welded to the packing plate.

The heights of the supports shall be adjusted so as to suit the pipeline gradient required and also the pipe work installed. The underside of the pipe should have a minimum distance of 300mm from the ground level. This enables easy maintenance of the pipelines and fittings. Special consideration should be given to the control valves etc. in the pipe run.

Grade stakes set to correct levels shall be provided along the pipeline alignment at suitable intervals for checking the levels of the pipe supports/ pipeline during construction of supports/ laying of pipelines.

Due care shall be taken while laying the pipeline on the supports. The Tenderer shall correct any damage caused to supports. No claims whatsoever will be entertained by MECON/ OWNER on this account.

The Tenderer shall provide pipe supports on steel structures:

Near changes in direction, branch lines and particularly near valves

On pipe and not on valves, fittings or expansion joints

On pipe and not on sharp radius bends or elbows

On runs which do not require frequent removal for maintenance

As close as practical to heavy load concentrations such as vertical runs which do not require removal for maintenance.

As close as practical to heavy load concentrations such as vertical runs, branch lines, heavy valves, separators, strainers etc. and as per direction of site engineer.

In establishing the location of pipe supports, the Tenderer should be guided by two requirements:

The horizontal span must not be so long that sag in the pipe will impose an excessive stress in the pipe wall

The pipeline must be pitched downward so that outlet of such span is lower than maximum sag in the span in order to facilitate drainage.

4.0 Flushing

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by fresh potable water or dry compressed air, wherever water flushing is not desirable, to clean the pipe of all dirt, debris or loose foreign material.

Required pressure for water flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing, the line / system will be pressurised by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in line or installed temporarily for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermo wells, which may interfere with flushing, shall not be included in flushing circuit.

The screens / meshes shall be removed from all permanent strainers before flushing. Screens / meshes shall be reinstalled after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned and reinstalled after flushing but before testing.

In case equipment such as column, vessel, exchanger etc. form part of a piping circuit during flushing, this shall be done with the approval of Engineer – in – charge. However, equipments thus included in circuit shall be completely drained and dried with compressed air after flushing is completed.

During flushing discharged water / air shall be drained to the place directed by the Engineer – in – charge. If necessary, proper temporary drainage shall be provided by the Tenderer.

Care shall be taken during flushing so as not to damage / spoil work of other agencies. Precautions shall also be taken to prevent entry of water / foreign matter into equipments, electric motors, instruments, electrical installation etc. in the vicinity of lines being flushed.

The Tenderer shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following:

Removing of valves, specials, distance pieces, inline instruments and any other piping part before flushing. The flanges to be disengaged for this purpose shall be envisaged by the Tenderer and approved by the Engineer – in - charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve distance pieces, piping specials, etc. shall be reinstalled by the Tenderer with permanent gaskets. However, flanges at equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the Tenderer for each piping system for the flushing done.

5.0 Testing

5.1 General:

Soundness of the welds shall be tested by means of hydrostatic tests. The test shall be conducted only after fulfilling the requirements of visual inspection, radiography, etc., and when the entire work is certified by the engineer-in-charge for performance of such testes.

This specification recommends minimum procedure to be followed, equipment to be used and conditions to be considered during the hydrostatic testing of pipelines.

Nothing in this recommended procedure should be considered as a fixed rule for application without regard to sound engineering judgment. Certain Governmental requirements may differ from the criteria set forth in this recommended procedure and its issuance is not intended to supersede/override such requirements.

5.2 Extent of testing

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding or fabrication.

To facilitate the testing of piping systems, vessels and other equipments may be included in the system with the prior approval of Engineer – in – charge if the test pressure specified is equal to or less than that for the vessel and other equipments.

Pumps, Compressors and other rotary equipments shall not be subjected to field test pressure.

Lines, which are directly open to atmosphere such as vents, drains, safety valves discharge need not be tested, but all joints shall be visually inspected. Wherever necessary, such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockade. However, such lines if provided with block valve shall be pressure tested up to the first block valves.

Seats of all valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where allowable seat pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested shall be excluded from the test by isolation or removals, unless approved otherwise by the Engineer – in – charge.

Restrictions, which interfere with filling, venting and draining such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not to be included in the test system. Where bypasses are provided test shall be performed through the bypass and / or necessary spool pieces shall be used in place of the control valve.

Pressure gauges, which are part of the finished system, but cannot withstand test pressure, shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valve or blinds.

5.3 General Requirement / Preparation for Testing

Testing shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer – in – charge

No pressure test shall be carried out against closed valve unless approved by the Engineer – in – charge.

The Engineer- in – charge shall be notified in advance by the Tenderer, of the testing sequence and programme, to enable him to be present for witnessing the test.

Before testing, all piping shall be cleaned by flushing to make it free from dirt, loose scale, debris and other loose foreign materials.

All piping system to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void exists due to any reasons, like absence of control valves, safety valves, check valves etc. it shall be filled with temporary spool pieces.

All joints welded, screwed or flanged shall be left exposed for examination during the test. Before pressuring the lines, each weld joint shall be cleaned by wire brush to free it from rust and any other foreign matter.

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spool pieces have been removed or disconnected prior to hydrostatic testing, shall be blinded off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portions of the system. For longer lines and vertical lines two or more pressure gauges shall be installed at locations decided by the Engineer – in – charge.

For lines containing check valves any of the following alternatives shall be adopted for pressure testing:

Wherever possible pressurise up- streamside of valve.

Replace the valve by a temporary spool pieces and reinstall the valve after testing.

Provide blind on valve flanges and test the upstream and downstream of the line separately and remove the blind after testing. At these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently.

For check valves in lines 1 ½“ and below flapper or seat shall be removed during testing (if possible). After completion of testing the flapper / seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by the Engineer – in – charge.

Piping which is spring or counter weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg / cm2 g may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of draining the line to make repairs. However, steam shall not be used for this purpose, if the steam temperature is more than the design temperature of the line.

5.4 Testing media, test pressure and test pressure gauges

a. Testing Media

In general all pressure test shall be hydrostatic using iron free water, which is clean and free

of silt.

Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer – in – charge.

b. Test Pressure

The hydrostatic / pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer – in – charge.

The selection of the piping system for one individual test shall be based on the following:

Test pressure required as per piping drawing.

Maximum allowable pressure for the material of construction of piping.

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

c. Test Pressure Gauge

All gauges used for field-testing shall have suitable range so that the test pressure of the various systems falls in 40 % to 80 % of gauge scale range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programme, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge showing an incorrect zero reading or error of more than +2% of full scale range shall be discarded. The Engineer – in – charge shall check the accuracy of master pressure gauge used for calibration.

5.5 Testing Procedure

a. Air Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver, after cooler and oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joint can be examined for leaks.

All other details shall be same as per hydro testing procedure (specified above).

b. Completion of Testing

After the hydrostatic test has been completed, pressure shall be released in a manner and at a rate so as not to endanger personnel or damage equipments.

All vents and drains shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining, lines / systems shall be dried by air.

After testing is completed the test blinds shall be removed and equipment / piping isolated during testing shall be connected using the specified gaskets, bolts, and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the Tenderer for complete loop / circuit including equipments (except rotary equipments).

Pressure test shall be considered complete only after approved by the Engineer – in – charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system / line shall be done by the Tenderer at his cost.

c. Test Records

Records in triplicate shall be prepared and submitted by the Tenderer for each piping system, for the pressure test done.

d. Hydraulic test

The Tenderer shall ensure that the pipelines have been thoroughly cleaned up by flushing with clean water/ compressed air of any foreign matter inside the pipes and dried before taking up for hydro test. The procedure adopted for cleaning shall be indicated by the Tenderer and subject to approval by MECON / OWNER.

All equipments materials, consumables including water and services required for carrying out the pressure testing of piping system shall be provided by the Tenderer at his own cost.

In case of buried pipes the trenches shall be kept free of water and the pipeline surfaces dry. The pipeline shall be filled with water and the pressure built up by means of test pump with a gauge to the specified pressure.

With the exclusion of instrumentation, piping systems fabricated or assembled in the shop / factories shall be tested at the site, irrespective of whether or not they have been pressure tested prior to site welding or fabrication.

The site – in – charge shall be notified in advance by the Tenderer of testing sequence / Programme, to enable him to be present for witnessing the test.

All vents and other connections used as vents shall be left open while filling the line with test fluid for complete removal of air. In all lines, for pressurising and depressurising the system, temporary isolating valves shall be provided if valved vents and drains do not exist in the system.

Pressure shall be applied only after the system / line is ready and approved by the Engineer – in – charge.

Pressure shall be applied by means of a suitable test pump or other pressure source, which shall be isolated from the system, as soon as test pressure is reached and stabilized in the system.

A pressure gauge shall be provided at the test pump discharge for guidance in bringing the system to the required pressure.

The test pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system whenever the pump is to be left unattended.

Test pressure shall be maintained for a sufficient length of time to permit thorough inspection of all joints for leakage or signs of failure. Any joint found leaking during a pressure test shall be retested to the specified pressure after repair. Test pressure shall be maintained for a minimum of two hours.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauge. These gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to temperature variation during the test.

5.6 Equipment for a Hydrostatic Test

Equipment for the hydrostatic test should be properly selected and in good working order.

Equipment affecting the accuracy of the measurements used to validate the specified test pressure should be designed to measure the pressures to be encountered during the hydrostatic test.

Equipment for conducting the hydrostatic test may include the following:

A high volume pump capable of filling the line at minimum velocity of 2 km/hr.

A test medium supply line filter capable of ensuring a clean test medium.

An injection pump to introduce corrosion inhibitors or other chemicals into the test segment, if their use is required.

A meter or other comparable means of measuring line fill.

A variable speed positive displacement pump capable of pressurising the line at 7 kg/cm2 (approximately 100 psi) in excess of the specified test pressure. The pump should have a known volume per stroke and should be equipped with a stroke counter (a constant speed pump having a variable flow rate control may be used in lieu of the above if the liquid test medium injected into the pipeline is measured during pressurisation).

Portable tank, if required, capable of providing a source of liquid test medium.

A large diameter bourdon tube type pressure gauge with a pressure range and increment

divisions necessary to indicate anticipated test pressures.

A deadweight tester certified for accuracy and capable of measuring increments of 0.1 kg/cm2 (1.5psi).

A 24-hours recording pressure gauge with charts and ink. This gauge should be deadweight tested immediately prior to and after use.

Two glass laboratory thermometers, with a 75mm. (approximately 3") immersion capability of measuring temperatures from 0 deg.C (32 Degree F) to 50 Degree C (122 Degree F).

A 24 hours recording thermometer capable of recording temperatures from 0 deg.C (32 Degree F) to 50 Degree C (122 Degree F).

Pigs, spheres and similar devices to be used to clean the test segment and to facilities the removal of air from the line.

Temporary manifolds and connections as necessary.

Equipment, materials and fluids needed to displace the test medium from the test segment.

5.7 Test Plan

The following factors should be considered in planning a hydrostatic test:

Maximum operating pressure anticipated through the life of the facility.
Location of pipe and other piping components in the test segment by size, wall thickness, grade type and internal design pressure(s).
Shell pressure rating and location of pipeline valves, air vents and connections to the segment.
Anticipated temperature of test medium, atmosphere and ground.
Source(s) of test medium and any inhibiting or other treating requirements
Locations and requirements for test medium disposal.
Profile and alignment drawing maps.
Safety precautions and procedures.

5.8 Test Procedures

A hydrostatic test procedure diagram with explanatory notes and data should be prepared prior to testing and should indicate in a detailed fashion the following:

The length and location of the test segment(s).
Test medium to be used.
Procedures for cleaning and filling the line.
Procedures for the pressurisation of test segment(s) including the locations of the injection points and the specified minimum and maximum test pressures.
Minimum test duration for test segment(s).
Procedures for removal and disposal of test medium.

Safety precautions and procedures.

A specified test pressure is defined as the minimum test pressure, which should be applied to the most elevated point in the test segment. A detailed analysis of the profile to determine static and dynamic pressures while the pipeline is being tested should be performed so that the pipeline will not be over pressurized at points, which are at low elevations.

5.9 Line fill and Cleaning

The line fill operation should serve the dual function of cleaning the line and introducing the necessary test medium into the test segment. Screens or filters should be installed in the test medium supply line to control the contamination of the test medium by debris or sediment. The quality and source of water should be determined. Water, which is not free of sediments and may be injurious to the pipe, valves, equipments, etc., should not be used unless it is filtered. The filling operation should be planned and executed in a manner, which prevents the infusion of air into segment to permit the purging of trapped air.

5.10 Pressurization

Personnel conducting the test should maintain continuous surveillance over the operation and ensure that it is carefully controlled.

The test segment should be pressurised at a moderate and constant rate. When approximately 70% of the specified test pressure is reached, the pumping rate should be regulated to minimise pressure variations and to ensure that increments of no greater than 1 kg/cm2 may be accurately read and recorded. Pipe connections should be periodically checked for leaks during pressurization.

5.11 The Test Hold

When the test pressure is reached, pumping should be stopped and all valves and connections to the line should be inspected for leakage, a period of conservation to the line should follow during which test personnel verify that specified test pressure is being maintained at the line pressure and temperature has stabilized. Upon completion, the injection pump should be disconnected of its connection to the pipelines and checked for leakage. Pressure should be monitored and recorded continuously during the duration of the test.

5.12 Displacement of test medium

Water should be completely drained off. Water should be disposed of at approved locations in a manner that will cause minimal environment effects.

The pressure shall be maintained for a minimum period of 1/2 hour unless otherwise

specified by the client. The hydrostatic test shall be considered positive only if there is no drop in pressure at the end of the specified period.

All welded and flange joints and the seam welds on the ERW pipe shall be inspected for leaks.

Leaky joints shall be repaired by chipping or gauging out such defects as required and re-welded. The cut out of joints shall be just sufficient to correct the defects. After repairing the leaky joints, the line shall be tested to prescribed pressure. No claims for expenditure incurred by the Tenderer towards such repairs of defective work and testing will be entertained.

After test, the water shall be completely emptied out and the line shall be made free of water.

All underground piping shall be tested and ensured of no leakage at test pressure before filling up trenches.

No painting shall be done at weld joints till the system is accepted in all respects.

6.0 Painting

6.1 General

This specification covers the requirement of selection, supply, application and workmanship of protective coating system for piping.

It is deemed that the work will be carried out by the Tenderer with the best quality of specified material and workmanship at his own cost.

Adequate numbers of required tools, brushes, blast material, scaffolding, shot / sand blast cleaning equipment, air compressors, etc., shall be arranged by the Tenderer at site.

During storage and application of paints, the paint manufacturer's instructions shall be strictly followed. Particular attention shall be paid to the following:

Proper storage avoiding exposure and extreme temperature.

Specified surface preparation.

Mixing and thinning.

Application of paints and the recommended time intervals between consecutive paint coats.

Two-pack paint system shall be mixed by mechanical means. The Engineer – in – charge may allow hand mixing of small quantities at his discretion.

Final Painting of pipelines / structural steel works shall be done only after the mechanical completion and testing of the system are completed.

'Fire Red' colour paint shall be used for painting firewater network, hydrant monitors, hoses,

boxes, etc.

Colour schemes shall be in line with standard industrial codes in line with OWNER practices, which will be indicated to the successful Tenderer.

Scope of pipeline painting work covered in the specification shall include:

Structural steel work, walkways, pipes supports, ladders, etc.

All above ground piping and fittings including identification marks.

Painting of valves.

Identification colour bands and directions on all piping as required.

Supply of all primers, paints and all other material required for painting.

Coating and wrapping of underground pipelines.

6.2 Surface Preparation

All rough welds, burrs, weld splatter, indentations and all other sharp surface projections shall be ground smooth prior to further surface preparation. Surface shall be blast cleaned to SA 2 ½. Maximum peak of surface profile shall be less by 5 – 10 microns from the primer DFT. Any protective coating used by the pipe manufacturer/ supplier shall be removed during blast cleaning.

All boltholes shall be drilled and smoothened before cleaning.

Any oil, grease, dust or foreign matter deposited on the surface after the surface preparation is completed shall be removed prior to painting. In the event rusting occurs after completion of surface preparation and before application of the primer the surfaces shall again be cleaned in accordance with the specified method.

Name plates, Manufacturer's identification tags, machined surfaces, instrument glass, control valve stems and other items in contact with or near the surface being coated shall be removed or marked as appropriate for protection, prior to protective coating application.

In order to achieve maximum durability, one or more of following methods of surface preparation shall be followed before blast cleaning:

a. Manual or Hand Tool Cleaning

This normally consists of hand descaling and / or hammering, hand scraping and hand wire brushing. Rust, mill scales, weld spatters, old coatings and other foreign matter shall be removed by hammering, scraping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags and the surface shall be brushed, swept, re-dusted and blown off with compressed air to remove all loose matter.

b. Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire brushes. Excessive brushing of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale, etc. shall be removed by clean rags and / or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

c. Blast Cleaning

The sand / shots used for blasting shall be free from moisture, salt. Sand size should be 16 mesh to 30 mesh in order to have surface profile range 55 – 65 microns.

Size of abrasive: 16 – 30 mesh. The particle should pass through 100% when sieved with 16 mesh and nothing to pass through when sieved with 30 mesh i.e., size below 16 and above 30 mesh are not recommended.

Shape of abrasive: Shape, semi-sharp, spherical or near spherical. Semi-sharp means some sharp as well as round edge in one particle grit.

The total surface shall then be blast cleaned to Swedish standard SA 2 ½.

The blasting has to be carried out at a pressure of 7 kg/cm2 at the nozzle tip. Compressed air is to be free from moisture and oil.

On completion of blasting operation, the blasted surface shall be made clean and free from any dust and scale or rust and must show a grey white metallic lustre as demonstrated in SA 2 ½.

Blast cleaning shall not be done in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned, or humidity exceeding 85%. Surface profile shall be uniform to provide good key to the paint.

Primer or first coat of paint shall be applied within 3 hours of sand blasting or as directed by Engineer – in – charge depending on weather conditions.

6.3 Coating Procedure

a. Coating System

Painting system for the pipelines and other structures shall be as indicated in this specification.

b. Application

Before application of primer, the surface shall be cleaned of dust etc. Surfaces shall not be coated in adverse weather conditions, rain, wind, snow, fog, mist, or / and in areas where

injurious airborne elements exist.

Cleaned surfaces shall be coated with one complete application of primer as soon as practicable but in no case more than three hours after surface preparation.

Application of coats shall not be carried out if the atmospheric temperature is less than 5°C or if the temperature exceeds 40°C in the shadow, 50°C due to the influence of sun or if relative humidity exceeds 85% or in case of adverse weather conditions like rain, fog, dust storm etc.

All paints shall be thoroughly stirred up prior to and during their application.

To the maximum extent practicable, each coat of material shall be applied as a continuous film of uniform thickness free of pores.

Coating media shall be applied in uniform thickness. All slots, recesses, grooves, corners, angles and interstices shall be covered by paint. Sag and runs shall be distributed or removed and new paint shall be applied uniformly.

Any thin spots or area missed in the application shall be recoated and allowed to dry before the next coat is applied.

Each coat shall be in proper state of cure / dryness before the application of the succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental line irregularities, such as lifting or loss of adhesion of the undercoat.

When successive coats of the same colour have been specified, alternate coats shall be tinted, when practical, sufficient to produce enough contrast to indicate complete coverage of the surface. When the material is of the same colour as of the steel, or when the tinting of the final coat is objectionable, the first coat to be applied shall be tinted. The tinting material shall be compatible with the material and not detrimental to its service life. Shade of each coat shall be got approved by Engineer – in – charge.

All containers of coating material shall remain as unopened original Manufacturer's containers until required for use. Coating materials that have jelled or deteriorated during storage shall not be used.

Paint containers shall be opened only prior to utilisation and shall be carefully closed immediately after withdrawal of paint. Expiry date of the paint should be checked before opening the container. Paints, which have become unserviceable during storage, shall not be applied. All painting material shall be kept in weatherproof barracks and shall be kept cool and dry.

All ingredients shall be thoroughly mixed before use to a smooth and uniform consistency using mechanical means. No air bubbling shall be used for this purpose.

All pigmented material shall be strained after mixing so as to remove any skin, etc. before use. Coating material shall not remain in spray pots or buckets over night but shall be

gathered into a closed container and remixed before use.

All thinning and mixing shall be done strictly in accordance with the Manufacturer's instructions for the particular materials and under the supervision and direction of the engineer-in-charge or his representative.

Where brush coating is applicable, brushes shall be of a style and quality that will enable proper application of paint. Wide flat brushes are suitable for large flat areas but they shall not have width over five inches. Rough or oval shaped brushes shall be used for irregular and rough surfaces.

The brushes shall conform to IS: 384. The width of the brushes shall not be more than 15cms.

Paint shall be applied by brush / conventional spray / airless spray. During spraying the paint shall be maintained thoroughly mixed in the spray gun.

Tenderer shall obtain approval for specification for spraying installation concerned, the type of equipment, nozzle diameter, pressure setting etc. The paint shall be sprayed uniformly. Surfaces impossible to be coated by spraying must be painted by brush.

Painting work shall be done in daytime only preferable between 9 am and 5 pm.

6.4 Repair of damaged paint surface

The Tenderer shall rectify painting work found defective under this specification at no additional cost to OWNER.

Where shop paint has been damaged in handling, all damaged and loosely adhering paint shall be removed and the surface thoroughly cleaned. Edges of the breaks shall be lathered and the designated number of prime and finish coats applied.

6.5 Paint Material

Primer and finish coats shall be of first class quality and shall conform to the specification indicated below:

a. Specification for paints:

Zinc Ethyl Silicate Primer (P1)

The zinc ethyl silicate consists of two packs. One pack contains the ethyl silicate binder with suitable solvents. The other pack contains zinc dust with additives. They have to be mixed in suitable proportions before application as recommended by manufacturer.

Colour	:	Grey
Application	:	Spray (airless / air)
Dry film thickness per coat	:	65-75 microns
Theoretical coverage	:	8 sq.m / litre

Drying time	:	4 hours
Re-coating time	:	10 hours (min)
% of total metallic zinc in dry film	:	85 – 90 % by wt.
(As per the ASTM D520 – Spherical size storage life)	:	4 months under sealed conditions.

b) Epoxy primer (P2)

The primer is a two pack anti corrosive epoxy primer for use on steel surfaces.

Volume of solids	:	40 ± 2%
Composition	:	Epoxy resin/ Zinc Phosphate
Colour	:	Red Oxide
Pigment volume concentration:		25-35%
Application	:	Brush or spray
Dry film thickness per coat	:	40-50 µm
Theoretical coverage	:	8-10 sq.m/ litre
Drying time	:	Touch dry – 1 hour; Hard dry – over night
Storage life	:	9 months under sealed conditions.

c) Two pack epoxy – polyamid mio undercoat (U1)

These coatings are high build paints based on cold cured epoxy polyamide system pigmented with chemically inert pigments and extenders formulated to permit application at a DFT higher than 100 microns per coat.

Type of epoxy	:	Condensation product of bisphenol A and epichlorohydrin with terminal epoxides groups.
Epoxide equivalent	:	450 – 500
Curing agent	:	Polyamide
Volume of solids	:	55 – 60 %
Pigment	:	The main pigment shall be micaceous iron oxide (MIO – Lamellar) constituting a minimum of about 65% w/w of total pigments.
Pigment volume concentration:		40 – 45 %
Application	:	Airless spray
Dry film thickness / coat	:	110 – 120 microns
Spreading rate	:	5- 5.5 sq. m / litre
Drying time	:	Touch dry in 2 hours, hard dry in 48 hours
Over coating time	:	24 – 48 hours. This should be very strictly adhered to in order to avoid peeling of subsequent coat.
Storage life	:	12 months under sealed conditions.

d) Epoxy high build finish paint (F1)

Type and composition	:	Two pack poly amide/polyamine cured epoxy resin medium suitably pigmented.
Volume of solids	:	62%
DFT(dry film thickness) (As per coat app.)	:	100-125microns
Theoretical coating capacity	:	5-6
Weight per litre (app) kgs/lts	:	1.4
Touch dry at 30°C	:	3hrs
Hard dry at 30°C	:	Overnight
Over coating interval	:	Min: Overnight Max: 5days
Pot life at 30°C for two component Paints (app.)	:	4-6 hrs

e) Two pack aliphatic acrylic polyurethane finish paint (F2)

Part-A: Part-A consists of polyacrylate polyol with appropriate primary extenders, solvent and additives.

Part-B: Part-B consists of an aliphatic polyisocyanate with appropriate solvents and additives.

Part A and Part B are to be mixed together to form a pigmented polyurethane paint in suitable proportions as recommended by manufacturer.

Volume of solids	:	45 %
Main pigment	:	Rutile TiO2 (min. 80% w/w on total pigment weight) and extenders with other suitable pigments to get the disered colour
Colour	:	As desired
Pigment volume concentration	:	15 – 20 %
Application	:	Brush or spray
Dry film thickness per coat	:	40-50 microns
Theoretical coverage	:	11 – 13 sq.m / litre
Drying time	:	Surface dry 1 hr. Full cure 7 days.
Storage life	:	3 months under sealed conditions

f) Synthetic Enamel (F3)

A high quality enamel based on synthetic resign vehicle stable weather resistant pigment designed

for both protection and decoration.

Volume of solids	:	38-40%
Application	:	by brush or conventional spray
DFT/Coat	:	30-35 microns
Spreading rate	:	11-13 sq. m/ lt
Drying time	:	Surface dry-4hrs Hard dry-18hrs
Storage life	:	12 months under scaled conditions

g) Painting System

For coastal area- Ennore Terminal

Painting specification for pipes and other connected item

Surface preparation	Blast clean to SA 2½
Paint system recommended	One coat of P1 (65-75 µm each) One coat of F1 (100-125 µm each)+ Two coats of F2 (40-50 µm each)
Total DFT (Min)	245 µm

For Structurals

Surface preparation	Blast clean to SA2 ½
Paint system recommended	First coat of P2 (50 µm each) +second coat (intermediate) of U1 (75 µm) To be deleted + third coat of F1 (90µm) +Finish coat of F2 (35µm)
Total DFT(min)	250 µm

6.6 Paint Manufacturers

An indicative list given below of the paint manufacturers whose product conforming to the respective qualities specified herein may be considered for use. However, the site engineer has the right to reject any material of these manufacturers, which do not conform to the specifications.

M/s Asian Paints India Ltd.

M/s Bombay Paints Ltd. Mumbai.

M/s Berger Paints India Ltd. Mumbai.
M/s Ameron / Goodlass Nerolac Paints Ltd. Mumbai.
M/s Jenson & Nicholson India Ltd. Kolkata.
M/s CDC Carboline, Chennai.
M/s Shalimar Paints Ltd. Mumbai.
M/s Solvo-Sol Paints (P) Ltd. Hyderabad.
M/s Grand Polycoats Company Pvt Ltd. Vadodara.
Sigma Coatings Mumbai
Akzo Noble coatings India Ltd., Bangalore or
Any other reputed make with the approval of OWNER/ MECON

7.0 Inspection and final acceptance

Required painting materials for application shall be procured directly from manufacturers as per specification. Manufacturer's test certificates for every batch should be submitted to Engineer – in – charge without which paints will not be accepted.

Engineer – in – charge at his discretion may call for tests for paint formulation. Tenderer shall arrange to have tests performed including batch wise test of wet paints for physical and chemical analysis at no extra costs to OWNER.

Painting work shall be subject to inspection and approval by MECON/ OWNER.

The painting work shall be subject to inspection by Engineer – in – charge at all times. Following aspects will be considered during inspection and Tenderer shall offer the work for inspection and approval of site Engineer before proceeding with the next stage. Stages of inspection are as follows.
Surface preparation
Primer Application
Each coat of paint

Any defect noticed during the inspection is to be rectified by the Tenderer to the satisfaction of Engineer – in – charge before proceeding further.

Each batch of paint shall be offered to him for approval before commencing application. Preparation of surface shall be subject to spot examination and approval, and where it is evident that surface preparation has been inadequate, the Engineer may require the surface to be stripped, cleaned etc. as necessary. Paint film thickness shall be examined at random locations after completion of primary coat, and also as completion of the final finishing coat.

Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make up the DFT specified without any extra cost to the Tenderer.

The Tenderer has to position an ELCOMETER at site for checking the paint thickness by the site engineer.

The Tenderer shall arrange and keep a Holiday Detector at site for testing of wrapping coating of underground pipelines.

Paint operations shall be aimed at producing smooth and neat finished surfaces and inspection of edge and lining details will take this requirement into consideration in accepting each part of the work. All splashes shall be cleaned up as they occur, and empty paint containers and other debris shall be removed from site.

All inspecting and examining instruments shall be calibrated and checked to indicate their proper functioning.

Irrespective of the inspection, repair and approval at intermediate stages of work, Tenderer shall be responsible for making good any defects found during the final inspection / guarantee period / defect liability period as defined in general conditions of contract.

8.0 Treatment of underground pipelines

a. Surface Preparation and primer application

The pipe shall be sand blasted to SA 2 ½. Primer shall be applied over the pipe at 150-gm/ sq.m. The primer shall be allowed to dry until the solvent evaporates and the surface become tacky.

b. Wrapping

Underground pipes shall be wrapped with 4mm thick polymeric corrosion protection tape, which shall conform to IS: 10221-1982 / AWWA C 203.

Polymeric tape (4mm) shall then be wound around the pipe in spiral fashion and bonded completely to the pipe by thermo fusion process. The same thermo-fusion process shall seal the overlaps.

Polymeric protection tape shall incorporate a center core of approx. 100-micron HDPE film. It shall have a second center core of textile fabric to give mechanical strength and dimensional stability to the tape. 3 layers of polymeric based coal tar, rubber and other polymers shall be interleaved between the above centre cores. All the seven layers shall be calendared together to create the above protection tape.

c. Testing of wrapping

Holiday test shall be conducted over the coated surface accordingly to AWWAC 203. After testing, the defective coating should be repaired and holiday test carried out again.

d. Adjacent Pipelines, Structures, etc.

If any damage is caused to the coating and wrapping of adjacent pipes or any other existing

structure during excavation or subsequent work or during coating or wrapping of flanged joints, the Tenderer shall carry out necessary repairs at his own cost in a manner as directed by the Engineer-in-Charge.

STANDARD SPECIFICATION
FOR
FIRE BUCKETS

SPECIFICATION NO: MEC/TS/05/28/081/03

(OIL & GAS SBU)
MECON LIMITED
DELHI

1.0 **Scope**

The specification covers the general requirement regarding the material, shape, design, dimensions, manufacture, finish and tests of galvanised mild steel fire bucket.

2.0 **Material**

2.1 Buckets shall be of mild steel black sheets confirming to grade ST42 of IS:1079.

2.2 Rod used for top & bottom handles shall be of mild steel confirming to IS: 226.

2.3 Wires used for stiffening of top rim shall be of mild steel, confirming to IS: 280.

2.4 Painting of fire bucket shall be as follows :

a)	Inside	-	Two coats of white paints (enamel finish), as per IS: 2932.
b)	Outside	-	Two coats of fire red paints, confirming to Shade No. 536 of IS: 5 (enamel finish), as per IS: 2932.
c)	Ears, Handles & Letters	-	Two coats of black paints, as per IS: 2932.

3.0 **Shape, Dimensions and Construction**

3.1 The shape and dimensions of the fire bucket shall be as per IS: 2546.

3.2 The body of fire bucket shall be in two halves and to be joined together by butt welding. Top rim of the body shall be wired and uniformly beaded without gaps. Thickness of body shall be 1.0 mm & dia of beading wire 3.55 mm.

3.3 Bottom sheet of fire bucket shall be 1.0 mm thick and dished. It shall be joined to the body by butt welding to avoid raw edge on the inside of the bucket.

3.4 Thickness of mild steel sheet for ears shall be 2.8 mm and shall be fitted to the body at the top by welding with the flat head on the side.

3.5 Top & bottom handle shall be of mild steel rod of 10.0 mm dia. The grip shall have no sharp edges.

4.0 Performance Test

4.1 The bucket shall be fully filled with water and kept for 15 minutes, there shall not be any leakage for the period.

4.2 The dry empty bucket with its top facing upward shall be pressed down the water in a water tank of suitable size vertically. In such a way that top of the bucket shall be minimum 6.0 mm above the water level. Water shall not enter inside the bucket.

4.3 After taking out the bucket, the bucket shall be reversed and pressed inside the water tank vertically. There shall not be any air bubble seen escaping through the water.

5.0 Workmanship and Finish

5.1 All parts shall be of good finish, clear of burrs.

5.2 All gas welds shall clean and sound and shall be free from porosity, blow-holes, scales and brittleness.

5.3 The bucket shall be galvanised after manufacturing with thickness of zinc coating on any portion not less than 0.06 gm./cm2 (both sides inclusive), as per IS: 2629.

6.0 Marking

Each fire bucket shall be clearly and permanently marked with the following information:

a) Manufacturers name or trade-mark,
b) Year of manufacture & capacity,
c) Word "FIRE" shall be painted in black centrally on outside with letters 75 mm high & 12 mm thick.

STANDARD TECHNICAL SPECIFICATION FOR NON-PERCOLATING FLEXIBLE FIRE-FIGHTING DELIVERY HOSE WITH COUPLING

SPECIFICATION NO: MEC/TS/05/28/081/19

(OIL & GAS SBU)
MECON LIMITED
DELHI

1.0 **Scope**:

This specification covers the general requirement regarding the material, design and construction, performance and test for non-percolating flexible fire fighting delivery hose with gunmetal male & female type instantaneous coupling.

2.0 **Material:**

2.1 The material for Delivery hose shall be as per IS: 636 TYPE A or TYPE B as defined in data sheet / MR / SOR .

2.2 The material for Male and Female instantaneous type coupling shall be of Gunmetal as per IS: 903.

3.0 **Design and Construction:**

3.1. The hose shall be constructed from a circular woven jacket having a waterproof rubberised fabric lining on the inside, facing the waterway.The jacket shall be seamless and compactly woven from good quality cotton yarn or from yarn made from suitable synthetic fibre of polyamide or polyester type of good quality or from their combinations.

3.2. Fire hose with outer coating/covering shall be manufactured using synthetic yarn only.

3.3. The Fire hose shall be of 15m length and of φ 63mm.

3.4. If cotton yarn is used in the construction of jacket, this shall be rootproofed as per IS: 636 and method as per IS: 11662.

3.5. The average mass of hose per metre length shall not exceed 0.425kg.

3.6. The delivery hose couplings shall be of φ 63mm and consist of male half and female half coupling assembled with washer as per IS: 903.

4.0 **Performance Requirements**

4.1 The delivery hose pipe shall be tested for kink, hydrostatic burst pressure, change in length and diameter, adhesion, abrasion resistance, moisture absorption and heat resistance as per methods and parameters mentioned in IS: 636.

4.2 The couplings shall be subjected to a hydraulic pressure of 2.1MN/mm^2 for a period of 2.5 minutes for the purpose of locating porosity in the casting and other defects.The couplings shall not show any sign of leakage or sweating.

5.0 **Workmanship and Finish**

5.1 The jacket shall be practically free from dirt, knots, lumps, irregularities of the yarn and other visible defects.

5.2 Inner lining shall be of rubberised fabric and shall be generally smooth and practically free from pitting and other imperfections.

5.3 All fittings shall be of good workmanship, finish, clear of burrs and sharp edges. All forgings and castings shall be clean and sound and shall be free from porosity, blowholes, scales, cracks and other imperfections and shall not be repaired or filled so as to hide casting defects. The water way of the fillings shall have a smooth finish.

6.0 Packing and Marking

6.1 Packing

The hoses may be dusted with French Chalk as per IS: 380 on the inside and shall be packed and delivered in a length of 15M in neat, clean and dry condition in Polyethylene bags.

6.2 Marking

A) Fire Hose

Beginning at a point not less than one metre from each end, each length of hose shall be marked with clear and indelible letters at least 20mm in height indicating:

a) Manufacturers name or trade-mark or both
b) Type, length and size of Hose
c) Month and year of manufacture
d) The Fire Hose shall also be marked with the BIS certification mark.

B) Delivery Couplings

The male and female instantaneous couplings shall be separately, clearly and permanently marked with following information:

a) Manufacturers name and trade-mark
b) Size of couplings
c) Year of manufacture
d) The Couplings shall also be marked with the BIS certification mark.

STANDARD SPECIFICATION FOR RESTRICTION ORIFICE PLATES

SPECIFICATION NO: MEC/TS/05/28/081/34

(OIL & GAS SBU)
MECON LIMITED
DELHI

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets, covers the requirements for the design, materials, nameplate marking, inspection, testing and shipping of restriction orifice plates and multistage restriction orifice assemblies.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry: -

ASME American Society of Mechanical Engineers
- B 16.5 Pipe Flanges and Flanged Fittings
- B16.34 Valves Flanged, Threaded and Welding End
- B 36.10 Welded and Seamless Wrought Steel Pipe.

EN European Standards
- 10204 Inspection Documents for Metallic Products

ISO International Organisation for Standardisation
- 5167 Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full.

1.1.3 In the event of any conflict between this standard specifications, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations

b) Data Sheets

c) Standard specification

d) Codes and standards

1.1.4 In addition to compliance to the purchaser's specification in totality, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets specify the material for restriction orifice plates. Unless specifically indicated otherwise, alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility

with the specified fluid and its operating conditions.

b) Purchaser's data sheets indicate the thickness of the restriction orifice plate. If found necessary, vendor may provide higher thickness of the restriction orifice plate considering process conditions, specified in the purchaser's datasheets.

c) Sizing of the multistage restriction orifice plate assembly and the number of stages to meet the process conditions specified in purchaser's data sheet.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instruction to the vendor attached with the material requisition.

1.2.2 All items as offered, shall be field proven and should have completed trouble free satisfactory operation individually for a period of minimum 4000 hours on the bid due date in the similar application with process conditions similar to those as specified in the purchaser's data sheet. Items with prototype design or items not meeting provenness criteria shall not be offered.

1.2.3 All documentation submitted by the vendor including their quotation, drawings, installation, operation and maintenance manuals etc. shall be in English language only.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, specification sheet and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets.. The required number of prints and soft copies should be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum;

a) Specification sheet for each restriction orifice plate.

b) Certified drawing sheets for each restriction orifice plate, which shall provide dimensional details, constructional details and material of construction.

c) Sizing calculation for multi-stage restriction orifice plate assemblies.

d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.

e) Installation procedure for each restriction orifice plate.

2.0 DESIGN AND CONSTRUCTION

2.1 Unless otherwise specified, restriction orifice plates shall be concentric square edge type.

2.2 Whenever multi-orifice plate assembly is specified, vendor shall supply complete assembly with orifice plates, spool piece and flanges duly welded. The orifice plate design shall be either of the concentric or eccentric. type. The number of stages of orifice plates shall be calculated by vendor based upon the process data indicated in the purchaser's data sheet.

2.3 Each restriction orifice plate shall have an integral handle, which upon assembly shall extend by minimum of 50mm beyond flange edge.

2.4 Where weld-in type restriction orifice plates have been specified, the welding and edge preparation shall be as per ASME B 36.10.

2.5 Where the restriction orifice plate is to be mounted between ring-type joint flanges, vendor shall reply the plate with a plate-carrying holder.

2.6 The inlet face of the orifice plate shall be as per ISO-5167 or any other standard indicated in the purchaser's datasheet.

2.7 The fluid outlet surface of the plate should be flat and smooth and shall not have roughness and scores that can be ascertained by touch or sight.

2.8 Restriction orifice plates in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride and all connections shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

3.0 NAMEPLATE

3.1 Each restriction orifice plate shall have the following nameplate information punched on its handle: -

a) Tag no. as per purchaser's data sheets.

b) Nominal pipe size in inches and rating in pounds.

c) Material of plate.

3.2 Each multi-orifice plate assembly shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information:

a) Tag number as per purchaser's datasheet

b) Manufacturer's name / trade mark

c) Nominal end connection size and rating

d) Orifice plate and assembly material of construction

e) Number of orifice plate stages

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan and approved quality documents. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 Each restriction orifice plate shall be packed inside thick polythene bags with suitable protective packing outside.

5.2 Each plate shall be packed separately.

5.3 All restriction orifice plates in oxygen and chlorine service shall be separately packed along with a certificate indication 'SUITABLE FOR OXYGEN/CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to the above requirements, shall be summarily rejected.

STANDARD TECHNICAL SPECIFICATION FOR HOSE CABINET

SPECIFICATION NO: MEC/TS/05/28/081/17

(OIL & GAS SBU)
MECON LIMITED
DELHI

CONTENTS

1.0 **SCOPE**

This standard lays down overall requirements regarding construction, material, design, shape, Painting, Marking and fixing arrangements of fire hose cabinet to be installed near fire hydrants and to be used for keeping fire fighting accessories.

2.0 **DESCRIPTION OF CABINET**

2.1 Depending upon place of installation to suit the requirement, hose cabinets shall be of two sizes and types for accommodating delivery hose, jet nozzle with branch pipe, or universal branch pipe, fireman axe (if required). The two types of hose cabinets have been defined as Type-A and Type-B.

2.2 Type-A hose cabinets are suitable for wall mounting installations. They shall be able to accommodate, one 63mm delivery hose having length 15m with end male / female coupling, one jet nozzle with branch pipe or alternately one universal branch pipe.

2.3 Type-A cabinet shall have single panel glass door. Necessary hangers and brackets for proper keeping / positioning of delivery hose, nozzles and branch pipe or universal branch pipe inside shall be provided with the cabinet.

2.4 Type-B hose cabinet shall be of self-supporting type and shall be suitable for outside installation. They shall be capable to accommodate two 63mm delivery hoses of 15m length with end couplings, two jet nozzles with branch pipe or two universal branch pipes.

2.5 Type-B hose cabinet shall have double panel glass door. Necessary hangers and brackets for proper keeping / positioning of delivery hose, nozzles and branch pipe or universal branch pipe inside shall be provided with the cabinet.

2.6 Both types of hose cabinets shall be provided with handle type lock, a small recess to keep cabinet key under glass cover, a small hammer secured to the cabinet with a chain to break open the key glass cover.

3.0 **MATERIAL OF CONSTRUCTION**

3.1 The hose cabinet shall be made of 16 gauge M.S. sheet suitably welded with single / double MS door frame glass covered, depending upon the type of hose cabinet. Glass shall be fitted to the door with gasket and rubber bidding so that it fits securely.

3.2 Door of the hose cabinet shall be provided with standard handle type lock – Godrej, Mortise or equivalent with prior approval of owner / MECON.

3.3 Hammer shall be made of M.S. whereas Chain for securing purpose of hammer shall be made of G.I.

3.4 Angle iron or M.S. round pipe of suitable size as per instruction of owner / MECON shall be provided for supporting Type-B cabinet.

3.5 Universal branch pipe shall confirm to IS: 2171. End coupling jet nozzle and branch pipe shall confirm to IS:903.

4.0 PAINTING AND MARKING

4.1 Each hose cabinet shall be painted with 3 coats of anti-corrosive paint of fire red colour from outside confirming to Shade no. 536 of IS:5 and white paint from inside. The paint shall confirm to IS:2932. Each cabinet shall be clearly and permanently marked as following:

i. The word in bold letters marked as “FIRE HOSE CABINET”
ii. Method of operation regarding opening and operation of equipments placed inside.
iii. List of equipments placed inside the fire cabinet.
iv. Year of manufacture.

STANDARD TECHNICAL SPECIFICATION FOR LANDING VALVE

SPECIFICATION NO: MEC/TS/05/28/081/21

(OIL & GAS SBU)
MECON LIMITED
DELHI

1.0 **SCOPE** :

This standard lays down the requirements of type, shape, materials, dimensions and test for vertical stand post type fire hydrant to be installed on fire water main with an isolation valve. The single / double outlet landing valve mainly consists of landing valve with complete set.

2.0 **CODES AND STANDARDS** :

The applicable codes and standards to be followed are as follows:

- TAC Manual
- IS: 5290 and IS: 903
- Other Government regulations / Codes
- All codes / standards mentioned elsewhere in this specification.

3.0 **MATERIAL:**

SL. NO.	ITEM / COMPONENT	MATERIAL OF CONSTRUCTION
1.	Valve body	Shall be of LTB-2 of IS:318 or corrosion resistant alloy steel or nickel brass casting conforming to IS: 3444
2.	Bonnet, check-nut, stop valve, instantaneous female outlet and blank cap	Shall be of leaded tin bronze conforming to grade LT B-2 of IS: 318 or aluminium alloy conforming to IS designation 4225, 4450 and 4600 of IS: 617. All aluminium parts shall of be die-cast.
3.	Valve spindle	Shall be made of brass rod conforming to IS: 320 for valve body of leaded tin bronze and of stainless steel conforming to IS: 6603 for valve body of aluminium.
4.	Handle wheel	Shall be made of M.S. conforming to IS: 1030.
5.	Seat valve and washer	Shall be of leather conforming to IS: 581
6.	Gland packing	Shall be asbestos threaded conforming to

		IS: 4687.
7.	Spring	Shall be of phosphor wire conforming to IS: 7608 for valve body of leaded tin bronze and of stainless steel wire conforming to IS: 6528 for valve body of aluminium.
8.	Tooth	Shall be forged from forged brass material conforming to grade FLB of IS: 6912 of IS: 291

4.0 **Design and Construction:**

The design and construction of landing valve shall be as per IS:5290, TAC guidelines and other government codes / regulations and as mentioned in this specification.

1. Water mains coming to post shall be of φ 150 & 100mm M.S construction and provided with Double outlet landing valve.

2. All hydrant outlets shall be situated 1m above floor level.

3. Only oblique hydrants with outlet angled towards floor shall be used. The hydrant couplings shall be of the instantaneous spring lock (female) type of 60mm dia and valves shall be of the slow down type.

5.0 **Performance Requirements**

5.1 **Water Tightness Test for the valve**

The stop valve shall be fully closed by screwing down the spindle. A hydrostatic pressure of 1.4 MN/m^2 (14 kgf/cm^2) shall then be applied to each valve on its inlet side. There shall be no leakage through the valve and its seat.

5.2 **Hydrostatic Pressure Test.**

Each assembled landing valve shall be subjected to a hydrostatic pressure of 2.1 MN/mm^2 (21 kg/cm^2) as per IS:5290 with the valve open and outlet closed for a period of 2½ minutes for the purpose of locating porosity in the casting when so tested, it shall not fail or show any sign of leakage either through the valve body or through the gland of the spindle.

5.3 **Flow Test**

Test shall be discharged through the valve assembly and its flow shall be measured using flow meter or V-notch. The flow shall not be less than 900 LPM for Type A and 1800 LPM for Type B at 7MN/m^2 (7kgs/cm^2) provided feed to the valves is not less than these figures.

6.0 **Workmanship and Finish**

6.1 All parts shall be of good finish, clear of burrs and sharp edges. All castings shall clean and sound and shall be free from plugging, welding or repair of any defects.

The valve top except the face of the flange and the instantaneous outlet shall be painted fire red of shade no. 536 of IS: 5. The outside of instantaneous outlet shall be highly polished. The hand wheel shall be painted black. Paints shall conform to IS: 2932: 1974.

7.0 **Anticorrosive Treatment and Painting**

7.1 All steel components subject to direct water contact shall be hot dipped galvanised to minimum thickness of 0.12mm. The thickness of coating shall be measured as per IS 3203. External surfaces and non-ferrous components may be wetted with lead tin alloy by electrical deposition process.

7.2 The stand post and its arms, valve top except the face of the flange and the instantaneous outlet from outside shall be painted with three coats of anti corrosive fire red paint of shade No. 536 of Is 5. The outside of instantaneous outlet shall be highly polished. The hand wheel shall be painted black. Paints shall confirm to Is 2932. Internal surface shall be painted with three coats of chlorinated rubber based rasin paint or zinc chromate paint.

7.3 The stand post and its arms shall be painted with three coats of anti corrosive fire red paint conforming to IS: 2932 from outside while internal surface shall be painted with three coats of chlorinated rubber based resin paint or zinc chromate paint. The paint shall conform to shade no. 536 of IS: 5 and IS: 2982.

7.4 All steel parts coming in direct contact with water shall be hot dipped galvanized to a thickness of not be less than 0.12 mm. The thickness of the coating shall be measured as per IS: 3203. External surfaces and non-ferrous components may be coated with lead-tin alloy by electrical deposition process.

8.0 **Marking**

1. Each assembled valve shall be clearly and permanently marked on the valve body as follows:

   a) Manufacturers name or trade-mark
   b) Code letter indicating the type of valve (Inscribing type of instantaneous female outlet),
   c) Year of manufacture
   d) The valve assembly shall also be marked with the BIS certification mark and IS: 5290.

9.0 **Inspection**

There shall be provision for inspection by third party inspection agency at contractor's cost. The agency shall have access at all reasonable times to the manufacturer's works, where hydrants are being manufactured and / or tested. However specifically prior call for inspection shall be communicated for performance test of hydrants.

TECHNICAL DATA SHEET FOR LANDING VALVE AND ACCESSORIES

1.0	Type	:	Type A Single outlet or Type B Double outlet
2.0	Code Standard	:	IS:5290
3.0	Material of construction	:	
3.1	Body	:	Leaded Tin Bronze Gr. LTB-2 of IS:318 or Aluminium alloy of IS designation 4225,4450 and 4600 of IS:617
3.2	Stop Valve	:	Leaded Tin Bronze to Gr. LTB-2 of IS:318
3.3	Spindle	:	Brass Rod to IS 320 or IS 319
3.4	Spindle Body	:	S.S. to IS 6603
3.5	Hand wheel	:	M.S to IS 1030
3.6	Washer, Gasket etc.	:	Rubber IS:937 or leather to Is 581
3.7	Spring	:	Phospher Bronze wire to IS:7608
4.0	Inlet flange	:	Size 100mm (100 NB) the drilling dimension including O.D. of flange shall be as per ANSI-B-16.5 class 150.
5.0	Working pressure	:	3.5 to 12 kg/cm^2
6.0	Hydrostatic test pressure	:	21 kg/cm^2
7.0	Flow/Hydrant	:	900 LPM for Type A or 1800 LPM at 7 kg/cm^2 for Type B
8.0	Approval	:	TAC approved

STANDARD SPECIFICATION FOR STAND POST TYPE WATER MONITOR

SPECIFICATION NO: MEC/TS/05/28/081/35

(OIL & GAS SBU)
MECON LIMITED
DELHI

CONTENTS

1.0 SCOPE

This specification covers the general requirements regarding the material, design and construction, material, workmanship, finish, anti corrosive treatment, painting, performance and test, accessories for single barrel ,stand post type water monitor.

2.0 CODES AND STANDARDS

IS: 8442	-	Stand Post Type Water and Foam Monitor for Fire Fighting
IS:1239-Part-1-Part-2	-	MS Tubes, Tubulars and other Wrought Steel Fittings
IS:5	-	Colours for Ready Mix Paints and Enamels
IS:2932	-	Enamel, Synthetic, Exterior: (a) Upper coating (b) Finishing Specification
IS:778	-	Specification for Copper Alloy Gate, Globe and Check Valves for Water Work Purpose
ANSI B16.5	-	Pipe Flanges and flanged fittings

3.0 MATERIAL

3.1 All the different parts of Water Monitor shall be generally in accordance with IS:8442 or as specifically defined in the data sheet.

3.2 Drain valve shall be of Copper alloy and confirm to IS: 778 class 2. Locks on swivels shall be made of brass to IS:291.

4.0 DESIGN AND CONSTRUCTION

4.1 Design and construction of Water Monitor shall generally confirm to IS:8442. However data sheet shall prevail upon the standard specification.

4.2 The monitor arrangement shall be such that monitor shall be self locking type and operated by a single person.

4.3 The monitor shall be mounted on a 100mm (4") N.B. raised face slip on type flange confirming to ANSI B 16.5 150lbs rating. Bolts and nuts for base flange shall have dimension confirming to ANSI B 16.5 Gasket shall be full face 3mm thick with drilling dimension same as for flange.

4.4 Near the base flange a drain connection shall be provided with a 15mm (1/2") NB drain valve at the end of pipe. The drain pipe shall be long enough to drain water away from the base flange.

4.5 The threaded end of the nozzle shall be hexagonal to facilitate screwing of the nozzle on the water barrel with nozzle spanner. Threads shall confirm to IS:2643 (Pt.-1) with class A tolerance.

4.6 The inner surface of the nozzle shall be finished smooth and polished for the converging length of the nozzle.

5.0 HYDRAULIC PERFORMANCE

5.1 Monitor shall be capable of discharging 25800lpm at a pressure of 7 Kg/cm2 at the inlet of monitor. However the data mentioned in the data sheet / SOR shall be final and binding.

5.2 The discharge of monitor in still air condition shall be 2580LPM, minimum horizontal ranges for water shall be 60m at 7 Kg/cm2 pressure and 45` nozzle angle from horizontal plane. Testing of the monitor shall be carried out in two horizontally opposite directions and average of both the readings obtained shall be considered as horizontal throw of the monitor.

5.3 While conducting the throw at 45` nozzle angle from horizontal plane at 7Kg/cm2 inlet pressure to monitor, with flow of 2580LPM, the minimum vertical throw for water shall be 17m.

6.0 WORKMANSHIP AND FINISH

6.1 All the parts shall have good workmanship and finish. All burrs and sharp edges shall be removed particularly water way and nozzle shall have smooth finish.

6.2 In leakages, Joints, locking joints movement in threaded joints, adhesives shall not be used.

7.0 ANTICORROSIVE TREATMENT AND PAINTING

7.1 All steel components subject to direct water contact shall be hot dipped galvanized after fabrication to a minimum thickness of 0.012mm. The thickness of coating shall be measured as per IS:3203. External surfaces and non ferrous components shall be coated with lead tin alloy by electrical deposition process.

7.2 Monitor's steel part shall be painted with fire red colour confirming to IS: 5 shade no. 536 over two coats of Red Oxide Zinc Chromate primer or single coat of Aluminium paint. The paint shall confirm to IS:2932 and copper alloy part shall be polished. Nozzle shall be yellow epoxy painted.

8.0 TEST

8.1 Monitor shall be tested to fulfill the requirements of hydraulic performance as elaborated in clause 5.0 or in the data sheet whichever is stringent.

8.2 The entire assembly shall be hydraulically tested to a pressure of 23 Kg/cm2 for 5 minutes without any leakage and horizontal rotation shall be carried out 50 times and then vertical rotation up and down for 25 cycles. During the test there shall be no leakage observed in any of the swiveled joints. After the above test is carried out, the performance test shall be conducted for hydraulic requirements.

9.0 MARKING

Each monitor shall be clearly and permanently marked with the following:

a) Manufacturer's name or trade mark
b) Year of manufacture
c) Purchaser's name
d) Type and discharge capacity in LPM / GPM
e) Approval authority marking i.e. UL Listing / FM / VDS Approval
f) BIS Certification mark

10.0 DRAWINGS, DATA SHEET, INSPECTION & APPROVAL

10.1 Vendor shall furnish drawings and data sheets in accordance with the requirements elaborated in TS and the bid document.

10.2 As evidence of UL listing / FM /VDS approval, vendor shall submit the copy of certified approved drawings / documents and certificates duly authenticate by the listing agency.

10.3 Owner / MECON's authorized representative shall have access at all reasonable times to Vendor's works where monitors are being manufactured, assembled, tested. It will be the sole responsibility of vendor for arranging all the tests, checking of design documents, materials, workmanship, performance, hydro testing etc.

STANDARD SPECIFICATION FOR PORTABLE FIRE EXTINGUISHERS CARBON DI OXIDE TYPE

SPECIFICATION NO: MEC/TS/05/28/081/25

(OIL & GAS SBU)
MECON LIMITED
DELHI

CO_2 PORTABLE EXTINGUISHER – TECHNICAL SPECIFICATION

1.0 **SCOPE**

This standard lays down requirements regarding construction, material, shape, and method of operation, performance and test of portable fire extinguisher of carbon dioxide type including first fill of CO2 gas .

2.0 **MATERIAL, SHAPE, CONSTRUCTION, METHOD OF OPERATION, PERFORMANCE, CONTENTS AND TESTS**

2.1 The construction, material, shapes, method of operation, performance, and test shall comply with IS: 2878 (latest edition) with ISI mark and approved by C.C.E. Nagpur.

2.2 Nominal size.

2.2.1 The extinguisher shall be following nominal sizes in kg: 1,2,3,4,5 and 6. The sizes being denoted as per clause 4.11 of IS: 2878.

2.4 Carbon Di-oxide gas used shall conform to IS: 15222 and extinguisher shall be filled as per IS 2878 CI. 6.0.

2.5 The cylinder shall be made of cold drawn seamless steel cylinders as per IS: 7285 and fitted with screw down type high pressure control valve as per IS: 3224 with a provision of safety release. Riveted joints will not be acceptable.

2.6 The extinguishers shall be fitted with discharge tube with swivel joint of atleast 1m length with elect. non-conductor discharge horn.

3.0 **APPROVALS**

3.0 Approval/clearance certificate of filling the extinguisher from “chief controller explosive” govt. of India, Nagpur shall be submitted for each cylinder. Testing of the extinguisher, painting, markings etc. shall be as per IS: 2878 with ISI marked

4.0 **MARKING**

4.1 Each extinguisher shall be clearly and permanently marked as per IS: 2878 along with BIS certification mark and following:

i. Manufacturer's name and trade mark.
ii. Method of operation.
iii. A large size picture showing a man operating the extinguisher in the

correct manner.

iv. The word " CO_2 Type (Capacity)".

v. The size of gas cartridge used.

vi. Liquid level to which the extinguisher is to be checked.

vii. Year of manufacture.

5.0 ACCESSORIES

Each extinguisher shall be supplied with M.S. bracket and spanner as may be necessary. The details of the same shall be submitted. The extinguisher shall be complete with wall mounting brackets and screws.

5.0 INSPECTION

6.1 Third party inspection agency at Contractor's cost shall have access at all reasonable times to the manufacturer's work where extinguishers are being manufactured and / or tested.

STANDARD SPECIFICATION FOR PORTABLE EXTINGUISHERS

SPECIFICATION NO: MEC/TS/05/28/081/26

(OIL & GAS SBU)
MECON LIMITED
DELHI

DRY CHEMICAL POWDER EXTINGUISHER – Technical Specification

1.0 SCOPE

This standard lays down requirements regarding construction, material, shape, anticorrosive treatment and test for ordinary dry powder type fire extinguisher.

2.0 MATERIAL, SHAPE TYPES, CONSTRUCTION, ANTICORROSIVE TREATMENT, PAINTING AND TESTS.

The construction, material, shape, anticorrosive treatment, painting, and test shall comply with IS: 2171 (latest edition).

Extinguisher body shall be made out of M.S. sheet of not less than 1.6mm thickness as per IS: 513. All the fire extinguishers shall be of welded construction fitted with leaded tin bronze (Gunmetal) cap as per IS: 318, high pressure discharge hose and squeeze grip nozzle. Plastic or PVC fittings will not be provided with initial fittings.

Dry chemical powder supplied with extinguisher shall be non-toxic as per IS: 4308 and ISI marked. The extinguisher shall have gas cartridge of pressure type. CO_2 gas cartridge shall be ISI marked and shall not be less than a capacity of 120gms as per IS: 4947.

The extinguisher shall have cap having vent holes, gas cartridge holder, plunger rod & piercing mechanism cap joint washers siphon tubes, braided hose of sufficient length and discharge nozzle.

All the extinguishers shall be treated with lead - tin alloy for anti-rust, anti-corrosive treatment by electrolytic deposition process. Extinguishers coated by dip coating process will not be acceptable.

3.0 PRINCIPLE

The method of expulsion of dry powder shall be as per IS: 2171 (latest edition) with either of the method of operation specified therein. Vendor shall indicate clearly the method adopted for operation.

4.0 CAPACITY

Nominal capacity of the extinguisher and the dry powder contents of the assembled body or dry powder container shall be as follows when charged with dry powder conforming to IS: 4308 (latest edition.)

NOM. CAPACITY OF EXTINGUISHER (KG)	DRY POWDER CONTENTS WHEN CHARGED MIN (KG)
1	1
2	2
5	5
10	10

Only dry powder confirming to IS: 4308 (latest edition) shall be used for charging the extinguisher.

5.0 ACCESSORIES

Each extinguisher shall be supplied with a suitable wall bracket or holder into which it may be mounted and from which it may be removed for use in an emergency and screws and spanner as may be necessary. Extinguishers shall be supplied with all accessories, initial charge etc.

6.0 MARKING

Each extinguisher shall be clearly and permanently marked with the information specified in IS: 2171 along with BIS certification mark and purchaser's name. Each extinguisher shall be painted fire red and clearly marked with following:

i. Manufacturer's name and trade mark.
ii. Method of operation.
iii. A large size picture showing a man operating the extinguisher in the correct manner.
iv. The word "DCP Type (Capacity)".
v. The size of gas cartridge used.
vi. Liquid level to which the extinguisher is to be checked.
vii. The word "Tested to a hydraulic pressure 2.5 MN/m2".
viii. The word "Keep this end up".
ix. Year of manufacture.

7.0 INSPECTION

Third party inspection agency at Contractor's cost shall have access at all reasonable times to the Manufacturer's work where extinguishers are being manufactured and / or tested. Samples from lots under a quality control system shall be done as per Appendix B of IS: 2171. The cylinder shall be hydraulically tested for 30kg/cm^2 of pressure.

Rev. : 0
Edition: 0

SPECIFICATION
FOR

Y / T TYPE STRAINERS

SPECIFICATION NO. : MEC/TS/05/21/010

(OIL & GAS SBU)

MECON LIMITED

DELHI - 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Status of Revision and Date			
			Rev-1	Rev-2	Rev-3	Rev-4

PREPARED BY :	CHECKED BY :	APPROVED BY :	ISSUE DATE :

C O N T E N T S

PREPARED BY :	CHECKED BY :	APPROVED BY :	ISSUE DATE :
(SHESH RAM)	(G. V. WALIMBE)	(A. K. JOHRI)	JULY 2008

1.0 **GENERAL**

1.1 This specification alongwith data sheets, other specifications & attachments to inquiry / order describes and constitutes the minimum requirement according to which vendor / manufacturer shall design, manufacture, test and supply the Y/T type strainer for removing solid contaminants from the liquid / gaseous stream.

The intent of these requirements is to supplement the requirements as given in data sheets/other specifications and other applicable codes / stand ards referred to in data sheets / specifications.

1.2 Except as specified herein, the strainers shall be designed, manufactured, tested and supplied in accordance with data sheets , specifications and applicable codes / standards (latest edition).

1.3 Manufacturer / Vendor shall seek Purchaser / Consultant's approval regarding such features wh ich are not specified by Purchaser / Consultant but requirements call for purchaser decision on these matters.

1.4 Strainer model offered shall be from the existing regular manufacturing range of the strai ner vendor. Vendor's / manufacturer's catalogue and general reference list shall be furnished along with the offer.

1.5 The offered strainer shall be of a proven design in similar service.

2.0 **SCOPE OF WORK OF VENDOR**

2.1 Engineering, design, manufacturing and supply of strainer.

2.2 Procurement of raw materials etc. from sub-vendors.

2.3 Preparation and submission of documentation for design approval by purchaser/ consultant.

2.4 Supply of recommended spare parts needed for start-up and commissioning and special tools or fixtures, if any.

2.5 Inspection and testing as per T.S.

2.6 Surface preparation, protective coating and painting as per T.S.

2.7 Packaging and transportation to site.

3.0 DESIGN

3.1 Following standards and codes (latest editi on) shall be followed f or design, fabrication, testing etc. of the equipment.

ASME SEC. II & ASTM	:	Material specification
ASME SEC. VIII DIV. I	:	Boiler and pressure vessel code
ASME SEC. IX	:	Welding and brazing qualifications
ANSI B 16.5	:	Pipe flanges
ANSI B 16.9	:	Butt-welded fittings.
ANSI B 16.11	:	Forged steel fittings socket welded and threaded.

3.2 Material of construction shall be as per data s heet. Manufacturer / Vendor shall however assume responsibility for suitability of selected material for specified service. If necessary, vendor should furnish superior materials than specified.

4.0 TECHNICAL REQUIREMENTS

4.1 The equipment shall be of the type as mentioned in the data s heet; and shall meet the duty requirements and performance parameters as mentioned therein.

4.2 Material of construction of body, filter medium, etc. of Y/T strainer shall be as compatible with connecting pipe specification and as per data sheets.

4.3 Effective free area of basket shall be minimum 3 times of the inlet nozzle area.

4.4 Corrosion allowance of 3 mm shall be considered for all carbon steel parts, unless otherwise mentioned in the data sheets.

4.5 Dimensions of flanges including shell flanges, nozzle flanges and blind cover flanges shall be as per ANSI B 16.5. Larger flanges not covered by ANSI shall be as per MSS-SP-44.

4.6 Drain and vent connections wherever provided shall be with matching blind cover flanges alongwith necessary gaskets, bolts and nuts.

4.7 Pressure parts joined by butt, Welds shall be with full penetration welds. Where both sides welding is not accessible, root run by tungsten Inert gas process or backing strip, shall be used to ensure full penetration. Backing, strip if used shall be removed after welding.

4.8 Fabricated body shall be post weld heat treated, whenever it is required due to service requirement or due to code requirements. Body shall be post weld heat treated as a complete unit and no welding shall be permitted after the post weld heat treatment is completed.

5.0 INSPECTIONS AND TESTING

5.1 Equipment shall be subjected to stagewise expediting, inspection and Testing at vendor's/ sub-vendor's works by purchaser/ its authorised inspection agency. Vendor shall submit Quality Assurance (QA) procedures before commencement of fabrication. Approved QA procedures shall form the basis for equipment inspection. The QAP shall generally be in done with one, which is enclosed with the tender enquiry.

5.2 Testing at vendor's works shall include but not limited to the following:

- Non-destructive tests such as radiography, dye penetration tests as per data sheet and other requirements,
- Hydrostatic test at a pressure not less than 150% of design pressure for the body.
- Any other tests as per data sheets / codes / standards and covered under approved QAP.

5.3 Any or all the tests, at purchaser's option, shall be witnessed by purchaser/ its authorised inspection agency. However, such inspection shall be regarded as check-up and in no way absolve the vendor of his responsibility

5.4 Extent of radiography shall be 100%.

6.0 **PROTECTIONS AND PAINTING**

6.1 All exposed carbon steel parts to be painted shall be thoroughly cleaned from inside and outside to remove scale, rust, dirt and other foreign materials by wire brushing and sand blasting as applicable. Minimum acceptable standard in case of power tool cleaning shall be St.3 and in case of blast cleaning shall be Sa 2½ as per Swedish Standard SIS 0055900.

6.2 Non-ferrous materials, austenitic stainless steels, plastic or plastic coaled materials and insulated surfaces of equipment shall not be painted.

6.3 Stainless steel surfaces both inside and outside shall be pickled and passivated.

6.4 Machined and bearing surface shall be protected with rust preventive agent like varnish or thick coat of grease.

6.5 Depending on the environment, following primer and finish coats shall be applied:

Environment	**(Description).**		
i) Normal Industrial	Surface Preparation	:	Sa 2½
	Primer	:	2 coats of Red oxide zinc chromate each 25 microns (min.) thick
	Finish	:	2 coats of Synthetic enamel, Each 25 microns (min.) thick.
ii) Corrosive Industrial	Surface Preparation	:	Sa 2½