BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP
Engineering Management
NOIDA

DOC. No.	**TB-383-510-060**	Rev.	**00**	Prepared	Checked	Approved
TYPE OF DOC.	**TECHNICAL SPECIFICATION**	NAME		**AA**	**MLK**	**VK**
TITLE ARMOURED FIBRE OPTIC CABLE		SIGN		-Sd-	-Sd-	-Sd-
		DATE		**27-04-18**	**27-04-18**	**27-04-18**
		GROUP		TBEM	W.O. No	
CUSTOMER	**ONGC Ltd , Hazira**					
CONSULTANT	**FICHTNER CONSULTING ENGINEERS PVT. LTD**					
PROJECT	**66kV GIS for 1x51MW CCCPP at Hazira**					

TECHNICAL SPECIFICATION

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Rev No.	Date	Altered	Checked	Approved	Revision details

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SECTION - 1

1.1 SCOPE

The scope includes inspection and testing before supply, packing loading and transportation to site of Fibre Optic Cable and subsequent services as mentioned in BOQ.

The equipment is required for the following project:

Customer : ONGC Ltd.
Project : 66kV GIS at Hazira

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

1.2 BILL OF QUANTITIES

The following items are required for ONGC Hazira Project.

S. No.	ITEM DESCRIPTION	Unit of Measurement	Qty.
1.	Fibre Optic Armoured Cable : Multi Mode , 6 Core , 62.5/125µm , Wave Length 1300nm	Km	16
2.	Fibre Optic Armoured Cable : Single Mode , 6 Core , 9/125µm , Wave Length 1300nm	Km	4
3.	Services : Supervision of Optical cable laying (Laying shall be in BHEL Scope)	Lot	1
4.	Services: Splicing / Termination of the supplied 6 core Multi mode cable. (1No. = 1 Termination)	Nos.	240
5.	Services: Splicing / Termination of the supplied 6 core Single mode cable. (1No. = 1 Termination)	Nos.	24

Note : 1) The optical fibre cable shall be of Aksh /Finolex make.

2) Supply of LIU/ pigtail / patch chord is not in bidders scope.

3) Bidder's offer shall include all other items/accessories(if any) required to successfully install and splice the supplied cable.

4) No additional price implication will be entertained after placement of order.

5) S.No 4 of BOQ: Number of terminations = 20(runs of cable) x 12(termination at either end of cable)

6) S.No 5 of BOQ : Number of terminations = 2(runs of cable) x 12(termination at either end)

7) Travel & lodging/boarding cost shall be included in the services under SN 4 & 5 , no additional cost shall be entertained.

8) The cable drum length shall be 2km.

9) Cables shall be of type tested design and reports as per relevant standards shall be submitted for review.

10) The length of each cable type shall be subject to a change of +/-30% .

	GTP FOR SAS EQUIPMENTS	
	Clock Frequency	384MHz
	Operating Voltage	5 VDC ± 5%
	Module size	233.4x160mm, 4WU
	Visual Indication for diagnostics	LEDs
8.4	**Power Supply Unit**	**PS 2632 for AK3**
	Input voltage	110-220VDC
	Input/ output connection contact type	Terminal Screw type
8.5	**Digital Input module**	**DI-2114**
	No of input points	64 inputs (8 x 8), time resolution 1 ms
	Input Isolation	Galvanically insulated by optocouplers
	Signal voltage	220 VDC
8.6	**Digital Output module**	**DO-2211**
	No of input points	64 inputs (8 x 8)
	Input Isolation	Galvanic Isolation
	Signal voltage	220 VDC
8.7	**Analog Input Module**	**AI-2300**
	No of input points	16 inputs
	Measuring ranges	Current measurement -20...0...+20 mA , 4...20 mA Voltage measurement -10...0...+10 V
	Input Isolation	Galvanic Isolation
8.8	**Configuration Software**	SICAM TOOLBOX II,SICAM-230 , DIGSI-4
	Manufacturers type & designation	**Preston**
	Wavelength	1300nm
	Unarmoured/armoured	Un Armoured
	Type of Connectors used	LC-LC/ST-LC
	Type of cable	Multimode/Singlemode
	Proper identification	(Tx), (Rx)
	Core diameter	62.5/9micron
	Attenuation at 850 nm	0.3 db/Patch Cable
	Numerical aperture	6.2 mm
	No of Cores per cable	Two
	Type of Material	Fibre Glass
10		Armoured Fibre optic cable
	Manufacturers type & designation	**Aksh/Finolex**
	Wavelength	1300nm
	Unarmoured/armoured	Armoured
	Type of cable	Multimode/Singlemode
	Proper identification	(Tx), (Rx)
	Core diameter	62.5/9micron
	Cladding diameter	125 micron
	Attenuation at 850 nm	3 db/Km
	Numerical aperture	6.2 mm
	No of Cores per cable	Six
	No of Spare Cores	Four
	Make	Preston
	Dimensions	Height - 45mm Width - 440mm-19 inches rack mountable Depth - 250mm
	Adapters	12/24 nos pre-installed
	Insertion loss	<0.1 db (for adapters)
	Pigtails	12/24 nos pre-installed
	Insertion loss	<0.3 db (for pigtails)
	Return loss	> 45 db
	Diameter	Typically 9–ums buffer or otherwise stated
	Splicing cassettes Quantity	1/2 nos
	Splicing cassettes capacity	12F each
	Splicing cassettes location	Peripheral
	Cable entry	Rear panel , real base
	Mimnium bending diameter	70mm
	cable clamp	rear panel , choice of multiple locations
	Splice protection sleeves	Qty- 25 nos
	Recovered diameter	2.5 mm
	Slide length	325 mm
	Protection	rodent entry protection
	Connector Type	LC
	Make	Numeric/Powerone/Alan/3M
	Inputs	
	Voltage	110 VAC , 1 Phase ,3KVA
	Frequency range	45-55 Hz/54-66Hz
	Phase	Single phase with ground
	Power factor	0.99 to unity
	Output	
	Voltage	110VAC , 1 phase
	Voltage regulation	+/-1 %
	Frequency	50/60 Hz '+/--0.2 hz
	Inverter efficiency (DC-AC)	>90%
	Efficiency (AC-AC)	>90%
	Power factor	0.8 (0.7 to unity within KVA/KW)
	General	

SECTION – 3
PROJECT DETAILS AND GENERAL SPECIFICATIONS

SL.NO.	DESCRIPTION	
1.	**PROJECT INFORMATION**	
	a) Customer	**ONGC Ltd.**
	b) Consultant	**FICHTNER Consulting Engineers (India) Pvt. Ltd.**
	b) Project	**66 KV GIS system for 1 X 51 MW CCCPP for ONGC , Hazira**
1.0	Location	ONGC Limited, Hazira
2.0	Elevation above mean sea level	RL 6.0 above, MSL
3.0	Nearest Railway Station	Surat, 20 KM
4.0	Nearest Airport	Surat, 10 KM
5.0	Nearest Harbour	Magdalla, 20 KM
6.0	Access Road	NH-8 (30 KM)
7.0	Atmospheric pressure at MSL	1.013 bar
8.0	Ambient Temperature	
a)	Max. average dry bulb temperature	45.6 oC
b)	Min. average dry bulb temperature	4.4 oC
c)	Design temperature for electrical equipment / device	50 oC
9.0	Relative Humidity	
a)	Max.	70%
b)	Min.	18%
c)	Average	64%
10.0	Seismic Zone	III (IS 1893)
11.0	Rainfall	
a)	Max. Intensity of rainfall in 24 hrs.	459.2 mm
b)	Period – Monsoon showers	June to September
c)	Average rainfall per annum	1203.5 mm
12.0	Wind data	
	Max. wind speed (as per IS:875) 20-61 kmph for 20 days in a year < 20 kmph for remaining period	62 kmph
	Most predominant wind direction	South -West
13.0	Land	
14.0	Tropicalisation	
	All equipment supplied against specification shall be given tropical and fungicidal treatment in view of the climatic conditions prevailing at site.	
	Tropical protection shall conform to BS: CP-1014-1965 "Protection of Electrical Power Equipment" against climatic conditions.	

Auxiliary Supply

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415 Volts	± 10%	50 +3% to -5%	3 phase/ 4	Solidly earthed

			wires	
240 Volts	± 10%	50 +3% to -5%	1 phase/ 2 wires	One point earthed
110 Volts DC	± 10%	DC	1 phase/ 2 wires	Isolated 2 wire system

2. **General electrical requirement** as per Vol III, Section 3.1 of ONGC specification.(4 pages) (enclosed)

The discharge of pollution in water and air as well as noise levels shall meet with the stipulations of State Pollution Control Board as well as other Acts of the Government under the Ministry of Environment and Forestry. It is a pre-condition that irrespective of what is stated in statutory regulations or any other act or norms, the Specification stipulated environmental qualities standards are the minimum requirements and shall be fulfilled in all aspects.

For control room and offices, noise level shall not exceed 60 dB (A) near to the duct and at other places in the control room/offices noise levels shall not exceed 50 dB (A).

Equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the State/Central government and with the Indian Electricity Rules.

Unless otherwise specified, at least 10 % margin shall be considered in equipment sizing over and above the calculated load current/fault current/power requirements.
If not specified otherwise the electrical operational equipment must be designed to meet protection classes stated below.

- HT Switchgear (Indoor) - IP 4X
- LT Switchgear (Indoor) - IP 52
- Control panels (Indoor) - IP 42
- Relay panel - IP 42
- Motors (indoor) - IP 54
- Motors and other equipment located outdoor - IP 55
- Emergency DG (Indoor) - IP 23

Each individual enclosure accommodating electrical equipment which is liable to suffer from internal condensation due to atmospheric or load variations shall be fitted with heating

3. Standards and Codes of Practice

All equipment, systems and works covered under these specifications shall be in accordance with all the applicable statutes, regulations, codes and standard specified as well as all such standards, statutes, regulations and safety codes applicable in the locality where the equipment will be installed. Contractor may familiarize themselves with all such requirements.
Complete design including pressure parts, piping, valves and fittings shall meet or exceed all the latest requirements of the Indian Boiler Regulations (IBR), latest Indian Standards /ASME codes, latest codes and standards as applicable. Any Indian/International standards shall be followed for any imported equipment. For plant layout aspects and area classification requirements OISD standards shall be followed.

The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with relevant standards and codes issued by Bureau of Indian Standards (BIS) and/or reputed international standards and codes as on the date of Award of Contract. A non-exhaustive list of reputed international standards is given below:

a) American National Standards Institute (ANSI)

b) American Petroleum Institute (API)

c) American Society of Mechanical Engineers (ASME)

d) American Society of Testing and Materials (ASTM)

e) American Water Works Association (AWWA)

f) American Welding Society (AWS)

g) British Standards (BS)

h) Cooling Technology Institute (CTI)

i) Deutsches Institut fur Normung (DIN), Germany

j) Gosstandart of Russia (GOST) standards

k) Heat Exchange Institute (HEI), USA

l) Hydraulic Institute Standards (HIS), USA

m) International Electro-technical Commission (IEC)

n) Institute of Electrical and Electronics Engineers (IEEE)

o) International Organisation for Standardisation (ISO)

p) Japanese Industrial Standards (JIS)

q) National Electric Code (NEC), USA

r) National Electrical Manufacturers Association (NEMA), USA

s) Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein

t) National Fire Protection Association (NFPA), USA

u) Occupational Safety and Health Administration (OSHA)

v) Tubular Exchanger Manufacturers Association (TEMA), USA

w) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany

x) OISD

Other international Standards, equivalent or superior to the above Standards can also be adopted. However, In the event of any conflict between the requirements of the international standards or codes and the requirements of the BIS standards or codes, the latter shall govern unless specified elsewhere in the specifications. Any Indian/International standards shall be followed for imported equipment.

The Plants and Electric Lines (within the plant) shall also be designed to comply with the requirements stipulated in.

a) Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006.

b) Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.

c) Central Electricity Authority (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the Authority.

d) Central Electricity Authority (Safety Requirements for Construction, Operation and

Maintenance of Electrical Plants and Electric Lines) Regulations as and when these are notified by the Authority.

e) Central Electricity Authority (Grid Standards) Regulations as and when these are notified by the Authority.

f) Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein

g) Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC) and

h) Applicable State Grid Code issued by appropriate Regulatory Commission.

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the above listed codes and Standards.

It shall be the responsibility of the Contractor to take all approvals required and get the HRSG registered under the IBR. In all other cases where IBR does not govern, IS/ASME, Japanese, American, British, German or other international standards established to be equivalent or superior to IS/ASME shall be acceptable with the approval of the Owner/Owner's representative at the time of detailed engineering.

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power plant, the Contractor shall carry out the design, manufacture, supply and installation on the basis of good engineering practice.

During the period of Contract execution, if any standards change, the Contractor shall be responsible to notify the Owner/Owner's representative and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard and the latest standards shall be followed by the Contractor.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

4. SPECIAL TOOLS, TACKLES AND EQUIPMENT

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid.

Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

The special tools and equipment for maintenance and repair shall be delivered by the Contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The following tools and appliances shall be supplied under this Contract for use by the Owner/Owner's representative:

• two sets of special tools and gauges required for the maintenance of the Plant
• one set of special lifting and handling tackles / appliances required for the maintenance of the Plant.

The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Contractor and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.
The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner/Owner's representative it has not been subjected to more than normal wear and is still fully suitable for its intended use.
Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant and equipment in question.

If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels.

Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle supplied under this contract. Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.
The Contractor shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner/Owner's representative.

The Contractor shall provide all runway beams, trolleys, lifting blocks, special slings necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations safety valves

The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner/Owner's representative at the time of Taking Over of the complete Plant.

Since the Contract includes site erection, any special tools or appliances required solely for erection shall be provided by the Contractor for his own use and shall remain the property of the Contractor.
Control and Instrumentation: Software with associated hardware required to access instruments or control systems to be provided.

5. INSPECTION, TESTING AND INSPECTION CERTIFICATE

Inspection testing shall be done as per customer specification (clause 8, Vol II, sec 1 , Sheet no. 51 -55) and inspection plan.

6. DOCUMENTATION

Format of Documentation
All engineering documents and drawings shall be of international "A" series sizes, that is, A0, A1, A2, A3 and A4.
One set of CD containing all the drawings in Auto CAD (for final as built drawings) shall also be supplied in addition to hard copies.
Soft copy of all other documents shall be supplied in a CD in PDF or editable format. For review purpose pdf or editable version shall be considered.
Grouped documents shall be provided by size A4, with the inclusion of bigger size drawings which, however, have to be folded as Size A4.

Numbering and Identification of Documents

All the drawings shall be identified through a common way of numbering in accordance with the requirement of contracting. The numbering system of drawings and documents proposed by the Contractor shall be in compliance with the plant identification system and to be agreed with the Owner/Owner's representative. Apart from this, some drawings may also be numbered in the way which the contractor or subcontractors are used to do. But, there shall be a common title Block on all published drawings which include the following contents:
- Owner
- Owner's Engineer
- Project
- Contractor
- System
- Drawing No.
- Sheet No
- Revision No.

The measuring units and dimensions marked on the project engineering drawings shall be of SI system conforming to ISO 1000.
English words shall be used as descriptions on drawings.
In case dimensions are not marked in conformity with the scale of drawings and any dimension on the drawing does not conform to those dimensions and sizes measured through certain scale, the actual marked dimensions shall be applicable.
For revision of drawings, the revised part shall be clearly and definitely shown on the drawing.
For revision of documents which have been grouped together, a brief description shall be a perpendicular line with the margin of the revised copy closely following it.

Provision for Documents

Generally, copies of drawings or documents containing trade secret and drawings with patented nature need not be provided.
However, to know whether the Contractor has performed its obligations, the Owner/Owner's representative has the right to examine those drawings within the Contractor's working scope.
The Contractor shall meet the Owner/Owner's representative's reasonable demands to files and do the following to satisfy the Owner/Owner's representative:

• Contractor will work according to the requirements specified in the contract.

• Contractor's working has been arranged properly and developed according to the plan.

• The quality control system is reliable.

• After receiving all documents necessary for power plant operation and maintenance,

Contractor shall supply equipment and systems.

• Having received all necessary documents for Contractor to perform its legal obligations or other

relevant responsibilities.

Distribution of documents
The source, distribution, no. of copies shall be as per the following document distribution schedule. Annexure 4

Title block for the Project:

a) Customer	**ONGC**
b) Consultant:	**FICHTNER Consulting Engineers (India) Pvt. Ltd.**

c) Project:	**66 KV GIS system for 1 X 51 MW CCCPP for ONGC , Hazira**
d) Main Contractor	**BHEL**

DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

1) Drawings in 2D and 3D format.
2) Guaranteed Technical Particulars
3) Type Test Reports
4) Manufacturing Quality Plan

DOCUMENTATION SCHEDULE AT CONTRACT STAGE

No. of Copies	A: For Approval
5	Copies of GA drawings (2d and 3D) with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
5	Copies of type test reports
5	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.
5	Copies of manufacturing and field quality plan.
5	Copies of installation, operation & Maintenance manual.
	B : After Approval and For Information/Distribution.
12	Copies of All drawings
12	Bound sets containing all drawings/manuals, type and routine test reports etc. along with sub-vendor's test reports for all bought out assemblies/components/parts including Internal wiring diagrams and exploded diagrams of assemblies/ parts, shall be furnished.
12	Copies of Installation, Operation & Maintenance manual.
	C: On Completion of Entire works
12	Bound sets of Installation, Operation & Maintenance manual and all as built drawings
12	Set of Computer CD-ROMs (with unbreakable CD Covers) containing all as-built drawings in Auto-Cad version 2008 or later with 2D and 3D drawings, Instruction Manual and GTP.

7. CLEANING, PROTECTIVE COATING AND PAINTING

Refer Vol III /Section 2/ Sub Section 2.15 Surface Preparation and Painting.

8. SPARE PARTS

The contractor shall also provide a list of recommended spares for two (2) years of normal operation of the plant over and above the mandatory spares.

List of Mandatory Spares

Refer Vol IV /Section 8/ Annexure 2

NOTE: All mandatory spares as per OEM declared critical items shall be included in the list.

9. Package, storage

All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear.

The Contractor and his appointed Subcontractor for installation should guarantee jointly that a good supplementary storage will be carried out within the equipment site controlled by them. Three classes for storehouse are described as follows:

Storehouse class A items: Special measures are taken to protect the stored goods and the temperature, humidity are controlled within a specified range.

Storehouse class B items: Goods are stored with temperature uncontrolled.

Storehouse class C items: It is an outdoor storage with a drainage system on the ground.

For storehouses of class A and B they should be fireproof, heat resisting, waterproof and well ventilated. They should not be wet and should be provided with good drainage system and preferably with a brick laying or concrete ground. For storehouses of class C, they should not be wet and should be well drained, preferably with a brick laying or crushed stone ground, should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible

Component surfaces should not be contacted directly with the ground or ground laying material. There should be a layer of oilcloth or wax or other similar materials between the machine surface and ground surface.

All components shall be inspected for their painting, storing, sealing and any damage or wear should be repaired during acceptance and storage periodically. The inspection interval is determined by the component function, applied protection measure and storehouse class.

Many components are provided with a drying agent or sealed in a coverage (polyethylene or insulating cover) containing drying agent. The drying condition shall be inspected during storage in an interval of every 4 weeks.

10. SPECIAL TOOLS, TACKLES AND EQUIPMENT

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid.

Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

The special tools and equipment for maintenance and repair shall be delivered by the Contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The following tools and appliances shall be supplied under this Contract for use by the Owner/Owner's representative:

- Two sets of special tools and gauges required for the maintenance of the Plant
- One set of special lifting and handling tackles / appliances required for the maintenance of the Plant.

The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Contractor and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.

The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner/Owner's representative it has not been subjected to more than normal wear and is still fully suitable for its intended use.

Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant and equipment in question.

If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels.

Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle supplied under this contract. Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.

The Contractor shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner/Owner's representative.

The Contractor shall provide all runway beams, trolleys, lifting blocks, special slings necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations safety valves.

The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner/Owner's representative at the time of Taking Over of the complete Plant.

Since the Contract includes site erection, any special tools or appliances required solely for erection shall be provided by the Contractor for his own use and shall remain the property of the Contractor.

Control and Instrumentation: Software with associated hardware required to access instruments or control systems to be provided.

11. Painting, Insulation, Anti-dewing

Anti-corrosive coatings and painting shall be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have distinct colours so that the later layer can be distinguished from the former one.

After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted.

Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Colour strip indication system should be used for pipes. These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some colour in whole length. ***Refer Annexure-3 (Vol-IV, Sec-8) for the colorcoding of piping and fire equipments.***

The principal colour of field equipment should be determined by Owner/Owner's representative and Contractor during execution stage. For Electrical equipment, paint shade shall be as mentioned in the equipment Specification.
Further requirements with regard to painting, insulation, and anti-dewing are specified in the relevant sections in the detailed technical specifications. The specified requirements shall be applied to the whole equipment and facilities of the Contract.
Insulation specification for MPP supplied equipment shall be as mentioned in detailed technical specification.

Language to be used

English shall be used as the general Contract language English translations shall be provided for any code and standards not in English language.
Name plates of equipment and instrument scale shall be marked in English.
Documents for training shall be provided in English.
Danger signs / Exit signs shall be in English, Hindi and Gujarati.

12. CONSUMABLES

12.1.0 Lubricants and greases

All lubricants proposed for the Plant operation shall be suitable for all operating and environmental conditions that will be met on site.
All oils and greases shall where possible be readily available in India.
The number of oils and greases shall be kept to a minimum to the extent feasible. For each type and grade of lubricant recommended the contractor shall list at least three equivalent lubricants manufactured by alternative companies. This will be in line with that suggested by
OEM and outcome will be informed to the Owner/Owner's representative.
In case of imported oils, lubricants and other consumables, the contractor shall indicate the indigenous equivalents to enable the Owner/Owner's representative to arrange subsequent fills. Preference should be given to indigenous oils and lubricants during first filling itself. Short shelf life items if any may be supplied in a phased manner keeping in view of their actual use.
The Contractor shall supply the first fill lubricants and greases, and also shall provide at the Completion Certificate sufficient lubricants and greases necessary for the efficient operation and maintenance of the Plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.

12.2.0 Chemicals and other consumables

Contract includes the supply (by the Contractor) of all chemicals, reagents, resins, and other consumables required for testing, commissioning and setting to work of each section of the Works.
The Contractor shall provide all chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.
The Contractor shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.
The Contractor shall deliver to site sufficient quantities of consumables in his supply to allow for 6 months running of the Works prior to the issue of the Completion Certificate. The delivery of the

remainder of the consumables shall be programmed to suit the operational requirements and space availability within the various stores.

13. Plant and Equipment Identification

The contractor shall follow identification system for the whole plant equipment, instruments, facilities and systems as per the Annexure-4 Guide for Coding Equipment, Documents & Drawings MPP generated drawings, identification system shall be based on MPP standard.

Labelling

Name plates which are to be firmly fixed on all the equipment, instruments, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the piping or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.

The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them. Indoor installed equipment (e.g., panels, cabinets, switchgear) shall also be labelled by appropriate name plate.

The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Contractor and the Owner/Owner's representative. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags. All buried pipes and cables routes shall be identified with permanent marker.

ANNEXURE - A

VOLUME - III

SUB-SECTION - 3.1

GENERAL ELECTRICAL REQUIREMENT

1.0.0 INTENT OF SPECIFICATION

1.1.0 This specification covers the design, manufacture, assembly, testing at manufacturer's works, packing, transportation to site including transit insurance, unloading, erection, testing & commissioning of Electrical Equipment complete with all accessories for efficient and trouble-free operation of combined cycle captive power project.

1.2.0 It is not the intent to specify completely herein all details of the equipment; nevertheless, the equipment shall be complete and operative in all respects and shall conform to the highest standard of engineering, design and workmanship.

2.0.0 ELECTRICAL SYSTEM DESCRIPTION

2.1.0 The proposed Power plant consisting of one Gas Turbine Generator (GTG) & one Steam Turbine Generator (STG). GTG shall be connected to the new 66kV indoor type Gas Insulated Switchgear (GIS) through a Step-up Generator Transformer using phase segregated bus duct. STG shall be connected to the 66kV Outdoor type Gas insulated switchgear (GIS) through a Step-up Generator Transformer using phase segregated bus duct. Power shall be evacuated from 66kV GIS to the grid through the 66kVoutgoing line feeders. For commissioning of plant the start-up power shall be drawn from grid to the 66kV GIS.

2.2.0 Auxiliary Power supply is envisaged at 11kV & 415V level. Two numbers of Station Transformers are provided for supplying unit loads.

2.3.0 Required numbers of unit and station service transformer (11/0.415 kV) are provided for supplying 415V loads. Electrical Auxiliary power distribution arrangement & Power Evacuation Arrangement is shown in the enclosed **"Key Single Line diagram"(Drg. No. 00-5111168-E-201, 2 sheets)**.

2.4.0 One number Black start cum Emergency DG set shall be considered for starting of Gas turbine and safe shutdown of units. During blackout condition Diesel Generator (DG) set shall feed essential loads, same Diesel generator set shall feed unit emergency loads for safe shut down of Units.

2.5.0 To provide uninterrupted power supply to DCS and other Control Panels, a dedicated 110 V AC UPS system shall be provided. To feed essential loads, such as the emergency oil pumps, Control Supply to Switchgears / Panels, Emergency DC lighting etc, 110 V DC supply backed by DC Batteries shall be provided. DC system shall include 66kV GIS control supply requirements also.

2.6.0 If 125V DC system is required by the Gas Turbine supplier as per manufacturer's standard the same shall also be provided.

2.7.0 Plant communication system shall be provided with Public address system & telephone system.

2.8.0 For all electrical MV/LV/Control panels, Local control panels and Junction boxes, Transformers, etc shall be painted with RAL 7032

ANNEXURE-A

3.0.0 ELECTRICAL SYSTEM DESIGN

3.1.0 The plant shall be designed to operate in Islanding mode of operation on tripping of all the grid incoming lines and Steam Turbine generator, so that the Gas Turbine generator unit can be made running with the available plant load under such condition.

3.2.0 The design, manufacture, assembly, shop testing, erection, testing & commissioning as well as performance of the equipment shall conform to the latest edition of relevant IS / IEC specifications.

3.3.0 Before starting manufacture of any equipment the Contractor shall have to take approval of relevant drawings and data from the Owner/Owner's representative.

3.4.0 All equipment supplied and all work carried out including design and detailed engineering shall comply with the statutory requirements local Government as well as Central Government and with the Indian Electricity Rules. The accuracy class of meters, CTs, PTs (inside GIS) for energy accountability shall be as per latest GETCO regulations.

3.5.0 Unless otherwise specified in the respective section, Electrical design ambient for all equipment sizing shall be considered as 50 Deg C dry bulb temperature and 95% RH. All the equipment are required to operate in a highly corrosive environment and highly humid (at costal area) atmosphere.

3.6.0 Unless otherwise specified, at least 20 % margin shall be considered in equipment sizing over and above the calculated load current/fault current/power requirements.

3.7.0 Makes of all Electrical equipment are subject to prior approval by the purchaser. Similar equipment and components shall be of same make. Equipment of same type and rating shall be interchangeable.

3.8.0 The 415V PCC & MCC panels shall be of minimum FORM 3B type of construction.

3.9.0 In respect to the above LV circuit breaker selection, following should be considered as per IEC:-

Utilisation Category	Application
Category A	Circuit-breakers with no assigned short-time rating (e.g Current limiting ACBs and MCCBs) cannot be used if coordination is required with downstream switchboard feeders. Applicable for the outgoing feeders
Category B	Circuit-breakers with assigned short-time rating (e.g ACBs and some Supplier's larger rated MCCBs) that shall be used if coordination is required with downstream switchboard / MCCs. Applicable for the incomer and outgoing feeders.

Outgoing feeders not requiring any coordination for example motor feeders Category "A" MCCB can be considered.

3.10.0 In switchgear for Motor feeders rated 15kW & above an ammeter & transducer shall be provided. All transducers will be of dual output type.

3.11.0 All LT motors rated 90 kW & above shall be controlled through Air Circuit Breakers. LT motors rated below 90 kW shall be controlled by fused contactor. In addition to the above ELCB shall be provided for all 415V motor feeder. Each feeder shall also provided with O/L relay and SPPR relay.

3.12.0 For the motor feeders, the essential auxiliaries shall have contactors with delayed drop out feature adjustable up to 3 sec and necessary auto reset facility and the relay should be of digital type. The

list of motors shall not be limited to BFP, AOP, JOP, lube oil pump, compressors, barring gear and any other drive recommended by GTG,STG & HRSG vendor.

3.13.0 The power cables upto and including 10 sq.mm should be copper conductor and above 10 Sq.mm Aluminium conductor may be used. For CT circuits minimum cable size shall be 4sq.mm copper. Minimum size of control cables shall be 2.5sqmm. 20% spare cores shall be provided in all control cables. The maximum no. of cores shall be limited to 27.

3.14.0 The equipment supplied shall meet the requirement of state electricity and Indian grid code.

3.15.0 The Substation Automation System (SAS) shall have provision for interfacing with remote PLDC (Regional Load Dispatch Centre) through suitable gateways with adequate number of ports along with modems at substation level.

3.16.0 Voltage Levels shall be as follows:

- Power Evacuation : 66 kV (±10%), 3 phase, 3 wire 50 Hz, effectively earthed.
- Generation Voltage : Manufacturer's standard Voltage,3 phase,50 Hz
- Plant HT Auxiliary Supply : 11000V (±10%), 3-phase, 3W, 50 Hz, earthed through resistance.
- Plant LT Auxiliary Supply : 415V (±10%), 3 phase, 4 wire, solidly earthed.
- Plant LT Emergency Supply : 415V (±10%), 3 phase, 4 wire ungrounded.
- Plant DC Supply : 110V (+10% to –15%), DC 2 wire unearthed.
- Plant UPS Supply : 110V (±10%), 1 phase, 2 wires 50 Hz, A.C.
- Transducers : 110V DC (For LT boards 230V AC)
- Metering : 110V AC PT Voltage
- Control & protection : 110V, DC 2 wire unearthed
- Panel lighting and space heaters : 240V, 1-phase, 2wires 50 Hz, A.C. with one point earthed.
- Control Supply for Breaker feeders : 110V, DC 2 wire unearthed
- Control Supply for LV DOL modules : 110V, 1 phase, 2 wires
- Permissible Frequency variation for generator : +3% to – 5%
- Permissible Frequency variation for auxiliaries : +5% to – 5%
- Voltage level for AC Motors below 0.2 kW : 240 V, Single phase, 50 Hz, with DOL start.
- Voltage level for AC Motors from 0.2kW up to and including 160 kW : 415 V, 3 phase, 50 Hz, with DOL start.
- Voltage level for A.C Motors above 160 kW : 11000V, 3 phase, 50 Hz, with DOL start.

3.17.0 Design short circuit levels shall be at least the following and has to be supported by calculation:

- Three phase symmetrical short circuit ratings of 66kV System : 40 kA for 3 sec
- Three phase symmetrical short circuit ratings of 11kV System : 44 kA for 3 sec
- Earth fault current for 11kV System : 100A.
- Three phase symmetrical short circuit ratings of 415V System : 50 kA for 1sec
- Short circuit ratings of 110V DC System : 20 kA for 1 sec (min)

3.18.0 Insulation level at various voltages shall be as follows:

66kV System

One minute Power Frequency withstand voltage : 140 kV (rms)
Switching Impulse withstand Voltage : 325 kV (peak)

11kV System

One minute Power Frequency withstand voltage : 28 kV (rms)
1.2/50 Micro sec, impulse withstand voltage : 75 kV (peek)

415 V System

One minute Power Frequency withstand voltage : 3 kV (rms)

3.19.0 Sizing criteria for auxiliary transformers

Design Criteria for Auxiliary Transformer and Generator Transformer

i. The Contractor shall size the auxiliary transformer as per sizing criteria furnished below:

Min. Rating of each Auxiliary transformer (in kVA at p.f.0.8)	=	1.2 x (Sum of total connected load + Max of (sum of 20% of total standby loads or the largest standby load) + max of (sum of 50% total intermittent loads or the largest intermittent load))

✓ The auxiliary transformers shall be sized for 2x100%

4.0.0 QUALITY ASSURANCE, TESTING & INSPECTION

4.1.0 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, tested, and commissioned at all the steges, as per approved Quality Plan.

4.2.0 All tests shall be conducted as per relevant IS/IEC/IEEE standards and shall be performed in the presence of purchaser's representative, if so desired by the purcheser. The Bidder shall give at least 15 days advance notice of the date when the tests are to be carried out.

4.3.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. Type testing shall be conducted without any cost implication to the purchaser if type testing is not already carried out for any equipment supplied. For the various bought out items test certificates from equipment manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards whether specifically mentioned or not. Specific type tests are to be carried out as specified in individual equipment specifications.

4.4.0 Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Purchaser's written approval of the test reports.

The charges for carrying out all routine tests shall be deemed to be included in the Bid price. The charge of carrying out each type test/ special test if any shall be given separately in "Unit Price Schedule".

7.17.0 List of Approved Sub-vendors

Refer Volume IV/Annexure-1/ Section 8.

With full information substantiating the technical acceptability of the proposed change. The Owner/Owner's representative's decision shall be final. Concessions granted shall not absolve the Contractor from any of his responsibilities under the Contract.

8.0.0 QUALITY ASSURANCE, SHOP INSPECTION AND TESTING

8.1.0 General

This section contains general requirements for inspection of material, parts, equipment and workmanship of the plant during manufacture, assembling to demonstrate compliance with specification, codes and standards to ensure overall reliability of plant operation and performance.

The Owner/Owner's representative and/or authorised Representatives shall, at any time, be allowed free and ready access to the Contractor's premises and those of his suppliers as well as to the site installation and the Contractor has to make the plant items available for the purpose of inspecting the specified equipment components and obtaining information as to the progress of the work. Failure on the part of the Owner/Owner's representative, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Owner/Owner's representative shall not prejudice the right to reject equipment if it does not give complete satisfaction in service.

8.2.0 Scope

All materials, components and equipments covered under this specification shall be tested at all stages of procurement, manufacturing, erection, commissioning as per a comprehensive quality assurance programme. The requirements of minimum quality plans to be followed by the Bidder in respect of various equipment are specified in detailed technical specification. The Bidder shall draw his own quality plans in line with these requirements and his standard practices and implement such programme after approval by the Owner/Owner's representative.The Owner/Owner's representative shall appoint a Third party inspection (TPI) agency for bought out items/outside inspection.The Owner/Owner's representative will carry out on-site supervision and inspection.

Manufacturing quality plan shall detail out, for all the components and equipments, various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by contractor's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised. during all stages of material procurement, manufacture, assembly and final testing/performance testing.

The Contractor has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted. It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organization and that the Contractor monitors the performance of these by the attendance at tests of experienced inspectors employed by the Contractor. The Contractor shall, at the appropriate time, prove that his

material and / or equipment comply with all the requirements of this Section, such proof being the successful completion of tests and inspections. Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.

All materials, components and equipment supplied under the contract shall be subject to inspection by the Owner/Owner's representative, his representative, Inspectors of Boilers (India) or his authorized Agency or any other Inspector of the Government, should they so require during manufacture, erection and after completion. The necessary inspection charges of the authorized agency of Inspection of Boilers (India) shall be borne by the contractor. The inspection and tests shall include but shall not be limited to the requirements of this section of the specification. Further requirements to be applied are specified in the detailed specification.

The Bidder along with quality plan, shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure referred by him in quality plans. These quality plans and reference documents/standards will be subject to Owner/ Owner's representative's approval and will form a part of the contract. In these approved quality plans, Owner/Owner's representative shall identify customer hold points (CHP), indicating tests/checks which shall be carried out in presence of the Owner/Owner's representative's or authorized representative and beyond which work will not proceed without consent of Owner/Owner's representative's in writing.

No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by Owner/Owner's representative or such pre-dispatch final inspection is waived by the Owner/Owner's representative and dispatch is authorized after review of test reports.

All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports duly approved by the Owner/Owner's representative. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.

All material used for equipment construction including castings and forgings shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or as specified in detailed specification.

All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner/Owner's representative for approval prior to carrying out qualification test in the presence of I/Owner/Owner's representative

All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.

Test results of qualification tests and specimen testing shall be furnished to the Owner /Owner's representative for approval. However, wherever required by the Owner/ Owner's representative, tests shall be conducted in presence of Owner/Owner's representative

All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All the sub-vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment-(list of which shall be drawn up by the Bidder along with his offer and finalized with the Owner/Owner's representative) shall be subject to Owner/ Owner's representative's approval.

The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the Owner/Owner's representative, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.

8.3.0 Inspection Program and Test Notifications

Before manufacturing commences and not later than 45 days after award of contract, the Contractor shall submit an outline of his proposed inspection program, which shall include all major stages during manufacturing. The inspection and test program shall include for the various items the designation No., name of equipment, part of equipment, the kind of test, test standard, company which carries out the test, place, date and witnesses by the Contractor, third party or Owner/Owner's representative's .

The Owner/Owner's representative will return a copy of the Contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be by Fax or email in a format to be agreed and shall be sent at least 20 days prior to the intended test in accordance with 'Conditions of Contract'. If the Owner/Owner's representative intends to be represented at the test he will provide at least 24 hours' notice and if his representative does not attend on the notified date, the test may proceed unless an alternative date has been requested by the Owner/Owner's representative.

8.4.0 Test Certificate Documentation

The results of all tests shall be certified by the manufacturer, Contractor or independent agency as appropriate.

Document files containing material certificates, welding procedures, test report shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

Three copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner/Owner's representative prior to commissioning.

Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

8.5.0 Certification of Equipment by Owner/Owner's representative's

The Personal and travelling costs in connection with the Owner/Owner's representative's inspection and witnessing of tests of equipment, components and material manufactured in India and abroad will be bome by the Owner/Owner's representative.

8.6.0 Codes and Standards

8.6.1 General

The type and extent of inspection shall generally be in accordance with that specified in the standard used for design and construction of the item of equipment supplemented or amended by the requirements of this section of the specification. The Contractor should provide the relevant codes and standard to the Owner/Owner's representative.

8.6.2 Reference to Codes and Standards

Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, In-shop and on-site testing, and methods of construction and/or installation which must be equalled or exceeded in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner/Owner's representative.

In all instances, the finally accepted applicable code or standard shall be the version last published.

8.6.3 Alternative Standards

Where no appropriate standard is available, tests shall be conducted in accordance with the manufacturer's standard practice, subject to the approval of the Owner/Owner's representative.

In such cases the Contractor shall submit to the Owner/Owner's representative, complete data and a suggested procedure for the testing to be performed. Commencement of manufacture before receipt of the Owner/Owner's representative's approval shall be at the Contractor's risk.

If the proposed procedures are accepted, the Contractor shall provide the Owner/Owner's representative with four additional copies in English before any test is performed.

8.6.4 Derating Standards

The Contractor's attention is drawn to the climatic conditions in the site area. Derating factors shall apply in accordance with the relevant and approved standards if not specified in the contract documents.

8.7.0 Services prior to and During Inspection and Testing

In accordance with and in addition to specified standards the Contractor shall submit procedures for material testing, manufacture, quality control and performance testing as they apply from the procurement phase of raw materials to the finished product. Manufacture commenced before receipt of the Owner/Owner's representative's approval of material specifications and testing procedures shall be at the Contractor's risk.

No inspection shall be valid unless the Contractor and manufacturer are in possession of relevant approved drawings and procedures for the item to be tested. The Contractor on

ANNEXURE-

16.4.1 Document Distribution Schedule - After Placement of Order

Sl. No.	Document	Total Copies	Distribution		
			Owner		Owner's representative
			HQ	SITE	
1.	PERT Network, work schedules, Bar charts, Layout drawings	10	-	5	5
2.	Data, drawings, documents, write-ups, calculation				
	- Preliminary	10	-	5	5
	- Revised	10	-	5	5
3.	Approved drawings and documents.	10	-	5	5
4.	Instruction manuals for erection and O&M	10	-	8	2
5.	As built drawings including O &M manual				
	- Hard Copy	10	-	8	2
	- Soft Copy	-	-	-	-

ANNEXURE - D

SUB-SECTION – 2.15

SURFACE PREPARATION AND PAINTING

CONTENTS

SUB-SECTION – 2.15

SURFACE PREPARATION AND PAINTING

1.0.0 SURFACE PREPARATION

1.1.0 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, component and system. The components and/or equipment shall be mechanically and / or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop.
- Cleaning before painting and / or corrosion protection (application of prime coat).
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment of welding at manufacturer's work or at site, as appropriate.

For cleaning in workshop and before painting mechanical cleaning as opposed to alternative chemical cleaning is the preferred method of for works cleaning except where this is precluded by design or access considerations.

Mechanical surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the purchaser's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted wire brushless used on austenitic steel bristles.

Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic / plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

various international standards equivalent to Swedish standard for surface preparation are given in Table-1.

The contractor shall arrange at his own cost, to keep a set of latest edition of the above standards and codes at site.

The paint manufacturer's instruction shall be followed as afar as practicable at all times. Particular attention shall be paid to the following.

a) Proper storage to avoid exposure as well as extremes of temperature.
b) Surface preparation prior to painting.
c) Mixing and thinning.
d) Application of paints and the recommended limit on the intervals between coats.
e) Shelf life for storage.

Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation of painting work in any specific location, even prior to completion of system test.

1.2.0 **Tools & Tackles**

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot/sand blasting equipment and air compressor etc. shall be arranged by the contractor at the site in sufficient quantity at his own cost. He shall arrange to his own cost, for suitable paint thickness measuring instrument like Elkometers acceptable to the Engineer (with calibration facilities).

Mechanical mixing shall be used for paint mixing operation in case of two pack systems except that the Engineer may allow the hand mixing of small quantities at his discretion.

1.3.0 **Mechanical Cleaning at Manufacturer's Works**

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Purchaser is prepared to consider alternative methods provided they achieve the necessary surface condition.

1.3.1 **Surface condition**

The Metal surfaces shall be clean and free of mill scale, rust dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

1.3.2 **Abrasives**

Abrasives containing silica, silicates of slag, residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

For austenitic materials only abrasives containing 98% or more of aluminia, $Al_2 O_3$, shall be used.

1.3.3 **Removal of abrasive and debris**:

After cleaning abrasive and debris shall be thoroughly removed from components.

1.3.4 **Alternative Chemical Cleaning at Manufacturer's Works**

The procedure shall comprise of Pre-treatment and Acid treatment.

To achieve cleanliness equivalent to that specified for mechanical cleaning. The procedure to be adopted must meet with the purchaser's approval.

1.3.5 **Protection at Manufacturer's Works**

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapour phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square metre or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds Cylindrical plugs shall not be drive into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

1.4.0 **Weather Conditions**

Painting shall be done only when the surface temperature is above 5°C surface temperature must be at least 3°C above dewpoint to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation, corrosive fumes and vapours shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming of finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc. before drying, shall be permitted to dry & the damaged area of primer shall be removed and the surface prepared & primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this an additional top coat of paint shall be applied.

1.5.0 **Surface Preparation**

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired so as to obtain a clean, dry, even surface to receive the priming or finishing coat(s) as called for in the painting schedules. Sharp adges should be rounded especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.
All surface should be blast cleaned whenever possible.

1.5.1 **Surface preparation methods.**

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 5900 or Steel Structures Painting Council, SSPC, Vis1,or DIN 55928, section 4.

1.5.1.1 **White metal blast cleaning**: Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal, Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic colour & correspond in appearance to the prints designated Sa 3.

1.5.1.2 **Near white metal blast cleaning** Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. Very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated Sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

1.5.1.3 **Commercial Blast Cleaning** Sa 2

Sa 2 Blast cleaning until atleast two-thirds of each element of surface area is free of all visible residues. This method of Blasting is suitable for steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint system.

1.5.1.4 **Near white metal blast cleaning** P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatment see Sub b).

1.5.1.5 **Very thorough mechanical scraping and wire brushing** St 3

St 3 very thorough scraping and wire-brushing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for St 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

1.5.1.6 **Thorough scraping and wire brushing**: St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

Table -1 (Surface Preparation Standards)

Surface preparation methods	SIS 055900	DIN 55928, Part-4	BS 4232 only for blasting	SSPC-Vis
Blasting ACC to item (a)	Sa 3		First quality	White metal SP 5
Blasting ACC to item (b)	Sa 2 1/2		Second near quality	White SP 10
Blasting ACC to item (c)	Sa 2		Third quality	Commercial blast SP 6
Hand / or power tool derusting ACC to item (f)	St 2		--	Hand tool cleaning SP 2
ACC to items (e)	St 3		--	Power tool cleaning SP 3
Flame jet cleaning		F1	--	Flame cleaning SP 4
Pickling		Be	--	Pickling

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar (g) at the nozzle shall be used.

After blast-cleaning all accumulated grit, sand, dust etc. must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness P Sa 2 1/2 before touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. before the coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

1.5.2 **Rub Down and Touch up of Primer**

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer. The compatibility between shop coat and field primer should be ascertained from the paint manufacturer. In case degreasing with white spirits is not effective, the surface should be finally wiped clean with aromatic solvent like xylol or light naphtha.

1.5.3 **Non Compatible Shop Primer**

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer.

Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

Shop primed equipment and surfaces shall only be spot cleaned in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment.

For package units / equipment, shop primer shall be as per the paint system given for particular environment.

In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case the coat is selected for upgrading existing alkyd coating to high performance coating, then surface preparation can be by manual / mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It should be touched with red oxide zinc chromate primer wherever it has peeled of before application of the coat. The tie coat shall be applied after 7 days of curing of red oxide zinc chromate primer. If new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

2.0.0 SCHEDULE OF PRIMER & FINISH COATS

2.1.0 PRIMERS

P-1 Red Oxide zinc chromate primer
P-2 High build chlorinated rubber zinc phosphate primer
P-3 High build zinc phosphate primer
P-4 Etch primer/wash primer
P-5 Epoxy zinc chromate primer
P-6 Epoxy zinc phosphate primer
P-7 Epoxy high build mio paint
P-8 Epoxy red oxide zinc phosphate primer
P-9 Epoxy based tie coat finish coats
P-10 Inorganic zinc silicate coating.

2.2.0 FINISH COATS

F-1 Synthetic enamel
F-2 Acrylic polyurethane paint
F-3 Chlorinated rubber paint
F-4 High build chlorinated rubber mio paint
F-5 Chemical resistant phenolic based enamel
F-6 Epoxy high build coating
F-7 High build coal tar epoxy
F-8 Self priming epoxy high build coating
F-9 High build black
F-10 Heat resistant aluminium paint suitable upto 250°c
F-11 Heat resistant silicone paint suitable upto 400°c
F-12 Synthetic rubber based aluminium paint suitable upto 150°c
F-13 Heat resistant silicone paint suitable upto 600°c

2.3.0 PRIMER

a) Primer (P-1) Red oxide zinc chromate primer

Type and composition	:	Single pack modified phenolic alkyd medium pigmented with red oxide and zinc chromate
Volume solids	:	30 - 35%
DFT	:	20 ~ 40 microns/coat (min)
Covering capacity	:	11-13 sq. m/Lit/coat

b) Primer (P-2) High build chlorinated rubber zinc phosphate primer

Type and composition	:	Single pack Chlorinated rubber medium plasticised with unsaponifiable plasticiser pigmented with zinc phosphate
Volume solids	:	35-40%

DFT	:	50 microns/coat (min).
Covering capacity	:	7-8 sq. m/lit/coat

c) **Primer (P-3)** High build zinc phosphate primer

Type and composition	:	Single pack Synthetic medium, pigmented with zinc phosphate
Volume solids	:	40 - 45%
DFT	:	35 - 50 microns/coat
Covering capacity	:	10 - 12 sq. m/lit/coat
Heat resistant	:	Upto 100 ^{0}C (dry)

d) **Primer (P-4)** Etch primer / Wash primer

Type and composition	:	Two pack of Polyvinyl butyl resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate
Volume solids	:	7 - 8%
DFT	:	8 - 10 microns/coat
Covering capacity	:	7 - 8 sq. m/lit/coat

e) **Primer (P-5)** Epoxy zinc chromate primer

Type and composition	:	Two pack of Polyamide cured epoxy resin medium pigmented with zinc chromate
Volume solids	:	40% (min.)
DFT	:	35 microns/coat
Covering capacity	:	11 - 12 sq. m/lit/coat

f) **Primer (P-6)** Epoxy zinc phosphate primer

Type and composition	:	Two pack of Polyamide cured epoxy resin medium pigmented with zinc phosphate
Volume solids	:	40% (min)
DFT	:	35 microns/coat (min)
Covering capacity	:	11 - 12 sq. m/lit/coat

g) **Primer (P-7)** Epoxy high build MIO paint (Intermediate coat)

Type and composition	:	Two pack of Polyamide cured epoxy resin medium pigmented with micaceous iron oxide
Volume solids	:	50% (min)
DFT	:	100 microns/coat (min)
Covering capacity	:	5.0 sq. m/lit/coat

h) **Primer (P-8)** Epoxy red oxide zinc phosphate primer

Type and composition	:	Two pack of Polyamide cured epoxy resin medium pigmented with red oxide and zinc phosphate
Volume solids	:	42% (min)
DFT	:	30 microns/coat (min)
Covering capacity	:	13 - 14 sq. m/lit/coat

i) **Primer (P-9)** Epoxy based tie coat

(Suitable for conventional alkyd based coating prior to application of acrylic polyurethane / epoxy finishing coat).

Type and composition	:	Two pack of Polyamide cured epoxy resin medium suitably pigmented
Volume solids	:	45-60%
DFT	:	40 microns/coat (min)
Covering capacity	:	10 - 12 sq. m/lit/coat

j) **Primer (P-10)** Inorganic Zinc silicate coating

Type and composition	:	Two pack of Self cured Ethyl - silicate solvent based Inorganic Zinc coating.
Volume solids	:	60% (min)
DFT	:	65-75 microns/coat
Covering capacity	:	8-9 sq.m./lit/coat

2.4.0 **FINISH COATS**

a) **Finish coat (F-1)** Synthetic Enamel

Type and composition	:	Single pack Alkyl medium pigmented with superior quality water & weather resistant pigments
Volume solids	:	30 - 40%
DFT	:	20 - 25 microns/coat (min)
Covering capacity	:	16 - 18 sq. m/lit/coat

b) **Finish coat (F-2)** Acrylic Polyurethane paint

Type and composition	:	Two pack Acrylic resin and isocyanate hardener suitably pigmented.
Volume solids	:	40 % (min)
DFT	:	30-40 microns/coat
Covering capacity	:	10-12 sq.m./lit/coat

c) **Finish Coat (F-3)** Chlorinated Rubber paint

Type and composition	:	Single pack Plasticised chlorinated rubber medium with chemical & weather resistant pigments.
Volume solids	:	30 % (min)
DFT	:	30 microns/coat (min)
Covering capacity	:	10 sq.m./lit/coat

d) **Finish Coat (F-4)** High build chlorinated rubber MIO paint.

Type and composition	:	Single pack Chlorinated rubber based high build pigmented with micaceous iron oxide.
Volume solids	:	40-50 %
DFT	:	65-75 microns/coat
Covering capacity	:	6-7 sq.m./lit/coat

e) **Finish Coat (F-5)** Chemical Resistant Phenolic based Enamel

Type and composition	:	Single pack Phenolic medium suitably pigmented.
Volume solids	:	30-40%
DFT	:	25 microns/coat (min)
Covering capacity	:	15 sq.m./lit/coat

f) **Finish Coat (F-6)** Epoxy High Building Coating

Type and composition	:	Two pack Polyamide cured epoxy resin medium suitably pigmented.
Volume solids	:	55-65%
DFT	:	100 microns/coat (min)
Covering capacity	:	6.0-6.5 sq.m./lit/coat

g) **Finish Coat (F-7)** High build coal tar Epoxy.

Type and composition	:	Two pack Polyamine cured epoxy resin blended with coal tar.
Volume solids	:	65 % (min)
DFT	:	80-125 microns/coat
Covering capacity	:	6.0-6.5 sq.m./lit/coat

h) **Finish Coat (F-8)** Self priming epoxy high build coating (complete rust control coating)

Type and composition	:	Two pack Polyamido-amine cured epoxy resin suitably pigmented. Capable of adhering to manual prepared surface and old coatings.
Volume solids	:	65-85%
DFT	:	100-125 microns/coat
Covering capacity	:	4-5 sq.m./lit/coat

i) **Finish Coat (F-9)** High build black.

Type and composition	:	Single pack Reinforced Bituminous composition phenolic based resin.
Volume solids	:	55 - 66 % (min)
DFT	:	100 microns/coat (min)
Covering capacity	:	5.5 – 6.0 sq.m./lit/coat

j) **Finish Coat (F-10)** Heat Resistant Aluminium Paint Suitable upto 250°C

Type and composition	:	Dual container (paste & medium) Heat resistant special Ole Ore resinous medium with leafing aluminium.
Volume solids	:	20 - 25 %
DFT	:	20 microns/coat (min)
Covering capacity	:	10 - 12 sq.m./lit/coat

k) **Finish Coat (F-11)** Heat Resistant Silicon paint suitable 250 - 400°C.

Type and composition	:	Single pack of Silicon resin based with aluminium flakes
Volume solids	:	15-25 %
DFT	:	20 microns/coat (min)
Covering capacity	:	7-12 sq.m./lit/coat

l) **Finish Coat (F-12)** Synthetic Rubber Based Aluminium Paint suitable upto 150°C.

Type and composition	:	Single pack of Synthetic rubber medium combined with leafing Aluminium.
DFT	:	20-25 microns/coat (min)
Covering capacity	:	9.5 sq.m./lit/coat

m) **Finish Coat (F-13)** Heat Resistant Silicon paint suitable 500 - 600°C

Type and composition	:	Single pack of Silicon resin based with aluminium flakes.
Volume solids	:	25-35%
DFT	:	20 - 25 microns/coat (min)
Covering capacity	:	12 - 14 sq.m./lit/coat

3.0.0 PAINT SYSTEM

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
1	Structural steel work, piping (oil + water) tanks outside surface, transmission towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
							35	x	
				Intermediate	1	P7	100		x
				Finish	1	F2	50		x
						Total DFT	**220**		
2	Structural steel work, piping, indoor and outdoor	130 to 200°C	Sa 2½	Prime	1	F9	75	x	
				Intermediate	1	F9	20		x
				Finish	2	F11	20		x
							20		x
						Total DFT	**135**		
3	Structural steelwork, piping, un-insulated carbon steel, indoor and outdoor	200 to 400°C	Sa 3	Prime	1	F9	75	x	
				Intermediate	1	F12	20		x
				Finish	1	F12	**20**		x
						Total DFT	**115**		
4	Structural steel work, piping (oil + water), tanks, indoor	upto 130°C	Sa 2½	Prime	2	P6	35	x	
							35	x	
				Finish	1	F6	100		x
						Total DFT	**170**		

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
5 (a)	Structural steel work in the battery rooms, Chlorination plant and water treatment plant (extreme aggressive atmosphere)	Ambient	Sa 3	Prime	2	P8	30	x	
							30	x	
				Finish	2	F6	100		x
							100		x
						Total DFT	**260**		
(b)	Un-insulated - equipment, tanks and piping etc.	upto 80°C	Sa 3	Prime	2	P3	35	x	
							35	x	
				Finish	2	F6	100		x
							100		x
						Total DFT	**270**		
6	Steel tanks inside surface (total) for oil storage	normal	Sa 2½	Prime	2	P3	35	x	
							35	x	
				Finish	2	F6	100		x
							100		x
						Total DFT	**270**		
7	Steel tanks inside surface (total) for water storage (potable and distilled water)	normal	Sa 2½	Prime	2	P2	50	x	
							50	x	
				Finish	2	F3	30		x
							30		x
						Total DFT	**160**		
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30	x	
							30	x	
				Finish	3	F7	125		x
							125		x
							125		x
						Total DFT	**435**		

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125		x
							125		x
							125		x
							125		x
						Total DFT	**500**		
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
							50	x	
				Finish	3	F3	30		X
							30		X
							30		X
						Total DFT	**190**		
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
							50	x	
				Finish	2	F6	100		x
							100		x
						Total DFT	**300**		

3.1.0 Colour Code for Piping

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines should comply with the standard and shall submit for Owner/Owner's representative's approval. (For colour code for piping and fire equipment refer Annexure-1).

Notes :

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during application, min specified DFT should be maintained.
2. All primers and finish coats should be cold cured and air dried unless otherwise specified.
3. Selected chlorinated rubber paint should have resistance to corrosive atmosphere and suitable for marine/saline environment.
4. All paints shall conform to relevant Indian Standard and shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.
5. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
6. In case of use of epoxy tie coat, manufacturer should demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat (P-9) alternate system may be used taking into consideration the service requirement of the system.
7. All primers should be top coated immediately as per manufacturer's recommendations.
8. In ONGC Hazira complex no sand blasting or shot blasting shall be done. All equipment shall be protected with anti-corrosive coat and after final painting only shifted to project site for further erection. Touch – up painting for the damage area during transportation can be done at project site.

3.2.0 **Specific Requirement**

3.2.1 Following paint schedules shall be followed :

- Acid resistant paint for DM plant building / structure, neutralisation pit, battery room, other corrosive area.
- Synthetic enamel paint for Structural steel, structural sheds, window grills, hand raillngs, etc.
- Epoxy high build paint for DM plant equipment with piping valves.

3.2.2 All steel work not embedded in concrete to be given one coat of commercial grade zinc chromate primer before painting.

3.2.3 Synthetic enamel paint :

a) General building / structure :

• Surface preparation	:	ST – 2 according to Swedish standard SIS 055900
• Primer paint	:	Two coats of Zinc phosphate in phenolic alkyd medium (DFT = 35 microns / coat)
• Finish paint	:	Two coats of Synthetic enamel (DFT = 25 microns / coat) confirming IS 2932, 1974.

b) Part of steel structure embedded in concrete :

• Surface preparation	:	ST – 2 according to Swedish standard SIS 055900 One coat of port land cement slurry.

c) Epoxy high building coating:

• Epoxy zinc phosphate primer	:	two coats of 35 DFT per coat.
• Epoxy high build coating	:	one coat of 100 DFT.