BHEL / ISG BANGALORE	ENQUIRY SPECIFICATION VENTILATION SYSTEM	IS-1-07-2001/096

Customer: RASHTIYA ISPAT NIGAM LIMITED - VIZAG STEEL PLANT Project: 6.3
MTPA EXPANSION PROJECT - LD CONVERTER AND ACCESSORIES (2x150 T LD CONVERTERS)

CONTENTS

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SECTION - I

1.0 GENERAL PROJECT INFORMATION:

Visakhapatnam Steel Plant (VSP) a part of Rashtriya Ispat Nigam Ltd. (RINL), for its expansion program is establishing a Steel Melt Shop - 2. As part of the program VSP is installing 2 x 150t LD converters to produce 2.8 MT of liquid steel. This Document covers the requirement for VETILATION system of the specified areas of the LD converter shop

The equipment for 2X 150 T LD CONVERTOR shall be designed taking into account following design data:

1.1 Ambient conditions

Average elevation Mean Sea Level -+10.5 m	
Barometric Pressure	-760mbar
Absolute maximum	-45 DEG C
Absolute minimum	-10.5 DEG C
Relative Humidity (Maximum) -88%	
Climate	-Tropical humid
Mean Wind Speed	-7.8 km/h
Maximum wind speed	-108 km/h

1.2 Ambient Air Quality: Laden with coal and steel dust particles, fumes, chemical gases from LD CONVERTOR Note: The Electrical rooms, Control rooms will be provided with adequate Air Conditioning / Ventilation systems. All electrical electronic and automation equipments will be designed for an ambient temperature of 45 Deg C. In addition to this for the switchboards / Control panels the in-panel temperature as per the enclosure used will also be considered for de-rating.

1.3 **Power Supply Characteristics**

Parameter	**LT**
Power Supply	415V, 3phase, 50 Hz, 4 wire
Voltage variations	+ 6% - 6%

Frequency variation	+ 3% - 3%
Combined V& F variation	+/-10%
System neutral	solidly grounded
System short circuit level	50 kA rms. at 415V for 1. second

1.4 Control voltages Control voltage 240 VAC, 1 –Phase, 50 Hz
1.5 Degree of protection -Control Panels IP 54
1.6 DESIGN PARAMETERS Design Parameters of VNTILATION system shall conform to General specifications (GS) for Air Conditioning and Ventilation systems: VSP-6.3/GS-M-04, GS for Thermal Insulation: VSP-6.3/GS-M-06 and shall achieve, area wise, various parameters specified therein

1.7 DESIGN COSIDERATIONS

AMBIENT CONDITIONS

The design Ambient conditions as given below shall be considered for all VENTILATION system

Description	**Summer**	**Monsoon**	**winter**
Dry bulb temp deg C	**38**	**31**	**16**
Relative Humidity , %	**70**	**85**	**70**
Absolute Max temp Deg C	**45.3**	**-**	**-**
Absolute Min temp Deg C	**-**	**-**	**10.5**
Cooling water temp deg C	**34**		

The ventilation system shall be justified based on heat load calculation.

1.8 GENERAL INFORMATION TO BIDDERS:

1.8.1 Bidders will carefully go through these specifications before furnishing their offers. Special attention need to be paid to VSP general specifications, regarding ACVS, painting etc., attached to these specifications.

1.8.2 Ventilation stations both supply and exhaust air, were identified for Cable tunnels. However, Layout and arrangement of these stations will be prepared by the supplier upon placement of order.

1.8.3 All Electrical Control Rooms (ECR) are provided with Ventilation Rooms. Sizes of these rooms are final. Provision openings at floor El. were already indicated in the layouts of these rooms supplier to co-ordinate accordingly. Wall openings and civil assignments are to be prepared and furnished as per schedules given in Section – VII.

1.8.4 Bidders are requested to visit BHEL offices at Bangalore, with prior intimation to the indenter, for a one time clarifications before submitting their offer. This visit can be within 5 working days upon receipt of enquiry. All clarifications will be given by the indenter. Mail ID of the indenter: kvb@bhelisg.com, gjnr@bhelisg.com , vssn@bhelisg.com.

1.8 .5 QUALIFYING CRITERIA: The bidder shall have executed at least one ventilation system job (involving design, supply and erection of supply and exhaust fans, ducts etc) on turnkey basis for a industrial plant, of value 50 lakhs in single order, within last 3 years. Further it is also necessary that the vendors who are not registered till date with BHEL / ISG shall do the vendor registration with BHEL. For this the vendor shall download the vendor registration form from BHEL web site www.bhel.com and do the registration immediately. The offer will be considered only if the enlistment criteria are satisfied.

Additionally, end user M/s RINL's , approval as a vendor is essential for execution of the order.

SECTION -II

2.0 APPLICABLE STANDARDS:

As listed in VSP General Specifications No.: .: VSP-6.3/GS-M-01, VSP-6.3/GS-M-04, for Chilled Water Plant, Air-Conditioning and Ventilation Systems. Reference shall be made, in particular, to VSP General Specifications No.: VSP-6.3/GS-M-04 & VSP-6.3/GS-M-06, and VSP-6.3/GS-P-01 attached to this Enquiry.

SECTION - III

3.0 SCOPE OF SUPPLY:

This specification covers the requirements for the design, engineering, fabrication, testing, delivery, and transport to the place of installation, installation and putting into operation of Complete Ventilation Systems for **VIZAG Steel Plant, VISHAKHAPATNAM** as per this Specification. The equipments will be located in Steel Melt Shop - LD Converters area and other areas as specified - of SMS-2, in VSP, VIZAG.

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3.1 VENTILATION SYSTEM

3.1 VOID.

3.2 VOID..

3.3 Fresh Filtered Air Supply with Natural Exhaust / Fresh Filtered Air Supply and Exhaust Air system/ Exhaust Air Ventilation System, as required, will be provided for various departments as per Annexure-3. Man-coolers will be provided at various locations as indicated in these specifications and annexures.

3.4 VOID.

3.5 All Inserts in the floor / wall, for the VENTILATION system shall form the part of supply scope and have to be included in the offer.

3.6 All minor Civil assignments and works connected with VENTILATION system, shall be included in the offer.

3.7 This offer shall be on ETC (Engineering, Testing and Commissioning) basis. Therefore the adequacy of the ventilation being offered will be the sole responsibility of the supplier/contractor. No future escalation / extra charges will be entertained and any small changes in the capacities due to small changes in room sizes / locations will have to be absorbed by the supplier.

3.8 The make of components selected shall be from the customer approved vendor list for various items mentioned at Annexure IV

SECTION - IV

4.0 REFERENCE DRAWINGS:

4.1 Steel Plant Layout – Converter and Accessories. Drawing No.: 0-21058450-E

4.2 Various Drawings indicated in Annexure- 3 are given at Annex -5.

5.0 TECHNICAL SPECIFICATIONS:

5.1 void.

5.1.1 void.

5.1.2 void.

5.1.3 void.

5.1.4 void.

5.1.5 void .

5.1.6 void..

5.1.7 CONTROLS AND ELECTRICAL EQUIPMENTS: For above ventilation system MCC-cum-PDB Panel shall be provided by the Purchaser for catering the power supply needs, which is located as shown in the layout of various areas. However a Local Control Panel (LCP) shall be located near the ventilation system in Ventilation room which will have necessary interlocks to isolate the ventilation units in case of Fire shall be in the scope of the vendor.. These LCPs shall be in turn wired to plant PLC (PLC supplied by purchaser) and shall have all the necessary components as per requirement of the ventilation System. Power supply shall be provided to the above panels MCC-cum-PDB.

5.18 void..

5.19 void..

5.20 void.

5.21 Ventilation system will be interlocked with teh fire detection system so that in case of fire the respective units are tripped automatically.

5.2 VENTILATION SYSTEM

5.2.1 Ventilation system will be designed either to maintain room inside temperature 5 deg C over outside ambient temperature or to have 15 air changes per hour in the ventilated areas, whichever is higher. However battery room, small plant rooms, and toilets will be ventilated on basis of air change only. Exhaust air qty will be 10 % less than the supply air qty at each ventilated area. Heat Load based Calculations and **Air Changes, 15 No.,** based calculations will be made for all Ventilated areas, such as Rooms, Basements, Cable cellars and Cable Tunnels **(Annexure-3).** The value whichever is HIGH will be taken to provide the Supply and Exhaust Air Fans.

5.2.2 BATTERY ROOMS: For Exhaust of stale air from Battery rooms exhaust air fans shall be provided. These fans shall be Tube Axial type in spark proof construction and shall be located in the room. These Fans shall be either Belt-driven or Bifurcated type. The exhaust air ducting for such system, if provided, along with Fan casing shall be suitably protected against acidic fumes.

5.2.3 EXHAUST FANS FOR TOILETS: For Exhaust of stale air from Toilets, Exhaust Air fan shall be provided. This fan shall be wall mounted and shall be suitably placed on the wall of the room.

5.2.4 SUPPLY AIR FAN (SAF) AND EXHAUST AIR FAN (EAF): Supply & Exhaust of air in Ventilated Areas, as per Annexure-3, of adequate Nos. and capacity shall be provided. These fans shall Supply and Exhaust out the air, with the help of supply & exhaust air ducting running through the rooms if necessary.

5.2.5 Cable tunnels will be isolated at an interval of 50 mtrs by fire resistant wall with fire check doors (not in vendor scope) . Each such segment will be ventilated buy providing one supply air station and one exhaust air station.

5.3 EQUIPMENT SPECIFICATIONS

5.3.1 DUCTS: All ducts for the ventilating systems shall be made out of galvanized sheets in accordance with IS: 655/ SMACNA. The exhaust air ducts of the battery room shall be additionally coated with acid resistant paint. The sheet thickness shall be as indicated in the following table, depending on the length of the longer side of the duct:

Upto 500 mm – 0.63 mm thickness
From 501 mm to 1000 mm – 0.8 mm thickness
From 1001 mm to 1250 mm – 1.0 mm thickness
Over 1251 mm – 1.25 mm thickness

All ducts shall be airtight with openings at suitable locations. If necessary, the rectangular elbows shall be equipped with aerodynamically formed guiding vanes. All take-off branches shall be equipped with an adjustable volume

extractor, which assists in balancing by directing a regulated amount of air for supply outlets from the main duct. All ducts shall be machine pre fabricated type with ROLAMATE flanges and shall be supported by structural angles, hanging in rods with adjustable nuts, anchored to the ceiling of walls by concrete fastener bolts or anchors. The duct supports should be zinc plated.

5.3.2 void.

5.3.3 GRILLES: The supply air grilles shall be used for correct air distribution by horizontal and vertical adjustable bars of sidewall installations. All the grilles shall be made of extruded aluminium of minimum 1.2mm thickness duly powder coated. The sizes have to correspond to the fixed noise criteria. Grilles for the battery room shall be epoxy painted.

5.3.4 void..

5.3.5 void .

5.3.6 void .

5.3.7 AIR FILTERS: The filter banks shall be composed of panels not bigger than 750 x 750 mm, which can be easily removed by hand. The filters shall be made out of the HDPE media laid in V-grooves duly supported by expanded aluminium mesh from both sides and preferably cleanable through compressed air. The Cleaning efficiency shall be 85-90% down to 10-15 microns. The frame structure of the panel cells shall be in aluminium construction.

5.3.8 void..

5.3.9 void..

5.3.10 void .

5.3.11 EXHAUST AIR AXIAL FLOW FANS: The exhaust air axial flow fans shall be of Tubular/ wall mounting design with cast alloy aluminium impeller having adjustable blades and directly driven by its electric motor. The exhaust air gravity louvers shall be of GI / Aluminium construction.

5.3.12 EXHAUST AIR CENTRIFUGAL FANS: The exhaust air centrifugal fans shall be of single inlet single width type centrifugal design having backward curved impeller suitable for V-belt drive arrangement. The casing of the fan shall be in MS duly painted with acid resistant paint.

5.3.13 void..

5.3.14 void..

5.3.15 BOLTS, NUTS AND WASHERS: All bolts, washers, screws and nuts shall be of metric thread standards and have hexagonal heads. The material shall be at least galvanized or stainless steel.

5.3.16 INSTRUMENTS: All necessary instruments and apparatus for maintenance, adjustment, control, measurements of airflow, lubrication and cleaning, are to be included in scope of supply.

5.3.17 Lighting load will be considered as 2W (Two Watts) per square foot of floor area for all the areas.

6.0 INSPECTION & TEST REQUIREMENT

6.1 Inspection will be by Third party , by ultimate purchaser and their representative along with BHEL . For this purpose a QAP will be prepared by the Vendor and shall be approved by purchaser / consultant.

6.2 Internal Manufacturer's Quality Plan (MQP) and Quality Assurance Plan (QAP) will be submitted along with the offer.

6.3 The extent and the tests to be carried-out by vendor at Manufacturer's works will be governed by IS standards and VSP- General Specifications attached with this specification.

6.4 BHEL/VSP or Their Representatives holds the right of Inspection at any stage of Manufacture process. Vendors will facilitate such inspection on demand from purchaser.

6.5 Vendors will have to give 3 (Three) weeks clear notice ahead of the date of inspection, to enable the purchaser or their representative to witness the tests.

6.6 Tests on Control Panels to be conducted.

6.6.1 RoutineTests:

Physical Inspection:

i) Check for overall and mounting dimensions, painting with respect to approved OGA Drawings.

ii) Checking with respect to general arrangement like feeder arrangement and designation, mounting of components, termination arrangement, buses, wiring and connections.

iii) Checking of mechanical interlocks like door interlock, mechanical interlocking of contactors etc.

iv) Checking of interchangeability of modules.

v) Checking of mechanical work like doors and covers, gaskets, surface finish, movement, engagement and latching of units etc.

vi) Checking of protective measures and earthing in line with relevant standards.

vii) Insulation resistance measurement and HV test in line with relevant standards.

viii) Insulation resistance measurement and HV test in line with relevant standards.

ix) Checking with respect to final schematic diagrams for technical data, ratings,

and setting of component, wiring and termination.

x) Functional test: Functions of all devices like switches, contactors, relays, push buttons and lamp etc. will be checked after energizing with simulation as per schematic drawings.

6.6.2 Type tests: The following type test certificates shall be furnished in line with relevant standards by the supplier: i) Temperature rise test. ii) Verification of short circuit strength for bus-bars. iii) Protection co-ordination test for feeders. iv) Verification of degree of protection for enclosure. For individual components and devices, supplier should furnish the relevant test certificates from sub supplier.

SECTION - VII

7.0 DRAWINGS AND DOCUMENTATION

The schedule for the submission of drawings and documents are as follows:

SL.NO	DESCRIPTION	FORM	QTY	TIME SCHEDULE	REMARKS
1	Heat Load Calculations for all Depts.,	Photocopy	1 Set	Along with Offer	For verifying the selection.
2	Manufacturer Quality Plans (MQP)	Photocopy	1 Set	Along with Offer	For evaluation
3 4	Quality Assurance Plans (QAP) Manufacturer Quality Plans (MQP)	Photocopy Signed Originals	1 Set 4 Sets	Along with Offer One week from LOI	For evaluation For Approval
5	Quality Assurance Plans (QAP)	Signed Originals	4 Sets	One week from LOI	For Approval
6	Air Flow Diagram for all systems	Original	1 Set	Along with Offer	For verifying adequacy
7	Air Flow Diagram for all systems	Photocopies	15 Sets	Within 2 weeks of placement of LOI	For Approval
8	Design Philosophy for entire VS	Signed Originals	15 Sets	Within 2 weeks of placement of LOI	For Approval
9	OGA LCB	Photocopies	15 Sets	Within 3 weeks of placement of LOI	For Approval
10	Load list & Power requirement	Photocopies	3 Sets	Within 2 weeks of placement of LOI	For Information

11	OGA of Exhaust Fans sectional view, **Plan & component layout, indicating weights, BOM, foundation plans for all** types.	Photocopies	15 Sets	Within 3 weeks of placement of LOI	For Approval

SL.NO	DESCRIPTION	FORM	QTY	TIME SCHEDULE	REMARKS
12	Catalogues for Window/ Split AC Units	Printed	1 Set	Along with Offer	For evaluation
13	Void.	Printed	15 Sets	Within 3 weeks of placement of LOI	For Approval
14	Data Sheets for items listed at Sl. No. 9 & 10	Photocopies	15 Sets	Within 3 weeks of placement of LOI	For Approval
15	Erection & commissioning plan along with Manpower planning.	Photocopies	3 Sets	Along with offer	For evaluation
16	void	Photocopies	15 Sets	Within 3 weeks of placement of LOI	For Approval
17	Schematic diagrams and P&I Diagrams	Photocopies	15 Sets	Within 3 weeks from date of PO / LOI	For Approval
18	Layout drawings, Civil Assignment Drawings for all zones of ventilated / Air conditioned areas.	White Background Prints	15 Sets	Within 3 weeks from date of PO / LOI	For Approval
19	Soft copy in electronic media (CD) of all drawings (Dwg. Format only) / documents/ design calculations as per drawing list	CD	3 sets	Within 1 (One) week after the final inspection and testing.	For Records

Notes on Drawings and Documentation

1. The drawings shall be furnished, after placement of LOI, by the supplier for our approval, as per the title block format of BHEL (TITLE FORMAT will be furnished along-with purchase order).

2. All documents to be furnished by the suppler shall be duly certified and signed by the competent authority and all revisions shall be duly recorded.
3. All drawings shall be mentioned in metric system & shall generally be of A1/A2/A3/A4 size only.
4. Title and written notation shall be in English.
5. Test certificates and documents of operation and maintenance manual shall be strictly in A4 size 297 x 210 mm only. All copies of test certificates as stipulated shall be on good quality of paper having good and legible printing. Catalogues and Mauals

6. The drawings shall be prepared in Auto CAD only (schematic diagram, wiring diagram, Bill of Material, OGA GA etc).
7. All documents shall be duly signed by competent authority of the manufacturer.

SECTION –VIII

8.0 INFORMATION REQUIRED FROM VENDORS

1. As mentioned in these specifications elsewhere, MQP and QAP will be furnished along with the offer.
2. Heat Load calculations will be furnished along with offer.
3. Air flow diagram will be furnished for each system separately along with the offer.
4. Catalogues (Printed - One of each type) shall be furnished along with the offer.
5. Bill of Material for each system of Ventilation system will be separately prepared and submitted along with the offer
6. Price format as indicated in these specifications will only be furnished along with the offer. Any additional information, which the bidder wants to furnish, can be added to the format.
7. It should be understood clearly that this offer will be on Turn-key basis and a confirmation that the offer is on Turn-key basis will be clearly brought out in the offer.

SECTION –IX

1.0 LIST OF ANNEXURES AND DOCUMENTS ATTACHED.

ANNEXURE 3 – 2 SHEETS
ANNEXURE 4 – 15 SHEETS
ANNEXURE -5 – 1 SHEETS
VSP-6.3/GS-M-04 - 14 SHEETS
VSP-6.3/GS-M-06 - 14 SHEETS
VSP-6.3/GS-P-01 - 15 SHEETS
ANNEXURE 1 TO VSP-6.3/GS-P-01- 3 SHEETS
ANNEXURE 2 TO VSP-6.3/GS-P-01- 1 SHEETS
ANNEXURE 3 TO VSP-6.3/GS-P-01- 8 SHEETS
ANNEXURE 4 TO VSP-6.3/GS-P-01- 2 SHEETS
ANNEXURE 5 TO VSP-6.3/GS-P-01- 6 SHEETS

VSP-6.3/GS-M-01 - 34 SHEETS
ANNEXURE 1 TO VSP-6.3/GS-M-01- 5 SHEETS

ANNEXURE 13 TO VSP-6.3/GS-M-01- 2 SHEETS

ANNEXURE 27 TO VSP-6.3/GS-M-01- 6 SHEETS
ANNEXURE 29 TO VSP-6.3/GS-M-01- 5 SHEETS

SECTION –X

PRICE FORMAT

Sl. No.	System / Equipment	Unit Rating	Unit Price	Total price	Remarks
1	**Ventilation System**				
2	**ETC Ventilation System**				

VENTILATION SYSTEM (15 Air-Changes or Heat Load whichever is HIGHER)						
Sl. No.	Department Name	Drawing No.	Heat Load		Remarks	Type of Ventilation System envisaged
			Equipment (KW)	People (Nos.)		
1	2	3	4	5	6	7
A	**CONVERTER CONTROL BLDG.**					
	AT EL. 11.0M	IS-1-EE-601-524-E004 Rev.07				
1	Tea Room at 'N' wall		2.00	2		Exhaust Air Ventilation System
3	Gents Toilet 'N' wall		2.00	2		
4	Ladies Toilet 'N' wall		0.50	2		
5	Gents Toilet 'S' wall		0.50	2		
6	Ladies Toilet 'S' wall		0.50	2		
	AT EL.7.5M					
1	Cable Floor		40.00			Fresh Filtered Air Supply and Exhaust Air system
2	Tea Room		2.00	2		Exhaust Air Ventilation System
3	Gents Toilet		0.50	2		
4	Ladies Toilet		0.50	2		
	EL. 00M					
1	Transformer Rooms		14.00			Exhaust Air Ventilation System
	AT EL. - 4.0M					
1	Basement		15.00			Fresh Filtered Air Supply and Exhaust Air system
B	**ECR-1 Bldg**					
	AT EL. 9M	IS-1-EE-601-524-E001 Rev.04				
1	Battery Room		4.00			
2	Ventilation Room		1.00			
3	Store Room		0.50	3		Fresh Filtered Air Supply and Exhaust Air system
4	Pantry 'S' wall		2.00	2		Exhaust Air Ventilation System
5	Toilet 'S' wall		0.50	2		
6	Pantry 'N' wall		2.00	2		
7	Toilet 'N' wall		0.50	2		
	AT EL. 5.5M					
1	Cable Floor		30.00			Fresh Filtered Air Supply and Exhaust Air system
	AT EL. 00M					
1	Ventilation Room		1.00			
2	Transformer Rooms 12.5MVA		30.00			
3	Transformer Rooms 3MVA		14.00			
4	Store Room (General)		5.00	3		Fresh Filtered Air Supply and Exhaust Air system
5	Store Room for Breakers under Maintainance		5.00	3		Fresh Filtered Air Supply and Exhaust Air system
6	DG Room		15.00			Fresh Filtered Air Supply and Exhaust Air system
	AT EL. - 4M					
1	Basement		40.00			Fresh Filtered Air Supply and Exhaust Air system
C	**ECR - 2 Bldg**					
	AT EL. 0.0M	IS-1-EE-601-524-E002 Rev.01				
1	Ventilation Room		1.00			
2	Store room		2.00	3		Fresh Filtered Air Supply and Exhaust Air system
3	Transformer Rooms		10.00			
	AT EL. - 4M					
1	Basement		30.00			Fresh Filtered Air Supply and Exhaust Air system
D	**ECR -3 Bldg**					
	AT EL. 9M	IS-1-EE-601-524-E003 Rev.05				
1	Battery Room		4.00			Exhaust Air Ventilation System
2	Ventilation Room		1.00			
3	Toilet (Ladies)		0.50	2		
4	Toilet (Gents)		0.50	2		
5	Tea Room		2.00	2		
	AT EL. 5.5M					
1	Cable Floor		20.00			Fresh Filtered Air Supply and Exhaust Air system
	AT EL. 0.0M					
1	Store room		2.00	3		Fresh Filtered Air Supply and Exhaust Air system
2	ventilation Room		1.00			
3	Transformer Room		10.00			Exhaust Air Ventilation System
	AT EL. -4M					
1	Basement		30.00			Fresh Filtered Air Supply and Exhaust Air system

E	**GRP Electric Bldg**					
	AT EL. 00M	IS-1-EE-601-524-E011Rev. 04				
1	Ventilation Room		1.00			
2	Toilet		0.50	2		Exhaust Air Ventilation System
3	Transformer Room		10.00			
	AT EL. -4M					
1	Basement		30.00			Fresh Filtered Air Supply and Exhaust Air system
F	**SECS Elec. Bldg**					
	AT EL. 00M	IS-1-EE-601-524-E012 Rev. 03				
1	Ventilation Room		1.00			
2	Toilet		0.50	2		Exhaust Air Ventilation System
	AT EL. -4M					
1	Basement		30.00			Fresh Filtered Air Supply and Exhaust Air system
G	**Control Pulpits**					
1	Converter Tapping Control Pulpit Converter-1	IS-2-EE-601-524-E024 Rev. 04	2.50	2		Man-Cooler Only
2	Converter Slagging Control Pulpit Converter-1	IS-2-EE-601-524-E025 Rev. 04	2.50	2		
3	Converter Tapping Control Pulpit Converter-2	IS-2-EE-601-524-E026 Rev. 04	2.50	2		
4	Converter Slagging Control Pulpit Converter-2	IS-2-EE-601-524-E027 Rev. 04	2.50	2		
5	Steel Transfer Car Control Pulpit Converter-1	IS-3-EE-601-524-E028 Rev. 04	2.00	2		
6	Steel Transfer Car Control Pulpit Converter-2	IS-3-EE-601-524-E029 Rev. 04	2.00	2		
7	Slag Transfer Car Control Pulpit Converter-1	IS-3-EE-601-524-E030 Rev. 04	2.00	2		
8	Slag Transfer Car Control Pulpit Converter-2	IS-3-EE-601-524-E031 Rev. 03	2.00	2		
9	Platform Transfer Car Control Pulpit	IS-3-EE-601-524-E032 Rev. 03	2.00	2		
10	Hot Metal Slag Pot Transfer Car Control Pulpit	IS-3-EE-601-524-E033 Rev. 03	2.00	2		
11	Transmitter Room in Valve House for Converter-1	IS-3-EE-601-524-E034 Rev. 03	2.50	2		Fresh Filtered Air Supply and Exhaust Air system
12	Transmitter Room in Valve House for Converter-2	IS-3-EE-601-524-E035 Rev. 03	2.50	2		Fresh Filtered Air Supply and Exhaust Air system
13	Hydraulic Room for Skirt Lifting Converter-1	IS-3-EE-601-524-E040 Rev. 02	2.50	2		Fresh Filtered Air Supply and Exhaust Air system
14	Hydraulic Room for Skirt Lifting Converter-2	IS-3-EE-601-524-E041 Rev. 02	2.50	2		Fresh Filtered Air Supply and Exhaust Air system
15	Laddle Tilter	IS-3-EE-601-524-E042 Rev. 01	...	1		Man-Cooler Only
16	Control Pulpit - Hot Metal Area (No.1)		2.00	1		
17	Control Pulpit - Hot Metal Area (No.1)		2.00	1		
H	**CABLE TUNNELS**					
1	Cable Tunnel A (Part - 1of 2)	IS-0-LO-601-524-E901 Rev.08(4Shts.)	40.00			Fresh Filtered Air Supply and Exhaust Air system
2	Cable Tunnel A (Part - 2 of 2)		30.00			
3	Cable Tunnel B1 (Part 1 of 3)		40.00			
4	Cable Tunnel B1 (Part 2 of 3)		40.00			
5	Cable Tunnel B1 (Part 3 of 3)		40.00			
6	Cable Tunnel B2 (Part 1 of 3)		40.00			
7	Cable Tunnel B2 (Part 2 of 3)		40.00			
8	Cable Tunnel B2 (Part 3 of 3)		40.00			
9	Cable Tunnel C1 (Part - 1of 2)		30.00			
10	Cable Tunnel C1 (Part - 2 of 2)		30.00			
11	Cable Tunnel C (Part - 1of 2)		30.00			
12	Cable Tunnel C (Part - 2 of 2)		30.00			
13	Cable Tunnel D		40.00			Fresh Filtered Air Supply with Natural Exhaust
14	Cable Tunnel E		40.00			
15	Cable Tunnel F		40.00			
16	Cable Tunnel F1 (Part - 1of 2)		30.00			Fresh Filtered Air Supply and Exhaust Air system
17	Cable Tunnel F1 (Part - 2 of 2)		40.00			
18	Cable Tunnel H		40.00			
19	Cable Tunnel A1 (Part - 1 of 3)		50.00			
20	Cable Tunnel A1 (Part - 2 of 3)		50.00			
21	Cable Tunnel Q		40.00			
	GCP PUMP-HOUSE		60.00	4		Fresh Filtered Air Supply and Exhaust Air system
	WET ESP TRAFO ROOMS		6.00	0	Three Rooms	Fresh Filtered Air Supply and Exhaust Air system

APPROVED VENDORS

Annexure 4

Sl. No.	Component	Make
	Papers etc.	HYDRABAD INDUSTRIES, MEGHA INSULA-TION
HANDLING EQUIPMENT		
1	Elevator	OTIS / THYSSEN KRUPP ECE ELEVATOR/ KONE/ IBIJI
2	Tanker	NMF/ TPS
UTILITY SYSTEM		
A.	**AIR CONDITIONING & VENTILATION SYSTEMS**	
	CHILLER UNITS	BLUE STAR/CARRIER/DUNHAM BUSH/ VOLTAS/YORK/TRANE/KIRLOSKAR/ HITACHI
	AIR HANDLING UNITS	BLUE STAR/CARRIER/EMERSON/ VOLTAS
	PACKAGE AIR CONDITIONERS	BLUE STAR/CARRIER/EMERSON VOLTAS
	SPLIT AIR CONDITIONERS	BLUE STAR/CARRIER/EMERSON VOLTAS/HITACHI
	WINDOW AIR CONDITIONERS	BLUE STAR/CARRIER/VOLTAS/HITACHI
	PACKAGE TYPE FRP COOLING TOWERS	DBR/HAMMON/PAHARPUR/SREERAM/THERMOPAK
	VENTILATION SYSTEMS	C.DOCTOR/DUSTVEN/NADI/S.K SYSTEM/ VOLTAS/ABB
	CENTRIFUGAL/AXIAL FLOW FAN FOR VENTILATION SYSTEM	C. DOCTOR/DUSTVEN/NADI/FLAKT/ S.K.SYSTEM
	INSULATION	BEARDSHELL/FGP/LLOYD/UP TWIGA
	AIR FILTER	C.DOCTOR/DYNA/FMI/S.K SYSTEMS
	GI SHEETS	JINDAL/SAIL/TATA/ISPAT/BHUSAN
	ALUMINIUM SHEETS	BALCO/HINDALCO/INDAL
B.	**AIR POLLUTION CONTROL SYSTEM**	ALSTOM/ACC/THERMAX/RIECO/BHEL
	BAG FILTER	THERMAX/RIECO/ALSTOM PROJECTS INDIA LTD/ACC/ANFREW YULE
	ESP	THERMAX/BHEL/ACC/ALSTOM POWER
	FAN	FLAKT WOODS / TLT/C.DOCTOR/ANDREW YULE/BHEL/NADI AIRTECHNICS/ARF/ DUSTVEN/RITZ/ACCO/BATLIBOI
	CHAIN CONVEYOR	DEMECH/MECP
	EXPANSION JOINTS	KELD/GBM
	DAMPER	FOURESS/BACHMAN/TSC

Sl. No.	Component	Make
C.	**PIPING SYSTEM**	
	PIPES	TATA/BST/JINDAL/THE INDIAN SEAMLESS AND METAL TUBES/ MAHARASHTRA SEAMLESS LTD/SAIL, ROURKELA/ KALYANI SEAMLESS
	PIPE FITTINGS	N.L. HAZRA/SHYAM ENGG/LIFE STYLE MARKETING/M.S. FITTINGS/ TEEKAY TUBE/ CHARGESON/VIVIAL FORGE PVT. LTD./TRUE FORGE/TUBE BEND
	TRAPS & STAINERS	UNI KLINGER/ESCO/FORBES MARSHAL
	EXPANSION JOINTS (METTALIC & NON-METALLIC)	ZAVERCHAND/ANUP ENGG./METTALIC BELLOW/SYSTEC FLEXO/SUR INDUSTRIES/IWKA
	GAS TIGHT ISOLATOR	FOURESS/L&T
D.	**VALVES**	
	GATE, GLOBE & CHECK VALVES:	
	CAST IRON	GM DALUI & SONS/ LEADER VALVES/LEVCON VALVES/NECCO SCHUBERIL & SALZER LTD /UPADHYAYA VALVES/ H.SARKAR & CO./AV VALVES/IVC/SHIVA DURGA/VALTECH INDUSTRIES/FLUID LINE VALVES/HAWA ENGINEERING
	CAST CARBON STEEL	FISHER XOMER SANMAR/NECO SCHUBERT & SALZER/ LEADER VALVES/KSB PUMP/FOURESS/ BDK/AUDCO/ VALTECH INDUSTRIES/ HAWA ENGINEERING/AV VALVES/OSWAL INDUSTRIES
	FORGED STEEL	AUDCO/BDK/FOURESS/LEADER/ NECO SCHUBERT/FISHER-XOMOX/AV VALVES/ VALTECH INDUSTRIES/ HAWA ENGINEERING/OSWAL INDUSTRIES
	BALL VALVES :	
	CAST IRON	AUDCO/BDK/FOURESS/REYNOLDS/ VALTECH INDUSTRIES
	CAST CARBON STEEL	AUDCO/BDK/FOURESS/VIRGO/ FISHER-XOMOX SANMAR/OSWAL INDUSTRIES/REYNOLDS/ VALTECH INDUSTRIES/LEADER
	FORGED STEEL	AUDCO/BDK/FOURESS/VIRGO/ OSWAL INDUSTRIES/REYNOLDS/ VALTECH INDUSTRIES/LEADER
	BUTTERFLY VALVES:	
	Cast Iron	AUDCO/BDK/FOURESS/INTER VALVE (INDIA) KSB PUMPS/SHIVA DURGA/ UPADHAYA VALVES/HI-TECH BUTTERFLY VALVES
	CAST CARBON STEEL	AUDCO/BDK/FOURESS ENGG(INDIA)/ INTERVALVE/HI-TECH BUTTERFLY VALVES

Sl. No.		Component	Make
		FORGED STEEL	AUDCO/BDK/FOURESS ENGG(INDIA)/ INTERVALVE/HI-TECH BUTTERFLY VALVES
		PLUG VALVES :	
		CAST IRON	AUDCO/FISHER-XOMOX SANMAR
		CARBON STEEL	AUDCO/FISHER-XOMOX SANMAR
		FORGED STEEL	AUDCO/FISHER-XOMOX SANMAR
		GOGGLE VALVE	AUDCO LTD/FOURESS ENGG (INDIA)
		PRESSURE REDUCING VALVES :	JNM/FISCHER XOMOX/ILP
		CONTROL VALVES :	JNM/FISCHER XOMOX/FISHER ROSEMOUNT/METSO/R.K.CONTROL/ TOSHNIWAL/ILP
		PRESSURE RELEASE VALVES :	JNM/ FISCHER XOMOX/ AUDCO CROSBY
		NEEDLE VALVES :	FISCHER XOMOX/TUFLIN/AUDCO/BDK
		FLOAT VALVES :	LEVCON/LEADER/SHIVA DURGA/UPADHYAY/IVI/IVC/H.SARKAR/G.M.DALUI
		AIR RELEASE VALVES:	LEVCON/LEADER/SHIVA DURGA/UPADHYAY/IVI/IVC/H.SARKAR/G.M.DALUI
		SPRING SUPPORTS	SUPPORTS SYSTEM/TECHNO INDUSTRIES
		VALVE ACTUATORS	AUMA/LIMITORQUE/ROTORK CONTROLS/EL-O-MATIC
		AIR COMPRESSOR	ATLAS COPCO/IR/ELGI/KIRLOSKER PNEUMATICS
		AIR DRYER	DELAIR/INDCON/ATLAS COPCO/PACE
		INSULATION	LLOYDS INSULATION/ROCKWOOL INDIA/JAYASHREE INSULATORS/FGP LIMITED/U.P.TWIGA FIBREGLASS LTD.
E.		**HYDRAULIC SYSTEM**	
		HYDRAULIC SYSTEM	REXROTH/VICKERS/PARKER/YUKEN (JAPAN)
		PUMPS (MAIN PUMPS)	REXROTH/VICKERS/PARKER/KAWASKI
		CIRCULATION PUMPS:	
	a)	SCREW PUMPS	ALWEILER/IMO
	b)	GEAR PUMPS	REXROTH/PARKER/RICKMEIER
		COMPENSATOR IN SUCTION LINE	REXROTH/PARKER/VICKERS/YUKEN (JAPAN)
		VARIOUS TYPES OF HYDRAULIC VALVES	REXROTH/VICKERS/PARKER/YUKEN (JAPAN)
		FILTERS	HYDAC/PALL/EPE-EPPEN-STEINER GMBH/PARKER/INTER NORMEN

Sl. No.	Component	Make
	HEAT EXCHANGER (PLATE TYPE), GASKETTED DESIGN	ALFA LAVAL/INDSWEP/G.E.A
	ACCUMULATORS	HYDAC/REXROTH/EPE-EPPEN-STEINER GMBH/PARKER
	COUPLING	LOVE JOY/ROTEX
	PRESSURE SWITCH	REXROTH/DANFOSS/SWITZER/ VICKERS/PARKER/HYDAC
	SHUT-OFF VALVE (BALL TYPE)	FLUTEC/AUDCO/PARKER/LEGRIS/ HYDAC
	SHUT-OFF VALVE (BUTTERFLY TYPE)	AUDCO/KEYSTONE
	MINIMESS COUPLING	STAUFF/HYDROTECNIK
	HYDRAULIC MOTORS	DANFOSS/STAFFA/VOLVO
	PROPORTIONAL VALVES	REXROTH/VICKERS/PARKER/MOOG
	SERVO VALVES	MOOG/REXROTH
	WELD-ON TYPE PIPE FITTINGS	HYLOC/PARKER/AVIT
	PIPE	GANDHI SPECIAL/INDIAN SEAMLESS/CHOWKSI TUBES/HEAVY METAL AND TUBES /AVIT
	PRESSURE INDICATOR	WIKA/STAUFF/SWITZER
	TEMPERATURE INDICATOR	SWITZER/WIKA/STAUFFF
	THERMOSTAT	INDFOSS/SWITZER/VARMA-TRAFAG
	LEVEL INDICATOR	REXROTH/LEVCON/STAUFF/ VICKERS/ DR. TIEFENBACH/TECHTROL
	LEVEL SWITCH	LEVCON/ STAUFF/SRIDHAN/DR. TIEFENBACH
	HYDRAULIC CYLINDER	HUNGER/REXROTH/PARKER/WIPRO
	SAE FLANGES	AVIT/PARKER/HYLOC
	BUTT/SOCKET WELD FITTINGS	AVIT/PARKER/HYLOC
	AIR BREATHER (WITH SILICA GEL)	HYDAC/STAUFF/PALL
	PIPE CLAMP	STAUFF/HYLOC/HYDAIR
	FLEXIBLE HOSE	A) HOSE FROM : GATES / AEROQUIP/MARRWEL B) HOSE ASSEMBLY BY: GATES/HYDROKRIMP A.C/INSAP/PARKER/K.B. ENGINEERS
	CENTRIFUGE	ALFA LAVAL
	MOBILE MOTORISED PUMP-MOTOR-FILTER UNIT FOR OIL FILLING	HYDAC/PALL/INTERNORMEN/PARKER

Sl. No.	Component	Make
	GAS HOLDER	CLAYTON WALKER/SMS DEMAG
	PRESSURE VESSELS	BHARAT HEAVY PLATES & VESSELS/ISGEC/ASSOCIATED PLATES & VESSELS/DECTEL/LLOYDS STEEL/L & T/BOC
	FLARE STACK	AIROIL FLAREGAS/COMBUSTION CONTROL/JOHN ZINK/ADOR WELDING LTD.
	ELECTRICAL HEAT TRACING	ADOR COOPERHEAT/RAYCHEM/THERMOGUARD/ INDCON PROJECTS & EQUIPMENT/UNITECH SYSTEMS
H.	**FIRE PROTECTION SYSTEM**	
	DETECTOR (INTELLIGENT & ADDRESSABLE)	NOTIFIER/EDWARD/CERBERUS AND UL/FM/LPC/APPROVED
	ALL MODULES (INTELLIGENT & ADDRESSABLE)	NOTIFIER/EDWARD/CERBERUS AND UL/FM/LPC/APPROVED
	FIRE ALARM PANEL (INTELLIGENT & ADDRESSABLE)	NOTIFIER/EDWARD/CERBERUS AND UL/FM/LPC/APPROVED
	REPEATER PANELS (INTELLIGENT & ADDRESSABLE)	NOTIFIER/EDWARD/CERBERUS AND UL/FM/LPC/APPROVED
	CABLES	UNIVERSAL/FORT/GLOSTER/INCAB/ INDUSTRIAL/FINOLEX/NICCO
	BATTERY	AMCO/STANDARD/EXIDE
	MANUAL CALL POINTS (INTELLIGENT & ADDRESSABLE)	UL/FM/LPC AND TAC APPROVED
	ELECTRONIC HOOTER (ADDRESSABLE)	UL/FM/LPC AND TAC APPROVED
WATER SYSTEM		
A.	**PUMPSETS**	
1	Horizontal Centrifugal	KSB / KBL / M&P
2	Vertical centrifugal	KBL / KSB/ SU MOTORS/ GRUNDFOSS
3	Vertical turbine	KBL/WPIL/JYOTI/M&P
4	Submersible (Borewell)	KSB/ GRUNDFOSS/ CALAMA/CRI
5	Submersible drainage/sewage	KSB/ GRUNDFOSS/ SU/ WASP/KISHOR/MBLI
6	Slurry/Sludge	WARMAN/ DENVER/ HDO/ AKAY/ BDK/ SAM TURBO
7	Sewage	KBL/ M&P/KISHOR/MBH/KSB/ SAM TURBO
8	Chemical (centrifugal)	AKAY/ KHIMLINE/ KSB/ KBL/ PROCESS PUMPS/ANTICO/ SAM TURBO

Sl. No.	Component		Make
12	11 kV and 6.6 kV HVLC Power Transformers (Oil-filled) & Earthing Transformers	-	BHEL / BB / CGL / AREVA / VOLTAMP / EMCO/ TELK /KIRLOSKAR(KEC)/ ABB/
13	11kV & 6.6kV LCSS power transformers (Oil-filled)	-	BB / CGL / AREVA / VOLTAMP / EMCO / KEC / TRANSFORMERS & RECTIFIERS
14	11kV & 6.6kV Cast Resin type power transformers	-	INDCOIL/ ABB / VOLTAMP / BHEL / HOLEC/ KIRLOSKAR (KEC)
15	11 kV & 6.6 kV Dry type power transformers	-	KIRLOSKAR(KEC)/ABB/BHEL/VOLTAMP/BB/CGL/ INDCOIL/AIMES IMPLEX
16	Winding and Oil Temperature Indicator	-	SKII / PRECI MEASURE / PRECISION INSTRUMENT /PERFECT CONTROL / OSMADIAL
17	Control and Relay Panel	-	AREVA / ABB / SIEMENS (All work in own works)/ ENPRO (for 33kV & below)
18	Magnetic Oil Level Indicator	-	SUKRUT
19	Buchholz Relay	-	PRAYOG / ATVUS
20	Battery (Lead Acid)	-	CHLORIDE (EXIDE) /AMCO / STANDARD /HBL-NIFE (SABNIFE)/ AMAR RAJA
21	Battery Charger	-	HBL-NIFE(SABNIFE)/ CHHABI ELECTRICALS/ DEBIKAY/ CALDYNE / AMAR RAJA/ HCE
22	Power Socket outlets	-	BCH / A BOND STRAND / INDO ASIAN
C.	**MEDIUM VOLTAGE SWITCHGEAR AND CONTROL GEAR**		
1	L.T. Air Circuit Breaker Distribution Board, fully drawout, single front (including circuit breaker), for main substation (process)	-	GE-POWER / L&T / SIEMENS / ABB / BCH / SCHNEIDER /COSMIC POWER SYSTEM / CONTROL & SWITCHGEAR (All work in own works)
2	L.T. Busduct	-	STARDRIVE/ ECC/C&S/PCE/HCE/ BRIGHT ENGINEERS/UNITED ELECTRIC/ Cosmic Power System / MK Engineers / Power Media
3	415 V Air Circuit Breaker	-	SIEMENS / GE-POWER / L&T / ABB / SCHNEIDER
4	Moulded Case Circuir Breaker (MCCB)	-	SIEMENS / GE-POWER / L&T / ABB / SCHNEIDER / BCH/ANDERW YULE
5	LT Switch board (semi drawout) for auxiliaries & Non process units	-	SIEMENS / BCH / L&T / GE-POWER / SCHNEIDER / ABB /COSMIC POWER SYSTEM / SEN&SINGH / ECC/ HCE/ Vijoy Switchgear Controls/ MK Engineers/ ELECMECH /Power Media, Hydrabad/ Industrial Switchgear Ltd, Mumbai/ Control & Switchgear (C&S)
6	415V Motor Control Centre for process units	-	SIEMENS / GE-POWER / L&T / ABB / SCHNEIDER (All work in own works)

Sl. No.	Component		Make
7	415V Motor Control Centre for non-process units / Power Distribution Boards(Single front) / Outdoor Distribution Boards	-	SIEMENS / BCH / GE-POWER / L&T / C&S / ECC/ SWITCHING CIRCUIT/ HCE / TECHNOCRATS/ TECHNO COMMERCE / SEN & SINGH / MK Engineers/ POWER & PROTECTION / Cosmic Power System/ Power Media / Switchgear Controls / SCHNEIDER / INDPOWER, Vizag/Industrial Switchgear Ltd, Mumbai
8	Power Distribution Boards (single front below 630A), Outdoor distribution boards (below 630A) and Lighting Distribution Boards	-	SIEMENS / BCH / GE-POWER / L&T / CGL / C&S / SWITCHING CIRCUIT / HCE / TECHNO COMMERCE/ SEN & SINGH / ECC / IND POWER / MK Engineers / 'TECHNOCRATS / POWER & PROTECTION / Cosmic Power System/Power Media/ Vijay Switchgear Controls/ SCHNEIDER/ SONTOSH ENGG WORKS, VIZAG
9	MPCB	-	SIEMENS/GE-POWER/L&T/ABB/SCHNEIDER/INDO ASIAN
D.	**MOTORS**		
1	HT AC Motor (1000 kW and above)	-	KEC /BHEL / CGL / AREVA
2	HT AC Motor (200 kW - 1000 kW)	-	SIEMENS / CGL / KEC / BHEL / AREVA
3	Synchronous & Sq. Cage Motors above 3000 kW	-	BHEL / SIEMENS / ABB
4	LT AC Sq-cage induction Motor (General purpose)	-	SIEMENS / CGL / ABB / AREVA /BB / ELGI / WEG / BHEL /KIRLOSKAR / Westing House / HINDUSTAN ELECTRIC MOTORS
5	LT AC Motor (Flame proof)	-	KIRLOKAR (KEC) / CGL / SIEMENS / BBL / AREVA
6	L.T. Geared Motor	-	KIRLOSKAR (KEC)/POWER BUILD/IC/BHARAT BIJLEE / SEW/FIMET
7	DC Mill Motor (Main Drive)	-	KRILOSKAR (KEC) / BHEL
8	DC Mill Motor (Auxiliary Drive) (AISE Type)	-	KIRLOSKAR (KEC) / BHEL
9	DC Motors (Industrial type)	-	CGL / AREVA / KIRLOSKAR (KEC) / BHEL
10	Roller Table Motors (AC)	-	BHARAT BIJLEE/ KIRLOSKAR(KEC)/ CGL/ AREVA/ BHEL / IC/ ABB/ SIEMENS
11	AC Drives, VVVF drive for non process units & auxiliary motors	-	SIEMENS/ ABB / L&T(Yasakawa)/ Control Technique/ SCHNEIDER/ TB Woods/ Rockwell/ AREVA/ EUROTHERM
12	DC Drives	-	SIEMENS / ABB / L&T / Control Technique / ANSALDO SCHNEIDER / AREVA / ROCKWELL AUTOMATION
13	VVVF Motors(AC) for process units	-	ABB / SIEMENS / HITACHI/AREVA/CGL/KEC/BBL

Sl. No.	Component		Make
E.	**DRIVES AND CONTROL EQUIPMENT**		
1	Converter duty cast resin transformer (6.6 kV)	-	BHEL / AREVA / ABB / HOLEC / KEC / VOLTAMP / BB/ INDCOIL / JYOTI / CGL
2	Thyristor Converter Unit	-	BHEL / SIEMENS / ROCKWELL/ AREVA/ ABB/SCHNEIDER
3	VVVF drive, AC drive for process units & mills	-	BHEL / SIEMENS / ABB / ROCKWELL / AREVA / L&T / SCHNEIDER
4	VVVF Drive (Flux Vector Control) - 2 level & 3 level Controller	-	ABB / SIEMENS / AREVA / HITACHI / ROCKWELL
5	UPS	-	KELTRON / GUJRAT HI-REL / SIEMENS / EMERSON / GE / DB POWER CONTROLS / IL Kota
6	Isolator	-	SIEMENS / L&T / AREVA / C&S / ABB / BCH
7	HRC Fuses	-	SIEMENS / AREVA / STANDARD (INDO ASIAN) / ABB / GE POWER / ESWARAN
8	AC Power Contactor	-	SIEMENS / L&T / BCH / ABB / SCHNEIDER / GE-POWER
9	DC Power Contactor	-	BCH / BHEL / SIEMENS / L&T / ABB
10	Bimetallic Relay	-	SIEMENS / L&T / BCH / GE
11	Single Phase Preventer	-	L&T/ MINILEC / SIEMENS / GE
12	Resistor boxes	-	SIEMENS/BCH/RSI/PEFCO/ELECTROMAG / Resistors India/ RESITECH /NARKHADE / KAKKU / Industries Syndicate
13	L.T. Capacitor	-	UNISTAR / CGL / AREVA / DANDAPANI
14	Semiconductor Fuse	-	ALSTOM / SIEMENS / FERRAZ / COOPER BUSSMAN /ABB
15	Thyristor	-	SIEMENS/ BHEL/ HIND RECTIFIER / ABB
16	LT Vacuum Contactor	-	GE / SCHNEIDER / L&T / SIEMENS / ABB
17	Soft-starter (LT)	-	ABB/ ROCKWELL/ SIEMENS/ AREVA/ SCHNEIDER/ LG/ BCH
F.	**CONTROL DESKS AND CONTROL DEVICES**		
1	Control Desk/ Control Panel/ Control Station	-	SIEMENS / L&T / BCH / BHEL/ C&S / TECHNOCRAT / B&C / MEDITRON /ELECTRO FABRIC / HCE /SEN & SINGH TECHNO COMMERCE /SWITCHING CIRCUIT / ECC / POWER & PROTECTION / Vijay Switchgear / Cosmic Power System

Sl. No.	Component		Make
2	Control Switch	-	SIEMENS / KAYCEE / AREVA / L&T / VAISHNO / C&S
3	Push Button	-	SIEMENS / BCH / L&T / VAISHNO / C&S / SCHNEIDER / TECHNIC / KAYCEE
4	Limit Switch	-	AG SYSTEMS/JAY BALAJI/TECHNOCRATS/ ELECTROMAG/ JSI/ TECHNIC (SIEMENS / BCH may be considered only for light duty)
5	Change Over Switch/Selector Switch	-	C&S / STANDARD / HHE /KAYCEE / SIEMENS/ BCH/L&T/ INDOASIAN
6	Discrepancy Control Switch	-	ABB / AG SYSTEMS
7	Timer/Time Delay Relay	-	BCH / L&T / SIEMENS / ABB / CGL
8	Emergency Switch/Belt Sway Switch/Pull Cord Switch/ Belt Slip Switch	-	JSI / AG SYSTEMS / PB / JAI BALAJI
9	Semaphore Indicator	-	ALSTOM / SIEMENS
10	Auxiliary Relay/ Control Contactor	-	SIEMENS / L&T / BCH / C&S (TM) / ABB / GE POWER /SCHNEIDER / ROCKWELL
11	Master Controller	-	SIEMENS / STROMKRAFT / ELECTROMAG AG Magnetics / Perfect Electrics/ KAKKU (EPC)
12	Control Transformer	-	INDCOIL / SIEMENS / AEP / INDUSREE / KAPPA
13	Voltage/Power/Current/Frequency/Energy Transducers	-	ABB / AEP / SIEMENS / AREVA / ELSTER/ ADEPT
14	Indicating Lamp (Cluster LED type)	-	SIEMENS / VAISHNO / TECHNIK / BINAY/ J-AUER
15	Temperature Scanner	-	JYOTI /APLAB / SYSTECH / MASIBUS
16	Photo-cell transducer	-	SYSTECH / TSC
17	Hooter/Buzzer/Bell	-	GETCO / KHERAJ / EDISON / KAKKU
18	Solid State Annunciator	-	APLAB / L&T / PROCON / CONTROL AND DYNAMICS / MINILEC / ELECMECH
19	Proximity Limit Switches (Non-contact type)	-	JSI / AG SYSTEMS / ROCKWELL / TELEMECHANIQUE
20	Zero Speed Switches	-	JAYSHREE / TELEMECHANIQUE / AG MECHANICAL / KAKKU / TECHNOCRATS
21	Current Transformer	-	AEP / KAPPA / INDCOIL
22	Voltage Transformer	-	AEP / KAPPA / INDCOIL
23	Tachos/Encoders	-	AREVA / HUBNER / IFM / VURLEY-TELEDYNE / Leine & Linde
24	Hot Metal Detector (HMD)	-	DELTA / DANIELI
25	Loop Scanner	-	DELTA / DANIELI
G.	**PROTECTION RELAYS**		

Sl. No.		Component		Make
1	a)	Electronic Motor Protection Relays	-	GE POWER / SCHNEIDER / L&T / SIEMENS / ABB / C&S / Sprecher & Schuh/ SANWA
	b)	Microprocessor based Motor Protection Relays for LT Motors	-	SIEMENS / L&T / AREVA / Sprecher & Schuh
	c)	Microprocessor based Protection Relays for HT Motors	-	L&T (MM 30) / ABB (SPAM 150) / Areva (motpro/micom) /SIEMENS (7SJ)
2		Auxiliary Relays	-	AREVA / EASUN / ABB / L&T / SCHNEIDER / SIEMENS /BCH / ROCKWELL / GE
3		Numerical Protection Relays (for HT system)	-	ABB / SIEMENS / AREVA / GE(Multilin) / L&T
4		Numerical Protection Relays (for LT system)	-	ABB/SIEMENS/AREVA/GE(Multilin)/SCHNEIDER/L&T(MM30) / ASHIDA
H.		**ELECTRICAL MEASURING AND TESTING EQUIPMENT**		
(i)		**ELECTRICAL MEASURING INSTRUMENTS**		
1		Ammeter/Voltmeter/Wattmeter/Var-meter	-	AEP / IMP / MECO
2		Watt-hour meter	-	ALSTOM / BHEL / IMP / MECO / HPL
3		PF meter	-	AEP / IMP / MECO
4		Frequency meter	-	AEP / IMP
5		Multimeter	-	MECO / MOTWANE / RUTTONSHAW
6		Low resistance ohm-meter and kelvin double bridge	-	MOTWANE / AGRONIC / TOSHNIWAL
7.		Electronic energy meter	-	CONZERV (ENERCON) / SEMS / SATEC / PML / L&T /HOTLINE / IMP / MOTWANE / HPL
(ii)		**SPECIAL INSTRUMENTS**		
1		Microprocessor based digital power meter	-	AEP/MECO/ALACRITY/DIGI
2		Maximum demand meter	-	AEP / MECO
3		True RMS' digital panel ammeter/voltmeter	-	AEP/MECO/ALACRITY
4		Intelligent P.F. regulator	-	AEP/MECO/ALACRITY
5		Transducer operated metering system	-	AEP / MECO
I.		**LIGHTING AND POWER WIRING EQUIPMENT AND ACCESSORIES**		
1		Lighting Fitting (SV/MV/MH/FLUROESCENT/CFL)	-	PHILIPS / GE / BAJAJ / CGL / FLOROCRAFT/ WIPRO

Sl. No.	Component		Make
2	Flameproof Lighting Fittings and Accessories	-	BAJAJ / BALIGA / CGL / SUDHIR / FCG / CEAG/ PROMT/ GOVAN
3	a) 240 V Switch Socket Outlet (10A & 20A)	-	HANSEL / HAVELL'S / BCH / ABB / LEGRAND/ SUDHIR/ INDO ASIAN
	b) 415 V Switch Socket Outlet (30A, 63A & 100A)	-	BCH / ABB / HANSEL /LEGRAND/INDO ASIAN
4	Flame-proof Equipment	-	BALIGA / FLAME PROOF EQPT. MFG. CO./ SUDHIR/ FCG/PROMPT/GOVAN/CEAG
5	MCB	-	MDS / STANDARD / CGL / SIEMENS / GE / HPL / HAVELL'S / MERLIN GERIN / GUTS / INDO ASIAN
6	ELCB	-	MDS / SIEMENS / GE / MARLINGERIN / HAVELL'S / HPL/ HAGER / GUTS/ INDOASIAN
7	MCB DB	-	MDS / HAVELL'S / MERLIN GERIN / SIEMENS / GE / HPL/ GUTS / INDOASIAN
8	Single-core flexible copper wire	-	RAJNIGANDHA / HAVELL'S / FINOLEX / THERMO PAD/ 'NICCO / RPG / FINECAB / RADIANT / POLYCAB / LAPP/ DELTON / UNIFLEX / KDK
9	High Mast Towers	-	BAJAJ / BP Projects / PHILIPS / CGL / VENTURA
10	Street Light Poles		
-	Octagonal Type	-	BAJAJ / BP Projects / PHILIPS / CGL /BMW
-	Tubular Type	-	Electro Steel / Quality Steel / Calcutta Poles &Tubes / Steel Pole Corporation / BMW / JINDAL
J.	**CABLES AND CABLING ACCESSORIES**		
1	33kV/ 11kV/ 6.6 kV XLPE Cable	-	RPG / UNIVERSAL / CCI/NICCO / TORRENT CABLES / INDUSTRIAL/INCAB / CRYSTAL/ UNIFLEX
2	a) 1.1 kV PVC/XLPE/HRPVC Cable (Power)	-	RPG / UNIVERSAL /CCI /NICCO/TORRENT/ INDUSTRIAL/ POLYCAB / FINECAB / INCAB / RADIANT / CRYSTAL / KEI / SPECIAL
	b) 1.1 kV PVC/XLPE/HRPVC Cables (Control)	-	RPG / UNIVERSAL / NICCO / TORRENT / INDUSTRIAL /POLYCAB / DELTON /CCI / CORDS / SPECIAL / CAPCAB/ FINECAB/ RADIANT/ INCAB/ CRYSTAL/ LAPP/Thermopads
3	Silicon Rubber insulated copper Cable	-	RPG / UNIFLEX / UNIVERSAL / NICCO / INCAB / CCI / INDUSTRIAL / POLYCAB / LAPP / TORRENT /
4	Flexible trailing copper cable	-	RPG/ UNIVERSAL/ NICCO/ INCAB/ CCI/LAPP/ Thermopads/ INDUSTRIAL / POLYCAB / TORRENT/ KEI
5	HT Cable Termination Kit/straight through jointing kits	-	RAYCHEM / M-SEAL(MECP) /YAMUNA GASES(DENSION)/
6	LT Cable Termination Kit/straight through jointing kits	-	RAYCHEM / M-SEAL(MECP) / DENSION/CCI

Sl. No.	Component		Make
7	Cable Reeling Drum (Stacker Reclaimer)	-	ELECTRO ZAVOD / ELECTROMAG / TECHNOCRATS/STEMMANN TECHNIC/ IS
8	Cable Reeling Drum (Cranes, Hoists, Transfer Trolleys)	-	ELECTRO ZAVOD / ELECTROMAG / IS / TECHNOCRATS/ STEMMANN TECHNIC
9	Cable Lugs	-	DOWELLS / FORWARD / COMMET / 3D / KALTER
10	Cable Gland	-	ELECTROMAG / CC I/ COMMET / PHOENIX / DOWELLS/ KALTER
11	Terminal Block	-	ELMEX / ESSEN / CONNECTWELL / C&S/WAGO/PHOINEX
K.	**MISCELLANEOUS**		
1	Diode	-	HIND/USHA RECTIFIER/BHEL/RUTTON SHAW
2	Battery (SMF)/ NiCd Battery	-	EXIDE / HBL-NIFE / AMAR RAJA / AMCO
3	Braking Resistance Panel	-	RESISTEC / BCH / KAKKU/ KINH ELECTRIC
4	DC EM Brake	-	BCH/STROM KRAFT/ELECTROMAG/ ELECTROMECH CORPN./ EPC/IS
5	Thrustor brake	-	IS / STROMKRAFT / ELECTROMAG / ELECTROMECH / EPCC / TECHNOCRAT
6	Lifting Magnet	-	ELECTROMAG / SUPERLIFT / EPCC / Electro Zavod
7	Power Pack for Magnet	-	ELECTROMAG / SUPERLIFT
8	Earthing Resistor	-	BHEL / BCH / IS /EEF / RESITECH / NARKHADE
INSTRUMENTATION AND CONTROL			
A.	**CONTROL ROOM EQUIPMENT**		
1	Distributed Control System (DCS)	-	YOKOGAWA / HONEYWELL / EMERSON / INVENSYS/(FOXBORO) / ABB / SIEMENS
2	PLC	-	ROCKWELL AUTOMATION / SIEMENS /ABB /SCHNEIDER/ GE-FANUC
3	HMI-PC	-	IBM / HP / DELL
4	HMI Software (3rd Party)	-	WONDERWARE (INTOUCH) / INTELLUTION(FIX) / US DATA (FACTORY LINK)
5	Controller	-	YOKAGAWA/HONEYWELL/SIEMENS/ABB/EUROTHERM/ INVENSYS (FOXBORO)
6	Recorder	-	YOKOGAWA/LAXONS(CHINO)/EUROTHERM/ABB/ HONEYWELL
7	Bargraph & Digital Indicator	-	MASIBUS/ EUROTHERM/ YOKOGAWA/ HONEYWELL
8	Totaliser	-	YOKOGAWA / ABB / MASIBUS/ HONEYWELL
9	Scanner	-	MASIBUS/APLAB/ECIL/WAAREE/M B CONTROLS / PROCON

Sl. No.	Component		Make
10	Alarm Annunciator	-	IIC/ MINILEC/ PROCON/ PIRI/ APLAB/ ICA/ DIGICONT / MB CONTROLS&SYSTEM / MINILEC/PROCON / SEMUDA
11	Signal Isolator/Multiplier	-	MTL/ YOKOGAWA/ MASIBUS/ PEPPERL & FUCHS
12	Instrument Panel/Cabinet/Desk	-	RITTAL/RKC/SIMCON/VERO/PYROTECH
13	Power Supply Unit	-	SIEMENS / PHOENIX / MTL/ COSEL
14	Intrinsic Safety Barrier	-	MTL/P&F/ABB/ENDRESS-HAUSER
B.	**FIELD INSTRUMENTS**		
1	Pressure Gauge	-	GIC/ H.GURU /FEIBIG/ WAREE/ PRICOL /WALCHANDNAGAR/ Y2K/GE GAUGES PVT LTD/INDUSTRIAL INSTRUMENTATION/ MANOMETER / WIKA/ FROBES MARSHALL
2	Draught gauge & DP gauge	-	SWITZER/GIC/ANI/H.GURU/PRICOL/GEG/WAREE/WIKA
3	Pressure and DP (Flow and Level) Transmitters (Electronic/SMART Type)	-	EMERSON / YOKOGAWA / HONEYWELL / ABB / FUJI /INVENSYS(FOXBORO) / SIEMENS
4	Pressure Switch/DP Switch (SOLID STATE)	-	WIKA / ABB / E+H / SCHNEIDER / HONEYWELL
5	Temperature Gauge	-	WIKA/GIC/ANI/H.GURU/ GEG/FEIBIG /A N INSTRUMENTS/ ASIATIC ENGINEERS / HIRLEKAR PRECISION/ ALTOP/ WAAREE/ FROBES MARSHALL/ MANOMETER / PRECISION INDUSTRIES/SREE GURU INSTRUMENTS/ WAREE/INDUSTRIAL INSTRUMENTATION
6	RTD and Thermocouple	-	NAGMAN/TOSHBRO/TEMPSENS/TOSHNIWAL INDUSTRIES/ GIC
7	Temperature Transmitter	-	YOKOGAWA / ABB / HONEYWELL/ EMERSON/SIEMENS/ EUROTHERM/MOORE CONTROLS/ MEDICAL & CONTROL INSTRUMENTS/ PEPPREL FUCHS LTD/ MTL/ TOSHNIWAL INDUSTRIES
8	Temperature Switch	-	SWITZER/ INDFOS/ HONEYWELL/ VERMA TRAFAG/ P&F
9	Level Gauge	-	GIC/DKI/BLISS ANAND/LEVCON/V.AUTOMAT
10	Level Switch/Transmitter	-	LEVCON/ TOSHBRO/ KRHONE/ ENDRESS-HAUSER/ SWITZER/ S.B.ELECTROMECHANICAL
11	Nucleonic Level Gauge	-	CONCORD (BERTHHOLD)/ EMERSON (K-RAY)/ ECIL/ ENDRESS HAUSER
12	Ultrasonic / Rader type Level transmitter	-	MILTRONICS/ ENDRESS-HAUSER/ ABB/ SIEMENS /MAGNETROL INTERNATIONAL/ VEGA / EMERSON (SAAB)/ FROBES MARSHALL/ PEPPERL FUSHS LTD

Sl. No.	Component		Make
13	Rotameter	-	KHRONE /IEPL /EMERSON(BROOKS) /EUREKA/AL FLOW/ TRANSDUCERS & CONTROLS / FROBES MARSHALL / INSTRUMENTATION ENGINEERS / KROHNE MARSHALL/ INSTRUMENTS / PLACKA / ROTA
14	Flow Elements (Orifice Plate, Nozzle, Ventury Tube)	-	ENGG. SPL/MECH. ENGR./ MICRO/ PRECISION
15	Magnetic Flowmeter/Ultrasonic Flowmeter	-	ENDRESS-HAUSER/KHRONE/ABB/ INVENSYS(FOXBORO)/ EMERSON/YOKOGAWA
16	Positive Displacement Flowmeter	-	TOSH. HYD(BOPP&REUTHER)/ ROCKWIN/ABB/ SWITZER
17	Vortex Flowmeter	-	ENDRESS HAUSER/YOKOGAWA/KRHONE/ EMERSON/ABB
18	Mass Flowmeter	-	EMERSON/ABB/ENDRESS HAUSER/YOGOKAWA
19	Control Valve and On-off Valve	-	IL/FISHER-XOMOX/SAMSON/ DRESSER MASONEILAN / FOURESS/FORBES MARSHALL(ARCA)/ R.K.CONTROLS / MIL / ABB (INTROL)
20	Electric Actuator	-	AUMA / IL / LIMITORQUE / ROTORK / ABB
21	I/P Converter	-	YOKOGAWA / EMERSON / MOORE / ABB / HONEYWELL
22	Solenoid Valve	-	AVCON/ROTEX/ASCO/VICKERS/SCHRADER
23	Air filter regulator	-	PLACA/SHAVO NORGREN
24	Encoder	-	P&F/ROCKWELL/HUBNER
C.	**SPECIAL INSTRUMENTS**		
1	Electronic Weighing System	-	ABB/SCHENCK/SARTORIOUS MECHATRONICS/ TRANSWEIGH/ METTLER-TOLEDO/ KLISTER-MORSE
2	Gas Analysers	-	EMERSON / ABB ANALYTICAL / SIEMENS /YOKOGAWA/ HONEYWELL (TELEDYNE)
3	Water Analysers	-	FORBES MARSHALL/ ABB ANALYTICAL /YOGOKAWA/ E+H / EMERSON
4	pH and Conductivity Meter	-	EMERSON / ABB ANALYTICAL / YOKOGAWA/ FORBES MARSHALL /INVENSYS(FOXBORO)/ TOSHBRO CONTROLS
5	Infrared Pyrometer	-	NAGMAN (IRCON) / EUROTHERM (LAND) / LAXSON (CHINO)/HONEYWELL/ FLUKE/ TOSHNIWAL (RAYTEK)
6	Molten Metal Temperature/ Oxygen Measurement system	-	ARDEE (ELECTRONITE)/FERROTRON Gmbh/ SEIDERMES (ITALY)

Sl. No.	Component		Make
7	Moisture Analyser	-	CONCORD (BERTHHOLD) / EMERSON (K-RAY) / ECIL/ ENDRESS HAUSER / EMERSON / YOKOGWAWA /CHINO-LAXSONS / ABB ANALYTICAL
8	Vibration Sensor & Monitor	-	BENTLEY-NEVADA / FROBESMARSHALL (SHINKAWA)/ SHERMAN(SKF)/ SCHENCK/ ROCKWELL AUTOMATION/ HONEYWELL
9	Pollution Control & Stack monitorinr system	-	DRAGER/ HONEYWELL/ ENVIROTECH/ EMERSON/ FROBES MARSHALL/ DURAG/ OPSIS
10	Flame detector	-	HONEYWELL/ FIRE-EYE/ KROM SCHODER/ DURAG
11	Calorific value analyser	-	UNION/REINEKE
12	Hot metal detector	-	WEBER SENSORS / DELTA / IMPAC ELECTRONICS / P&F/ AMERICAN SENSORS
D.	**INSTRUMENT CABLES AND ACCESSORIES**		
1	Screened Cables, Control Cables & Compensating Cables	-	DELTON / FINOLEX / SPECIAL CABLES / ELKAY-TELELINKS / CORDS / TOSHNIWAL / GOYOLENE/ THERMOPAD / UNIVERSAL /CMI / LAPP / Toshniwall Cables/ Reliance Cables /Brooks Cables
2	Ball Valve	-	AUDCO / KSB / VIRGO / BDK
3	Instrument Fittings	-	SWAGALOK / PARKER
PROCESS CONTROL COMPUTER SYSTEM			
1	Computer Systems		
	- PCs/Workstaton/Servers	-	IBM / HP/ DELL
2	Computer Peripherals		
	- Printers/Scanners/Plotters	-	HP / CANON / KONICA
3	Network Components - Switches/Routers - Converters/Repeaters/Modems/Radio Modems	 - -	 CISCO / 3-COM / NORTEL MULTI TECH/US ROBOTICS/ PRUDENT/ LOTUS/ DLINK
4	Cables - Fibre Optic/Co-axial/UTP	-	RPG/ AT&T/ MOLEX/ LUCENT
5	Process Control Systems (IRON & STEEL MAKING/MILL/SCADA)	-	VAI / DANIELI/ SMS/STEIN/HITACHI/B RICMONT/ MPIANTI/ RAUTTA-RUUKKI/SIEMENS/ABB/HAIL/ ALSTOM/ROCKWELL
6	SCADA System	-	ABB/ALSTOM/HAIL/GE FANUC/SIEMENS/RAIL/GE ENERGY/ YIL
7	Large Screen Display	-	BARCO / LG / SAMSUNG / SONY
8	Network Software/Network Management Software	-	CISCO / AGILENT / HP / 3-COM / IBM / NORTEL

Annexure 5

LIST OF DRAWINGS ENCLOSED WITH ENQUIRY FOR ACVS

SL. NO.	DRAWING NUMBER
1	IS-1-EE-601-524-E001 REV 04 – SHEET 1 TO 2
2	IS-1-EE-601-524-E002 REV 01 – SHEET 1
3	IS-1-EE-601-524-E003 REV 05 – SHEET 1
4	IS-1-EE-601-524-E004 REV 07 – SHEET 1 TO 3
5	IS-1-EE-601-524-E011 REV 04 – SHEET 1
6	IS-1-EE-601-524-E012 REV 03 – SHEET 1
7	IS-2-EE-601-524-E013 REV 05 – SHEET 1
8	IS-2-EE-601-524-E014 REV 04 – SHEET 1
9	IS-2-EE-601-524-E024 REV 04 – SHEET 1
10	IS-2-EE-601-524-E025 REV 04 – SHEET 1
11	IS-2-EE-601-524-E026 REV 04 – SHEET 1
12	IS-2-EE-601-524-E027 REV 04 – SHEET 1
13	IS-2-EE-601-524-E037 REV 04 – SHEET 1
14	IS-3-EE-601-524-E016 REV 05 – SHEET 1
15	IS-3-EE-601-524-E017 REV 05 – SHEET 1
16	IS-3-EE-601-524-E018 REV 05 – SHEET 1
17	IS-3-EE-601-524-E019 REV 05 – SHEET 1
18	IS-3-EE-601-524-E020 REV 05 – SHEET 1
19	IS-3-EE-601-524-E021 REV 03 – SHEET 1
20	IS-3-EE-601-524-E022 REV 03 – SHEET 1
21	IS-3-EE-601-524-E023 REV 04 – SHEET 1
22	IS-3-EE-601-524-E028 REV 04 – SHEET 1
23	IS-3-EE-601-524-E029 REV 04 – SHEET 1
24	IS-3-EE-601-524-E030 REV 03 – SHEET 1
25	IS-3-EE-601-524-E031 REV 03 – SHEET 1
26	IS-3-EE-601-524-E032 REV 03 – SHEET 1
27	IS-3-EE-601-524-E033 REV 03 – SHEET 1
28	IS-3-EE-601-524-E034 REV 03 – SHEET 1
29	IS-3-EE-601-524-E035 REV 03 – SHEET 1
30	IS-3-EE-601-524-E036 REV 03 – SHEET 1
31	IS-3-EE-601-524-E038 REV 05 – SHEET 1
32	IS-3-EE-601-524-E039 REV 05 – SHEET 1
33	IS-3-EE-601-524-E040 REV 02 – SHEET 1
34	IS-3-EE-601-524-E041 REV 02 – SHEET 1
35	IS-3-EE-601-524-E042 REV 01 – SHEET 1
36	IS-0-LO-601-524-E901 REV 08 – SHEET 1 TO 4
37	021058450 REV -G

RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION NO. VSP-6.3/GS-M-01

FOR

PIPEWORK

MARCH 2006

M.N. DASTUR & COMPANY (P) LTD
Consulting Engineers
P-17, Mission Row Extension
Kolkata 700 013

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RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION

FOR

PIPEWORK

1.0 SCOPE

1.1 This general specification covers pipework for various systems. The term 'pipework' referred herein generally covers 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, Gas Tight Isolators, Slide Plate Valves, Goggle Valves, pressure regulating, flow control, relief, safety, manually gear operated, electrically operated, pneumatically operated valves etc), traps, strainers, drip pots, filters, spectacle blinds, flash back arrestors, expansion joint, compensators, u-loops , flaring devices, flexible hoses, hose couplings, hose clamps, hose nozzles, fire hydrant assemblies, oil and moisture separators, lubricators, pipe supports (such as trestles, towers, pipe bridges, pipe racks, saddles, brackets, hangers, U-bolts, clamps, spring supports etc), hot & cold insulation, corrosion protection etc.

1.2 Pipework covered herein is intended to convey fluids such as different qualities of water, industrial effluents (contaminated water), various types of fuel gases like blast furnace gas, coke oven gas, LD gas, Propane , LPG, liquid fuels (like fuel oil, naptha, LSHS, light diesel oil, coal tar fuel), compressed air, steam, oxygen, nitrogen, hydrogen, argon, hydraulic fluids, lubricants, coolants, grease, etc. Pipework covered herein also includes pipework for pneumatic conveying of dust and other similar materials, either for process or for solid waste disposal.

1.3 This general specification does not cover pipework for process fluids such as those involved in coke by-product processing, air separation plant, chemical water treatment etc. For such pipework, the specifications are covered in the particular technical specifications for concerned units. Storm water drains and other open type sewerage systems, and sanitary sewage from toilets, canteens, showers, comfort stations, drinking fountains, etc are also not covered in this general specification.

1.4 The design and construction of all pipework shall be suitable in every way for the service intended and shall be oriented towards maximising interchangeability of components and minimising maintenance. Pipework shall be complete in all respects, including all accessories essential for proper installation, operation and maintenance, irrespective of whether such items are specifically mentioned in the Technical and General Specification or not.

1.5 In the interest of standardisation, the Purchaser reserves the right of selecting a particular manufacturer for any item and the Contractor shall supply the item of that make, if so desired by the Purchaser.

2.0 STANDARDS AND OTHER REGULATIONS

2.1 The pipework shall be designed, manufactured, assembled, tested and commissioned as per the standards laid down in this specification and as per technical specification (TS). Detailed instructions on such aspects as are not indicated herein shall be as per the latest standards, codes and recommendation of the Bureau of Indian Standards. Where Indian Standards are not available/practiced, the Standards of American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), American Water Works Association (AWWA) or other equivalent national standards for pipework of the country of origin shall be used as per contract for design and construction of pipework with the approval of the Engineer.

2.1.1 Wherever applicable, the Interplant Standards for Steel Industry (IPSS) developed by the Steel Authority of India Ltd. shall be followed.

2.2 The norms indicated in this specification shall be adhered to, unless adoption of these norms would vitiate the function and/or safety of the systems offered. In such cases and where different norms are adopted by the Contractor, the same shall be clearly indicated with reasons and Engineer's approval shall be obtained.

2.3 All pipework shall comply with the statutory requirements of the Government of India and the State Government of Andhra Pradesh. Wherever required by Mandatory Regulations, the successful tenderer will have to obtain the approval of the relevant government agencies such as the Boiler Inspectorate, Explosives Inspectorate, Factory Inspectorate and Pollution Control Board etc.for the work covered in this General Specification (GS).

2.4 In preparing the working drawings of the pipelines, the line codes given in Annex-1 shall be used. Drafting symbols shall be as per international codes and practices and a detailed legend shall be furnished with the offer.

2.5 If the offer deviates from the standards specified, the tenderer shall indicate clearly in his offer, the standards he proposes to adopt, with details thereof. Copies of such standards shall be enclosed with the offer.

3.0 DESIGN BASIS

3.1 Definitions

3.1.1 Working Pressure (PW)

It is the effective operating pressure in kilogram per square centimeter gauge (kscg) of a piping system. It shall be designated by the abbreviation PW. PW shall not exceed the maximum pressure which could develop during normal operating conditions of the system under consideration.

3.1.2 Nominal Pressure (PN)

It is the pressure in kscg which shall be used to design all piping elements. It shall be determined by increasing the working pressure of the system to suit the temperature and type of fluid being carried, as per clause 3.1.5. It shall be designated by the abbreviation PN. The typical designation of a piping system where the nominal pressure is 40 kscg shall be PN 40.

3.1.3 Test Pressure (PT)

It is the pressure in kscg to which all the elements of a piping system shall be subjected to determine their adequacy. This shall be designated by the abbreviation PT. The test pressures against various nominal pressures are given in Clause 3.1.5.

3.1.4 Nominal Diameter (DN)

Every part of a piping system shall be identified by its nominal diameter. The nominal diameter shall be designated by the abbreviation DN; the typical designation of a pipeline system where nominal diameter is 50 mm shall be DN 50.

3.1.5 Pressure Temperature Rating for Pipework

The pressures for various services are furnished in Annex-1. Table 1 details the guidelines for determining the nominal and test pressures for different working conditions and this table shall be used to determine the nominal and test pressures for

fluids not specifically covered in Annexe-1, with the approval of the Engineer.

TABLE 1 - PW AND PT AT DIFFERENT PN

Maximum Allowable Working Pressure (PW) in kscg

Nominal Pressure kscg	CLASS I	Class II	CLASS III		Hydraulic test pressure (PT) kscg
	For fluids considered not chemically dangerous and at temper atures not exceeding 120ºC	For temperature of 120°C to 300°C & chemically dangerous fluids at temperature below 120°C	For temperatures of 300°C to 400°C and chemically very dangerous fluids at temperatures above 120°C		
			Flange	Pipe	
1	1	1	-	-	2
(2)	2	1.6	-	-	4
2.5	2.5	2	-	-	4
3.2	3.2	2.5	-	-	5
4	4	3.2	3.2	2.5	6
(5)	5	4	4	3.2	8
6	6	5	5	4	10
8	8	6.4	6.4	5	12
10	10	8	8	6.4	15
(12.5)	12.5	10	10	8	18.75
16	16	13	13	10	24
(20)	20	16	16	13	30
25	25	20	20	16	37.5
(32)	32	25	25	20	48
40	40	32	32	25	60
(50)	50	40	40	32	75
64	64	50	40	40	96
(80)	80	64	50	50	120
100	100	80	64	64	150
125	125	100	80	80	187.5
160	160	125	100	100	240
200	200	160	125	125	300
250	250	217	185	185	375
320	320	278	236	236	480
400	400	348	296	296	600

NOTE: Nominal pressures inside brackets shall be used only in case of absolute necessity

3.2 Materials and Dimensional Specification

3.2.1 For the fluids covered in this specification, the materials, dimensional standards, and other required features for pipework are given in enclosed Annexes 2 to 30. The design parameters, line codes and other relevant data for each fluid

are indicated in Annexe-1. PN rating of various pipes shall be taken into consideration by suppliers of equipment/systems while calculating the wall thickness of pipes not covered in this specification.

3.2.2 The annexes cover the materials generally used such as steel, cast iron, etc for the piping systems of the different fluids handled. Other special types of piping materials such as asbestos cement (AC), prestressed concrete, Hume pipe, steel cylinder Hume pipe, rigid PVC (PVC), high density polyethelene (HDP), glass reinforced plastic (GRP) and non-ferrous pipes such as copper pipes may be used in particular applications with the prior approval of the Engineer. The piping systems shall be lined with appropriate lining materials, where required and the lining material and the lining procedure shall be subject to the approval of the Engineer.

3.2.3 Where for the same fluid, alternative material and dimensional standards are indicated in the Annexes, Contractor may be required to make alternative offers for all such materials, for techno-economic evaluation.

3.3 **Layout**

3.3.1 In general yard pressure pipework for all utilities including water will be routed on overhead trestles/towers. However, make-up water, drinking water and treated waste water pipework in the yard shall be laid underground. All overhead pipes shall be routed such that they will have a minimum clearance of 6.0 metres between bottom of supporting structures and road crown/railway track. The pipelines laid over hot metal tracks will have a minimum clearance of 10.0 metres; in case of using protective shields heat shields in these places, this clearance is allowed to be reduced to 6.0 metres. However, the branch pipe lines to the repair shops and other minor shops shall be routed such that they will have a minimum clearance of 5.0 metres from ground level and 6.0 metres from rail head respectively. All buried pipes shall be laid with a minimum earth covering of 1200 mm in areas subject to temporary loads and minimum earth covering of 1000 mm in areas not subject to temporary loads, unless otherwise specified. All MS pipelines for water service shall be laid in accordance to IS:5822.

3.3.2 For the pipelines laid on roof, the distance from the external generatrix of the pipe to the roof shall be at least 0.5 m. Where disc (lens) type compensators are used, the distance from the external generatrix of the compensator to the roof shall be at least 0.3 m. In case of laying of gas pipelines between two consecutive skylights, the distance of both from gas pipelines shall be at least 0.8 m.

*

3.3.3 All shop headers, except for gravity return fluids, shall be generally routed along columns in multiple rows at a height 4 to 6 metres above floor level. The connections to equipment shall be taken through suitably covered floor trenches for shops at ground floor and for basements; for elevated operating floors, the equipment pipework connections may be taken below the floor level. All gravity pipes shall also be preferably taken along the same route. Isolated single pipe connections to equipment may be buried in the flooring/equipment foundations. Pipework from basements and oil cellars to main equipment shall be routed in pipe tunnels/trenches, with adequate spacing for easy maintenance. All pipe trenches shall be covered by chequered plates or by concrete slabs. Pipes to be laid in the rock shall be placed on sand cushions.

3.3.4 The outlet pipes for purging lines and other exhaust pipework shall be routed upward along columns/gable ends and/or walls to a height of 4,000 mm above the roof level.

3.3.5 For the gas pipelines laid along the building walls, the clearance between the gas pipelines generatrix and the wall shall be adopted so as to ensure the possibility for maintenance of the gas pipelines. The gas pipelines laid on the walls shall not cross the window and door openings.

3.3.6 Gas branch pipes from the headers to the building through walls and the roof shall be encased. At the same time a circular ridge shall be provided on the roof, while the branch shall be provided with a conical hood to prevent seepage of rain water.

3.3.7 Gas pipelines (Low pressure fuel gases, hydrogen, oxygen, Acetylene and LPG / Propane) shall be earthed. When laid under high-voltage lines, a protective steel guarding shall be provided above the gas pipelines. The guarding shall be earthed. The earthing resistance shall be not over 10 ohm.

All work in connection with earthing of pipes and trestles/ towers shall be generally as per IS:3043.

3.3.8 Platforms, access ladders, hand railing etc shall be provided for operation and maintenance of valves, instruments and controls. If necessary, a catway shall be provided on the flat roof along the gas pipeline. The distance from the skylights shall be taken as at least 1.5 m; no transverse crossing of monitors is allowed. Manholes and hatches shall be provided for access inside the large gas diameter pipelines and also for ventilation of the same. In case the gear units and electric drives for the valves are to be located at a height of more than

1.4 m from the maintenance level, a platform with stairs shall be envisaged (either stationary or light-weight portable ones).

3.3.9 At all the places of regular maintenance (gate valves, throttle valves, orifice plates, hatches, manholes, bleeders etc) if located at a height of over 2.5 m from the maintenance level) provision shall be made for stationary platforms with railings and stairs.

For individual platforms which are used rarely, vertical ladders can be provided. Guard railing for the platforms and stairs shall be at least 1.2 m high.

3.3.10 On outdoor overhead fuel gas pipelines of all sizes a (grating type) continuous walkway along the entire length shall be provided with hand railings on both sides. The height of the hand railings shall be at least 1.2 metres. In case of a number of pipelines, the passage shall be provided on the upper most pipeline.

3.4 Pipe sizing

3.4.1 The velocities for sizing pipework as given in Annex-1 shall be adopted, unless otherwise specified in Technical Specification, or warranted by considerations of pressure drop, safety and noise abatement. The contractor shall ensure that the velocities mentioned in the relevant Annex shall not be exceeded for the maximum flow rates envisaged.

3.4.2 In finalising diameter of the outdoor and shop pipelines, the design should proceed from the provision of required pressure at consumer, with the maximum flow at a given pipe run.

3.4.3 Pipe size above DN 50 shall not be used for Acetylene service.

3.5 Expansion and Flexibility

3.5.1 All pipework shall be designed to provide sufficient flexibility to prevent development of undesirable forces or moments at points of connection to equipment, at anchorages or at guide points due to thermal expansion.

3.5.2 Flexibility shall be provided by changes of direction or by the use of bends, loops, offsets or expansion joints. Normally metallic expansion joints of corrugated (wave) type shall be used, if required. The complete metallic expansion joint shall be of ss construction. However , the companion flanges and jointing materials shall be of cs construction. Expansion joints of slip joint or other types may be used with prior approval of the Engineer .

3.5.3 Wherever no self-compensation can be used to cater for the expansion deformation of the pipelines, expansion loops (U-loops) or special expansion joints shall be provided. In general, expansion loops (U-loops) shall be used for pipelines of DN 300 and under. Wave-type (corrugated) expansion joints (bellows) shall be used for pipelines of low pressure gases of over DN 300. In special circumstances, disc type expansion joints with not more than three (3) discs may be used with prior approval of Engineer. Gland compensators may be used for Coke Oven Gas Pipelines.

Whenever wave type compensators (bellows) are not available for the pressure/temperature/diameter of the pipes involved then expansion loops (U-loops) shall be used even for pipe sizes above DN 300 (e.g. Steam, Cold Blast pipelines etc).

3.5.4 In the case of steam lines or other fluid pipework operating at high temperatures, sections of pipe may be cut short and cold sprung into place. Unless otherwise specified, all cold springing shall not exceed one-half the total expected expansion between anchor points.

Expansion joints used on low pressure Fuel Gas Pipework may also be cold sprung if so specified in the relevant piping drawings.

3.5.5 For all piping systems, the provision for expansion and flexibility shall take into consideration the maximum possible temperature differential between the design temperature and the ambient temperature (the lowest ambient temperature in cold season shall be considered). The co-efficient of linear expansion of the piping materials shall be considered and means shall be provided for proper anchoring or other methods of restraining and taking care of the anticipated expansion without failure of pipework and without imposing excessive loads on connected equipment, structures, supports etc. For steam pipework including expansion joints, covered under Indian Boiler Regulations (IBR) and the provisions of relevant clauses of IBR shall be taken into account. The axial forces and moments occurring during expansion/contraction shall be determined by calculation as per ANSI 31.3 & 31.1 . The result and calculation shall be furnished .

3.5.6 The contractor shall be responsible for the proper fabrication of all piping systems with regard to expansion and flexibility, including the branch lines and connections to equipment, even through such details might be omitted in the drawings. Supporting shall ensure freedom for expansion and movement as well as restrict sagging to reasonable limits.

3.6 Valves and Measuring Devices

3.6.1 Valves shall be provided on pipework for isolation of pipe sections and equipment, control of pressure, flow and level of fluids, venting, draining, pressure relief etc. They shall be suitable for the service conditions in all respects and located suitably considering ease of operation and maintenance.

3.6.2 The valves provided shall include but not be limited to the following:

a) Isolation valve shall be provided as follows:

- on all pipe lines both at the source and consumers;
- in the branch pipes to individual buildings and shops shall be provided with an isolation valve.
- in the points of sectionalization and the links between the pipelines required to ensure the reliable supply of utilities.

b) Isolating and by-pass valves for flowmeters, filters, trap assembly etc.

c) Check valve on all pipelines requiring unidirectional flow.

d) Quick acting safety shut-off valves on fuel oil, gas and air lines to furnaces and heaters as well as before each consumer or group of consumers.

e) Pressure regulating valves together with isolating, by-pass and relief valves for all pressure reducing installations.

f) Regulating valves with integral pressure gauge for all oxygen outlet points, fuel gas outlets etc.

g) Manual drain valves at low points and manual vent valves at all high points of pipework. However, automatic air release valve shall be provided on water lines wherever required. The size of drain valve shall be DN 150 for pipe sizes < 300 dia, DN 200 for 300 to 700 pipe, DN 250 for size above 700 pipe.

h) Isolation of large diameter low pressure fuel gas lines shall be done with water seals alongwith rising spindle gate valves .

i) Sectionalising/ isolation for purging of fuel gas lines may be done with Spectacle blinds/ slipper plates .

3.6.3 For fluid lines with working pressures over 16 kscg, valves of DN 300 and above shall be provided with by-pass arrangement unless otherwise specified in Technical Specification or respective Annexes.

3.6.4 Manually operated shut-off valves, regulating valves of DN 300 and above shall be complete with gear drive with enclosure and handling arrangements where necessary. Shut-off valves of DN 450 and above shall be provided with electric drives with provision of manual operation.

All valves shall be provided with operating wheel/handle/ lever/wrench within easy reach wherever necessary, operating platforms shall be provided.

3.6.5 All valves located remotely, requiring frequent operation and/or with automatic control shall be provided with electric drives, solenoids, etc.

3.6.6 Shop pipework for all production and ancillary units shall have metering of flow, pressure and temperature at the battery limits.

3.6.7 The gas cut-off arrangement shall ensure the possibility of complete cut-off of gas along with fast and safe operation. The cut-off valves shall be supplied with companion flanges. The gas pipelines shall be cut-off by means of steel and cast iron gate valves and cocks designed for gas service. Gate valves for gas pipelines of DN 450 and above shall be driven by electrical motor-actuators. Electrically operated gate valves for gas pipelines of smaller diameter are recommended to be used only if they are incorporated in the automation scheme. Installation of water seals for the purpose of cutting-off the gas pipelines shall be used.

3.6.8 Vent pipes from the shop header shall be taken outside the shop with two gate valves which shall be installed in succession with a bleeder in between. After the second gate valve a provision shall be made for installation of a blind flange.

3.6.9 For technical requirements of various special valves and accessories refer to Annex-29.

3.7 Drip Legs and Appurtenances

3.7.1 Drip legs shall be provided as required. They shall include all appurtenances required for their operation and provisions for disposal of fluids such as condensate, moisture, sludge etc. They shall include trap assemblies/ drip pots (including pressure type drip pots), valves, by-passes, connections to sewers and other items as required.

3.7.2 Diameter of drip legs on pipes DN 150 or higher shall be at least 75 per cent of the main diameter; drip legs on smaller mains shall be of same size as the mains. The depth from the centreline of the main to the trap off-take shall be at least twice the main diameter subject to a minimum of 600 mm. Drip legs, likely to accumulate undesirable liquid or solid matter, shall have flanged bottom cover.

3.7.3 For steam and compressed air lines, the drip legs shall be connected to a trap and a strainer assembly of the type specified in the relevant Annex. The trap and strainer assembly shall be complete with necessary by-pass and shall ensure discharge of condensate with minimum leakage of steam/air.

3.7.4 The drip legs for Blast Furnace Gas, Coke Oven Gas, Converter Gas, Mixed Gas lines shall be led to drip pots, so that the condensate can be collected in water-filled drip pot and periodically removed. The drip pots shall be specified in the relevant annex.

3.8 **Drains**

3.8.1 Drains shall be provided at all low points of liquid pipelines and near sectionalising valves of steam pipelines. They shall be of size adequate to drain the lines within the desired time period but in no case more than 30 minutes. Only gate valves or plug valves shall be used for the drains. Pipe plug or blind flanges may be used where space is limited, with prior approval from Engineer.

3.8.2 To ensure the condensate drainage, the gas pipelines shall be laid with a gradient of about 0.005 towards the water drains.

3.8.3 The height of the water drains hydraulic seal shall be determined according to the maximum pressure in all low pressure fuel gas lines, but shall be at least 2,000 mm for all low pressure fuel gas pipelines. Water drains shall be equipped with bleeders. Inside the shops, the water drains shall be provided with additional U-shaped pipe seals of at least 1.5 m height. From the water drains, water shall be disposed into the sewerage system by a discontinued stream. From the individual remote water drains, condensate can be disposed into the water-tight pits.

3.8.4 In the lower points of the steam pipelines and before vertical lifts the permanent drainage of steam pipelines shall be provided. At these places and on the straight runs of the steam pipelines, the starting drainage of steam pipelines shall be provided spaced every 400-500 m in case of the gradient in the same direction, and in every 200-300 m in case of the

adverse gradient unless otherwise specified in technical specification. Actual distance will be selected based on the condensate drainage capacity of the steam traps used. Diversion of condensate from the permanent drainage into the pressure condensate pipeline shall be allowed provided the pressure in the drainage condensate pipeline exceeds that in the pressure condensate pipeline by at least 1 kg/cm^2. In all the other cases, condensate shall be disposed into the gravity-flow condensate pipelines or outside (to the ground surface or into the special drain wells).

3.9 **Vents/Air Release**

3.9.1 Pipelines subjected to air locking shall be provided with Air Release Valve and an isolation valve ahead of it shall be provided or vent with valve at high points.

3.9.2 Pipelines subjected to hydraulic test shall be provided with vent with valves at high points.

3.9.3 Bleeders on all the gas handling devices and pipelines shall be installed in such a way as to have the possibility of purging and venting any space of the gas pipeline. The purging bleeders of different gas pipelines are not allowed to be combined into one bleeder. The same is true for the runs of one pipeline separated by gate valves. The bleeder shall be taller than the gas pipeline or roof of the building (in case of the shop pipelines) by 4 metres, but not lower than 12 metres from the ground level. In the presence of the aeration monitors on the roof of the building, the bleeder shall be arranged so as to eliminate the possibility of gas getting inside the premises during purging.

3.9.4 **Purging**

3.9.4.1 Gas pipelines of Blast Furnace Gas, Coke Oven Gas, Converter Gas and Mixed Gas shall have provision for purging with both steam and nitrogen. For LPG / Propane service , only provision for nitrogen purging shall be provided . The connection of nitrogen or steam pipeline to the gas pipeline must be done by means of flexible hoses only during the period of purging out the gas pipelines. The purge line connection sizing shall be such that the entire section of the gas line is purged in about 1 to 2 hours time.

3.10 **Safety Devices**

3.10.1 **Flash Back Arrestor**

3.10.1.1 Flash back arrestors shall be provided in each section of the pipework for Acetylene gas to prevent flame propagation or pressure surges. These may be hydraulic/ cartridge type flash

back arrestors (or back pressure valves). Hydraulic type flash back arrestors shall be filled as soon as they are installed and before being connected to the distribution lines.

3.10.1.2 In case more than one arrestor is required, the arrestors shall be arranged in parallel, so that the gas cannot pass through more than one arrestor en route to the various station outlets. When a branch connection is taken from a main line, it should be through a flash back arrestor. No unprotected branch lines are permitted to be taken from any point on the main line.

3.10.1.3 The hydraulic arrestors must be accessible at all times to permit frequent checking of the liquid level and shall be rigidly supported to prevent leaks at the connections. The relief valve assembly shall be connected to a DN 40 galvanised steel pipe; the vent shall terminate with a goose neck outlet at a height of at least 4 metres above the gas pipelines (in yard piping) or roof of the building (in case of shop pipelines), but not lower than 12 metres from ground level.

3.10.1.4 Shut-off globe valves shall be provided for installation on both the inlet and outlet sides of the arrestor, and unions shall be provided for repair or replacement, if required.

3.10.2 **Explosion Flaps**

3.10.2.1 Spring loaded explosion flaps shall be provided on the low pressure fuel gas piping such that it does not allow the pressure in the pipework to build up to a value in excess of 1.1 times the maximum working pressure. Reputed and certified devices shall be used.

3.10.2.2 At inlet to the explosion flaps, a rupture disc (bursting disc) set so as to rupture when the pressure in the protected pipework exceeds 1.1 times the maximum working pressure shall be used. The rupture disc shall conform to BS 2915 (latest edition) or equivalent. A suitable isolating gate valve shall be used upstream of the bursting disc, and this valve shall be kept locked-open; it shall be used only for replacement or maintenance of the rupture disc.

3.11 **Pipe Heating Systems**

3.11.1 Pipe heating systems such as electrical tape heating, electric impedance heating , steam tracing and thermic oil heating shall be suitably provided where the temperature of the fluid conveyed is to be kept above minimum desired values for process requirements or for reduction of viscosity.

3.11.2 Electric Tracing shall be provided for fuel oil/LSHS and Coal Tar Fuel to maintain the minimum temperature as required. For hydraulic oils and lubricants Steam Tracing may be provided in case electrical heating is incompatible.

The electrical heat tracers or steam tracer lines shall be insulated together with the service line. The steam tracer lines shall be provided with adequate trap assemblies and other appurtenances.

3.11.3 Wherever Electrical Heat Tracing System is provided, the electrical systems shall be complete with all requisite equipment such as step down transformers, isolating devices for electrics, cabling etc.

3.11.4 All heating systems shall be designed for automatic and safe operation and for energy conservation. Thermostatically operated isolating devices shall be provided to cut-off supply of steam to the heating systems when the temperature of the heated fluid exceeds the pre-set value and to supply steam when the temperature of heated fluid falls below the pre-set value. The heating systems shall be designed such that overheating at isolated spots does not occur. Electrical heating devices shall be designed such that they conform to the relevant General Specification for Selection of Electrical Equipment Installation, Testing and Commissioning regarding safety, earthing etc. Electrical heating systems shall be suitably sectionalised and power supply to these shall be made from suitable points to reduce length of cabling.

3.11.5 For details of Electrical Heat Tracing System refer to Annex-26.

3.12 Supports for Above-ground Pipework

3.12.1 Pipe supports, anchors, hangers, guides, restraints sway bracings, vibration dampers etc shall be according to ANSI B 31.1, B 31.2, B 31.3, B 31.4, B 31.5 as relevant or equivalent. Design, material and workmanship for structural steelwork used for pipe supports shall conform to relevant Indian Standards for Structural Steelwork and Civil Engineering Work.

3.12.2 The Contractor shall provide all required supports, anchors, saddles, hangers, rollers, clamps, U-bolts, guides, spring supports, sway bracings, vibration dampners, etc for aligning and controlling the pipework. Supports shall prevent, under operating conditions, excessive stresses and excessive vibration of supporting elements from possible resonance with imposed vibrations.No pipe support shall be welded directly to

pipe . Support shall be welded to pad plate provided between pipe and pipe support.

3.12.3 The movable supports of the pipelines shall be of the following types:

Sliding supports	..	independent of direction of horizontal displacement of the pipelines.
Sliding supports with teflon strips	..	for large diameter piping, the sliding support may be provided with teflon strips below saddles to reduce friction force.
Roller type supports, Spring type supports or Hangers,	..	In places of vertical displacement of the pipes.
Rigid hangers	..	At overhead laying of the pipelines

3.12.4 All supporting elements, except for springs, shall be designed for the weight of the pipe filled with water or the medium transported, whichever is heavier, and the weight of the insulation used. Exceptions may be made for lines (e.g. low pressure fuel gas lines, other gas lines, compressed air lines, exhaust steam or safety valve relief piping etc.) only when there is no possibility whatsoever of such lines becoming full of water or other liquid during testing, operation and at any other time. Thrust load shall be considered wherever significant. Other loads such as thermal and frictional load, weight of fittings, walkways, platforms, stairs, lining, live loads, accumulated dust, condensate, internal pressures, wind loads, and special loads due to cracks in compensators, settlement of supports etc shall be considered wherever applicable.

3.12.5 All supports for overhead yard pipework shall conform to the approved working drawings. These shall include pipe trestles, bridges, saddles, as well as other types of supports mentioned in para 3.12.2 above. Supports for pipework within buildings may be taken from building structures such as columns, trusses, crane girders, etc. where suitable with prior approval of Engineer. In that case, any additional members such as struts, purlins etc. as required shall be provided by the contractor. Where suitable building structures are not available, pipes shall be supported on trestles, towers and/or bridges.

3.12.6 The design shall prevent complete release of the piping load in case of spring failure or misalignment. Hangers and supporting elements shall not get disengaged by movement of the piping and permit free movement of piping for expansion and contraction. This shall be accomplished by the use of long

rod hangers, spring hangers, roller supports etc. Roller supports shall be provided at corners or bends with long rods to permit free cross movement of the piping. Hanger rods shall have welded eyes for rod sizes 20 mm and above.

3.12.7 Anchors, pivots, or restraints shall e provided to secure the desired points of piping in relatively fixed positions. They shall permit the line to expand and contract freely in opposite directions away from the anchored point and shall be so arranged as to be structurally suitable for the particular location, line and loading conditions under consideration.

3.12.8 For insulated pipe, steel protectors for the insulation shall be provided at points where the pipe is supported on rollers, slides or other elements requiring contact outside the insulation.

4.0 FABRICATION OF PIPEWORK

4.1 Pipe Joints

4.1.1 Metallic Pipework

4.1.1.1 All black steel pipework shall be of butt-welded construction. Flanges shall be provided on straight lengths at suitable intervals and at other joints as may be required for ease of maintenance and replacement. Flanged joints shall also be provided to match the connecting ends of equipment, valves, fittings etc. Where specific equipment connection necessitates, screwed joints and unions shall be provided.

4.1.1.2 Galvanised steel pipework upto DN 65 shall be of screwed and socketed construction. Galvanised screwed unions shall be provided at suitable intervals on a straight lengths and at other joints as necessary for easy erection and maintenance. Screwed unions shall be provided at connection to valves etc as required. In case, flanged connections are required for pipe sizes DN 80 and above, galvanised screwed flanges shall be used.

4.1.1.3 Cast iron pipes and fittings shall have bell and spigot ends suitable for rubber ring joint with cement mortar sealing. Ductile iron pipes shall have "Tyton" type joints. Flanged tail pieces shall be provided for mounting of valves or any other flanged items. Branches up to DN 40 shall be made by tapping. In case of a larger branch, socket and spigot tee shall be installed in the line.

4.1.1.4 Special joints such as flare and compression joints, victaulic couplings, sleeve type couplings, lapped joints, etc shall be used where required. Such joints shall conform to relevant

AWWA/ANSI codes for pressure piping for the services for which they are intended.

4.1.1.5 All lined steel pipework shall have seamless steel pipes, with flanged joints for each pipe length, which shall not exceed 2 metres for size DN 40, 3 metres for size DN 50 to DN 65 and 6 metres for larger sizes. Flanges shall also be provided at both ends of the pipe fittings, e.g. bends, tees, reducers, etc as well as for connection to equipment and valves.

4.1.1.6 All stainless steel pipelines shall be of butt or socket welded construction using shielded arc welding process. Flanges shall be provided on straight lengths at suitable intervals and at other joints as required for ease of maintenance and replacement.

4.1.1.7 For non-ferrous pipework such as those of deoxidized copper, aluminium, nickel, titanium and alloys of these metals, butt welded joints as per relevant ANSI codes or equivalent shall be adopted. Flanged joints shall be provided at suitable intervals and at connections to valves, accessories, equipment etc as required for ease of maintenance and replacement.

4.1.1.8 Joints shall be assembled ensuring the inside of all pipes, and fittings smooth, clean and free from burrs blisters, scale, welding slag, sand and dirt. The inside edges of pipes and tubings shall be reamed after cutting to remove burrs. Where required, the inside of the weld without backing rings shall be ground smooth.

4.1.1.9 Flange faces shall be free from particles of weld metal. Screwed orifices flanges shall be screwed-on tight with end of pipe projecting beyond the face of the flange and then the flange face and projecting end of pipe shall be machined to permit both pipe and flange to bear against the gasket.

4.1.1.10 Threaded joints shall be made up with a sealing compound, suitable for the service for which the pipework is intended. However, for oxygen and fuel gas pipework, no oil or grease shall be used; a soap and water mixture may be used when cutting threads for such pipework.

4.1.1.11 Cement lined steel pipes to AWWA C 205 shall be joined by butt welding of exposed steel pipe ends, followed by concrete lining of the exposed internal and external surfaces.

4.1.2 **Non-metallic Pipework**

4.1.2.1 Thermoplastic piping materials such as polypropylene, vinylidene flouride pipe (Kynar), polyethylene etc shall be made from fresh materials and not from recycled materials.

Such piping shall be jointed by thermal bonding (fusion welding) using a heat source and filler rod of suitable quality. Polyvinylchloride (PVC) pipes shall be preferably jointed by solvent cement bonding.

4.1.2.2 Flanged joints, using cemented and back welded flanges of the same materials shall be provided on pipework at intervals of 30 metres on straight runs and at connection to valves, accessories and equipment as required. All flanges shall adhere to relevant standards adopted by the U.S. Department of Commerce or equivalent, and suitable for the service conditions.

4.2 **Welding**

4.2.1 All jointing by electric arc and gas welding processes shall be as per IS:823, IS:9595, IS:10234 and IS:1323 or equivalent. However, the provisions of mandatory codes such as Indian Boiler Regulations, Explosive Manual, Petroleum and Carbide of Calcium Manual and IS:6044 (Part I & II), Fire Protection Manual of the Insurance Association of India etc shall be met where required. All welding of oxygen lines shall be done in conformity with practices recommended in ANSI B31.2 or approved equivalent.

4.2.2 Welded Carbon Steel Piping need not be stress relieved except where specified. Such stress relieving may be done by uniformly heating welded area with nichrome/induction coil to 660 $\pm$ 15 deg C, holding the temperature for one hour for each 25 mm of wall thickness or fraction thereof and then cooling at a rate not in excess of 315 deg C per hour in still air.

4.2.3 Alloy and stainless steel pipework shall be heat treated after welding and cold working in accordance with the relevant codes to maintain their composition and grain structure and to keep their strength and corrosion-resistant properties. Non-ferrous pipework need not be heat treated after welding or cold working.

4.2.4 All welding work shall be carried out by qualified welders; all filler materials, edge preparation, post-weld treatment etc shall be as per relevant strands. All welds shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond the root areas. The voltage, amperage, and polarity of welding current shall be accordance with the electrode manufacturer's recommendations. Reinforcement, if provided shall be applied in such a manner that it will have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used without approval of Engineer.

4.2.5 Pipe and attachments shall be aligned properly by accurate and permanent methods prior to welding. If tack welds are used, the tacks shall be either fused into the first layer of weld or else chipped out. All welds shall be built up by the application of multiple beads or passes; the thickness of metal deposited in each bead or pass shall not exceed 3 mm. Each bead shall be cleaned and, if not a work hardening material, shall be lightly peened before the next bead is laid. The complete weld shall be cleaned of slag and splatter metal oin all surfaces and the inside beads shall be ground smooth where practicable.

4.2.6 All welding by the shielded electro arc process shall be done using electrodes in accordance with the relevant standards. Composition of consumable electrodes or filler rods in case of non-consumable electrodes, shall be same as that of the parts being welded so that there is no dilution of the alloying components at the welded joints.

4.2.7 Bends, branches, reducers etc may be fabricated from pipes, by cutting and welding as above, where permitted by the service conditions given in Annexure - 1.

4.2.8 Field welding of pipe supports to primary structural members of buildings and crane rails etc and field burning or patching of structural members shall not be carried out without approval/guidance of the Engineer.

4.3 Bending

4.3.1 Metallic Pipework

4.3.1.1 Smooth bends may be fabricated by bending pipes. Cold bending may be adopted for DN 50 and lower size of pipes. For higher sizes, hot bending, if specified for carbon steel pipes shall be done at a temperature between 800°C and 1100°C. After hot bending, the pipe shall be allowed to cool slowly in still air.

4.3.1.2 Pipe bends shall be true to angle and shall have a smooth surface free of flat spots and wrinkles. Actual inside diameter at any portion of the pipe shall not deviate by more than ± 3 per cent from the inside pipe diameter. Thinning due to bending shall be not more than 12.5 per cent of nominal thickness.

4.3.1.3 Smooth bends shall have a radius of 3 times the nominal diameter, unless otherwise mentioned in Annexes.

4.3.1.4 Standard bends and elbows shall have dimensions as per relevant IS or equivalent code for the service. Bends and elbows shall have butt welding ends unless otherwise specified in the relevant Annex.

4.3.1.5 Mitred bends fabricated from pipes shall be used as per IPSS standard. Wherever large diameter pipe sizes do not cover in IPSS standard , the same shall be fabricated similar to IPSS standard for large diameter pipes .

4.3.1.6 For cast iron pipework standard bends with socket or flanged ends shall be used.

4.3.2 **Non-metallic Pipework**

4.3.2.1 Bends for non-metallic pipes shall be of the same materials as the pipe and shall be manufactured by moulding process to dimensional standards adopted by U.S. Department of Commerce or equivalent.

4.3.2.2 Mitred bends fabricated from pipes shall be used only after specific approval from Engineer. They shall have a radius of 3 times the pipe diameter and shall comprise at least 5 segments for a 90 deg bend.

4.4 **Other Pipe Fittings**

4.4.1 **Metallic pipework**

4.4.1.1 Other fittings such as tees, reducers etc shall conform to the specifications given in Annexes.

4.4.1.2 Site fabrication of bends, tees, reducers etc shall be avoided as far as possible.

4.4.2 **Non-metallic pipework**

4.4.2.1 Standard tees, reducers etc conforming to specifications adopted by U.S. Department of Commerce or equivalent shall be used.

4.4.2.2 Site fabrication of pipe fittings such as bends, tees, reducers shall be avoided as far as possible.

4.5 **Lining of Pipes**

4.5.1 Rubber lining of steel pipes for corrosive fluids shall be carried out as per IS:4682 (Part-I). Lining with other materials may be carried out as per the guidelines given in IS:4682 (Part II to VI) as applicable.

5.0 ERECTION

5.1 General

5.1.1 All pipework shall be erected in conformity with relevant ANSI codes or equivalent, for pressure piping.

5.1.2 Pipes shall be cut to measurement and installed without forcing or springing except where cold springing is explicitly specified.

5.1.3 Unions or flanges shall be installed in all piping connections to equipment, valves, instruments, steam traps and miscellaneous specials to facilitate dismantling for maintenance.

5.2 Supports for Overhead Pipework

5.2.1 All supports, anchors, hangers, spring supports, rollers, clamps, guides, sway bracings, vibration dampeners etc required for aligning, supporting and controlling the pipework shall be installed. These shall include all structural steel piping supports in open yards. The work shall include installation of such protection as may be needed to prevent mechanical damage to piping. Such installations shall be made in a manner satisfactory to the Engineer.

5.2.2 Unless otherwise approved by Engineer, the maximum unsupported horizontal span for ferrous, non-ferrous and thermo-plastic pipelines shall be generally followed as indicated in Table 2.

5.2.3 Timber or wire shall not be used as permanent support of pipework except where specifically indicated for hydraulic and lubrication pipework.

5.2.4 Vertical cast iron or steel pipework shall be supported at intervals of approximately 3,500 mm and at the base of each riser.

5.2.5 Vertical copper tubing shall be supported at approximately 3,000 mm intervals for piping of DN 40 and larger and 2,000 mm for DN 32 and smaller.

TABLE 2 - PIPE SUPPORT SPACING

Pipe size, mm	Maximum unsupported span, mm			
	Carbon, alloy stainless steel	Copper	Aluminium	Thermo Plastics

15 and below	1,500	1,500	1,500	C
20, 25, 32	2,000	2,000	2,000	C
40, 50, 65	3,000	3,000	3,000	1,000
80, 100, 150	4,000	4,000	3,000	1,000
200, 250	6,000	5,000	4,000	1,500
300, 350, 400	7,500	6,000	5,000	2,000
450 to 600	13,000	-	-	
750 to 1000	15,000	-	-	
1100 to 1500	18000			
1600 to 2000	24000			
2100 to 2500	27000			
2600 to 3000	28000			
3000 to 3600	30000			

NOTES:

(1) The symbol `C' means `continuous support'

(2) Supports shall be as shown in drawings approved for construction

5.3 Buried Pipework

5.3.1 General

MS pipes shall be laid in accordance to IS:5822.

5.3.1.1 All buried pipework 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 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 shall be obtained.

5.3.1.2 Non-metallic piping such as concrete pipes, plastic pipes shall be laid in accordance to IS:783 and IS:7634 respectively. Protection against mechanical damage, shall be provided by means of suitable protective construction such as anchors, earth covering above rocky layer.

5.3.1.3 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 falling of sides etc. All work shall be organised such that trench digging, pipe laying, testing and backfiling of trenches follow one another closely.

5.3.1.4 Large stones, rubble etc found during excavation shall be dumped far away to avoid damage to pipework during refilling. The trench bottom shall be levelled to the required levels keeping in view the pipe slopes required. In steeply sloping trenches, pipe anchors shall be provided at suitable locations.

5.3.1.5 Where loose earth is met during excavation, or where trench is very deep, side walls shall be shored properly with timber or other means.

5.3.2 **Carbon steel pipework**

5.3.2.1 Precautions shall be taken at all times to prevent damage to the coating and wrapping on the pipe and appurtenances by workmen or trespassers. During laying and at any other time while pipe is exposed, no person shall be permitted to walk on a pipe (or in, if lined) wearing boots or shoes with nails or other attachments that may injure the coating. Care must be exercised to prevent the dropping of tools, rivets and other materials on, and the dragging of heavy objects over a pipe, and other acts that would mar its coating and wrapping. Pipe handling slings and any blocking used in handling or storing pipe must be well padded to avoid damage to pipe coating.

5.3.2.2 Ends of coated pipes in the storage yard shall be closed by an approved head or barrier, unless otherwise specified. The heads or barriers shall not be removed until a pipe is about to be laid. Each day, at the close of work and when laying is not in progress, the open ends of a line shall be similarly protected. If it becomes necessary to backfill a trench before making connections to adjacent piping, the open ends shall be closed by suitable timber bulkheads.

5.3.2.3 After a pipeline has been laid on skids, it shall be thoroughly cleaned, inspected and any damage to the protective coating satisfactorily repaired while the pipe is suspended above the trench. The pipe shall then be lowered into place upon the subgrade and laid to the required line and grade.

5.3.2.4 After completion and acceptance of the field test on each major section of an underground pipeline, all testing media shall be removed from the section and all interior surface cleaned. All abrasions and other damages to the coating shall then be repaired as per clause 7.0 of this specification.

5.3.3 **Cast iron pipework**

5.3.3.1 All cast iron pipelines shall be laid in accordance with IS:3114 or relevant AWWA standards or equivalent. all bell and spigot ends shall be joined using rubber ring and cement mortar. Ductile iron pipes shall have "Tyton" type joints. Other methods of joining shall have prior approval of Engineer.

5.3.4 **Cement lined steel pipe**

5.3.4.1 Installation shall be carried out in accordance with AWWA Manual M 9 or equivalent.

5.3.4.2 Pipe trenches shall be backfilled after completion and acceptance of field tests, and repair of coating as required. The backfilling shall be done in 150 mm layers with ramming for proper consolidation.

5.3.4 **Road and track crossing**

5.3.4.1 All underground pipelines crossing rail tracks or roads shall be under a reinforced concrete culvert, or through reinforced concrete pipe sleeve. The annualar space between casing pipe and inner pipe at the ends shall be suitably sealed. Adequate encasement and earth coverage should be provided to restrict the pipe deflections with the limits specified in AWWA M11 or equivalent.

5.3.4.2 Wherever possible, the culvert or other protection shall extend beyond the ends of railroad ties or where such extension will interfere with other structures, the contractor shall submit specific designs embodying reinforced concrete wing walls or other protection for approval by the Engineer.

5.3.4.3 NP3 or NP4 Class concrete pipe sleeves as per IS:458 of 2,500 mm lengths, wherever practicable. The minimum size of a casing pipe shall be as given in Table 3.

TABLE 3 - CASING PIPE SIZES

DN of service pipe	Minium diameter of casing pipe	
	for flanged pipelines	for welded pipelines
mm	mm	mm
100	300	200
150	400	250
200	500	300
250	600	400
300	600	500
350	600	500
400	700	600
500	800	600
600	900	700

NOTE:

(1) In case of flanged pipeline, the pipe shall rest on approved saddles to permit clearances between the bottoms of the casing pipe and the flange.

5.3.5 Suitable anchors of concrete shall be provided at bends and other locations in a pipeline installed on ground or underground where unbalanced pressures may develop under normal or test pressure and tend to cause movement in the pipeline.

5.3.6 The contractor shall take precaution against the floating of the pipe due to water flowing into the trench. Incase of any damage to pipeline, the contractor shall suitably replace/repair the pipeline.

5.3.7 **Valve Chambers**

5.3.7.1 Valves on an underground pipeline shall be located in valve chambers with RCC manholes with covered in the RCC roof and access ladder. The chamber size shall enable free movement during maintenance and/or repair work to the valves. Chambers which because of their design or construction could become, in any way, hazardous to human life shall not be permitted.

5.3.7.2 The design shall incorporate sufficient escape provisions for personnel in the event of flooding or other emergency. A minimum of two manholes must be provided where, because of its size, maintenance or replacement of valves may require more than one person at a time. Manholes shall be of suitable size and shall be located on the roof in opposite locations. A separate rung ladder shall be provided at each manhole.

5.4 **Pipe Sleeves**

5.4.1 Pipe sleeves shall be provided for pipelines 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.

5.4.2 Sleeves in floors or roofs shall be projected sufficiently above the floor or roof to prevent drainage through them. Approved hoods and flashings shall be provided for sleeves and pipework passing through roofs. Where sleeves are located in floors, outside walls, walls of pressurised rooms or other similar installations, they shall be packed with mineral wool, grout or other approved material after installation of pipeline and ends closed with cover plates or other approved means.

5.4.3 Generally, sleeves shall be indicated on the drawings, but unless specifically shown as omitted, they shall be installed.

5.5 Structural Platforms and Supports

5.5.1 All required operating platforms, valve stands, access ladders, handrails etc shall be erected complete, after the piping has been installed. Structural steelwork in connection with those item shall conform to the relevant Indian Standards for Structural Steelwork.

5.6 Special Instructions for Fabrication and Erection

5.6.1 Fabrication, erection, testing and commissioning of oxygen pipework shall conform to the details given in Annexe-28.

5.7 LPG / Proapane

5.7.1 LPG/Proapane pipework shall meet the requirements of IS-6044, and shall be erected as per ANSI B 31.2/B 31.4 or equivalent. Care shall be taken that all parts as erected shall be free of oil, grease, scale and dirt.

5.7.2 Exposed pipelines shall not be erected under or near high voltage overhead power lines. Underground pipelines for LPG/ Propane Gas is not permitted to be laid in trenches/ tunnels.

5.8 Hydrogen Pipework

5.8.1 Care shall be taken that all parts, when in erected assembly, shall be free of oil, grease, scale and dirt. All components of hydrogen systems shall be cleaned in accordance with the service requirements.

5.8.2 Exposed pipelines shall not be erected under or near high voltage overhead power lines. Underground pipelines shall not be installed in trenches, ducts or tunnels occupied by power lines. Valves must never be placed in pits.

5.8.3 Trenches, ducts and tunnels shall be properly vented. In addition to the specification set forth in clause 5.3 for protection of lines under railway tracks or roadways, encasement for hydrogen pipelines shall be vented at both ends.

5.8.4 The contractor shall install such protection as may be needed to prevent mechanical damage to pipework. Such protection shall be made in a manner satisfactory to the Engineer or as shown in the drawings.

5.8.5 The pipelines shall be purged with nitrogen immediately before commissioning. No purging shall be required if a line is commissioned immediately after completion of the final pressure test with nitrogen.

5.8.6 DN 15 purging connections with approved valve (open end brass plugged) shall be provided on either side of main line sectionalising valves and at downstream side of main branch valves.

5.8.7 All station outlets and section shut off valves shall be identified by a metal tag attached to or placed in the immediate vicinity of the valves.

5.9 **Pipework for Water Supply and Sewerage**

5.9.1 Under the main railway tracks and for transportation of the hot goods, the pipelines shall be laid in a tunnel with provision of isolating devices.

Under other railway tracks and motor roads, the pipelines are allowed to be laid within RCC pipe sleeves.

5.9.2 Depth of laying the underground pipelines from the ground surface level shall be as follows (up to pipe top):

a) Not less than 1.2 m in areas subjected to temporary loads, viz. motor roads and railway tracks.

b) Not less than 1.0 m in areas not subjected to temporary loads.

5.9.3 Laying of pipes in the back filled soil shall be done after soil consolidation in layers for all the materials.

5.9.4 Water pipes inside the buildings shall be normally laid along the walls, columns and covering structures. If necessary, the pipes may be laid in trenches and tunnels.

5.9.5 In the production premises where wet cleaning is required, the watering cocks of DN 25 shall be provided from treated waste water net work pipeline. If treated waste water pipeline is not available, it is not to be provided from drinking and fire fighting water pipeline. Tapping from drinking water is not permitted for any other purpose other than drinking.

6.0 INSPECTION AND TESTING

6.1 General

6.1.1 All components of the pipework shall be subjected to visual inspection and testing as per the relevant codes specified. Routine and type tests for various components shall be performed at the manufacturer's works and test certificates including those for materials/equipment/ accessories shall be furnished.

6.1.2 The procedure for inspection and shop testing of pipework components at manufacturer's works shall conform to the General Conditions of Contract and the Technical Specifications.

6.2 Tests at Site

6.2.1 The pipework as erected shall be tested in sections at site for strength and leakage. For hydraulic tests, the test pressure shall be adopted as per Clause 3.1.5 except where Mandatory Regulations indicate otherwise.

6.2.1.1 Systems under vacuum conditions shall be tested at 1.5 kg/cm^2 greater than the nominal external pressure of the system.

6.2.1.2 Services having temperature of 400°C or above shall be tested at 2.5 times the PW.

6.2.1.3 Expansion joints and/or other elements intended for absorbing stresses through directional movement shall be separately tested at 1.25 times the PW or the pipe test pressure, whichever is higher.

6.2.1.4 Valves, traps, strainers, separators etc shall be tested as specified/approved by Engineer. Drainage, venting and similar systems shall be tested at 3 m water column.

6.2.1.5 Fire protection pipework shall be tested as per statutory regulations for these services, as applicable.

Steam and fuel gas pipework shall be tested as per Regulations for these services

6.2.2 Testing Procedure

6.2.2.1 Hydraulic Tests

In general, pipelines for all liquid services and steam shall be hydraulically tested for pressure, unless specified otherwise. Flushing oil or hydraulic fluid shall be used for testing of hydraulic systems. Welded joints shall be subjected to hand hammer test while under test pressure. The tests pressure shall be maintained until the entire section under test has been examined for leakage. Defects revealed by the tests shall be repaired, or defective parts replaced and the system retested.

6.2.2.2 **Pneumatic Tests**

Pneumatic tests shall be adopted for air and gas pipelines and instrument control air lines. Unless otherwise specified in the relevant Annexes or in the technical specifications, all these systems regardless of construction, shall be capable of withstanding without failures, leakage or permanent distortion, an internal pneumatic test pressure of 1.1 times the PN. The tests shall be performed with compressed air, dry compressed air or nitrogen as applicable with soap suds applied at all joints or points where leakage may occur. Defects revealed by the tests shall be repaired, or defective parts replaced and the system retested.

6.2.2.3 **Field Testing of the Designed Pipelines**

After the pipe has been laid and all joints completed, the trench may be backfilled leaving 600 mm on each side of the joints exposed till the line had been tested and approved. Bulkheads of plugs of a type which will not damage lining, pipe ends or threads shall be used in each section to be tested. Before applying the pressure, all air shall e expelled from the section under test. Field testing of pipelines for overhead and underground yard and shop pipework shall be followed as per VSP/G/-TEST-1.

6.2.2.4 **Testing Procedure**

The water pipelines or section thereof under testing shall be slowly filled to prevent possible water hammer and ease should be exercised to allow all the air to escape during filling operation. The test pressure (equal to 1.5 times the working pressure) measured at the lowest point of elevation shall be applied by means of pump. The duration of each pressure test shall be 2 hours minimum and during the test period there shall be no drop in the pressure.

During the test period there can be maximum 1 per cent pressure drop in case of pneumatic tests for air lines after temperature corrections. For fuel gas lines subjected to pneumatic tests, allowable pressure drop shall be as per relevant standards. Testing of oxygen , acetylene , LPG and Propane lines, hydraulic and lubrication lines shall be as per VSP/G/-TEST-1.

While a line is under pressure all visible leaks shall be prevented by tightening where possible. Other type of defective joints shall be cut and replaced. Any cracked or defective pipe, fittings, valve etc. shall be removed and replaced by the contractor with sound material and the test shall be repeated until the results are satisfactory. Defective

welds shall be repaired by removing the defective piece of pipe which caused the leak and rewelding. No weld leaks shall be replaced by mechanical caulking.

The contractor shall furnish the pumps, barrels, tanks, bulkheads, blanks, connections, test gauges and all other equipment necessary for pressure testing. Compressed air shall be arranged by the contractor from portable air compressors unless otherwise indicated by the Enginer. The contractor shall furnish, install and dismantle, all temporary lines to the system under test.

For fuel gas pipework and steam pipework as well as oxygen, LPG / Propane , nitrogen and hydraulic system pipework, radiographic tests shall be carried out for all welded joints as per relevant standards and as per the Mandatory Regulations. Radiographic tests shall meet the requirements of relevant IS/ASTM codes or equivalent. Contractor's scope of work shall include the certified interpretation of the radiographic films by a recognised international agency.

The contractor shall conduct all tests and keep proper records of all tests, duly certified by the Engineer. Values of line pressure and temperature as well as ambient conditions shall be taken at each 'reading'. The interval between the successive readings shall be 30 minutes unless otherwise directed by the Engineer. Tested pressure gauges, temperature indicators etc shall be used in duplicate for tests.

6.3.3 The contractor shall provide the pumps, barrels, tanks, bulkheads, blanks, connections, test gauges, and all other equipment necessary for pressure testing. Compressed air shall be arranged by the contractor from portable air compressors unless otherwise indicated by the Engineer. The contractor shall provide, install and dismantle all temporary lines to the system under test.

6.3.4 For fuel gas pipework , LPG / Propane, hydrogen, oxygen and hydraulic system pipework , radiographic/ultrasonic tests shall be carried out for welded joints as per relevant standards and Mandatory Regulations, as applicable and if specified in Technical Specification. Number of joints to be tested shall be as specified or as per relevant codes/standards. Radiographic/Ultrasonic testing of welded joints of steam lines, if required, shall be as per stipulations in Indian Boiler Regulations. Radiographic/ultrasonic tests for other lines shall meet the requirements of relevant IS/ASTM codes or equivalent. Contractor's scope of work shall include the certified interpretation of the results of radiographic/ ultrasonic tests by a recognised and approved agency.

7.0 PROTECTION COATING FOR BURIED STEEL PIPELINES

7.1 General

7.1.1 Unless otherwise specified in the Technical Specifications, all buried steel pipelines shall be given a corrosion protection coating, compatible with the saline soil conditions at Visakhapatnam. The coating shall not crack, scale off, sag, flow or loose bond under the working conditions.

7.2 Cleaning and Priming

7.2.1 The pipe to be coated shall be cleaned absolutely free from rust, scale and other foreign matters, as well as from oil, grease etc by an approved chemical or mechanical method.

7.2.2 The cleaned surfaces shall be given a coat of coal tar primer-cold application. The primer shall be allowed to dry hard before hot pipeline coating and wrapping.

7.3 Coating and Wrapping

For wrapping and coating of underground pipelines the Contractor shall consider the following procedure:

a) Wire brushing the pipe to remove all foreign debris.

b) Application of a coat of primer comprising of fibre, coal tar and solvent of density 0.92 g/cc and viscosity of 1000-2000 cps @150 gms/sq m. The primer shall be applied by brushing so as to produce effective bond between metal and subsequent coating of pipe coating membrane. Ends of the pipes shall be left without coating and wrapping for a distance of 230 mm for joints which shall be coated and wrapped manually at site after laying, welding and testing of pipeline.

c) The wrapping tape shall consist of three layers of high density polyethylene, three layers of polymeric mix and one layer of polyester. The same shall be applied under tension by heating the inner surface of the membrane by means of blow torch, melting the lower most polyethylene layer and softening the polymeric mix taking care that the centre core is not overheated and pressing the molten surface onto pipe so that no air is entrapped or voids are formed. The resulting coating shall be free from air, bubbles, irregularities. The wrapping and coating shall be done as per requirement indicated in IS:10221.

7.4 The contractor may also provide alternative coating such as coal tar epoxy coatings, tape coatings of PVC, polyethylene etc with suitable primers or bonding components. In such cases the detailed specification of such coatings, the mode of

application and the relative advantages and problems shall be stated clearly and Engineer's approval taken.

8.0 CATHODIC PROTECTION

8.1 All buried steel pipeline shall be given cathodic protection in addition to the coating described in Clause 7.0 wherever required.

8.2 'Sacrifificial anode' method shall be adopted for the cathodic protection. The contractor shall test the soil, measures its resistivity, select the metal to be used for the system and submit it for approval by Engineer. Where necessary, he shall conduct a current drainage survey to obtain integrated information about the variables.

8.3 Unless the survey reveals results to the contrary zinc anodes are preferred. The life of the protected system shall be capable of being extended by adding extra anodes to compensate for anodes sacrificed.

8.4 The cathodic protection system offered shall include all necessary electrical equipment, fittings, appurtenances etc necessary for the complete operation and maintenance of the system. One set of testing equipment shall also be included for installation checks. These shall include corrosion voltmeter/ammeter, reference electrodes and soil resistivity meter.

9.0 THERMAL INSULATION AND PAINTING

9.1 Painting and colour identification of pipework shall conform to General Specification for Painting (VSP-6.3/GS-P-01).

9.2 Thermal insulation for pipework shall conform to General Specification for Thermal Insulation (VSP-6.3/GS-M-06).

10.0 COMMISSIONING

10.1 General

10.1.1 The cleaning, flushing/purging and commissioning of the pipework shall be carried out after completion of hydraulic/pneumatic and other tests. Cleaning shall be carried out prior to erection as well as after erection as per these specifications.

10.2 Cleaning

10.2.1 The piping elements shall be thoroughly cleaned of all foreign matters such as scales, dirt, oil, grease etc by wiping and wire brushing before fabrication and erection/ assembly. All

components of hydraulic pipework and lubrication pipework shall be cleaned, degreased, pickled, passivated and commissioned as per the special instructions given in the relevant Annex. All components of oxygen pipelines shall be pickled/degreased as per relevant Annex.

10.3 **Flushing/Purging**

10.3.1 All pipelines shall be flushed/purged till all dirt, scales and foreign matters are removed immediately prior to commissioning. The minimum duration of purging/flushing shall be 30 minutes. During flushing, valves and pipelines accessories such as filters, cylinders, bearings, etc shall be isolated and by-passed where required.

10.3.2 Pipework for compressed air, steam and nitrogen shall be flushed with the fluids for which the pipework is intended, unless otherwise approved by Engineer. Fuel gas, oxygen, hydrogen and LP gas pipework shall be primarily flushed with nitrogen followed by the fluid for which the pipework as intended, slowly replacing the nitrogen.

10.3.3 Pipework for water, condensate, pressure and gravity type industrial sewerage, rinse water, acidic and alkaline effluents etc shall be flushed with water. The pipes for water system shall be flushed by making minimum 60% opening in the pipe that is flushed and the quantity of water that shall be used for flushing shall be more than the normal flow rate for which the pipe is designed. Temporary tappings/pipe connections shall be made for supply and return pipelines for flushing purpose. Each pipe shall be flushed 3 to 4 times at above flow rate and each time not less than 30 minutes. Bigger pipe size DN 1800 underground and above shall be cleaned manually by making temporary opening in the pipeline. Concentrated acid systems shall be flushed with water and completely drained prior to commissioning, unless otherwise approved by Engineer. Hydraulic and lubrication pipework shall be flushed with flushing oil. All cooling water pipelines shall be chemically passivated after flushing.

11.0 **DRAWINGS AND OTHER DOCUMENTS**

11.1 The following types of drawings and technical information shall be provided for pipework.

11.1.1 Routing drawings showing arrangement of pipework.

11.1.2 Isometric drawings for steam lines, stress analysis report in conformity with ANSI 31.1/31.3 .

11.1.3 O&M manuals for major equipment.

11.1.4 Catalogue information on components.

11.1.5 Component service sheets.

11.1.6 Diagrams showing the location of controls, instruments etc.

11.1.7 Bill of material listing components by name, catalogue designation, serial and/or design number etc.

11.1.8 Installation information.

11.1.9 Test reports.

11.1.10 List of spares and wearing parts.

11.1.11 Instructions for safety.

11.1.12 Instructions for stoppage, dismantling, cleaning and re-commissioning.

ANNEXE - 1

LINE CODES, WORKING AND DESIGN PARAMETERS OF FLUIDS

Sl. No.	Service	Line Code	Max.working Pressure (PW), kscg	Design Temperature Deg C	Design Velocity m/s	Applicable Annexe	Pipe thickness Schedule (Ref Annexe-27)
1.	Compressed air - Plant air	33	8	60	8 to 10	2	A
2.	Compressed air - Dry air	34	7	60	8 to 10	2	A
3.	Coke oven gas - HP	21(6)	6	60	8 to 10	2	A
4.	Nitrogen	26(10)	10	60	8 to 10	2	A
5.	Argon	27(7)	7	60	8 to 10	2	A
6.	Nitrogen - 99.9% pure	26(40)	40	60	8 to 10	3	C
7.	Oxygen 95% pure	25	16	60	8	4	D
8.	Oxygen - 99.5%	30	40	60	8	5	C
9.	Liquified petroleum gas	71(1.5)	1.5	60	8	6	B
10.	Propane	82	1.5	45	8	6	B
11.	Hydrogen	37	1.5	60	8	6	B
12.	Liquified petroleum gas (LPG)	71	8	60	1 to 2	7	B
13.	Clean Blast furnace gas	22	0.15(Normal)	40/105*	15	8	F
14.	Coke oven gas (COG)	21(0.15)	0.15	40/105*	15	8	F
15.	Mixed gas (MG) (CO+BF)	23	0.13	40/105*	15	8	F
16.	Converter gas (LDG)	24	0.15	60	15	8	F
17.	Feed water (FDW)	18F	150	230	3	9	G
18.	Steam	31(12)	12	300	30	12	I

Sl. No.	Service	Line Code	Max.working Pressure (PW), kscg	Design Temperature Deg C	Design Velocity m/s	Applicable Annexe	Pipe thickness Schedule (Ref Annexe-27)
19.	Steam	31(3)	3	150	30	12	I
20.	Condensate - (Pressure)	32	6	170	2	13	B
21.	Condensate - (Gravity)	32(a)	6	170	1.5	13	B
22.	Hydraulic fluids	HF(150)	150	85	1 to 4 max (For pressure line on discharge side of main pumps and on A, B lines)	14	-
23.	Hydraulic fluids -	HF(250)	250	85	1 to 6 max (For pressure line on discharge side of main pumps and on A, B lines)	15	-
24.	Roll coolant (RC)	RC	10	60	2	16	-
25.	Oil lubricant (OL)	OL	10	80	1 to 3 max (On discharge side of pumps and on feed oil lines)	17	-
26.	Grease	GR	210	60	2	18	-
27.	Grease	GR	400	60		19	
28.	Fuel oil	41	12	100	1.5	20	J
29.	Low sulphur heavy stock oil	41L	12	100	1.5	20	J
30.	Coal tar fuel	42	12	100	1.5	20	J
31.	Drinking water	1	(10)	35	2	23	
32.	Fire fighting water	1F	(10)	35	2	21	
33.	Fresh water (make-up)	2	(10)	35	2	21	

Sl. No.	Service	Line Code	Max.working Pressure (PW), kscg	Design Temperature Deg C	Design Velocity m/s	Applicable Annexe	Pipe thickness Schedule (Ref Annexe-27)
34.	Cold water for clean recirculating cycle (supply)	3	(10)	35	2 to 2.5	21	
35.	Hot water for clean recirculating cycle (pressure return)	4	(10)	60	2 to 2.5	21	
36.	Hot water for clean recirculating cycle (gravity return)	4a	(10)	60	1	21	
37.	Clarified cold water of contaminated recirculating cycle (supply)	5	(10)	35	2 to 2.5	21	
38.	Waste hot water of contaminated recirculating cycle (pressure return)	6	(10)	60	2 to 2.5	21	
39.	Waste hot water of contaminated recirculating cycle (gravity return)	6a	(10)	60	2	21	
40.	Soft cold water (supply)	7	(10)	40	2	21	
41.	Soft hot water (return)	8	(10)	60	2	21	
42.	Sludge water (pressure) (including ash slurry)	9	(10)	60 to 90	2	24	
43.	Sludge water (gravity)	9a	(10)	60 to 90	2	24	
44.	Acidic and alkaline sewerage (pressure)	10					
45.**	Acidic and alkaline sewerage (gravity)	10a					
46.**	Chilled water (supply)	14				21	
47.**	Chilled water (return)	15				21	
48.	Filtered water	16	(10)	35	2	21	

Sl. No.	Service	Line Code	Max.working Pressure (PW), kscg	Design Temperature Deg C	Design Velocity m/s	Applicable Annexe	Pipe thickness Schedule (Ref Annexe-27)
49.**	Chemically treated deaerated water	17					
50.	Chemically treated water (soft make-up)	17F	(10)	35	2	21	
51.**	Demineralised deareated water	18	(10)	40	2		
52.	Emergency water	E	(10)	35	2	21	
53.	Industrial waste effluents (pressure)	19	(10)	60	2	21	
54.	Industrial waste effluents (gravity)	19a	(10)	60	1	21	
55.	Hot water of recirculating cycle from metal conditioning units (pressure)	20	(10)	60	2 to 2.5	21	
56.	Hot water of recirculating cycle from metal conditioning units (gravity)	20a	(10)	60	1	21	
57.	Demineralised make-up water	DMMu	(10)	35	2	22	
58.	Demineralised water (supply)	DM(S)	(10)	40	2 to 2.5	21	
59.	Demineralised water (return)	DM(R)	(10)	60	2 to 2.5	21	
60.**	Contaminated B.F. gas	22(d)					
61**.	Acetylene	28					
62.**	Semi-clean B.F. gas	29					
63.**	Hot water	35					
64.**	Blast air	36					
65.*	Light diesel oil	41D					

Sl. No.	Service	Line Code	Max.working Pressure (PW), kscg	Design Temperature Deg C	Design Velocity m/s	Applicable Annexe	Pipe thickness Schedule (Ref Annexe-27)
66.**	Dehydrated coal air	42D					
67. *	Aviation oil MC-14	43(14)					
68.*	Aviation oil MC-20	43(20)					
69.*	Engine oil AE-5	44(5)					
70.*	Transmission oil II-28	45(28)					
71.*	Transmission engine oil GOST 547-50	45(TA)					
72.*	Turbine oil T-30	47(30)					
73.*	Industrial oil II C-30	47(30)					
74.*	Industrial oil I C-50	47(50)					
75.*	Cylinder oil 24	48(24)					
76.*	Cylinder oil 38	48(38)					
77.*	Raw water	72	(10)	35	2	21	
78.*	Water for construction	73	(10)	35	2	21	

NOTE:

1.(*) Fluids required for localised services to equipment only, where material specification, operating conditions etc. are not indicated.

2.(**) Fluids required for network services to systems, where operating parameters are not indicated.

3. Working pressures indicated in brackets, e.g. (10), are considered as design pressures.

4$ During steam purging design temperature will be 105 deg C

ANNEXE - 13

Specifications for Condensate

Sl. No.	Item	Nominal dia DN, mm	Specification
1.0	Pipe	15 to 150	ASTM A106 Gr. B or equivalent, seamless, black.
		200 to 450	API 5L Gr. B Seamless
2.0	Pipe fittings		
2.1	Welded fittings		
2.1.1	Bends	50 and below	Fabricated from pipes by cold bending with 3 DN radius/ forged carbon steel, SW, 3000 lbs, ASTM A105, ANSI B16.11
		65 to 200	Seamless B.W. elbow to ASTM A-234 Gr. WPB Sch. 40, dimension to ANSI B 16.9
		200 and above	Mitred bends with radius 1.5 DN, made from pipes
2.1.2	Tees/reducers	50 and below	Forged carbon steel, 3000 lbs, SW, ASTM A105, ANSI B16.11
		65 to 200	Seamless B.W., carbon steel to ASTM A-234 Gr. WPB Sch. 40. Dimension to ANSI B16.9
		200 and above	Fabricated from pipe
3.0	Bolting	All sizes	IS:1367
4.0	Gaskets	All sizes	Compressed asbestos to IS:2712, Gr. W/3, 1.5 mm thick
5.0	Flanges	All sizes	Plate flanges to IS:6392, Table-17, made from carbon steel plates to IS:2002 Gr. 2A, with bore to suit pipe O.D.

Sl. No.	Item	Nominal dia DN, mm	Specification
6.0	Valves		
6.1	Isolation	50 and below	Forged steel gate valve, body to ASTM A105 rising S.S. spindle, trim to ASTM A182, Gr. F6 screwed ends
		65 to above	C.I. gate valve generally as per IS:14846, PN 1.6, with SS rising stem and trim, flanged ends.
6.2	Throttling	50 and below	Forged steel globe valve with regulating type discs, with SS rising stem, body to ASTM A105 and trim material to A182, Gr. F6, screwed ends
		65 and above	C.I. globe valve with regulating type discs , SS rising stem and trim, suitable for pressure rating of PN 1.6 MPa, flanged ends.
6.3	Non-return	50 and below	Forged steel check valve, body and cap to ASTM A105 and trim material to ASTM A182, Gr. F6, screwed ends.
		65 and above	CI swing check valve, as per IS:5312 (Part-I), flanged ends.
7.0	Strainer		Strainer with cast iron body and brass strainers of 16 g sheet with1.25 mm dia perforation @ 20 per sq. cm. Ends screwed / flanged
8.0	Hose assembly		Metallic hoses of 15 m length complete with screwed female swivel couplings at both ends.

NOTES:

(1) For special valves, refer ANNEXE-29.

(2) Rating and drilling details of companion flanges for valves shall match with respective valve flanges.

ANNEXE - 27

DIMENSIONAL STANDARDS FOR STEEL PIPES

(I) **PIPE THICKNESS SCHEDULE: A**
For Services: CA, IA, NT(10), AR, COG - HP
(Applicable ANNEXE – 2)

Nominal dia DN, mm	OD mm	Nominal thickness IS:1239 (Part I) (See Note 2)
15	21.8	2.6
20	27.3	2.6
25	34.2	3.2
40	48.8	3.2
50	60.8	3.6
65	76.6	3.6
80	89.5	4.0
100	115.0	4.5
125	140.8	4.8
150	166.5	4.8

		API 5L Gr B (ERW) IS:1978 Yst. 25 (ERW)
200	219.1	4.78
250	273.1	5.56
300	323.9	6.35
350	355.6	7.92
400	406.4	7.92
450	457.2	7.92

		IS : 3589	API 5LS Gr. B
500	508.0	7.0	6.35
600	609.6(610.0)	8.0	6.35
700	711.2(711.0)	8.0	7.92
800	812.8(813.0)	8.0	7.98
900	914.4(914.0)	8.0	7.92
1000	1016.0	10.0	9.53
1100	1117.6(1118.0)	10.0	9.53
1200	1220.0(1219.0)	10.0	9.53
1400	1420.0(1422.0)	10.0	9.53
1600	1620.0(1626.0)	10.0	10.31

NOTES:
(1) For nominal dia 500 mm to 1600 mm, OD indicated within brackets corresponds to API 5 LS, wherever they are different from OD for IS:3589 pipes.
(2) For pipes to IS: 1239 (Part I), thickness are for medium grade ERW or seamless pipes, as applicable.

(II) **PIPE THICKNESS SCHEDULE: B**

For Service: LPG(L), LPG (G), PG, H2, CD (P), CD(G)
(Applicable ANNEXE – 6, 7, 13)

Nominal dia DN, mm	OD mm	Nominal thickness, mm ASTM A106 Gr.B (Seamless)	API 5L Gr.B (Seamless)
15	21.3	2.8	-
20	26.7	2.9	-
25	33.4	3.4	-
40	48.3	3.7	-
50	60.3	3.91	-
65	73.0	5.16	-
80	88.9	5.49	-
100	114.3	6.02	-
125	141.3	6.55	-
150	168.3	7.11	-
200	219.1		6.35
250	273.1		6.35
300	323.9		6.35
350	355.6		6.35
400	406.4		7.92
450	457.0		7.92
500	508.0		9.53
600	610.0		9.53

(III) **PIPE THICKNESS SCHEDULE : C**

For Services: NT (40), OX (40)
(Applicable ANNEXE-3, 5)

Nominal dia DN, mm	OD mm	Nominal thickness, mm ASTM A106 Gr.B (Seamless)	API 5LGr.B (Seamless)
15	21.3	3.73	-
20	26.7	3.91	-
25	33.4	4.55	-
40	48.3	5.08	-
50	60.3	5.54	-
65	73.0	5.16	-
80	88.9	5.49	-
100	114.3	6.02	-
125	141.3	6.55	-
150	168.3	7.11	-
200	219.1	-	8.18
250	273.1	-	9.27
300	323.9	-	10.31
350	355.6	-	11.13
400	406.4	-	12.70
450	457.0	-	14.27
500	508.0	-	15.09
600	610.0	-	17.48

(IV) **PIPE THICKNESS SCHEDULE: D**
For Service: OX (General Purpose)
(Applicable ANNEXE-4)

Nominal dia DN, mm	OD mm	Nominal thickness, mm ASTM A106 Gr.B (Seamless)	API 5L Gr.B (Seamless)
15	21.3	3.73	-
20	26.7	3.91	-
25	33.4	4.55	-
40	48.3	5.08	-
50	60.3	5.54	-
65	73.0	5.16	-
80	88.9	5.49	-
100	114.3	6.02	-
125	141.3	6.55	-
150	168.3	7.11	-
200	219.1	-	8.18 (6.35)
250	273.1	-	9.27 (6.35)
300	323.9	-	10.31 (6.35)
350	355.6	-	11.13 (7.92)
400	406.4	-	12.70 (7.92)
450	457.0	-	14.27 (7.92)
500	508.0	-	15.09 (9.53)
600	610.0	-	17.48 (9.53)

NOTE: Nominal thicknesses indicated within parenthesis are applicable for low pressure Oxygen Service at 6 to 8 kscg (e.g. GPO)

(V) **PIPE THICKNESS SCHEDULE NO: E**
For Service: MPST
(Applicable ANNEXE-11)

Nominal dia	OD	Nominal thickness , mm ASTM A 335, Gr.P12 ASTM, A 106, Gr. B	DIN 17175, 13 Cr Mo 44
DN, mm	mm		
15	21.3	3.73	2.0
20	26.7 (26.9)	3.91	2.3
25	33.4 (33.7)	4.55	2.6
40	48.3	5.08	2.9
50	60.3	3.91	3.2
65	73.0 (76.1)	5.16	3.6
80	88.9	5.49	4.0
100	114.3	6.02	4.5
125	141.3 (139.7)	6.55	5.0
150	168.3	7.11	5.6
200	219.1	8.18	7.1
250	273.1 (273.0)	9.27	8.8
300	323.9 (323.3)	10.31	10.0
350	355.6	11.13	10.0
400	406.4	12.70	11.0
450	457.0	14.27	12.5
500	508.0	15.88	14.2
600	610.0	19.05	16.0

NOTE: OD indicated within brackets corresponds to DIN 17175, wherever they are different from OD for ASTM pipes.

(VII) **PIPE THICKNESS SCHEDULE : G**

For Service: FDW

(Applicable ANNEXE-9)

		Nominal thickness. mm	
		ASTM A 106	DIN 17175
Nominal dia	OD	Gr B	St 45.8
DN, mm	mm		
15	21.3	4.78	3.6
20	26.7(26.9)	5.56	4.0
25	33.4(33.7)	6.35	4.5
40	48.3	7.14	6.3
50	60.3	8.74	7.1
65	73.0(76.1)	9.53	8.0
80	88.9	11.13	10.0
100	114.3	13.49	11.0
125	141.3(139.7)	15.88	14.2
150	168.3	18.26	16.0
200	219.1	23.01	20.0
250	273.1(273.0)	28.58	25.0
300	323.9(323.3)	33.32	28.0
350	355.6	35.71	30.0
400	406.4	40.49	36.0
450	457.0	45.24	40.0
500	508.0	50.01	45.0
600	610.0	59.54	50.0

NOTE : OD indicated within brackets corresponds to DIN 17175 wherever they are different from OD for ASTM pipes.

(VIII) **PIPE THICKNESS SCHEDULE : H**

For Service: HPST

(Applicable ANNEXE-10)

		Nominal thickness. mm	
		ASTM A 335	DIN 17175
Nominal dia	OD	Gr P 22	10 Cr Mo 910
DN, mm	mm		
15	21.3	4.78	4.0
20	26.7(26.9)	5.56	4.5
25	33.4(33.7)	6.35	5.6
40	48.3	7.14	7.1
50	60.3	8.74	8.8
65	73.0(76.1)	9.53	11.0
80	88.9	11.13	12.5
100	114.3	17.12	16.0
125	141.3(139.7)	19.05	20.0
150	168.3	21.95	22.2
200	219.1	-	25.0
250	273.1(273.0)	-	30.0
300	323.9(323.3)	-	36.0
350	355.6	-	40.0
400	406.4	-	45.0
450	457.0	-	50.0
500	508.0	-	55.0
600	610.0	-	65.0

NOTE: OD indicated within brackets corresponds to DIN 17175 wherever they are different from OD for ASTM pipes.

(IX) **PIPE THICKNESS SCHEDULE : I**

For Services: LPST

(Applicable ANNEXE - 12)

Nominal dia DN, mm	OD mm	Nominal thickness, mm ASTM A106 Gr. B (Seamless)
15	21.3	3.73
20	26.7	3.91
25	33.4	4.55
40	48.3	5.08
50	60.3	3.91
65	73.0	5.16
80	88.9	5.49
100	114.3	6.02
125	141.3	6.55
150	168.3	7.11
200	219.1	7.04
250	273.1	7.80
300	323.9	8.38
350	355.6	9.53
400	406.4	9.53
450	457.0	9.53
500	508.0	9.53
600	610.0	9 53

(X) **PIPE THICKNESS SCHEDULE : J**

For services - FO/LSHS/CTF

(Applicable ANNEXE - 20)

Nominal dia DN,mm	OD mm	API 5L Gr.B (ERW) IS:1978 Yst 25 (ERW)
200	219.1	4.78
250	273.1	5.56
300	323.9	6.35
350	355.6	7.92
400	406.4	7.92
450	457.2	7.92

NOTE: For nominal dia upto 150 mm refer pipe thickness Schedule: A

(XI) **PIPE THICKNESS SCHEDULE: K**

For all the services marked in ANNEXE-21, 23

Nominal dia mm	OD mm	Nominal thickness, mm IS:1239 (Part-I), Heavy, ERW black
15	21.8	3.2
20	27.3	3.2
25	34.2	4.0
32	42.9	4.0
40	48.8	4.0
50	60.8	4.5
65	76.6	4.5
80	89.5	4.8
100	115.0	5.4
125	140.8	5.4
150	166.5	5.4

		API 5L Gr.B (ERW)
200	219.1	7.0
250	273.1	7.1
300	323.9	7.1
350	355.6	7.1
400	406.4	7.92
450	457.0	7.92
		Spiral welded pipes of Rourkela Commercial Quality
500	508.0	7.92
600	610.0	9.53
700	711.0	9.53
800	813.0	9.53
900	914.0	9.53
1000	1016.0	9.53
1100	1118.0	10.0
1200	1219.0	10.0

NOTE: For Drinking Water Service Galvanised pipe shall be used upto DN 100

(XII) **PIPE THICKNESS SCHEDULE : L**
For Service: SW(P), SW(G)
(Applicable ANNEXE-24)

		Nominal thickness, mm	
Nominal dia DN, mm	OD mm	IS:1239 (Part-I) (Heavy, ERW)	Rolled from Plates to IS:3589/Rourkela Commercial Quality
15	21.8	3.2	-
20	27.3	3.2	-
25	34.2	4.0	-
32	42.9	4.0	-
40	48.8	4.0	-
50	60.8	4.5	-
65	76.6	4.5	-
80	89.5	4.8	-
100	115.0	5.4	-
125	140.8	5.4	-
150	166.5	5.4	-
200	219.1	-	10
250	273.0	-	10
300	323.9	-	10
350	355.6	-	10
400	406.4	-	10
450	457.2	-	10
500	508.0	-	10
600	609.6	-	10
700	711.2	-	12
800	812.8	-	12
900	914.4	-	12
1000	1016.0	-	12
1200	1220.0	-	12

ANNEXE - 29

SPECIAL VALVES AND ACCESSORIES

1.0 PRESSURE REDUCING VALVES (PRESSURE REGULATORS)

1.1 General

Irrespective of specified variations in upstream pressure, these shall maintain a reduced constant pressure on the downstream side of pipelines on which they are mounted. The valve shall be of globe/ needle type, with material specifications, dimensional standards etc. as per the relevant ANNEXE for the service for which the valve is intended. The valves shall be actuated by internal pilot diaphragm or piston. The downstream pressure shall have an adjustable range, within which the required value can be set manually.

1.2 For Compressed Air

Pressure regulators of sizes up to DN 50 shall be complete with a prefilter having 40 micron porous bronze filtering element in shatterproof plastic or glass container, pressure regulator and pressure relief arrangement to prevent overpressure at downstream of the regulator.

For higher sizes to meet larger flow rates, the pressure regulator shall be self actuating type as per manufacturers' standards, but capable of meeting the service conditions and duty specified.

1.3 For Steam

For sizes up to DN 50, pressure reducing valves of single seated diaphragm type having in-built strainer, with screwed ends up to DN 20 for PN 10 and below and flanged ends for higher sizes and for higher PN. Body of main and pilot valves shall be of cartoon steel/alloy steel castings/forging, diaphragms shall be of stainless steel, internal springs of stainless steel and pressure adjustment springs of spring steel.

For higher sizes to meet larger flow rates, the pressure reducing valves shall be as per manufacturer's standards, but capable of meeting the service conditions and duty specified.

1.4 For dry air, nitrogen and argon the pressure reducing valves shall be of stainless steel. For oxygen service, the valve shall be of bronze construction and shall be decreased and cleaned to meet the service requirements.

1.5 For acetylene and LP gas services, the pressure regulators shall have material for the service. For acetylene, the materials of construction shall not have copper in excess of 70 per cent by composition.

1.6 Pressure regulators for large diameter gas lines shall comprise butterfly type valves actuated by means of an oil hydraulic control system, which is actuated in turn by changes in the preset downstream pressure through impulse pipework.

2.0 SAFETY SHUT-OFF VALVES

These shall shut-off in case the pressure on the upstream side of the valve becomes less than preset values. The valves shall generally be of globe type for DN 50 and below and butterfly type for DN 65 and above; the material shall be suitable for service conditions. The valves shall be actuated by electromagnetic or pneumatic devices working in conjunction with pressure switches located on the pipelines being safeguarded and shall include all components required for its functioning.

3.0 MOTOR CONTROLLED VALVES

These shall be actuated by electric motors through reducing gears. The valves shall be in accordance with the specifications in relevant ANNEXE. The drive assembly for the valve shall consist of a drive motor, transmission gear, limit switches for on-off control. Valves having proportional control shall have rheostat and transformer/rectifier, as required. The drive assembly shall. be enclosed in a suitable casing and internally wired and ending with terminals suitable for connection to a source of power supply having voltage as specified.

4.0 ELECTROMAGNETIC VALVES

These shall be actuated by electromagnetic actuators. The valves shall be in accordance with the specifications laid down in relevant ANNEXE. The actuator shall consist of electromagnet, limit switches and transformer/rectifier, as required. The actuators shall be enclosed in a suitable casing.

5.0 RELIEF/SAFETY VALVES

These shall he of spring loaded type and shall automatically open when the pressure on the pipelines, on which they are mounted, exceed preset values. The valves shall leave end connections and materials specified for throttling valves in relevant ANNEXE.

Relief/Safety valves for steam service shall have IBR certification. Relief valves shall have hand wheel/wrench for adjustment of preset value of relief pressure.

6.0 AUTOMATIC AIR RELEASE VALVES

These shall release air from water lines on which they are mounted. They shall be as follows:

a) Cast iron, small orifice, single air valve with screwed isolating stop cock, threaded encl, for sizes DN 25 and below,

b) Cast iron, double air valve with gun metal / bronze screwed down isolating valve, flanged end, for sizes DN 40 and above.

7.0 FLOAT VALVES FOR WATER

These valves shall automatically open or shut-off water supply to tanks depending upon water level in the tanks. They shall conform to IS:1703.

8.0 LABORATORY COCKS

8.1. Water Services

Water cocks shall be as follows:

i) Swan-neck (removable) screwed down tap DN 15 with two DN 15 inlets for hot & cold water, each complete with a tap, of brass construction with chromium plated finish;

ii) Three way swan-neck (removable) screwed down tap of DN 15 with two DN 8 side taps (plug type) with angle noses, of brass construction with chromium plated finish;

iii) Swan-neck (removable) screwed down tap of DN 1.5, of brass construction with chromium plated finish;

iv) Three-way water tap with three screwed down bib taps on 15 mm brass pillar, of brass construction with chromium plater finish.

8.2 Fuel Gases

Fuel gas cocks shall be as follows:

i) Two-way DN 8 horizontal. outlet taps (plug type) with DN 15 vertical inlet, suitable for bench fittings, of M.S. construction with chromium plated finish or SS construction;

ii) Three-way DN 10 horizontal outlet taps (plug type) with DN 15 vertical inlet, suitable for bench fittings, of M. S. construction with chromium plated finish or SS construction;

iii) Two-way DN 15 horizontal outlet taps (plug type) with DN 15 horizontal inlet, suitable for bench fittings, of M. S. construction with chromium plated finish orbs construction.

9.0 BUTTERFLY VALVES

Where specified, butterfly valves may be used for pipeline isolation in water, compressed air, or fuel gas lines. Butterfly valves shall be of Cl or fabricated carbon steel. Manually actuated valves shall have actuating handle with pointer and graded quardant showing area of opening, locking arrangement to fix valve at desired openings etc. Valves with motor or gear actuation shall have suitable connections complete in all respects. Valves shall be flanged, unless otherwise specified.

10.0 THERMOSTATIC TEMPERATURE CONTROLLER FOR STEAM

This shall be provided to regulate the flow of steam to heating elements in vessels and heat exchangers so as to keep the heated fluid within a preset range of temperature. The thermostatic controllers shall be provided as specified for pipe sizes DN 40 and below and for steam having PW not in excess of 15 kscg and temperature less than 280°C. The controller shall be complete with C.S./gun metal globe valve, connected to a mechanism containing actuating spring and brass bellows assembly to which a suitable length of copper bulb its connected. The bulb is connected to the vessel at a location where the preset temperature of the heated fluid is to be maintained. The entire assembly shall have IBR approval. The unit shall have screwed/ flanged end connections to suit service conditions.

11.0 SIGHT FLOW INDICATOR

These shall be provided as specified for horizontal pipework or vertical
pipework having upward flow, for transparent or slightly opaque solutions and for gases. The indicator shall have flanged ends, and shall have materials compatible with service conditions. The unit shall have a gauge glass and an internal indicator (flapper) and shall conform to manufacturer's standards.

12.0 WATER FLOW METER

For drinking water pipework of DN 50 and helow, domestic type inferential vane wheel dry dial type water meters to IS: 779 shall be provided. For larger size drinking water pipes, bulk type spiral-vane-wheel water meters with in-built stream director and suitable (graphitic ebonite. type) bearings shall be provided, unless specified otherwise. The bulk type meter shall conform to IS:2373.

13.0 SEPARATORS

For separating water in steam or compressed air lines, separators shall be provided as specified. These shall be of C.S for steam and gun metal for compressed air, with screwed/flanged ends and shall have draining' arrangement. For steam service, the separators shall have IBR approval.

14.0 MULTIPORT VALVES

Three-way and four-way valves shall be of taper plug type or ball plug type. Material and dimensional standards shall conform to those for straight-through plug/ball valves for the service as given. in the relevant ANNEXE. Valves shall be provided as specified in the Technical Specifications. These shall have flanged ends.

RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION NO. VSP-6.3/GS-M-04

FOR

CHILLED WATER PLANT, AIRCONDITIONING AND VENTILATION SYSTEMS

MARCH 2006

M.N. DASTUR & COMPANY (P) LTD
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RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION

FOR

CHILLED WATER PLANT, AIR CONDITIONING AND VENTILATION SYSTEMS

1.0 GENERAL

1.1 This specification covers chilled water plant, air conditioning and ventilation systems required for various plant areas.

1.2 The chilled water plant shall be of vapour compression type, complete with cooling towers and water circulation system.

1.3 The air conditioning systems shall be provided by installing air handling units using the chilled water generated from the chilled water plant. Also depending on the application, package type air-conditioners, split type air conditioners, and window model air conditioners shall be installed to cater to requirement of air conditioning at different premises.

1.4 Ventilation systems shall be provided at hydraulic cellars, oil cellars by means of centrifugal fans. The air will be distributed to the cellars through ductwork and grilles. Cable cellars, cable vaults, cable basements, cable tunnels, hydraulic room etc. shall be ventilated by providing tube axial fans.

1.5 Air conditioning and ventilation systems shall be provided for conditioning the air to specified limits of temperature and humidity as required and to have adequate air changes in the working premises for human comfort and for equipment cooling.

1.6 The design and construction of the air conditioning and ventilation systems shall be suitable in every way for the service intended and oriented towards maximising interchangeability and minimising maintenance. Each system shall be complete in all respects including all accessories essential for proper installation, operation and maintenance irrespective of whether such items are specifically mentioned in the Technical Specification (TS) and General Specification (GS).

1.7 If there is any contradiction between Technical Specification (TS) and, General Specification (GS), the stipulations of Technical Specification will govern.

2.0 STANDARDS AND OTHER REGULATIONS

2.1 The air conditioning and ventilation systems shall be designed to conform to the Standards, Codes and Regulations as applicable and in general shall comply with the requirement of BIS, ASHRAE and TEMA as stated below.

2.2 List of applicable Indian Standards :

Sl.No.	Number	Title
1	IS:277, 1992	Galvanised Steel
2	IS:655, 1963 reaffirmed 1991	Sheet metal ducting work for air conditioning/ventilation
3	IS:659, 1964 reaffirmed 1991	Safety Code for air conditioning
4	IS:2312, 1967 reaffirmed 1991	Propeller type fans
5	IS:3588, 1987 reaffirmed 1991	Electrical axial flow fans
6	IS:4894, 1987 reaffirmed 1991	Centrifugal fans
7	IS:5111, 1993	Testing of refrigerant compressors
8	IS:6595(2)-1993	Horizontal Centrifugal pump for clear cold water
9	IS:7613, 1975 reaffirmed 1991	Method of testing of panel type air filter for AC
10	IS-10609-1983 reaffirmed 1991	Refrigerants – Number and designation
11	IS-11327-1985 reaffirmed 1991	Requirement for refrigerant condensing unit
12	IS:12065 – 1997	Permissible limits of noise level for rotating electrical machines
13	IS:12075 – 1987 reaffirmed 1991	Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher measurement, evaluation and

limits of vibration severity

2.2 List of applicable chapters of ASHRAE Handbook :

2.2.1 ASHRAE Handbook 1997 – Fundamentals : Chapters 1, 3, 6, 18, 19, 20, 25, 28, 32 and 33.

2.2.2 ASHRAE Handbook 1996 – HVAC Systems and Equipment : Chapters 1, 2, 3, 5, 16, 17, 18, 20, 21, 34, 35, 36, 38, 40, 41 and 43.

2.2.3 ASHRAE Handbook 1999 – HVAC Applications : Chapters 11, 28 and 46.

2.3 Heat exchangers shall be designed as per TEMA(Eighth edition) Class "C" exchangers.

3.0 AIR CONDITIONING AND VENTILATION SYSTEMS

3.1 Heat generated within electrical and non-electrical premises shall be taken out by properly designed air conditioning and ventilation systems to achieve the specified room inside conditions. The air conditioning and ventilation systems shall be designed in consideration to the standards stated above. The areas where controlled and specific room inside conditions are required to be maintained, air-conditioning systems shall be provided at those areas.

3.2 **Information of Plant Site and Design Ambient Condition:** Information of plant site and design ambient condition as given below shall be considered for design of air conditioning and ventilation systems.

Elevation above mean sea level (Formation level)	..	+ 10.5 m
Barometric pressure	..	760 mm Hg
Ambient temperature :		
Absolute maximum :	..	46°C
Absolute minimum :	..	10°C
Relative Humidity :		
Absolute maximum :	..	100%
Absolute minimum :	..	4%
Wind velocity :		

Highest monthly mean wind speed		
For 24 hours	..	15.4 Kmph
Extreme wind velocity	..	131.0 Kmph

Design Ambient Condition

		Summer	Monsoon	Winter
Dry Bulb Temperature, (°C)	..	38	31	16
Relative Humidity, %	..	70	85	70
Cooling water temperature,(°C)	..	35		

3.3 **Design Basis**

3.3.1 Unless otherwise specified in Technical Specification the following thermal and relative humidity conditions shall be maintained in various premises of the plant in general.

a) Control rooms including all electronic AC drive panels, control pulpits, computer rooms, laboratories, office buildings, canteen, first-aid stations etc. shall be air-conditioned to maintain room inside temperature of (25±2)°C and relative humidity of (55±5)%. If any other premises is required to be maintained at different temperature and humidity conditions the same shall be maintained as specified in Technical Specification.

b) Chilled water produced shall be also be provided for process cooling, wherever required.

c) MCC rooms, switchgear rooms and those rooms accommodating dry-type transformers, capacitor rooms shall be air-conditioned to maintain room inside temperature of (32±2)°C and maximum relative humidity of 70%.

d) Dry ventilation systems comprising of filtered air supply and/or controlled exhaust shall be provided at cable basement, cable cellar, cable vault, cable tunnel, transformer rooms, hydraulic rooms, compressor rooms by means of Tube Axial supply and exhaust air fans to restrict the room inside temperature to five (5) degree centigrade above outside ambient temperature. To facilitate standarisation, the capacity of supply air fans shall preferably be 5000, 10000, 15000, 20000, 30000, 40000 m3/hr. Correspondingly, the capacity of respective exhaust air fans shall be 10% less than the supply air fan capacity. For ventilation of cable tunnel, the tunnel should be isolated in different segments of maximum 150 m length by

fire- resistant doors. Each segment shall be ventilation by means of one (1) No. supply air fan and one (1) No. exhaust air fan, to be installed in ventilation shafts provided at end of each tunnel segment.

e) Oil cellars and hydraulic cellars shall be provided with dry ventilation system by means of centrifugal fan with ductwork. Exhaust shall be natural through cellar doors, opening on ceiling etc. Inside temperature of the cellars shall be maintained within five (5)°C above outside ambient temperature.

f) Battery rooms shall have dry ventilation system with tube axial exhaust fans. These fans shall be either belt-driven or bifurated type. The impellers and casing shall have acid-resistant paint. Toilet blocks shall have propeller type exhaust fans.

g) For spot cooling in non-air conditioned spaces such as offices, change room, rest rooms, time office, pay office, stores-cum-tool-room etc, ceiling or pedestal fans shall be installed. For spot cooling in hot zones in production and ancillary shops, man-coolers shall be provided.

3.4 Other Design Aspects

3.4.1 Air-conditioning systems

3.4.1.1 Air-conditioning systems shall be designed based on the specified ambient parameters, requirement of room inside dry bulb temperature and relative humidity alongwith associated input data such as internal heat load, occupancy, building orientation with configuration, dehumidified air requirement etc. The temperature and relative humidity requirement of air-conditioned spaces shall be as per technical specification.

3.4.1.2 Unless otherwise specified in technical specification, in general:

a) Chilled water based central system shall be considered for areas which require high cooling load and where the conditioned premises require stricter control of dry bulb temperature and relative humidity.

b) Aircooled/water cooled package units may be considered for areas which require light to moderate cooling load and have requirement of rigid control of room inside dry bulb temperature and relative humidity.

c) In case of fire, the air handling units and package units shall be tripped automatically from signal received by Fire Detectors through fire alarm panel.

d) Window & aircooled split units shall be considered for offices and areas which require relatively lighter cooling load and where no rigid control of dry bulb temperature and relative humidity within the rooms are required. The compressors of window units shall be of reciprocating type since these units will work under severe plant condition. All units shall be of 1.5 TR capacity without remote unit.

e) All overhead cranes operating above the heat emitting zones shall be supplied with air tight heat insulated cabins which will be provided with air-conditioners, suitable for high ambient temperature (70°C), high ambient dust content and shall take care of vibration.

However, the selection process shall be based primarily on techno-economic consideration as well as factors like equipment standardisation (with existing equipment), availability of utilities, clients preference, if any etc. and shall be indicated in technical specification.

3.4.2 **Ventilation systems**

3.4.2.1 In order to maintain proper working environment compatible with human hygienic requirement, the working areas under structural shops shall be generally provided with natural ventilation. The same shall be as indicated in General Specification for Structural steelwork and cladding (VSP-6.3/GS-S-01.

3.4.2.2 Mechanical ventilation systems shall be provided only in the following cases:

a) At the working areas, where provision of natural ventilation will not ensure maintenance of working atmosphere compatible with human hygienic requirement.

b) If a particular zone is to be ventilated in a working area.

c) If for technological requirement, a working area is maintained below certain temperature.

d) In underground working areas without natural draft.

3.4.2.3 Working areas where maintenance of proper working environment compatible with human hygienic requirement can be partially achieved with natural ventilation, provision of both natural and mechanical ventilation shall be made.

3.4.2.4 All ventilation fans of respective areas shall be interlocked with fire detection and alarm system so that in case of fire each fan shall trip automatically through fire alarm panel.

3.4.2.5 General Offices which are not air-conditioned shall be provided with ceiling fans. Number of fans shall be based on 650 to 900 cu m per hour per sq m of floor area.

3.5 Equipment & Selection Criteria

3.5.1 The equipment for Air conditioning and ventilation systems may be any of the following types or combination of the same:

- Central air conditioning by chilled water based system
- Air-conditioning systems with package, split, window type air conditioners
- Fresh filtered air ventilation system with natural exhaust
- Fresh filtered supply and exhaust air ventilation system
- Exhaust air ventilation system

3.6 Central Air-conditioning by Chilled Water Based system

3.6.1 Chilled water based central air-conditioning system shall have chilled water generating plant from where chilled water at desired temperature and pressure will be delivered by supply water piping to air handling units located in the building/areas to be air conditioned. The chilled water shall be taken back to the chilled water plant by return water piping.

Chilled water generation shall be by vapour compression system with reciprocating/screw/centrifugal compressor. The refrigerant used for producing chilled water shall be environment friendly, like R134a or equivalent.

Reciprocating chillers shall be used upto 100 TR cooling capacity. From 100-400 TR cooling capacity, preferably screw chillers shall be provided. In case cooling capacity is more than 400 TR, the preferable selection shall be of centrifugal chiller.

The system shall be complete with chillers having refrigerant compressors, condensers, chilled water and condenser water pumps, cooling towers, expansion tank, pipework, electrics, instrumentation and control etc. as required.

3.6.2 Air handling units shall have double skin and shall be provided with filters, fans, cooling coil, chilled water piping with flowmeter, valves, strainers, dampers, electrics, instrumentation and control etc. complete as per the requirement. Heater and humidifier shall be provided where rigid control of dry bulb temperature and relative humidity are required. All air handling units shall be installed in separate rooms.

3.7 **Airconditioning systems with Package, Split, Window Model Airconditioners**

3.7.1 Package air conditioners shall be plenum or ductable type located in the conditioned space or at a separate room adjacent to it. Package air-conditioners may be aircooled or water cooled type. The air-conditioned spaces where surrounding temperature is hot/dusty shall preferably be provided with water cooled packages units. Cooling tower along with recirculating pumps and piping shall be required to be provided for such water cooled system. Remote spaces to be air-conditioned where water cooling systems is difficult to be available or air-conditioned spaces which are not located at hot zones may be provided with aircooled package air-conditioners. All package air conditioners (indoor units) shall be installed in separate rooms. Outdoor units shall be suitably located outside the conditioned premises.

3.7.2 Air cooled split airconditioners shall have its outdoor units suitably located at terrace or on roof while indoor units, single or multiple, shall be installed at ceiling, floor or wall of the conditioned space as per the requirement. Ductable units shall be considered wherever necessary for uniform distribution of conditioned air.

3.7.3 These units shall contain adequately sized energy efficient compressor, hermetically sealed scroll/reciprocating compressor preferably in multiples of 5.5 TR, evaporators, condensers, refrigerant pipework, filters, fan, electrics, instrumentation and controls etc. as required. Strip heaters & humidifiers may be considered for package air-conditioners where rigid control of dry bulb temperature and relative humidity are required.

3.7.4 Blast Furnace control room, where critical electrical equipment to be installed, shall be provided with standby arrangement by installing package airconditioner. Emergency power connection shall be provided for these package airconditioners. All other critical areas, where single package airconditioners are provided shall have their respective dedicated standby arrangement.

3.8 **Fresh filtered air ventilation system with natural exhaust**

3.8.1 Hydraulic cellars and oil cellars shall be provided with fresh filtered air ventilation system by means of centrifugal supply air fan. These systems shall include air intake louvre, dry air filter with filter frame, supply air duct with grilles, damper, fire damper, connection piece, etc. Exhaust shall be natural through cellars doors and openings on cellar roof.

3.8.2 Hydraulic room, transformer room shall be provided with fresh filtered air supply by means of tube axial supply air fan and exhaust by gravity louvre. This system shall include dry air filter with filter frame, rain cowl, connection piece etc.

3.9 **Fresh filtered air supply and exhaust air system**

Cable basement, cable vault, cable cellars, cable tunnels and compressor rooms shall be provided with fresh filtered supply and exhaust air ventilation system by means of tube axial supply and exhaust air fans. These systems shall include dry air filter with filter frame, connection piece, fire damper, rain protection cowl etc.

3.10 **Exhaust air ventilation system**

Exhaust air ventilation system shall consist of tube axial/ propeller type exhaust fan, rain protection cowl, bird protection screen.

4.0 **AIR MOVING DEVICES (AMD)**

4.1 **Standards**

4.1.1 The Air Moving Devices (AMD) shall be designed, manufactured, erected, tested and commissioned as per the standards specified and in the Technical Specification. Detailed instructions on such aspects shall be as per the current edition of the relevant codes and standards published by the Bureau of Indian Standards (BIS). In general all AMD's shall conform to the codes/standards of BIS. Where such BIS codes/standards are not available, the AMD's shall be designed and supplied as per other relevant international standards such as ASHRAE Standards.

4.1.2 All AMDs shall conform to the statutory and other Regulations in force such as Indian Factories Act, Environmental Protection Act, Environmental Protection Rules, Indian Electricity Rules, etc.

4.2 **Equipment**

4.2.1 **General Construction of Fans**

4.2.1.1 The rotating elements shall be statically and dynamically balanced. Large fans shall operate below first critical speed; others shall have a minimum margin of twenty (20) per cent from first and second critical speeds.

4.2.1.2 All moving and exposed parts, flexible couplings, belts, pulleys, drives etc shall be adequately guarded to prevent accidents to personnel.

4.2.1.3 Each fan shall be complete in all respects and include impeller, casing, shaft, bearings, stuffing box, coupling or pulley drive, common base frame, vibration isolators (for centrifugal fans), mounting frame (for propeller fans), pedestal (for mancooler), connection piece, inlet and outlet dampers (as specified), foundation bolts, electric motor, starter, electrical controls, switches and instruments.

4.2.1.4 Sound level of fans shall not exceed 85 dB(A) at one (1) metre distance from the rotating fan parts. This should be limited to 65 dB(A) within conditioned premises.

4.2.1.5 The fan casing shall be of welded/split construction unless otherwise specified. Thickness of casing material shall be appropriate for the duty specified and shall be indicated by the contractor. Inlet screens of wire mesh shall be provided on open inlet fans.

4.3 **Special Requirements**

4.3.1 Centrifugal fans shall be generally of limit load design, unless otherwise specified.

4.4 **Electric Motor, Controls, Cabling and Earthing**

4.4.1 All drive motors, starters, controls, cabling and earthing shall conform to the relevant General Specifications for Electrical Equipment and the Technical Specification.

5.0 **FRESH AIR FILTER**

5.1 **Dry air filter:** Air filter shall be of 3-ply HDPE with one layer of Aluminium support mesh arranged in pleated form with GI/Al frame of preferable module size 610 x 610 x 50 thk. The pleats shall be suitably supported with Aluminum spacers. The filter shall be housed in a frame with GI intake louvre. The efficiency of filters shall be 90% down to 10 micron dust. The face velocity of filters and louvres shall be within 1.5 – 2 m/sec. Fan details are indicated under AMD (Clause 4.0).

6.0 DUCTWORK

6.1 Design Basis

6.1.1 Ducts for conditioned/filtered air supply systems shall be as per the norms recommended by ASHRAE. In general, the supply air velocity shall be about 8-9 m/s in main headers, about 5-6 m/s in branches and about 2-3 m/s at grilles/outlets. Return air velocity shall be about 20 per cent lower compared to supply air velocity.

6.1.2 Ductwork for general ventilation systems or for air conditioning systems shall be of rectangular cross-section. In general, these shall be constructed of galvanised sheet steel conforming to IS:277, Class-VIII. Constructional features shall conform to the latest revision of IS:655. For underground air distribution systems, concrete ductwork may also be used. The ratio of size of duct to the radius of elbow shall be normally not less than 1:1.5.

6.2 Duct Supports

6.2.1 Supports for horizontal and vertical ducts shall be made and positioned so that no weight is taken at connections to equipment and ductwork is not deformed during erection and after installation.

6.2.2 Where ducts are external to buildings, supports shall be fitted to restrain wind thrust. Securing of supports to sides of horizontal ducts shall not be accepted.

6.2.3 It shall be ensured that duct reinforcement, type of supports and spacing of supports shall be enough to hold the weight of the system. Type of supports and their spacing shall be clearly indicated and Purchaser's/Consulting Engineers' approval obtained.

6.3 Insulation

6.3.1 Thermal Insulation

Entire supply air duct and return air duct outside conditioned premises shall be suitably insulated to prevent condensation of moisture from surface of duct. Chilled water pipe lines laid indoor and outdoor shall also be provided with insulation. Insulation shall be as per the General Specification for Thermal Insulation..

6.3.2 Acoustic Insulation

Initial 5 M of supply air duct from the mouth of air handling unit/package air conditioner shall be provided with acoustic insulation. The room for air handling unit/package unit, if installed within administrative building, shall be acoustically insulated, if required.

6.3.3 Underdeck Insulation

The exposed roof of any building shall be provided with underdeck insulation.

All insulation shall conform to General specification no. VSP-6.3/GS-M-06.

6.4 **Dampers**

6.4.1 Dampers shall be provided at inlet/outlet of each centrifugal fan. Dampers of big fans shall be provided with operating lever and position indicators showing percentage of opening. All diffusers/grilles connected at supply air duct of air-conditioning and ventilation systems shall be provided with volume control dampers. Self-acting dampers to ensure required pressurisation inside premises and fire dampers shall be provided as required. Electrically actuated dampers may be provided at the centrifugal fans, if necessary.

6.4.2 **Fire Dampers:** Fire dampers shall be of fusible link type and shall be installed in accordance with relevant codes of the National Fire Protection Association (NFPA) of USA or equivalent. Fire dampers shall be provided where ducts penetrate walls or floors forming fire barriers. The fire rating of each damper shall be 1 & 1/2 hours. The fusible link shall melt at a temperature of 65-70^{0}C.

6.5 **Flexible Connection**

6.5.1 Flexible connections shall be fitted at inlet and outlet of centrifugal fan units to prevent transmission of vibration. These connections shall be leak proof and made of impregnated canvas, 3 mm thk. The length of these connections shall not be less than 250 mm, unless otherwise specified.

6.6 **Other Accessories**

6.6.1 These include diffusers, grilles, louvres etc. Material of construction of diffuser/grilles shall be powder coated

GI/Anodised Aluminum and colour of the same shall match with the interior decoration.

6.6.2 The selection of each diffuser and grille shall be based on manufacturer's performance data for air delivery, air throws, terminal velocity and pressure drop characteristics. Each shall be selected to maintain low noise level in accordance to IS:3483 or equivalent. These shall be provided with volume and directional control devices.

6.6.3 Airhandling units and package airconditioners shall have provision for measurement of temperature and air quantity at equipment outlet.

7.0 ASSEMBLY, ERECTION, TESTING AND COMMISSIONING

7.1 All components of air-conditioning and ventilation systems shall be inspected for completeness and correctness of supply as per contract stipulations before assembly and erection.

7.2 Assembly and erection shall generally be carried out as per manufacturer's guidelines and under his supervision. The stipulations in the contract as regards erection of equipment, tools, safety, procedures etc shall also be followed. Systems shall be tested and commissioned as per the guidelines and procedures given in the contract or agreed to during engineering.

8.0 PAINTING

Painting of air conditioning and ventilation systems shall conform to the General Specification for Painting (VSP-6.3/GS-P-01).

9.0 INSPECTION AND TESTING

9.1 Manufacturers Premises

9.1.1 All equipment and items for airconditioning and ventilation systems shall be inspected and tested at the manufacturer's works by the Purchaser/Consulting Engineer as per General Specification for Inspection and testing requirement for plant and equipment at manufacturer's premises (VSP-6.3/GS-IN-01).

9.2 Site Test

9.2.1 All components of each airconditioning and ventilation system shall be inspected for completeness and correctness of supply and erection as per General Conditions of Contract

and as specified in relevant clauses of the technical specification for the systems and equipment.

9.2.2 Performance test of equipment/system shall be carried out as per Purchaser's/Consulting Engineers' standard practice for asserting the correctness of flow rate, pressure drop, temperature, humidity, power consumption, as per the requirement of condition of contract.

10.0 DRAWINGS AND DOCUMENTS

Technical information in the form of drawings and documents shall be furnished in accordance with General Conditions of Contract and as specified in the relevant clauses of Technical Specification.

RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION NO. VSP-6.3/GS-M-06

FOR

THERMAL INSULATION

APRIL 2006

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RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION

FOR

THERMAL INSULATION

1.0 **SCOPE**

1.1 This General specification covers the thermal insulation required for hot as well as cold services, for pipes, ducts and various other requirements. The term Thermal insulation used here generally covers all items of the assembly used to minimise heat gain by cold services or heat loss by hot services and to avoid injury to people due to contact with hot or very cold surfaces. Such assembly shall include, but not be restricted to the material of insulation; the items, securing the insulation material to the part to which it is applied; the coating or wrapping applied to secure the insulation and to act as a vapour seal and/or protect the insulation material from damage due to environmental conditions and mechanical damage and cladding to hold the insulation in position, protect it from damage, give the insulation a neat and aesthetically pleasing appearance, and to act as a heat reflector, etc.

1.2 The design and installation of all thermal insulation shall be complete in every way for the service intended and suitable for achieving the desired reduction in heat transmission as well as maintaining the surface temperature within allowable limits. The installation shall be complete in all respects including all items essential for proper installation, irrespective of whether the requirements are specifically mentioned in the Technical and General Specifications.

1.3 This general specification does not cover thermal insulation for buildings and structures. However, for specific purposes such as air conditioning of work premises, for which thermal insulation of the conditioned space has been considered, relevant clauses of this specification shall be considered as applicable.

1.4 This specification does not cover insulation for furnaces, metallurgical and production equipment operating above 600 deg C, for cryogenic applications, for Cold Blast lines and for Steam lines in Power Plants.

1.5 If any special insulation system, not covered by this specification is required, the same shall be submitted with the proposal with detailed functional description and specification for the insulation system for Engineers' approval.

2.0 **STANDARDS**

2.1 The thermal insulation shall be designed, manufactured, tested and installed as per the standards mentioned in this specification. Detailed instructions on such aspects as are not indicated herein shall be as per the standards, codes and recommendations of Bureau of Indian Standards (BIS) or as per the national standards of the country of origin or the codes of practices followed by the manufacturer.

2.2 Wherever applicable, the following Interplant Standards for Steel Industry (IPSS) developed by the Steel Authority of India Ltd shall be followed.

1) IPSS:1-06-031-93 Code of Practice for Thermal Insulation of Cold Service

2) IPSS:1-06-015-93 Code of Practice for Thermal Insulation of hot pipelines and accessories

2.3 The thermal insulation used for electrical equipment shall conform to the latest codes of the International Electrotechnical Commission.

3.0 **DESIGN BASIS**

3.1 Thermal insulation shall be provided for all surfaces substantially hotter or cooler than ambient conditions. The following data shall be used for selection of thermal insulation.

Information of Plant Site and Design Ambient Condition:

Information of plant site and design ambient condition as given below shall be considered for design of air conditioning and ventilation systems.

Elevation above mean sea level (Formation level) .. + 10.5 m

Barometric pressure .. 760 mm Hg

Ambient temperature:

Absolute maximum: .. 46°C
Absolute minimum: .. 10°C

Relative Humidity :
Absolute maximum: .. 100%
Absolute minimum: .. 4%

Wind velocity:
Highest monthly mean wind speed
For 24 hours .. 21.4 Kmph
Extreme wind velocity .. 131.0 Kmph

Design Ambient Condition

		Summer	Monsoon	Winter
Dry Bulb Temperature, (°C)	..	38	31	16
Relative Humidity, %	..	70	85	70
Cooling water temperature,(°C)	..	35		

3.2 Thermal insulation shall also be provided for spaces being served by air conditioning systems, if such insulation is specified in the relevant technical specifications or if such is warranted by reasons of economy or aesthetics.

3.3 The thermal insulation provided shall ensure that the temperature of outside surface of insulation (Cladding) shall be as follows:

a) For hot service: Outside surface temperature shall not exceed 10°C above maximum ambient temperature

b) For cold service: Outside surface temperature shall not be more than 10°C below the ambient temperature

4.0 MATERIALS AND APPLICATION

4.1 Insulation for Hot Services

4.1.1 These cover pipelines carrying hot fluids such as steam, condensate, hot water, hot oils, hot air, hot flue gases, etc., as well as equipment operating at elevated temperatures.

4.1.2 Insulation Materials

4.1.2.1 Mineral wool (made from rock, slag & glass) insulation materials shall be used for hot services. The insulation material shall be one of the following types.

4.1.2.2 For pipe work upto DN 350, pipe-sections of light resin-bonded mineral wool (rock/slag wool) as per IS:9842 shall be used. In addition to the compulsory requirements indicated in clauses 4.1 to 4.11 of the IS code, optional requirements laid down in clauses 4.12.1 to 4.12.4 of the IS code shall be fulfilled in all cases.

4.1.2.3 For pipe sizes above DN 350 and for flat surfaces and equipment, resin bonded mineral wool (rock wool) mattress as per IS:8183, with factory stitched G.I. Wire netting on outer surface. In addition to the compulsory requirements indicated in clauses 4.1 to 4.9 of the IS code, optional requirements laid down in clauses 4.10.1 to 4.10.7 of the IS code shall be fulfilled in all cases.

4.1.2.4 The minimum bulk density of insulating materials shall be as per clause no. 2.3 of IPSS:1-06-015-93.

4.1.3 **Anti-corrosive property:** The insulating material shall not cause corrosion of the surface on which it is applied. Chloride content of the insulation material shall not exceed 35 ppm, for application on stainless steel surface to avoid chloride corrosion. The thermal insulation shall be chemically inert and non-corrosive to GI. If chloride content of insulation exceeds 35 ppm at the time of application, GI foil wrapping (0.1 mm thick) shall be provided over the stainless steel surface before application of insulation.

4.1.4 **Heat resistance:** The insulating material of the selected bulk density shall be suitable for continuous use at the maximum service temperature specified in the technical specification. When tested as per IS:3144 by heating to the maximum service temperature, the material shall maintain its general form and shall not suffer visible deterioration of the fibrous structure.

4.1.5 **Insulation thickness**

4.1.5.1 For hot service equipments the required thickness shall be provided to ensure that the outside surface temperature of insulation is limited to values specified in clause 3.3 above. However, the minimum thickness of insulation adopted shall be 40 mm.

4.1.5.2 For hot service piping, the thickness of insulation shall not be lower than the thicknesses indicated in the table in Annexure-1. Where the actual maximum pipe surface temperatures are different from Table-1, the required insulation thickness shall be provided to ensure that the outside surface temperature of insulation is limited to value specified in clause 3.3 above.

4.1.6 **Insulation Application**

4.1.6.1 **Cleaning of surface**

The surfaces to be insulated shall be thoroughly cleaned, dried and made free from all loose scale, dirt, rust oil and grease.

4.1.6.2 All insulating materials shall be dry before application and shall be protected from moisture, weather and ingress of dirt.

4.1.6.3 For all types of insulation, expansion/contraction joints shall be provided at regular intervals not exceeding 8 metres. These joints shall be made by providing a gap of 25 mm between adjacent sections and filling up the same by compressing loose insulation of the same material. Suitable expansion joints shall also be provided on the metal cladding over insulation.

4.1.6.4 GI foil wrapping shall be provided over stainless surface to be insulated, as per clause 4.1.4 of this specification.

4.1.6.5 **Application of pipe section insulation**

4.1.6.5.1 The preformed pipe sections shall be snapped on to the pipe surface in a staggered configuration. End joints of adjacent pipe section blocks (both for straight runs and for blocks/segments for valves. bends etc) shall be staggered by one-and half of the length of the block. All insulation sections shall be trimmed and tightly butted to eliminate voids.

4.1.6.5.2 The insulation shall be firmly secured in place with at least three (3) loops of binding wire/band - two (2) located at 75 mm from each end and one (1) located at the middle. Mitred sections at bends and elbows shall be secured by minimum two (2) wire loops. Insulation at valves and other fittings shall also be suitably secured. Binding wire shall be 16 SWG (1.63 mm) G.I. wire. Band shall be of GI, 0.63 mm thick, and at least 20 mm wide. For pipe sizes DN 150 mm and below, insulation segments at bends shall be secured by spirally winding 16 SWG (1.63 mm) G.I. wire.

4.1.6.6 **Application of Mattress Insulation**

4.1.6.6.1 **Regular surfaces:** The surfaces to be insulated shall be cleaned of loose materials. Flat surfaces and larger diameter vessels/equipment shall be provided with M.S. spikes or studs welded to hold the insulation. Vertical pipelines shall be provided with M.S. collars as per clause 4.3.2. The insulating mattresses shall be fitted closely to

the surfaces, butting all joints tightly and laced down with 0.915 mm dia (20 SWG) G.I. wire joints in vertical as well as in horizontal planes which shall be staggered at least by 150 mm.

4.1.6.6.2 **Irregular surfaces:** In case of irregular surfaces after securing the insulation in place, all voids, depressions, cracks etc shall be filled with loose insulation material. Valves shall be insulated upto bonnet flanges: the insulation shall be applied only after initial operation has stabilised tightness and operation of valves and specials. Insulation for a flanged joint shall be forged in the shape of a continuous ring block, reinforced with metal lathe or equal with sleeves to cover adjacent pipe ends by at least 50 mm and be butted with the pipe insulations; the flange insulation shall be applied only after pressure testing of the pipeline. In case of flanged joints at pipe terminations and connections to uninsulated equipment, the pipe insulation shall be nearly levelled down to the flange so as to end inside the bolt circle.

4.1.7 **Insulation Finishing**

4.1.7.1 **Cladding support:** All insulation shall be provided with weather proof cladding of 0.63 mm thk GI sheets. The cladding shall be supported on spacers made of 25 x 3 mm thick steel flats, the spacers shall be fitted with 4 mm dia rivets to angle cleats, welded on to the surface being insulated. The angle cleats shall be of size, so that the gap between the surface being insulated and outer surface of the spacer is same as the desired insulation thickness. Pure asbestos mill board packing of 3 mm thickness shall be used between the cleats and spacers to minimize heat conduction. Spacer rings are not required for 80 mm dia and smaller pipes.

4.1.7.2 **Cladding application:** The cladding shall be bent true to shape, grooves made on all sides for making water tight joints and holes drilled for fixing. Each sheet shall be fixed to the spacers by means of studs: self tapping, flat headed, nickel plated steel screws shall be used for jointing the sheet. Suitable bitumen washers shall be used below all screws and studs and bituminous felt strips used between sheet metal joints to ensure water proofing. Irregular items like flanges, valves etc shall be clad with sheet metal boxes fitting the contour of insulation and continuous with the main cladding. Openings in the cladding shall be avoided as far as possible. Where openings are essential e.g. around pipe saddles, hangers, clamps, anchors etc., they shall be well filled with insulating material and finished smooth with the pipe insulation.

4.1.7.2.1 The cladding shall be applied with minimum 50 mm overlap on both longitudinal and circumferential joints. All overlaps shall be arranged to shed water. GI bands of 0.63 mm thick, 20 mm wide shall be fixed to secure the GI cladding, on a maximum 300 mm centres. One band shall be located on each circumferential joint and the distance between the joints divided into equal band spacing.

4.1.7.2.2 Metal cladding on vertical or near vertical piping with insulation outside diameters of 300 mm or more shall be supported from the adjacent lower section with minimum two (2) Nos. "S" clips fabricated from 0.63 mm thick GI sheet. The "S" clip shall be of sufficient length to allow minimum overlap of 50 mm.

4.2 **Insulation for cold services**

4.2.1 These cover pipelines carrying cold fluids, such as chilled water, cold drinking water, chilled brine, refrigerants, cold air ducts, air conditioned spaces etc as well as cold sections of refrigeration equipment, cold air handling units etc.

4.2.2 **Insulation Materials**

4.2.2.1 For pipe work upto DN 350, pipe-sections of light resin-bonded mineral wool (glass wool) as per IS:9842/expanded polystyrene shall be used. In addition to the compulsory requirements indicated in clauses 4.1 to 4.11 of the IS code, optional requirements laid down in clauses 4.12.1 to 4.12.4 of the IS code shall be fulfilled in all cases.

4.2.2.2 For pipe sizes above DN 350 and for flat surfaces and equipment, resin bonded mineral wool (glass wool) mattress as per IS:8183/expanded polystyrene, with factory stitched G.I. Wire netting on outer surface. In addition to the compulsory requirements indicated in clauses 4.1 to 4.9 of the IS code, optional requirements laid down in clauses 4.10.1 to 4.10.7 of the IS code shall be fulfilled in all cases.

4.2.2.3 Expanded polystyrene boards/resin bonded glass wool shall be used as underdeck insulation for the building roofs exposed to sun. Similar insulation shall also be used for insulating building walls, whenever necessary. In fire hazard area, self-extinguishing type resin bonded glasswool shall be provided. Expanded polystyrene blocks and pipe sections/ segments shall be used for chilled water pipelines/valves. The material shall conform to IS:4671 and shall be of type 1 unless specified otherwise. The apparent density shall be compatible with the loading conditions. Self-extinguishing (type 2) material shall be used where fire hazard exists.

4.2.2.4 Entire supply air duct and part of return air duct passing through higher temperature zones shall be insulated. Resin bonded glasswool shall be provided for the purpose of insulation.

4.2.3 **Insulation Thickness**

4.2.3.1 For cold service equipment, the required thickness shall be provided to ensure that the outside surface temperature of insulation is limited to the values specified in Clause 3.3 above. However, the minimum thickness of insulation shall be 25 mm.

4.2.3.2 For cold service piping, the thickness of the insulation shall not be lower than the thicknesses limits indicated in the Table furnished in Annexure-1. Where the actual maximum pipe surface temperatures are different from Table-1, the required insulation thickness shall be provided to ensure that the outside surface temperature of insulation is limited to value specified in clause 3.3 above.

4.2.3.3 Supply air duct when installed inside the building, shall be provided with 50 mm thk resin bonded glasswool having density of 24 kg/m3 covered with 0.63 mm GI sheet. When installed outside, this duct shall also have 50 mm thk resin bonded glasswool having density of 24 kg/m3 out covered with 0.63 mm GI sheet.

Return air duct within the building shall be provided with 25 mm thk resin bonded glasswool having density of 24 kg/m3 covered with 0.63 mm GI sheet when installed outside. This duct shall have 50 mm thk resin bonded glasswool having density of 24 kg/m3 covered with 0.63 mm GI Sheet.

4.2.4 **Insulation Application**

4.2.4.1 If mineral wool insulation is used, the method of application shall be as mentioned in clauses 4.1.7.1, 4.1.7.2, 4.1.7.3, 4.1.7.5 and 4.1.7.6. Before application of insulation a coat of solvent free anti-corrosive suitable primer shall be applied on the surface to be insulated. For galvanised steel surface, a special primer suitable for the purpose shall be used. The method of application for expanded polystyrene insulation shall be as per clauses 4.1.7.1, 4.1.7.2, 4.1.7.3 and as follows:

4.2.4.2 **Regular surfaces:** The surfaces to be insulated shall be thoroughly cleaned, dried and made free from all loose, scale, dirt, oil or grease and a coat of solvent free, anti-corrosive, suitable primer shall be applied. For galvanised steel surface, a special primer suitable for the purpose shall be used. Insulation blocks or shaped pieces shall be coated on the inside surfaces as well as edges, with hot industrial bitumen of grade 85/25 or other suitable solvent free bonding compound. The insulation shall then be stuck to the primed surfaces with adjacent sections tightly pressed; all joints shall be staggered and filled with bitumen. The insulation segments shall be secured by hexagonal G.I. wire netting of 0.915 mm dia (20 SWG) and the netting stitched with 0.915 mm dia (20 SWG), G.I. wire.

4.2.4.3 **Irregular surfaces:** In case of irregular surfaces such as flanged joint, valves etc, the main insulation shall be terminated at a distance necessary for removal of bolts. All irregularities on the surface shall be filled up with a mixture of expanded polystyrene granules and bitumen on which suitably cut insulation blocks or shapes shall be stuck to as in the case of regular surface, overlapping the main insulation. The insulation shall be secured with the main insulation by metal bands or tape and not stuck to one another by industrial bitumen. Valves shall be insulated upto their bonnet flanges.

4.2.5 **Insulation Finishing**

4.2.5.1 For mineral wool insulation the insulation finish shall be as mentioned in clause 4.1.8. Before applying the GI cladding, a vapour barrier shall be provided as described below:

4.2.5.1.1 **Vapour barrier**

A 3 mm (wet) thick coating of approved vapour seal mastic (suitable to retain its sealing properties at prevailing temperatures, non-corrosive to GI and stainless steel, compatible with the insulation material and fire resistant) shall be applied to the surface of the insulation as soon as possible, after erection, to reduce moisture ingress into the insulation system. Whilst this coat is still wet, open weave 10 mesh glass cloth (5 mil thick) shall be laid over the surface and embedded in the mastic. Care shall be taken to ensure that the glass cloth is laid smooth and free from wrinkles and that no pockets of air are trapped beneath the surface. At junctions in the glass cloth, the overlap shall not be less than 75 mm.

A second 3 mm coat of mastic shall be applied after approximately 12 hours. When dry, these two wet (3 mm + 3 mm = 6 mm) coats of mastic shall be converted to minimum 1.50 mm dry film thickness. The vapour seal shall be carried down over all exposed edges of insulation and bonded to the surface of pipe or vessel with a mastic fillet on long runs of pipe, the ends of insulation shall be sealed off at regular intervals, and the vapour seal shall be carried down to the pipe surface. The mastic shall not be applied over wet insulation. During the drying time, the insulation shall be protected from the weather by "Alkathene" film type tarpaulin or similar approved materials.

4.2.5.1.2 While fixing GI cladding, care should be taken to ensure that the vapour barrier is not punctured anywhere.

4.2.5.2 For expanded polystyrene insulation, Membrane type vapour barrier shall be used as per Clause 4.4 and 5.2.3 of IPSS:1-06-031-93. The finish of insulation shall be as indicated below.

4.2.5.2.1 For pipes, the insulation shall be covered with galvanised steel chicken wire of approved quality, finished with 1:4 cement sand plaster. Under deck insulation shall be applied at soffit of roof with two (2) coats of hot bitumen @ 2 kg/sqm over a primer coat of emulsion as per manufacture's specification. The insulation shall be covered with galvanised steel chicken wire of approved quality. For underdeck insulation, where there is no provision of false ceiling, the insulation shall be finished with 1:3 cement sand plaster.

4.2.5.3 The insulation shall be continuous as far as possible. Openings shall be made for supports, brackets, clamps etc., and where required timber saddles shall be provided on the lower half of pipe or duct in place of insulation.

4.3 **Special Insulation**

4.3.1 In case of special requirements not covered by clauses 4.1 & 4.2 of this specification, the insulation material, thickness, application and finish shall be subject to Purchaser's approval.

4.3.2 **Vertical Insulation Supports**

For all types of insulation on vertical or inclined piping (at an angle greater than 45 degree from horizontal),6 thk M.S. collars (bolted) shall be provided at approximately 5 metres interval. O.D. of collar shall be 10 mm less than O.D. of insulation.

4.3.3 **Insulation for Electric Heat Traced/Steam Traced Lines**

Insulation on electrical heat traced/steam traced lines shall be applied so as to enclose both main pipe and tracer, and shall fit as snugly as possible. In case of steam traced lines, the steam tracer expansion loops shall be insulated and finished same as adjoining main pipe insulation.

If the traced line may at times be below dew point temperature, then the insulation shall be suitably sealed to make all joints vapour tight.

4.4 Special consideration for coastal location

Special consideration as laid down in Appendix-1 of IPSS:1-06-031-93 shall be taken into consideration for selection, application and installation of all types of insulation.

5.0 **INSPECTION AND TESTING**

5.1 Routine and type tests for various items shall be performed at manufacturer's works and test certificates including those for material/accessories furnished.

6.0 **PAINTING**

6.1 Hot surfaces provided with insulation and cladding need not be painted for corrosion protection. For cold surfaces provided with insulation and cladding, a primer coat as indicated in Clause 4.2.4 shall be applied.

6.2 Pipework having insulation and cladding shall however, be provided with colour identification for the fluids handled and for indicating direction of flow.

6.3 Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

6.4 All painting done as mentioned above for insulated surfaces shall conform to the relevant clauses of General Specification for Painting VSP-6.3/GS-P-01.

7.0 **MEASUREMENTS**

7.1 Measurements for insulation shall be taken over the finished insulation surfaces, in accordance with the measurement clauses in IS:14164 (latest). In case of any dispute, the decision of the Purchaser/Engineer shall be final and binding.

8.0 PERFORMANCE TESTING

Performance of the installed insulation system may be assessed against the specified requirement as per clause 7.1 of IPSS:1-06-015-93.

9.0 DRAWINGS AND OTHER DOCUMENTS

9.1 The following types of drawings and technical information shall be provided by the Insulation Contractor:

9.1.1 Properties of the insulating materials and test certificates.

9.1.2 Complete design data and drawings for all insulation works.

9.1.3 Sketches/Technical literature showing insulation materials, finish and method of application.

9.1.4 Manuals dealing with safety aspects and instructions for combating fire arising out of insulation work.

9.1.5 Instruction on maintenance of insulation work and storage of spare insulating materials.

ANNEXURE - 1

MINIMUM THICKNESS OF INSULATION FOR PIPES

(In millimetres)

	Hot Service			Cold Service
Pipe Size	Steam	Steam	Condensate	Chilled water (Supply and Return)
DN, mm	(315°C)	(190°C)	(170°C)	(7°C & 13°C)
15	60	40	40	25
20	60	45	40	25
25	60	45	40	25
40	65	50	40	40
50	70	50	40	40
65	75	55	40	40
80	75	55	50	40
100	80	55	50	50
125	90	60	50	50
150	90	60	50	50
200	90	60	60	75
250	100	65	75	75
300	100	65	75	75
350	100	65	75	75
400	100	65	75	75
450	105	65	75	75
500	105	70	75	75
550	105	70	75	75
600	110	70	75	75

NOTE:

1) The table above indicates the minimum insulation thicknesses for the above mentioned specific services. However, actual thickness shall be based on the above table or as per following, whichever is higher:

   a) For hot service: Outside surface temperature of insulation cladding shall not exceed 10°C above maximum ambient temperature

   b) For cold service: Outside surface temperature of insulation cladding shall not be more than 10°C below the ambient temperature.

RASHTRIYA ISPAT NIGAM LIMITED

VISAKHAPATNAM STEEL PLANT
VISAKHAPATNAM

GENERAL SPECIFICATION NO. VSP-6.3/GS-P-01

for

PAINTING

APRIL 2006

M.N. DASTUR & COMPANY (P) LTD.
Consulting Engineers
P-17, Mission Row Extension
Kolkata-700013

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GENERAL SPECIFICATION

for

PAINTING

for

VISAKHAPATNAM STEEL PLANT

1.0 GENERAL

1.1 This specification covers materials, tools, facilities and quality requirements for surface preparation and painting of steelwork, equipment, including piping, ductwork etc for Visakhapatnam Steel Plant expansion at Visakhapatnam. The term 'Painting' referred herein covers rust preventive and decorative organic, inorganic and metallic coating and surface protection of the following:

1.1.1 Structural steelwork including building frames, technological structures and surfaces of floor plates, steel doors, windows etc subject to regular handling or use.

1.1.2 Various equipment inclusive of electric motors, panels, control desks and accessories.

1.1.3 Steel tanks, vessels and stacks.

1.1.4 Pipework including valves, fittings, supports, hangers etc.

1.1.5 Metallic ductwork such as ventilation ducts, gas ducts including supports, hangers etc.

1.2 The term 'surface' used herein shall mean iron and carbon steel surfaces (including castings) exposed to atmospheric action and/or to corrosive media unless otherwise stated. Painting shall be applied after specified surface preparation to protect all surfaces even in cases where no painting requirement is mentioned, in any other General or Technical Specification.

1.3 Surfaces in direct bonded contact with concrete, asbestos, aluminium, brass, bronze, galvanised steel, stainless steel and other corrosion resistant alloys and rubber/synthetic polymers, and buried pipework are not required to be painted unless specified, except for identification bands, where relevant. Corrosion protection of buried pipe work will be as stipulated in VSP.6.3/GS-P-03 for pipe work. Except for such surfaces, painting and surface preparation shall be provided to protect all surfaces that shall be subject to atmospheric action and exposed

to corrosive media, irrespective of mention in the other General and Technical Specifications.

1.4 Painting shall provide a continuous adherent film of adequate thickness on the surface being treated and protect it from attack due to continuous exposure in industrial atmosphere prevailing at sites located inland or in marine environment, and exposure in other corrosive environment. The climatic condition of site is outlined in the TSs.

1.5 The work shall consist of surface preparation and application of prime, intermediate and finish coats of organic and inorganic coating or metallic coating as specified herein, and supervision & testing as required, complete in all respect for protection of surfaces. This shall also include required environmental control, and occupational and safety precautions.

1.6 This specification shall be read along with the following five annexures enclosed with the specifications

Annexure-1	..	List of applicable standards
Annexure-2	..	Surface preparation standards
Annexure-3	..	Painting system
Annexure-4	..	Special area painting
Annexure-5	..	Colour code

2.0 STANDARDS

2.1 For work executed in India, all materials, tools and workmanship shall be in accordance with the latest editions of relevant Indian Standards published by the Indian Standards Institution, wherever available. IS:1303 gives the glossary of terms. Where Indian Standards are not available, the work shall conform to generally accepted codes of practice for good painting based on specifications such as those published by Steel Structures Painting Council (SSPC), 4400 Fifth Avenue, Pittsburgh, Pa 15213, USA, or as per DIN 55928. A list of applicable and related standards is given in Annexure-1 hereof.

2.2 For work executed outside India, painting and surface protection shall be carried out and tested as per the standards laid down in this specification. Detailed instructions on such aspects as are not indicated herein shall be as per the codes and practices indicated in the latest specifications of SSPC or DIN or as per the National Standards Institution of the country of origin or the codes of practices recommended by the paint manufacturers of the country of origin.

3.0 SURFACE PREPARATION

3.1 Surface preparation being a pre-requisite for any paint application, shall be such as to clean the surface thoroughly of any materials which will be conducive to premature failure of the paint substrata.

3.2 All surfaces shall be cleaned of loose substances and foreign materials, such as dirt, rust, scale, oil, grease, welding flux etc irrespective of whether the same has been spelt out in the standards in order that the prime coat is rigidly anchored to the virgin metal surface. The surface cleaning shall conform to pictorial representation of surface quality grade of Swedish Standards Institution SIS 05 5900 or equivalent standards such as SSPC-VIS-1.67 or DIN 55928 (Part 4) or BS 4232 or IS:1411 (Part I). In this specification, relative equivalent standards of surface preparation quality grade to be adopted in respect of SIS 055900 are presented in Annexure-2 for ready reference. Any oil, grease, dust or foreign matter deposited on the surface after preparation shall be removed and care taken that the surface is not contaminated with acids, alkalis, moisture or other corrosive chemicals. The prime coat shall be applied as soon as possible after the surface preparation is completed. The time gap shall not extend 4 hours for relative humidity not exceeding 75 per cent, and within one hour for hire relative humidity.

3.3 The acceptable surface preparation standards are described under each paint system. The procedures covered are solvent cleaning, hand tool cleaning, power tool cleaning, flame cleaning, blast cleaning, pickling or combination thereof. These are briefly described below.

3.3.1 **Solvent Cleaning**

The surface is cleaned by wiping, immersion, spraying or vapour contacting of a suitable solvent or washing with an emulsion or alkaline solution or chemical paint stripper. The method effectively removes oil, grease, dirt, soil, drawing compounds, old paint and other similar foreign matters but does not remove rust, scales, mill scales or weld slag. Also, hydrocarbon solvents do rot remove corrosive salts such as chloride and sulphate. Therefore, before application of paint, solvent cleaning is normally to be followed by other cleaning procedures.

3.3.2 **Hand Tool Cleaning**

The surface is cleaned to St-2 or St-3 quality as required, by vigorous wire brushing done manually. Chipping and scraping is usually carried out before wire brushing; oil and grease are removed by solvent cleaning before hand tool cleaning. On welded work, before wire brushing, particular care shall be taken to remove by blast cleaning, washing with water, phosphate rinsing or power tool cleaning as much welding flux, slag and fume deposit as is possible. This method effectively removes loosely adherent materials but would not affect residues of rust or mill-scales that are intact and firmly adherent.

3.3.3 Power Tool Cleaning

The surface is cleaned to St-3 quality, by electric or pneumatic tools, such as brushes, sanding machines, sanding discs, abrasive grinders, chipping, hammers, descalars, needle guns and rotary descalers. Oil and grease are first removed by solvent cleaning and heavy rust scale removed prior to use of power tools. The tools are used carefully to prevent excessive roughening of surface and formation of ridges and burrs; also, care is taken to avoid mill scale being burnished to a smooth, slick surface. This method will remove loosely adherent material but would not affect residues of rust, or mill scales that are intact and firmly adherent.

3.3.4 Flame Cleaning

The surface is cleaned by rapid heating up by means of oxyacetylene flame to loosen the adherent scales, followed immediately by wire brushing. Oil and grease are first removed by solvent cleaning and all accessible welding flux and spatters removed before application of flame. The surface is also cleaned of all unbound mill-scale and dehydrated by the passage of oxyacetylene flame adjusted to have neutral characteristics. This method will remove loosely adherent materials as well as most of the adherent scales and mill-scales. In order to minimise or prevent distortion, flame cleaning shall not be used on members having thickness of 6 mm or lower.

3.3.5 Blast Cleaning

The surface is cleaned by impingement of abrasive materials, such as graded sand or grit of cast iron, malleable iron, steel or synthetic material at high velocity created by clean and dry compressed air blast. Prior to application of the blast, heavy deposits of oil and grease are removed by solvent cleaning and excessive surface scale removed by hand tool or power tool cleaning. This method will remove loosely adherent materials as well as adherent scales and mill scales. The extent of removal of adherent scales is varied, depending on the application, and are defined by the surface quality grades Sa 1, Sa 2, Sa 2½ and Sa 3 in the order of increasing cleanliness. Blast cleaning is not recommended for sheet metal items.

3.3.6 Pickling

In this method the surface is cleaned of mill scales, rust and rust scales by chemical reaction or electrolysis or both. Normally, pickling is done in a bath of dilute sulphuric, hydrochloric or phosphoric acid, with or without heating, followed by thorough rinsing with fresh water to remove the acid traces. Pickling in sulphuric acid may be followed by dipping in phosphoric acid containing iron phosphate. Prior to pickling heavy deposits of oil, grease, soil, drawing compounds and foreign matters other than rust, scales or oxides are removed by

solvent cleaning. This method will remove loosely adherent as well as adherent scales and mill scales.

3.3.7 **Degreasing, Pickling and Phosphating**

Surface preparation for shop painting of sheet metal items like electrical control panels, desks, etc. may be done in seven or nine tank systems of solvent cleaning and pickling, followed by giving the cleaned surface a thin coating (of not less than 5 gm per sq m) zinc, iron or manganese phosphate deposited either by immersion or powder spray. The phosphate coating shall be tested, when required, by a continuous salt spray as per ASTM B 117, for a period of not less than 96 hours.

4.0 PAINT MATERIALS

4.1 The paint systems specified herein and listed in Annexure-3 for different exposure conditions shall be the minimum acceptable quality of surface protection against the respective environment, provided the paint materials are manufactured from quality products under stringent quality control. For any proprietary paint formulation, the performance of which has been tested in actual site conditions or under stimulated conditions in test laboratory, the manufacturer's recommendations in all respects shall be adhered to.

4.2 The vehicle for the specified paint system for the respective service exposure conditions shall be one of or a combination of the following:

i) Synthetic enamel to oil-based alkyd or PVC-copolymer-based alkyd or acrylic modified alkyds or styrenated alkyd
ii) Modified phenolic resin varnish.
iii) Chlorinated rubber
iv) Two component epoxy-polyamide free of alkyd and plasticiser
v) Two component epoxy-polyamine for stove drying
vi) Two component polyurethane
vii) Silicone
viii) Coal tar epoxy
ix) Solvent based inorganic zinc silicate

4.3 The rust inhibitive pigments shall be any one of or a combination of the following depending on the nature of exposure and compatibility with other ingredients present in the selected vehicle:

i) Red lead (about 96% Pb304, 4% PbO)
ii) Zinc chromate (about 38% ZnO, 44% CrO3)
iii) Zinc phosphate
iv) Micaceous iron oxide
iv) Manganese phosphate with Barium Chromate
v) Zinc dust (about 96% Zn)
vi) Non-leafing aluminium

Red lead pigment shall not be used in case of paint being sprayed

4.4 The contractor shall furnish paint manufacturer's test report or technical data sheet pertaining to the paint selected. The data sheet shall indicate among other things the relevant standards, if any, composition in weight per cent of pigments, vehicles, additives, drying time, viscosity, spreading rate, flash point, method of application quality of surface preparation required, corrosion resistance properties and colour.

4.5 Paint materials shall be procured from suppliers subject to approval by the Purchaser. Recommended paint suppliers are Berger, J&N, Asian Paints and Goodlass, Nerolac. A list of their products for various primers, intermediates and finish coats will be issued to successful tenderers. Other suppliers and their brand names may be permitted, at the discretion of the Purchaser, provided there as good or better than those in the schedule and documents are submitted corroborating this.

5.0 MIXING AND THINNING AND STORAGE OF PAINT

5.1 All ingredients in a paint container shall be thoroughly mixed to break-up lumps and disperse pigments before use and during application, to maintain homogeneity. Mixing shall be mechanical except when the container size is 20 litres or less. Mixing by air bubbling is not permitted. All pigmented paints shall be strained after mixing to remove skins and other undesirable matters.

5.2 Dry pigments, pastes, tinting and colours shall be mixed and/or made into paint so that all dry powders get wetted by vehicles, and lumps and particles are uniformly dispersed.

5.3 Additives that are received separately, such as, curing agents, catalysts, hardeners etc shall be added to the paint as per manufacturer's instructions. These shall be promptly used within the pot life specified by the manufacturers and unused paint thereafter discarded.

5.4 Thinners shall not be used unless essential for proper application of the paint. Where thinners are used, they shall be added during the mixing process and the type and quantity of thinner shall be in accordance with the instructions of the paint manufacturer.

5.5 Storage of Paint

5.5.1 All paints shall be store strictly in accordance with requirements laid down by the paint manufacturer. The storage area shall be well ventilated and protected from sparks, flame, direct exposure to sun or excessive heat, and preferably be located in an isolated room or in a separate building.

5.5.2 All paint containers shall be clearly labelled to show at the time of use the paint identification, date of manufacture, batch number, order number and. special instructions in legible form. The containers shall be opened only at the time of use. Paints which have livered, gelled or otherwise deteriorated during storage shall not be used. Paints for which the shelf life specified by the manufacturer has expired, shall not be used without inspection and approval by the Purchaser

6.0 PAINT APPLICATION

6.1 General

6.1.1 Paint shall be applied in accordance with manufacturer's recommendations as supplemented by this specification. The work shall generally follow IS:1477 (Part II) for jobs carried out in India and SSPC-PA-1 or DIN 55928 or equivalent for Jobs carried out outside India

6.1.2 Paint shall generally be applied by brushing, except that spraying may be used for finish coats only when brushing may damage the prime coats. Roller coat or any other method of paint application shall not be used unless specifically authorised. Spraying shall not be adopted for red lead or zinc rich paints. Daubers may be used only when no other method is practicable for proper application in areas difficult to access.

6.1.3 Paint shall generally not be applied when the ambient temperature is 10°C and below. For paints, which dry by chemical reaction, the temperature requirements specified by the manufacturer shall be met with. Also, paint shall not be applied in rain, wind, fog or at relative humidity of 80 per cent and above or when the surface temperature is below dew point resulting in condensation of moisture or during fog, rain or mist. Any wet paint exposed to damaging weather conditions shall be inspected after drying and the damaged area repainted after removal of the paint.

6.1.4 Each coat of paint shall be continuous, free of pores and of even film thickness without thin spots. The film thickness shall not be so great as to affect detrimentally either the appearance or the service of the paint.

6.1.5 Each coat of paint shall be allowed to dry sufficiently before application of the next coat to avoid damage such as lifting or loss of adhesion. Defects such as pinholes, voids, runs, sags, over-spray, orange peel, fish-eye and skins shall be prepared by mild sanding (by hand/power) of the damaged area. Undercoats having glossy surface shall be roughened by mild sand papering to improve adhesion of subsequent coat. Successive coats of same colour shall be tinted, whenever practical, to produce contrast and. help identify the progress of work.

6.1.6 The application of paint by brush or spray are covered below

6.2 **Brush Application**

6.2.1 Proper brushes shall be selected for a specific work piece. Round or oval brushes to IS:487 are better suited for irregular surfaces whereas flat brushes to 1S:384 are convenient for large flat areas. The width of" flat brushes shall not normally exceed 125 mm.

6.2.2 Paint shall be applied in short strokes depositing uniform amount of paint in each stroke followed by brushing the paint into all surface irregularities, crevices and corners and finally smoothing or levelling the paint film with long and light strokes at about right angles to the first short strokes. All runs and. sags shall be brushed out. Brush marks shall not be left in the applied paint as far as practicable.

6.3 **Spray Application**

6.3.1 The spraying equipment shall be compatible with the paint material and provided with necessary gauges and controls. The equipment shall be cleaned of dirt, dried paint, foreign matter and solvent before use.

6.3.2 The paint shall be applied by holding the gun perpendicular to the surface, at a suitable distance and moved in a pattern so as to ensure deposition of a uniform wet layer of paint. All runs shall be brushed out immediately. Areas not accessible to spray shall be painted by brush or dauber.

6.4 **Shop Painting**

6.4.1 All fabricated steel structures shall have a minimum of two primer coats prior to despatch to site. The paint shall be applied immediately after surface preparation to the specified quality preferably within two hours.

6.4.2 Surfaces in contact during shop assembly shall not be painted. Surfaces in contact after field erection shall receive three shop coats of specified primer unless the paint will interfere with assembly. Surface which will be inaccessible after assembly shall also receive three shop coats of specified primer. Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease to IS:958 or solvent deposited compound to IS:1153 or 1674 or an international equivalent

6.4.3 Surfaces to be in contact with concrete shall not be painted. Surfaces to be in contact with wood, brick or other masonry shall be given one shop coat of the specified primer.

6.4.4 The shop coats shall be continuous over all edges including ends meant for joining at site by welding, except where the paint is harmful to welding operator or is detrimental to the finished

welds. In such cases, no paint shall be applied within 50 mm of the welding edge and the unprotected surface shall be given a coat of corrosion inhibitive compound. The unpainted area shall be exposed prior to welding, the welded joint cleaned and deslagged and. immediately covered by paint same as that has been used for the remaining surface.

6.4.5 Small machinery, motors, electrical equipment and instruments etc shall receive the full specified coats of paint in the shop.

6.4.6 Large machinery, large motors, cranes, gear cases, conveyors etc shall be shop painted completely as per the relevant paint system taking into account the service conditions.

6.5 **Site/Field Painting**

6.5.1 After the erection/assembly of fabricated structures at the Plant site, damaged and defective shop coats shall be touched up with the same type of paint as used for shop coat. The work shall include removal of damaged paint work, surface preparation of the damaged area (due to erection or due to site fabrication) to the specified quality and painting thereof to cover-up all field connections, welds, rivets and all damaged or defective paint and rusted areas. If in the opinion of the Purchaser, damage to shop primer coats is extensive, then instead of spot touch up, one overall coat of primer for each coat shall be applied after cleaning. The fabricated steel structures shall then be painted with intermediate (where applicable) and finish coats as specified.

6.5.2 Equipment and large machinery pieces shall be despatched from shop after application of two coats of primer while intermediate (if necessary) and finish coats of paint shall be applied at site. In case vendors are permitted by Purchaser to despatch these items after application of finishing paints, these items shall be given one finish coat compatible with shop finish coats after cleaning and retouch, if necessary.

6.5.3 The first coat of paint at site shall be applied before weathering of the top shop coat becomes excessive, preferably within three months of the application of shop coat. The finish coats of paint shall be applied after all concrete work has been completed and all cement and concrete spatters and drippings removed and damaged surfaces touched up before application of the finish coats.

6.5.4 Surfaces requiring painting which have not been shop/yard painted shall be given necessary surface preparation and prime coats before application of intermediate and finish coats and before any damage occurs to the Surface from weather or other exposure

6.5.5 Steel structures, which are fabricated shall be painted with prime and finish coats after specified surface preparation on completion of fabrication and erection.

6.5.6 All cracks and crevices considered not detrimental to mechanical strength shall be filled with compatible paint or putty.

6.5.7 All field welds and all areas within 50 mm of welds shall be cleaned before painting, using surface preparation method as specified to attain the specified surface quality grade. All welds shall either be blast cleaned, or thoroughly power wire brushed or chemically scrubbed or solvent cleaned depending on the nature and position of the weld deposits.

6.5.8 During application of paint at site care shall be taken to prevent any damage to building, floors, structures, electrical equipment including motors, valve stems, glass, moving parts, bearings, couplings, shafts, lubrication points and other sensitive parts. Any paint falling on or applied to such surfaces shall be removed.

7.0 PAINT SYSTEMS

The paint systems to be followed in general for different service conditions has been classified and listed in Annexure- 3. In addition, some specific areas requiring special attention and the painting system, which has been found to be effective, are listed in Annexure-4 hereof.

7.1 General Service Painting

7.1.1 This system is applicable for painting of non-load bearing structure, such as partitions, minor platforms, ladders, walkways etc under normal atmospheric environment, which is fairly clean, dry and non-corrosive

7.1.2 Surface preparation shall be of SIS grade St-2 hand tool cleaning or St-3 power tool cleaning for oil-based paint and Sa 2½ near white blast cleaning in case PVC-copolymer-alkyd-based paint is used.

7.1.3 The paint system for this service the details of which has been specified in Annexure-3 shall be at least two coats or oil-based red lead or zinc chromate or zinc phosphate or equivalent primer and one coat of weather resistant modified phenolic resin varnish with micaceous iron (MIO) as an intermediate coat in the shop and one finish coat or long oil-alkyd resin paint at site after necessary touch-up operation. Alternative paint specification based/on PVC-copolymer alkyd can be used.

7.1.4 Steel doors, windows etc which are subject to regular handling shall have surface preparation to SIS grade St-3 power tool cleaning or pickling. The prime coat as specified in Annexure-3, shall be red lead based - two component epoxy-polyamide and

an intermediate coat of micaceous iron oxide (MIO) based two component epoxy-polyamide in the shop. The finish coat at site shall be two component epoxy-polyamide MIO paint followed by two component polyurethane, after filling all cracks with putty during application of primer coat.

7.2 **Wearing Surface Painting**

7.2.1 This system covers floor plates, walkways, staircase treads and other similar surfaces for general service.

7.2.2 Surface preparation shall be Sa 2 or Sa 2½ or St-3 depending on nature of exposure and paint system adopted as outlined in System No. 7.2 in Annexure-3.

7.2.3 The shop prime coat for light corrosive environment shall be either zinc chromate based PVC-copolymer alkyd enamel or red Lead/zinc chromate based epoxy ester resin varnish. The intermediate coat at shop shall be a compatible paint with micaceous iron oxide. The finish coat at site shall be compatible with prime and intermediate coat that is either PVC-copolymer alkyd or epoxy. Top surface of floor plate shall have higher paint film thickness than bottom.

7.2.4 In case of extreme corrosive atmosphere, the shop primer coat for top and bottom surface shall be two component epoxy polyamide with zinc chromate and. One intermediate coat shall be compatible paint with micaceous iron oxide. The site painting shall be of epoxy polyamide finished with two component polyurethane

7.2.5 For hand railing two coats of red lead epoxy as a primer and two coats of epoxy polyamide as finish coat shall be applied.

7.3 **Light Corrosive Service Painting**

7.3.1 This system is applicable where marine industrial atmosphere prevails or light corrosive atmosphere exists due to presence of mild corrosive fumes and gases of neighbouring plant. In view of the location of site, the paint system, which shall be generally applicable for most of the equipment and structures shall be covered under this category unless otherwise specified

7.3.2 Painting of all load bearing steel structures, structural steelwork for plant and shop building, equipment, pipework etc which are exposed to such light corrosive atmosphere as detailed in Annexure-3 are covered under this system.

7.3.3 The surface preparation shall be of Sa 2, or Sa 2½ or Sa 3 depending oil nature of paint system adopted.

7.3.4 The paint system under this service as specified in Annexure-3 for respective item shall be any one of the following such as chlorinated rubber, PVC-copolymer alkyd, epoxy polyamide and

zinc ethyl silicate and combination thereof depending on nature of exposure conditions, compatibility and durability of paint life

7.3.5 For temperature condition in between 80°C and 150°C zinc ethyl silicate primer shall be used followed by a coat of high build epoxy polyamide enamel.

7.3.6 For temperature condition above 150°C the primer coat shall be zinc ethyl silicate and finish coat shall be silicone-aluminium paint.

7.4 **Extreme Corrosive Service Painting**

7.4.1 This system is applicable where there is extreme corrosive atmosphere prevailing due to presence of inorganic and organic acids, alkalis, corrosive salts, corrosive vapours and fumes, solvents etc.

7.4.2 Painting of all load bearing steel structures, equipment, pipes and ducts, and its fittings which are exposed to such extreme corrosive atmosphere as detailed in Annexure-3 are covered under this system.

7.4.3 The surface preparation shall be Sa 2½ or Sa 3 or St-3 depending on nature of paint system adopted.

7.4.4 The paint system under this service as specified in Annexure-3 shall be primarily red lead/zinc chromate based epoxy-polyamide punt as primer coat and micaceous iron oxide as intermediate coat and epoxy-polyurethane as finish coat.

7.4.5 In case of higher temperature service of above 150°C and zinc ethyl silicate shall be used as prime- coat and silicone-aluminium as finish coat.

7.5 **Hot Surface Painting**

7.5.1 'This system is applicable when temperature condition under light or extreme corrosive service exceeds 80°C.

7.5.2 The prime coat shall be ethyl zinc silicate or epoxy-polyamide and silicone aluminium as a finish paint the specific application of which has been indicated in Annexure-3.

7.6 **Heavy Machinery and Accessories Painting**

7.6.1 This system is applicable for heavy machinery such as those in rolling mills and accessories, which are subjected to varying exposure conditions and excessive wear.

7.6.2 The surface preparation shall be of Sa 2½ or Sa 3 depending on paint system adopted.

7.6.3 The paint system shall be epoxy polyamide based as specified in Annexure-3.

7.7 **Switchboards/Control Panel Painting**

7.7.1 This system covers fabricated sheet metal items, namely. Electrical panels, switchboards, instrument panels, control desks, cabinets etc.

7.7.2 The surface preparation shall be pickling or white blast cleaning to Sa 2½. The clean surface shall be given a phosphate coating consisting of a thin layer of zinc, iron or manganese phosphate deposited either by immersion or powder spray. The coating weight shall not be lower than 5 gm per sq m; the coating shall be tested, when required, by a continuous salt spray as per ASTM B 117.

7.7.3 The phosphate coated surface shall have one coat of baking primer of zinc chromate - butylated melamine - alkyd resin based and two coats of finish paint of amino-alkyd resin stove enamel as specified in Annexure-3.

7.7.4 For large electric drives, transformers etc for indoor and outdoor installation, epoxy polyamide and polyurethane system shall be adopted as indicated in Annexure-3.

7.8 **Metallic Coating**

7.8.1 This system covers permanent structures namely, transmission towers, outdoor electric substation structures, pipe trestles, poles etc which cannot be conveniently repainted.

7.8.2 The surface preparation shall be degreasing, followed by pickling as per para 3.3.6, and in accordance with IS 2629.

7.8.3 The cleaned surface shall be coated by a layer of zinc by hot dipping, in accordance with IS 4759. The deposition shall be at least 610 gm per sq m for metal thickness of 5 mm and above, and 460 gm per sq m for up to 2 mm metal thickness. Alternatively hot dip aluminium coating can be used, in accordance with IS 6697.

7.8.4 In case hot dip coating can not be applied, sprayed aluminium/zinc coating as per IS 5905 can be applied with the permission of the Purchaser.

7.9 **Small Items of Equipment Painting**

7.9.1 Standard bought out items and machines such as valves, pumps, cylinders, small motors which are mass production item and are being painted in a production line in the manufacturer's shop, may be painted as per respective manufacturer's standard but shall meet the requirement of the exposure condition and the specific system of painting thereof as stipulated in this

specification. The colour to be adopted for such equipment shall be subject to approval by Purchaser before commencement of manufacture.

8.0 COLOUR CODE

8.1 Shades of finish paint coat to be applied shall be as per 1S:5 or as per Munsell colour reference (published by Munsell Colour Co Inc, Baltimore, USA). Shades of finish coat of major item like steel structures, equipment and piping are specified in Annexure-5. However, prior approval shall be taken from the Purchaser after placement of order before adopting final colour shade for any particular item being painted.

9.0 INSPECTION AND TESTING

9.1 The contractor shall ensure that the surface treatment and painting carried out meets the requirements of the relevant painting systems specified.

9.2 Testing shall be carried out on materials to be used by the Contractor, as well as work being carried at stages. Record shall be maintained by the Contractor of all such tests and reports submitted to the Purchaser. The Purchaser may examine the test reports, and in addition undertake inspection at any or all stages.

9.3 Manufacturer's test certificates shall be made available by the Contractor for all materials to be used in the works. In addition, the Purchaser reserves the right to call for test of samples at random, reject any batch or lot if the quality thus found is deficient, and the Contractor shall have to bear expenses of testing.

9.4 The inspection and test reports shall include but not be limited to the following essential information which are grade of surface preparation, paint system adopted, name of paint manufacturer, dry film thickness of each coat as measured.

i) Rust grade
ii) Grade of surface preparation
iii) Container identification of each coat of paint applied
iv) Dry film thickness of each coat

9.5 For the job execution, inspection shall be carried out by the Contractor after each stage of work, namely pre-treatment and each coat of paint. The Contractor shall maintain record of stage inspection, in formats to be approved by Purchaser. Countersignature by Purchaser on these will be required, before proceeding with next stage of work.

9.6 The Contractor shall maintain equipment required for inspection and testing required during job execution. These shall include but not be limited to the following.

a) Sling psychrometer and electric psychrometer for measuring wet and dry bulb temperatures, digital thermometer for instant air temperature.

b) Digital and surface temperature thermometer for recording temperature of substrate.

c) Zahn Cup for measuring viscosity of paint.

d) Wet film thickness gauge, inter-chemical wet film thickness gauge, Elcometer minitest and quanmix of different models, Positector 6000 for measuring coating thickness, and pocket-size 30X Microscope for examination of coatings.

e) Pinhole and holiday detectors e.g. Tinker-Rasor high and low voltage wet sponge holiday detector, K-D bird dog low voltage wet sponge holiday detector, spy high voltage holiday detector are required to find the nicks, scrapes and pinholes in the coating film.

9.7 Record shall be maintained by the Contractor on inspection of each identifiable part of the work, including but not limited to the following:

In addition, Dew point and relative humidity be shall recorded at the start of work, in the middle of each shift, or at intervals approved by Purchaser.

9.8 The Contractor shall have available, for reference at the work site, a set of essential standards, such as IS 1477 (Parts I & 2), IS 1303, and SIS 055900 (or equivalent ISO, SSPC, BS).

10.0 SAFETY MEASURES

10.1 For safety point of view the persons along with the supervisors who have to do painting, cleaning, shot blasting, etc. must take safety measures as is the normal practice in existing plant. Necessary instructions would be provided by safety engineering department of the Purchaser. The supervisor must follow the safety induction instructions such as use of safety belt, helmet, goggles, apron, mask, etc. while doing the job.

10.2 In addition plant and personnel belonging to the Purchaser and other agencies would be protected from damage due to the painting work to be carried out by the Contractor. This will include, but not be limited to, providing protective barriers/covers at job site, especially when carrying out air blast cleaning.

ANNEXURE - 1

APPLICABLE STANDARDS

Standard No.	Year of Publication (reaffirm)	Title
IS 5	2004	Colours for ready mixed paints & enamels
IS 101	various	Methods of sampling and test for paints, varnishes and related products (several parts & sections)
IS 158	1981(2004)	Ready mixed paint brushing, bituminous black, lead-free, acid, alkali & heat resistant
IS 384	1979(2002)	Brushes, paints & varnishes, flat
IS 430	1972(2004)	Paint remover, solvent type non-flammable
IS 431	1972(2000)	Paint remover, solvent type non-flammable
IS 487	1997	Brushes, paints and varnishes (i) oval ferrule bound and (ii) round ferrule bound
IS 958	2000	Temporary corrosion preventive grease, soft film-spec.
IS 1153	2000	Temporary corrosion preventive fluid, hard film, solvent deposited-specification
IS 1154	2000	Temporary corrosion preventive fluid, soft film, solvent deposited, water displacing-specification
IS 1303	1983(2001)	Glossary of terms related to paints
IS 1477(1)	1971(2000)	Code of practice foe painting of ferrous materials in building-pretreatment
IS 1477(2)	1971(2000)	Code of practice foe painting of ferrous materials in building-painting
IS 1674		Superseded by IS 1154
IS 2074	1992(2002)	Ready mixed paint, after drying, red oxide zinc chromate, priming-specification
IS 2339	1963 (2004)	Aluminium paint for general purpose use in dual container
IS 2379	1990(2000)	Colour code for identification of pipelines
IS 2395(1)	1994(1999)	Code of practice for painting concrete, masonry and plaster surfaces-operations and workmanship
IS 2395(2)	1994(1999)	Code of practice for painting concrete, masonry and plaster surfaces-schedule
IS 2629	1985 (2001)	Recommended practice for hot dipped galvanising of iron and steel
IS 2932	2003	Enamel, synthetic, exterior: (a0) undercoating (b) finishing-specification
IS 3531	1997(2002)	Glossary of terms relating to corrosion of metals
IS 3618	1966(2002)	Specification for phosphate treatment of iron and steel for protection against corrosion
IS 4759	1996 (2001)	Specification for hot dip zinc coating on structural steel and other allied products
IS 4777	1968(2002)	Performance tests for protection schemes used in protection of light gauge steel sections against corrosion
IS 5555	1970(2002)	Code of practice for conducting field studies in atmospheric corrosion of metals

Standard No.	Year of Publication (reaffirm)	Title
IS 5905	1989 (2005)	Sprayed aluminium & zinc coating of iron & steel
IS 6005	1998	Code of practice for phosphating of iron and steel
IS 6048		Withdrawn
IS 6049	1971(2002)	Code of practice for application of temporary corrosion preventives
IS 6050	1971(2004)	Specification for temporary corrosion preventives, strippable, hot dipping type
IS 6745	1972 (2001)	Method for determination of mass of zinc coating on zinc coated iron & steel
IS 6697	1988 (2000)	Hot dip aluminium coating on ferrous parts (other than sheets, steels & wires) for general purpose
IS 7808	1975(2002)	Code of practice for conducting underground corrosion of metals
IS 8062 1I)	1976(2002)	Code of practice for cathodic protection of steel structures, general principles
IS 8062 (2)	1976(2002)	Code of practice for cathodic protection of steel structures-underground pipelines
IS 8629(1-3)	1977(2000)	Code of practice for protection of iron and steel structures from atmospheric corrosion
IS 9954	1981(2000)	Pictorial surface preparation standard for painting of steel surfaces
IS 10221	1982 (2003)	Code of practice for coating and wrapping of underground mild steel pipelines
IS 10493	1983 (2002)	Corrosion protection tests for temporary corrosion preventives
IS 13607	1992(2002)	Ready mixed paint, general purpose, synthetic-specification
IS 14191	1996(2000)	Corrosion of metals and alloys-classification of corrosivity of atmosphere
IS 14209	1994(2004)	Epoxy enamel, two component, glassy-specification
IS 14297	1995(2000)	Corrosion of metals and alloys-corrosivity of atmosphere-determination of corrosion rate of standard specimens for the evaluation of corrosivity
IS 14321	1995(2000)	Corrosion of metals and alloys-recommended values for the corrosivity categories of atmosphere
IS 14322	1996(2000)	Corrosion of metals and alloys-corrosivity of atmosphere-measurement of pollution-methods
IS 14428	1997(2004)	Guidelines for painting of structures in aggressive chemical environment
IS 14506	1998(2003)	Epoxy red oxide zinc phosphate weldable primer, two component-specification
IS 14779	2000	General purpose oil based temporary corrosion preventives-specification
IS 14589	1999(2004)	Zinc priming paint, epoxy based, two pack-specification
IS 14925	2001	Epoxy resin for paints-specification

Standard No.	Year of Publication (reaffirm)	Title
IS 14946	2001	Zinc ethyl silicate primer, two components-specification
IS 14947	2001	Enamel synthetic, oil resistant air drying-specification
IS 14948	2001	Paint coal tar epoxy, two pack, black and brown (base & hardener)-specification
BS7079(I)	1989(1994)	Specification of rust grades and preparation grades of uncoated steel substrates and of steel substrates after removal of previous coating
- do- supplement 1		Representative photographic examples of appearance imparted to steel blast cleaned with different abrasives
ISO 8501-1	1988(E)	Preparation of steel substrates before application of paints and related products-visual assessment of surface cleanliness ; Part 1 – rust grade and preparation grades of uncoated steel substrates after overall removal of previous painting
ISO 8501-1 Supplement	1994	Representative photographic examples of appearance imparted to steel when blast-cleaned with different abrasives
ASTM B 1171997		Standard practice for operating salt spray (fog) apparatus
SSPC-Vis1	1989	Description of visual standards
SSPC-Vis2	1982	Rust protection manual
SSPC-SP-1	1995	Solvent cleaning
SSPC-SP-2	1995	Hand tool cleaning
SSPC-SP-3	1995	Power tool cleaning
SSPC-SP-4	1995	Flame cleaning of new steel
SSPC-SP-5/NACE1	1995	White metal blast cleaning
SSPC-SP-6/NACE3	1995	Commercial blast cleaning
SSPC-SP-7/NACE4	1995	Brush off blast cleaning
SSPC-SP-8	1995	Pickling
SSPC-SP-10/NACE2	1995	Near white blast cleaning
SSPC-PA-1		Shop, field and maintenance painting
SIS 055900	1988	Pictorial surface preparation standard for painting of steel
DIN 55928-4/Suppl 1	1991	Corrosion protection of steel structures by application of organic or metallic coating; preparation and testing of surfaces; representative photographic examination

ANNEXURE - 2

EQUIVALENT STANDARDS OF SURFACE PREPARATION GRADE

Surface preparation	Pictorial representation of Swedish Std SIS 055900	DIN Std. DIN 55928 (Part 4)	SSPC Std.	BS Std. BS:4232	IS Std. (IS:1477) (Part 1)
1. Blast cleaning to white metal:	Sa 3	Sa 3	SSPC-SP-5	1st qlty	CI A1.2
Removal of all visible rusts, mill scales, paint and foreign matters					
2. Blast cleaning to near white metal:	Sa $2^{1/2}$	Sa $2^{1/2}$	SSPC-SP-10	2nd qlty	CI A1.2
95% of any section of surface area is free from all rusts, mill-scales and visible residues					
3. Blast cleaning to commercial quality:					
At least 2/3 of any section of the surface area is free from all rusts, mill-scales and visible residues	Sa 2	Sa 2	SSPC-SP-6	3rd qlty	CI L1.3
4. Brush-off blast cleaning:					
Removal of all loose mill-scales, rust and foreign matters etc	Sa 1	Sa 1	SSPC-SP-7	-	CI A1.4
5. Power tool cleaning:					
Very thorough scrapping and wire brushing to remove loose mill-scale, rust and foreign matters to have pronounced metallic shine	St-3	St-3	SSPC-SP-3	-	CI 6.2.1.2
6. Hand tool cleaning:					
Removal by hand brushing of loose mill-scale, loose rust and foreign matters	St-2	St-2	SSPC-SP-2	-	CI 6.2.1.1

ANNEXURE - 3

PAINTING SYSTEM

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
7.1	General service painting	Normal atmospheric environment non-corrosive atmosphere									
7.1(i)	Non-load bearing structural steelwork such as partitions, minor platforms, walkways, ring ladders pipe/cable support brackets etc. Location - all indoor temperature less than 80^0 C		St 2 or St 3	2 P	35	Oil based red lead or zinc chromate/zinc phosphate anticorrosive primer	Clean and retouch	1 F	30	Synthetic enamel of long oil alkyd resin based paint	155
				1 I	55	Dust preventive paint based on modified phenoloc resin with MI0					
7.1(ii)	Steel doors, windows etc. of regular handling		St 3	1 P	30	Red lead based two component epoxy polyamide paint	Clean and retouch	1 F	50	High build two component epoxy polyamide with MI0	170
				1 I	50	High build two component epoxy polyamide with MI0		1 F	40	Two component polyurethane	
7.2	Wearing surface painting										
	Painting of floor plates, walkways, staircase treads handrailing etc. which are prone to mild abrasion	Light corrosive atmosphere									
7.2(i)	Floor plates/walkways/staircase treads etc.										
	Top surface temperature less than 80^0 C		Sa 2.5	1 P	15-20	Weldable shop alkyd primer (optional)					
				1 P	70-80	PVC-copolymer-alkyd resin-zinc chromate	Clean and retouch	2 F	40-50	PVC-copolymer alkyd resin	220-260 (Excluding weldable primer coat)
				1 I	70-80	PVC-copolymer alkyd resin with MI0					
						OR					
			Sa 2 or St 3	WP	15	Long exposure type zinc chromate based vinyl	Clean and retouch	1 F	120-130	High build coal tar epoxy with polyamide hardner	230-270 (Excluding wash primer)

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
						butynal resin varnish wash					
				2 P	30-40	Dust preventive red lead/zinc chromate based epoxy polyamide					
				1 I	50-60	Dust preventive epoxy ester paint with MI0					
7.2(ii)	Floor plates/walkways/staircase trends etc.										
	Both surface: temperature less than 80^0 C	Light corrosive	Sa 2.5	1 P	15-20	Weldable shop alkyd primer (optional)	Clean and retouch	1 F	40-50	PVC-copolymer resin	180-210 (Excluding weldable primer)
				1 P	70-80	PVC-copolymer alkyd resin-zinc chromate					
				1 I	70-80	PVC-copolymer alkyd resin with MI0					
						OR					
			Sa 2	1 P	15	Long exposure type zinc chromate based vinyl butynal resin varnish wash	Clean and retouch	1 F	120-130	High build coal tar epoxy with polyamide	200-230 (excluding wash primer)
				1 P	30-40	Dust preventive red lead/zinc chromate based epoxy ester resin varnish					
				1 I	50-60	Dust preventive epoxy ester paint with MI0					

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
7.2(iii)	Floor plates/walkways/staircase treads etc.										
	Top and bottom surface - temperature less than 80^0 C	Extreme corrosive atmosphere	Sa 2.5	1 P	15-25	Weldable epoxy based, shop primer					
				1 P	30-40	Two component epoxy polyamide - zinc chromate	Clean and retouch	2 F	30-40	Two component epoxy polyamide	180-230 (excluding weldable primer)
				1 I	50-60	Two component epoxy polyamide with MIO		1 F	40-50	Two component polyurethane	
7.2(iv)	Hand railing (site fabricated)	Light corrosive	Nil			-	St 3	2 P	40	Read lead epoxy	160
								2 F	40	Two component epoxy polyamide	
7.3	Light corrosive service painting	marine industrial atmosphere in tropical climate, or mild corrosive environment due to presence of mild acidic fumes and gases from neighbouring plant									
7.3(i)	Structural steelwork for plant and shop building: temperature less than 80^0 C	Light corrosive	Sa 2.5	1 P	15-25	Weldable epoxy based shop primer					
				2 P	30-40	Red oxide - zinc chromate/non-leufing aluminium based chlorinated rubber plant	Clean and retouch	2 F	30-40	Chlorinated rubber resin varnish with weather resisting pigments	170-210 (excluding weldable epoxy primer)
				1 I	50-60	High build chlorinated rubber paint with MIO					

System No.	Description	Nature of exposure	Treatment in the snop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
7.3(ii)	Miscellaneous technological steel structure such as conveyor galleries, pipe trestles etc. indoor and outdoor: temperature less than 80^0 C	Light corrosive	Sa 2.5	1 P	15-25	Weldable epoxy based shop primer	Clean and retouch	2 F	30-40	Chlorinated rubber with weather resisting pigments	170-210 (excluding weldable epoxy primer)
				2 P	30-40	Red oxide - zinc chromate/non-leafing aluminium based chlorinated rubber					
				1 I	50-60	High build chlorinated rubber with MIO					
7.3(iii)	Manufactured equipment and its associated structures such as vessels, bunkers, exchangers, heaters, furnace, pumps, cranes, stacks etc.	Light corrosive	Sa 2.5	1 P	15-25	Weldable shop alkyd primer (optional)					
				1 P	70-80	PVC - copolymer alkyd resin with zinc chromate	Clean and retouch	1 F (optional)	40-50	PVC - copolymer alkyd with weather resistant pigment and of glossy finish	180-210
	- Non-insulated, temperature less than 80^0 C			1 i	70-80	PVC - copolymer alkyd resin with MIO					
				1 P	40-50	PVC - copolymer alkyd resin with weather resistant pigments and of glossy finish					
						OR					
			Sa 2.5	1 P	15-25	Weldable epoxy based shop primer (optional)	Clean and retouch	1 F (optional)	25-30	Chlorinated rubber paint with weather resisting pigments of glossy finish	150-180
				2 P	25-30	Red lead/zinc chromate based epoxy primer					
				1 I	50-60	Dust preventive epoxy ester resin paint with MIO					
				2 P	25-30	Chlorinated rubber paint with weather resisting pigments of glossy finish					

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
	- Temperature 80^0 - 150^0 C		Sa 2.5	1 P	60-70	Zinc ethyl silicate					
				1 F	60-70	High build epoxy polyamide enamel	Clean and retouch	1 F (optional)	60-70	High build up polyamide enamel	130-140
	- Temperature over 150^0 C		Sa 3	1 P	60-70	Zinc ethyl silicate	Clean and retouch	1 F (optional)	15-20	Silicon - aluminium	90-110
				2 P	15-20	Silicon - aluminium					
	- Insulated surfaces										
	Temperature less than 80^0 C		Sa 2.5	Same as of non-insulated surface but without any finish coat			Clean and retouch				100-120
	Temperature over 80^0 C		Sa 3	1 P only	60-70	Zinc ethyl silicate	Clean and retouch				60-70
7.3(iv)	Overground pipework inclusive of pipes, fittings, hangers, cable ducts, gas ducts etc.	Light corrosive									
	Non-insulated pipework :										
	- Indoor and outdoor temperature less than 80^0 C		St 2 or 3	2 P	40	Red lead/zinc chromate based epoxy resin primer	Clean and retouch	2 F	30	Chlorinated rubber with weather resisting pigments	140
	- Indoor and outdoor temperature between 80^0 C and 150^0 C		Sa 3	1 P	60-70	Zinc ethyl silicate	Clean and retouch	1 F	40	Two component epoxy polyamide enamel	100-110
	- Indoor and outdoor temperature between 80^0 C and 150^0 C		Sa 3	1 P	60-70	Zinc ethyl silicate	Clean and retouch	2 F	15	Silicon - aluminium	90-100
	Insulated pipework :										
	- Indoor and outdoor temperature less than 80^0 C		St 2 or 3	2 P	40	Red lead/zinc chromate based epoxy resin primer	Clean and retouch	-	-	No finish coat	80
	- Indoor and outdoor temperature over 80^0 C		Clean	1 P	40-60	Corrosion protective wax/grease					40-60

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
7.4	Extreme corrosive service painting	Strongly corrosive atmosphere due to presence of inorganic and organic acids, alkalis, salts, corrosive vapours and fumes etc.									
7.4(i)	Equipment such as process, vessels, pumps etc. and its associated structure in handling and treatment area, neutralising area etc. where acids/ alkalis/miscellaneous chemicals are handled	Extreme corrosive	Sa 2.5	1 P	15-20	Zinc phosphate - weldable epoxy primer (optional)	Clean and retouch	1 F (optional)	30-40	Two component polyurethane	170-180 (weldable primer coat excluded)
				2 P	30-40	Two component - epoxy polyamide - zinc chromate					
	Temperature below 150^0 C			1 I	50-60	Two component: high build epoxy polyamide with MIO					
				1 F	30-40	Two component epoxy polyamide enamel					
				1 F	30-40	Two component polyurethane					
7.4(ii)	Overground pipework inclusive of pipes, fittings, supports, hangers, cable ducts, gas ducts etc.	Extreme corrosive									
	Non-insulated pipe/duct work :										
	- Indoor and outdoor temperature below 150^0 C		Sa 2.5	1 P	40	Two component epoxy polyamide zinc chromate	Clean and retouch	2 P	50	Two component epoxy polyamide enamel	190-200
				1 I	50-60	Two component epoxy polyamide with MIO		1 P	40	Two component polyurethane	
	- Indoor and outdoor temperature over 150^0 C		Sa 3	1 P	40-70	Zinc-ethyl silicate	Clean and retouch	2 P	15	Silicone aluminium	90-100

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
	Insulated pipe/duct work :										
	- Indoor and outdoor temperature below 1500 C		Same as of non-insulated pipe/duct work						No finish coat		90
	- Indoor and outdoor temperature over 150^0 C		Clean	1	40-60	Corrosion protective wax or grease					40-60
7.5	Hot surface painting										
	Temperature above 80^0 C	Environment may be light or extreme corrosive similar to system no. 7.3 and 7.4 respectively				Painting shall follow according to system no. 7.3 and system no. 7.4 depending on temperature conditions and nature of environment					
7.6(i)	Mill machineries, heavy equipment and accessories										
	Temperature upto 150^0 C	For all environment	Sa 2.5	2 P	25-30	Two component epoxy polyamide zinc chromate	Clean and retouch	1 F (optional)	40-50	Two component epoxy polyamide enamel	180-220
				1 I	50-60	Two component epoxy polyamide with MIO					
				2 P	40-50	Two component epoxy polyamide enamel					
7.6(ii)	Light machineries, such as general working machineries, machine tools etc.										
	Indoor location and temperature upto 80^0 C	Light corrosive environment due to handling of mineral oils, vegetable oils, grease etc.	Sa 2	2 P	25-30	Phenolated alkyd with zinc chromate	Clean and retouch				140-170
				1 I	40-50	Phenolated alkyd based under coat with MIO					
				2 P	25-30	High gloss styrenated alkyd enamel					

System No.	Description	Nature of exposure	Treatment in the shop				Treatment at site				Total DFT in microns (shop & site)
			Surface quality	No.of coats	DFT/coat in microns	Paint system	Surface quality	No.of coats	DFT/coat in microns	Paint system	
7.7	Switchboard/control panel painting										
7.7(i)	This includes fabricated sheet metal item such as switchboard, control panel, control desks, cabinet, starters, small electric machineries etc.	For all environment	Pickling or Sa 2.5 phosphate treatment	1 P	25	Zinc chromate - butyrated melamine - alkyd resin baking primer					
				1 I		Aminoalkyd resin putty					75
				2 P	25	Aminoalkyd resin baking enamel paint					
7.7 (ii)	Electric motors, transformers etc.										
	- Indoor and outdoor installation	For all environment	Sa 2.5	2 P	25-30	Two component epoxy polyamide zinc chromate	Clean and retouch	1 F (optional)	30-40	Two component epoxy polyamide or polyurethane	160-200
	- Temperature less than 150^{0} C			1 I	50-60	Two component epoxy polyamide with MI0					
				2 P	30-40	Two component epoxy polyamide or polyurethane					
7.8	Metallic Coating Protection System										
	This system is applicable for protection of permanent structures, which cannot be conveniently repainted, such as transmission towers, outdoor electruc substations structures, pipe tressels, poles, etc.		Pickling followed by metallic coaging								

Note:

(1) Legend : surface quality : Surface preparation grade as per SIS 05 5900 or equivalent, P : Primer cost, I : Intermediate coat, F : Finish coat DFT : Dry film thickness in microns, MI0 ; Micaceous iron oxide, WP ; Wash primer.

(2) Clean and retouch shall mean cleaning of contaminants related to the metal (rust) to St 3 grade and cleaning of all contaminants other than metal such as weld moisture, slag electrode deposition etc., retouching shall be of same number and kind of shop coat.

ANNEXURE - 4

SPECIAL AREA PAINTING

SCOPE

This covers areas requiring special attention. This also defines the painting systems found to be effective, and are to be adopted. These systems are briefly described below.

Sl. No.	Area covered	Painting system
1.0	**Blast Furnace**	
1.1	Pouring building except +1.9 m platform structure	Hand tool cleaning to St2 grade, and 3 coats of HR aluminium paint for 400°C
1.2	Structures below 1.9 m platform in pouring area	Blast cleaning to Sa2 grade, one coat ethyl zinc silicate primer and one coat air drying silicone aluminium paint
1.3	Structures of inclined gallery	Blast cleaning to Sa2 grade, one coat ethyl zinc silicate primer and two coats air drying silicone aluminium paint
1.4	Structure of distribution areas below +6 m	Blast cleaning to Sa2 grade, one coat ethyl zinc silicate primer and two coats air drying silicone aluminium paint
1.5	Structures of exhaust area & distribution area above +6 m	Blast cleaning to Sa2 grade, two coats of epoxy coal tar paint for total DFT of 200 microns
1.6	Roof sheeting of exhaust area	Etch primer, two coats of epoxy coal tar paint for total DFT of 200 microns
1.7	Hot metal ladle repair & torpedo ladle repair station Roof sheeting	HR aluminium paint 400°C
1.8	Heating station structure & roof sheeting	HR aluminium paint 400°C
1.9	Junction houses of slag conveyors	Blast cleaning to Sa2 grade, two coats of epoxy coal tar paint for total DFT of 200 microns
1.10	Slag granulation plant roof & chimney structures	Blast cleaning to Sa2 grade, two coats of epoxy based primer and two coats of epoxy based enamel finish paint for total DFT of 125 microns
1.11	GCP area in BF throttle structures	Blast cleaning to Sa2 grade, two coats of chlorrubber based primer and two coats of chlorrubber based finish paint for total DFT of 125 microns

Sl. No.	Area covered	Painting system
1.12	CO gas flare stack	Blast cleaning to Sa2 grade, two coats of chlorrubber based primer and two coats of chlorrubber based finish paint for total DFT of 125 microns
2.0	**Steelmelt Shop**	
2.1	Steel & slag transfer car track roof structure & CGI sheets	Hand tool cleaning to ST2 grade, HR aluminium paint 600°C
2.2	Heat shield over all machines in CCD & over L.D. in converter	Hand tool cleaning to ST2 grade, HR aluminium paint 600°C
3.0	Flood Light Towers	Blast cleaning to Sa2 grade, two coats of chlorrubber based primer and two coats of chlorrubber based finish paint for total DFT of 125 microns

ANNEXURE – 5

COLOUR CODE

Shades of finish coat of paint applied over respective item are as under:

Items painted	Colour	Colour No. of IS:5	Equivalent Munsell Value
1. Structures			
Building frames Including bracings, Side girts, louvres, etc.	Aircraft grey	693	9.5BG 5.0/0.7
Crane girders	Azure blue	104	3.9B 4/3.4
Crane stops	Post office red	538	8.7R 3.0/13.2
Monorail with maintenance walkway	Post office red	538	8.7R 3.0/13.2
Gutters	Black bituminous Aluminium	-	-
Fire escape platforms, ladders etc.	Signal red	537	8.7R 3.8/15.5
Vertical posts of handrailing	Black	-	-
General hand railing, top runners	Lemon yellow	355	3.2Y 7.6/11
Rung ladders	Lemon yellow	355	3.2Y 7.6/11
All members blocking passages for movement	Lemon yellow	355	3.2Y 7.6/11

Items painted	Colour	Colour No. of IS:5	Equivalent Munsell Value
Trestles, towers and pipebridges	Dark admiralty grey	632	8.2B 3.9/1.0
Conveyor gallery structures	Aircraft grey	693	9.5BG 5.0/0.7
Steel chimneys	Aluminium	-	-
2. Equipment and machinery			
General indoor equipment	Light grey	631	3.5G 5.8/1.1
General outdoor equipment	Dark admiralty grey	632	8.2B 3.9/1.0
Hoppers, chutes and bin structure (except supporting beams)	Post office red	538	8.7R 3.0/13.2
Crane bridges, trolleys, hooks etc and other mobile equipment	**Base:** Lemon yellow **Stripes:** Black (100 mm wide)	355 -	3.2Y 7.6/11 -
Furnaces	Aluminium	-	-
Tanks	**Base:** Same as for general equipment **Stripes:** Same shade As for piping around The tank at half the Tank height		
Fire-fighting Equipment	Signal red	537	8.7R 3.8/15.5

3. Pipework:

Colours shall be as given below. The base colour shall be applied throughout entire length except, on surfaces if materials such as asbestos, aluminium, brass, bronze, galvanised steel, stainless steel and other corrosion resistant alloys and rubber/synthetic polymers. In such cases identification colour bands of at least 500 mm width shall be provided near each branch, valve and at distances not exceeding 10 m either as local colour coatings or coloured adhesive type of suitable material or label attached to the pipework. Additional identification bands superimposed over the base colour shall be provided near each branch, valve and at distance not exceeding 10 m, the bands shall be at least 25 mm wide except in case of double bands where the first band shall be about 100 mm wide. Direction of flow shall be clearly marked on the pipelines at intervals not exceeding 10 m and at all branches and change of directions:

Service	Colour	Colour No. of IS:5	Equivalent Munsell Colour No.
Sea or river water (untreated)	base – Sea green	217	6.8 GY 6.2/5.5
	band – White	-	-
Cooling water	base - Sea green	217	6.8 GY 6.2/5.5
	band – French blue	166	5.4PB 3.9/7.4
Boiler feed water	base – Sea green	217	6.8 GY 6.2/5.5
Condensate	base – Sea green	217	6.8 GY 6.2/5.5
	Band – Light brown	410	7.7 YR 4.9/4.9
Drinking water	base – Sea green	217	6.8 GY 6.2/5.5
	first band – French blue	166	5.4PB 3.9/7.4
	second band – Signal red	537	8.7R 3.8/15.5
Industrial water	base – Sea green	217	6.8 GY 6.2/5.5
	band – Light orange	557	3.3 YR 5.5/14.1
Hydraulic power water	base – Sea green	217	6.8 GY 6.2/5.5
	band – Black	-	-
Compressed air	base – Sky blue	101	0.6 BG 6.3/2.9
Instrument air	base – Sky blue	101	0.6 BG 6.3/2.9
	Band – Light brown	410	7.7 YR 4.9/4.9

Items painted	Colour	Colour No. of IS:5	Equivalent Munsell Value
Vacuum	base – Sky blue	101	0.6 BG 6.3/2.9
	Band – Black	-	-
Steam (below 3.5 kg/ sq cm g)	base: Silver grey if bitulac or Al-jacket	628	1.5 GY 5.8/2.1
	band: Brilliant green	221	0.2 G 4.2/5.3
(between 3.5 kscg and 20 kscg)	base: Silver grey if bitulac or Al-jacket	628	1.5 GY 5.8/2.1
	band: French blue	166	5.4PB 3.9/7.4
(21-40 kg/ sq cm g)	base: Al-jacket	-	
	band: Dark violet	796	7.5 P 2.6/7.7
(above 40 kg/ sq cm g)	base: Al-jacket	-	
	band: Signal red	537	8.7R 3.8/15.5
Drainage	base – Black	-	-
Lubricating oil	base – Light brown	410	7.7 YR 4.9/4.9
	band – Light grey	631	3.5G 5.8/1.1
Hydraulic oil	base – Light brown	410	7.7 YR 4.9/4.9
	band – Dark violet	796	7.5 P 2.6/7.7
Transformer oil	base – Light brown	410	7.7 YR 4.9/4.9
	band – Light orange	557	3.3 YR 5.5/14.1
Fuel oil	base – Light brown	410	7.7 YR 4.9/4.9
	band – Signal red	537	8.7R 3.8/15.5
Coke oven/coal gas/ other fuel gases	base – Canary yellow	309	5.6 Y 8.2/11.2
	band – Signal red	537	8.7R 3.8/15.5
Freon (chloro-fluore derivative of mathane and ethane)	base – Canary yellow	309	5.6 Y 8.2/11.2
	band – Light grey	631	3.5G 5.8/1.1
Argon	base – Canary yellow	309	5.6 Y 8.2/11.2
	band – Fench blue	166	5.4PB 3.9/7.4

Items painted	Colour	Colour No. of IS:5	Equivalent Munsell Value
Acetylene	base – Canary yellow	309	5.6 Y 8.2/11.2
	band – Dark violet	796	7.5 P 2.6/7.7
L.P. gas	base – Canary yellow	309	5.6 Y 8.2/11.2
	first band – Signal red	537	8.7R 3.8/15.5
	second band – Traffic green	267	2.8 G 3.8/3.3
Nitrogen	base – Canary yellow	309	5.6 Y 8.2/11.2
	band – Black	-	-
Oxygen	base – Canary yellow	309	5.6 Y 8.2/11.2
	Band – White	-	-
Regenerated acid (dilute)(1)	base – Dark violet	796	7.5 P 2.6/7.7
	band – Light brown	410	7.7 YR 4.9/4.9
Hydrochloric acid (conc.) (1)	base – Dark violet	796	7.5 P 2.6/7.7
	first band – Light brown	410	7.7 YR 4.9/4.9
	second band – Light brown	410	7.7 YR 4.9/4.9
Spent liquor	base – Dark violet	796	7.5 P 2.6/7.7
	first band – Light grey	631	3.5G 5.8/1.1
	second band – Light brown	410	7.7 YR 4.9/4.9
Wash liquor	base – Dark violet	796	7.5 P 2.6/7.7
	band – Light grey	631	3.5G 5.8/1.1
Dilute acidic liquors	base – Dark violet	796	7.5 P 2.6/7.7
	first band – Light grey	631	3.5G 5.8/1.1
	second band – Brilliant green	221	0.2 G 4.2/5.3
Hydrofluoric acid (conc.)(1)	base - Dark violet	796	7.5 P 2.6/7.7
	band – Silver grey	628	2.5 GY 5.5/2
Acidic slurries (1)	base – Dark violet	796	7.5 P 2.6/7.7
	band – White	-	-

Items painted	Colour	Colour No. of IS:5	Equivalent Munsell Value
Alkalis	base – Dark violet	796	7.5 P 2.6/7.7
	band – Deep buff	360	7.5 YR 5.5/6
Non-acidic slurries	base – Sea green	217	6.8 GY 6.2/5.5
	Band – White	-	-
Fire fighting system	base – Signal red	537	8.7R 3.8/15.5
Rain water down pipes	base – Sea green	217	6.8 GY 6.2/5.5
	Band – Sky blue	101	0.6 BG 6.3/2.9
Duct work	base – Aluminium	-	-
Lighting conduits	base – Black	-	-
	Band – Canary yellow	309	5.6 Y 8.2/11.2
Instruments – conduits	base – Black	-	-
	band – Signal red	537	8.7R 3.8/15.5
Power conduits	base – Black	-	-

Note: (1) For these service, hazard marking as per fig. 4C of IS:2379 shall also be provided.