NATIONAL THERMAL POWER CORPORATION LTD.

FEROZE GANDHI UNCHAHAR THERMAL POWER PROJECT

STAGE – IV (1X500 MW)

TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM

SPECIFICATION NO.: PE- TS- 401- 555- A001
Rev. 00

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERIING MANAGEMENT
NOIDA

CONTENTS

SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification is intended to cover design, engineering, manufacture, inspection and testing at vendor's/ sub-vendor's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation at site , Erection & Commissioning including commissioning spares, civil works as required on FOR site basis, Performance and guarantee testing and handing over of **COMPRESSED AIR SYSTEM PACKAGE** as per details in different sections / volumes of this specification for 1**X500 MW UNCHAHAR TPP in dist. RAEBARELI (UTTAR PRADESH).**

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning of **COMPRESSED AIR SYSTEM PACKAGE.**

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.

1.5 The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information , ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL/NBPPL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer

themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations / clarifications, if any, should be very clearly brought out clause by clause in the format enclosed in Volume II; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. Each deviation shall be furnished with its cost of withdrawal in both priced and un-priced bid. In case of No-deviation, bidder to furnish the No-deviation / compliance certificate in the format enclosed in Volume II of this specification.

1.9 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.10 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL/NBPPL and /or NTPC including their consultant as interpreted by BHEL/NBPPL in the relevant context.

SECTION-B

PROJECT INFORMATION

1.00.00	**BACKGROUND**
	Feroze Gandhi Unchahar Thermal Power Station, FGUTPS was conceived as a Load Centre coal based Power Station of 1050 MW capacity by UPSEB. The land for the project was acquired and stage-I (2x210MW) was implemented by UPSEB. The 2x210 MW Unchahar station was taken over by NTPC from Uttar Pradesh Rajya Vidyut Utpadan Nigam of Uttar Pradesh in 1992. Thereafter, NTPC implemented Stage- II (2x210 MW) and Stage-III (1X 210 MW). The present expansion proposal is to install one additional unit of 500 MW under Stage-IV thus making the ultimate capacity of the FGUTPP 1550 MW.
1.01.00	**LOCATION AND APPROACH**
	The plant is located in Raebareli district of Uttar Pradesh, having latitude and longitude of 25°54'50"N and 81°19'50"E respectively. It is bounded by villages Khnapur, Faridpur and Khaliqpur Khurd. Mustafabad town is located at a distance of about 3 Kms from the plant. Unchahar railway station on Allahabad-Raebareli broad gauge (BG) section of Northern Railway (NR) is 2 Kms away. The nearest airport is located at Lucknow a distance of approximately 110 km from the project site. Vicinity Plan of the project is placed at **Annexure-I**
1.02.00	**LAND REQUIREMENT**
	During the implementation of FGUTPS, Stage-I, II & III total area of about 2203 acres of land was acquired. The plant facilities, ash disposal and township for this expansion Stage-IV (1x500 MW) would be accommodated within the available land with dismantling and relocation of some buildings. No additional land has been envisaged to be acquired for this expansion project.
1.03.00	**WATER**
	As per agreement between NTPC & Irrigation department, 105 Cusec of water is supplied through S.S Canal to NTPC-Unchahar. The Stage-IV (500MW) consumptive water requirement shall be accommodated within the existing commitment of water to FGUTPP. Sharda sahayak canal and Dalmau Pump House (DPH) on Purwa Branch Canal are available sources of water for the project and therefore, the make up water requirement for the plant is proposed to be drawn from these sources.
1.04.00	**COAL AVAILABILITY AND TRANSPORTATION**
1.04.01	**Coal Availability**

The coal requirement shall be about 2.7 Million tonnes per year.

The matter has been taken up with Ministry of Coal, Govt. of India for Long Term Coal Linkage for Stage-IV (1x500 MW)..Coal requirement for FGUTPP, Stage-I ,II & III is being met from North Karanpura Coal fields of CCL. For FR purposes, coal from North Karanpura Coal fields of CCL has been considered.

1.04.02 **Coal Transportation**

The envisaged mode of coal transportation from the coal mines to the power plant is by Indian Railways rakes. The rakes shall be unloaded at the track hopper.

1.04.03 **Coal Quality Parameters and Fuel Oil Characteristics**

The Coal quality parameters and Fuel Oil Characteristics are enclosed as **Annexures-II-1 and II-2** to this subsection.

1.05.00 **CAPACITY & POWER EVACUATION**

Stage- I	:	2x210 MW	Under Commercial Operation
Stage-II	:	2x210 MW	Under Commercial Operation
Stage-III	:	1x210 MW	Under Commercial Operation
Stage-IV		1x 500 MW	Present proposal

The existing capacity of plant is 1050 MW Step up/ power evacuation voltage for station is 220 KV. Presently 1000 MW is already being evacuated at 220 KV, addition of another 500 MW at 220 KV may cause overloading of 220 KV systems and lead to increase in fault levels at 220 KV system. Considering this 400 KV has been considered as step-up/power evacuation voltage for Stage-IV. Power Generated from FGUTPP- Stage IV, 500 MW unit would be stepped up to the evacuation voltage level through suitably rated Generator Transformer.

The power generated from Stage-IV is envisaged to be absorbed by Northern Region beneficiaries. For finalisation of Associated Transmission System (ATS) of the project, the matter would be taken up with Power Grid Corporation of India Ltd. (PGCIL)/CEA/appropriate authority depending on the various routes/options of power sale envisaged for the project.

1.06.00 **METEOROLOGICAL DATA**

Important meteorological data from nearest observatory at **Allahabad** is placed at **Annexure - III.**

1.07.00 **PLANT WATER SCHEME**

	The Plant water scheme is described below.
1.07.01	**Source of Water** The source of water for the project is normally from the Allahabad branch canal of the Sharda Sahayak link canal. During the canal closure period, water will be drawn from the Dalmau canal.
1.07.02	**Water Requirement** Normal Make up water requirement for this project would be about 2000 Cu.M/hr with ash water re-circulation system in operation. However, whenever ash water system needs to be operated in once thru mode, water drawl shall be of the order of 3300 cum/hr.
1.07.03	**Raw Water System** Raw water shall be drawn from the source by a gravity channel upto raw water pump house located inside the plant. It is envisaged to provide three (3) numbers (3 x 50 % Capacity) of raw water pumps for supplying water to Water PT Plant in the raw water pump house. In addition two (2) numbers (2 x 100% capacity) of pumps shall be provided to supply raw water for ash handling plant which shall be operated as and when required. Separate set of pipelines of carbon steel construction shall be provided from respective raw water pumps to Water treatment plant and Ash Water tanks.
1.07.04	The quality of Raw water and Clarified water is enclosed with this sub-section
1.08.00	**Criteria for Wind Resistant Design of Structures and Equipment** All structures and equipment of the power plant, including plant auxiliary structures and equipment, shall be designed for wind forces as given in Sub-Section- D-01, Part-B, Section-VI, i.e. Technical Specification for Civil and Structural Works.
1.09.00	**Criteria for Earthquake Resistant Design of Structures and Equipment** All power plant structures and equipment, including plant auxiliary structures and equipment shall be designed for seismic forces as given in Sub-Section- D-01, Part-B, Section-VI, i.e. Technical Specification for Civil and Structural Works.

DESIGN RAW WATER ANALYSIS

S.No	Constituent	As	mg/l
1	Calcium	CaCo3	110
2	Magnesium	CaCo3	95
3	Sodium+ Potassium	CaCo3	130
4	Total cations	CaCo3	335
5	Bicarbonates	CaCo3	250
6	Chloride	CaCo3	50
7	Sulphate	CaCo3	35
8	Total Anions	CaCo3	335
9	Silica	As SiO2	12
10	Iron	Fe	1
11	pH Value	-	7.7-8.3
12	Turbidity (NTU)	NTU	Upto 700
13	Organic Matter(As per KMnO4 method)	Number	7.2

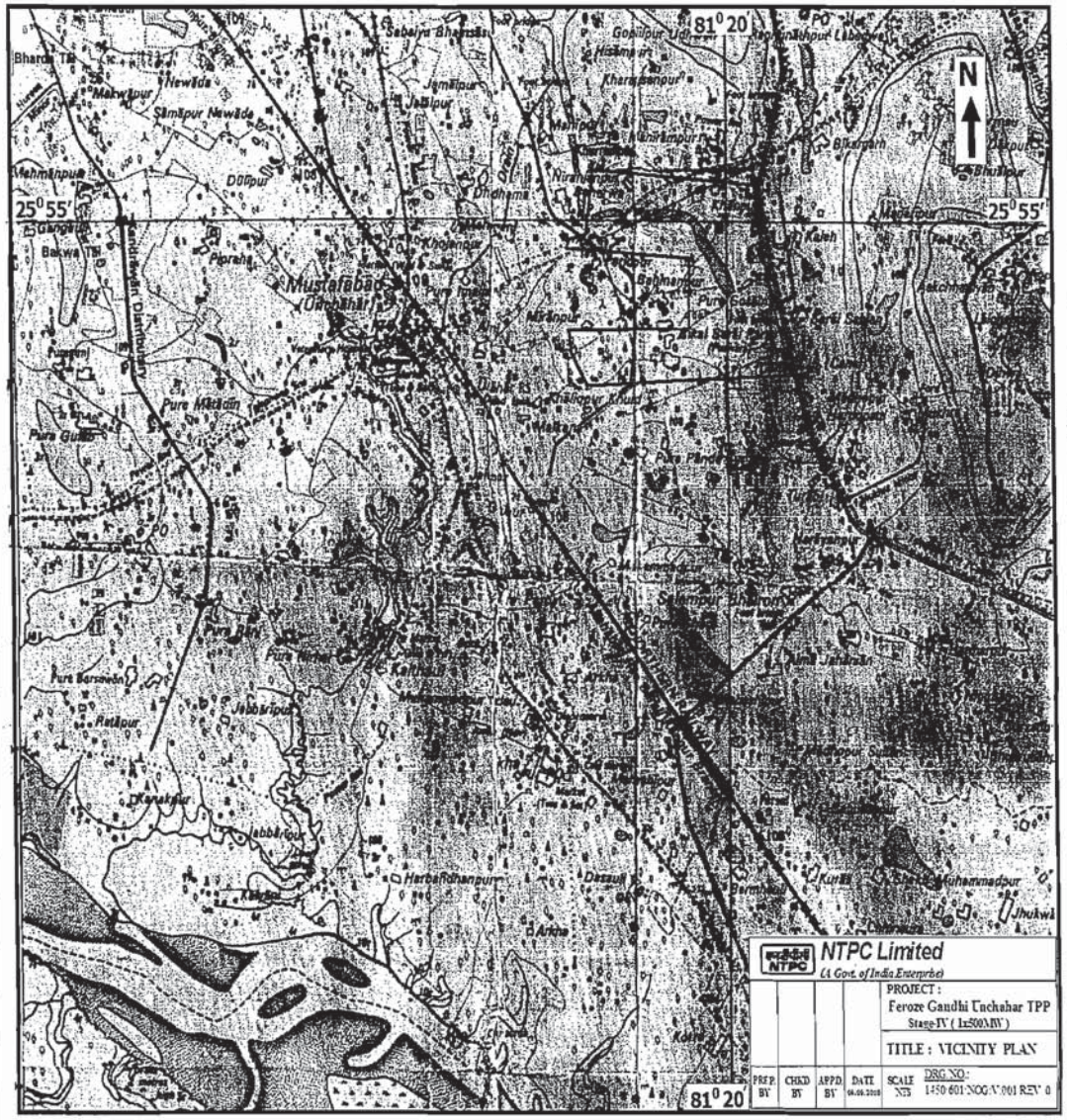
DESIGN CLARIFIED WATER ANALYSIS FOR DM PLANT

S.No	Constituent	As	mg/l
1	Calcium	CaCo3	135.2
2	Magnesium	CaCo3	95
3	Sodium+ Potassium	CaCo3	130
4	Total cations	CaCo3	360.2
5	Bicarbonates	CaCo3	245.7
6	Chloride	CaCo3	57
7	Sulphate	CaCo3	57.5
8	Total Anions	CaCo3	360.2
9	Silica	As SiO2	12
10	Iron	Fe	0.3
11	pH Value	-	7.0-8.2
12	Turbidity (NTU)	NTU	10

CLAUSE NO.	PROJECT INFORMATION	एनटीपीसी NTPC

VICINITY PLAN

ANNEXURE- I



FGUTPP STAGE-IV
(1X500 MW)
EPC PACKAGE

CLIMATOLOGICAL TABLE

ANNEXURE-III (PAGE 1 OF 2)

जलवायवी सारणी
CLIMATOLOGICAL TABLE

इलाहाबाद
STATION : Allahabad

अक्षांश LAT 25°27' N देशांतर LONG 81°44' E

समुद्री तल माध्य से ऊँचाई HEIGHT ABOVE M.S.L. 98 मीटर METRES

1951 से 1980 तक के प्रेक्षणों पर आधारित
BASED ON OBSERVATIONS FROM 1951 TO 1980

		स्टेशन का सतह दाब STATION LEVEL PRESSURE (एच. पी. ए. hPa)	वायु तापमान AIR TEMPERATURE — माध्य MEAN: शुष्क बल्ब DRY BULB (डि.सें. °C)	नम बल्ब WET BULB (°C)	दैनिक अधिक तम DAILY MAX (°C)	दैनिक न्यून तम DAILY MIN (°C)	माह में उच्चतम HIGHEST IN THE MONTH (°C)	माह में निम्नतम LOWEST IN THE MONTH (°C)	चरम EXTREMES: उच्चतम HIGHEST (°C)	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST (°C)	दिनांक और वर्ष DATE AND YEAR	आर्द्रता HUMIDITY: सापेक्ष आर्द्रता RELATIVE HUMIDITY (प्रतिशत %)	वाष्प दाब VAPOUR PRESSURE (एच.पी.ए. hPa)	मेघ की मात्रा CLOUD AMOUNT: समस्त मेघ ALL CLOUDS (आकाश के अष्टमांश Oktas of sky)	निम्न मेघ LOW CLOUDS	वर्षा RAINFALL: मासिक योग MONTHLY TOTAL (मि.मि. mm)	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	वर्षसहित सबसे नम महीने का योग TOTAL IN WETTEST MONTH WITH YEAR (मि.मि. mm)	वर्षसहित शुष्कतम महीने का योग TOTAL IN DRIEST MONTH WITH YEAR (मि.मि. mm)	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS (मि.मि. mm)	दिनांक और वर्ष DATE AND YEAR	माध्य पवन गति MEAN WIND SPEED (कि.मी. प्र. घं. Km/h)
	I	1006.2	12.5	10.6	23.8	8.7	27.9	4.5	31.1	29 1934	2.0	07 1972	78	11.3	2.1	0.7	19.2	1.6	126.0 1900	0.0	70.9	24 1900	3.4
	II	1003.1	20.6	15.0									53	12.7	2.0	0.5							
	I	1003.8	16.0	12.5	27.2	11.2	32.4	6.1	36.1	27 1896	1.1	02 1905	66	11.9	1.7	0.6	15.6	1.4	103.9 1928	0.0	51.3	11 1898	4.1
	II	1000.6	24.8	16.5									40	12.1	1.8	0.6							
	I	1000.8	23.0	16.0	33.6	16.5	39.0	10.9	42.5	30 1973	7.2	02 1906	46	12.6	1.8	0.4	9.2	0.9	81.0 1944	0.0	35.5	11 1978	4.8
	II	996.9	31.4	18.5									25	10.8	2.0	0.5							
	I	996.5	30.2	19.1	39.4	22.5	43.5	17.3	45.1	29 1979	12.7	01 1965	32	13.1	1.5	0.2	5.7	0.5	43.7 1933	0.0	28.8	01 1965	5.9
	II	992.3	37.3	20.5									18	10.6	1.9	0.5							
	I	991.8	33.5	22.2	42.3	26.7	45.9	22.5	47.3	28 1956	17.2	11 1924	38	17.4	1.4	0.5	9.9	0.7	62.3 1971	0.0	54.0	18 1971	7.0
	II	987.4	40.1	22.8									20	13.8	1.5	0.6							
	I	988.0	32.8	25.3	40.1	28.5	45.2	24.0	48.8	06 1979	19.4	21 1930	55	25.9	3.8	1.4	85.4	4.4	526.5 1916	0.0	176.0	23 1916	8.0
	II	984.2	37.3	25.6									41	23.2	4.2	2.1							
	I	988.0	29.2	20.4	34.1	26.4	39.3	23.5	45.6	01 1901	22.0	22 1975	80	32.1	6.4	3.6	300.1	12.8	782.1 1925	28.2 1918	229.4	15 1963	7.4
	II	985.0	31.5	27.0									71	32.0	6.5	3.7							
	I	989.7	26.3	26.3	32.7	25.7	38.5	23.6	42.7	03 1972	21.1	23 1953	85	32.5	6.6	3.9	307.6	14.4	914.7 1953	63.3 1083	335.3	20 1953	6.2
	II	986.5	30.2	26.9									77	32.7	6.6	3.8							
	I	993.8	28.2	25.5	33.2	24.7	36.2	22.3	39.6	11 1968	18.3	22 1912	00	30.4	4.8	2.8	189.8	8.7	781.5 1970	0.5 1807	266.2	04 1938	5.7
	II	990.6	30.4	26.1									71	30.4	5.0	2.9							
	I	1000.0	25.9	21.8	33.1	20.5	35.8	15.9	40.6	03 1896	11.7	31 1898	69	23.1	1.9	0.8	40.1	2.2	576.8 1894	0.0	163.3	04 1894	3.4
	II	996.7	28.7	22.9									55	22.5	2.0	1.0							
	I	1004.6	19.8	15.8	29.7	13.8	32.7	9.6	35.9	07 1965	5.6	30 1941	65	15.0	1.3	0.2	11.7	0.5	118.1 1956	0.0	96.0	01 1956	2.4
	II	1001.4	25.2	18.4									49	15.8	1.4	0.3							
	I	1006.6	14.0	11.7	24.8	9.3	28.4	5.3	31.1	02 1946	-0.7	26 1961	75	12.1	1.8	0.3	3.4	0.5	68.3 1885	0.0	54.6	11 1886	2.6
	II	1003.5	20.7	15.6									56	13.8	1.7	0.3							
योग य ... OR	I	997.5	24.5	19.4	32.8	19.5	48.1	3.0	48.8		-0.7		64	19.8	2.9	1.3	1017.7	48.6	1935.5	410.5	335.3		5.1
	II	994.0	29.9	21.3									48	19.2	3.1	1.4			1094	1968			
वर्षों ... ARS	I	30	30	30	30	30	30	30	100		100		30	30	30	21	29	29	99	99	99		24
	II	30	30	30									30	30	30	21							

CLIMATOLOGICAL TABLE

ANNEXURE-III
(PAGE 2 OF 2)

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : इलाहाबाद
STATION : Allahabad

माह MONTH		मौसम परिघटना के साथ दिनों की संख्या – WEATHER PHENOMENA No. OF DAYS WITH: वर्षण 0.3 मि.मि. या अधिक PPT 0.3mm or more	ओले HAIL	गर्जन THUNDER	कुहरा FOG	धूल भरी आंधी DUST STORM	चंड वात SQUALL	पवन (WIND) की गति के साथ दिनों की संख्या (कि. मी. प्र. घं.) No. OF DAYS WITH WIND SPEED (Km. p. h.): 62 या अधिक 62 or more	20-61	1-19	0
जनवरी JAN	I	3.0	0.2	1.3	4.5	0.1	0.1	0	0	19	12
	II							0	0	18	13
फरवरी FEB	I	2.8	0.1	2.3	1.3	0.0	0.2	0	0	19	9
	II							0	1	22	5
मार्च MAR	I	1.7	0.0	2.9	0.1	0.4	0.7	0	1	25	5
	II							0	2	26	3
अप्रैल APR	I	1.0	0.1	2.3	0.0	0.9	0.4	0	2	24	4
	II							0	4	24	2
मई MAY	I	1.3	0.0	2.7	0.0	1.5	0.5	0	2	24	5
	II							0	3	26	2
जून JUN	I	6.5	0.0	8.0	0.0	2.7	1.1	0	4	23	3
	II							0	5	24	1
जुलाई JUL	I	16.8	0.0	12.0	0.0	0.2	0.4	0	3	25	3
	II							0	2	25	4
अगस्त AUG	I	18.2	0.0	12.0	0.0	0.5	0.4	0	2	25	4
	II							0	1	25	5
सितम्बर SEP	I	11.5	0.0	8.4	0.1	0.0	0.6	0	2	24	4
	II							0	1	22	7
अक्तूबर OCT	I	3.5	0.0	2.7	0.4	0.1	0.2	0	0	20	11
	II							0	1	14	16
नवम्बर NOV	I	0.8	0.0	0.2	0.4	0.0	0.0	0	0	15	15
	II							0	0	10	20
दिसम्बर DEC	I	0.9	0.0	0.4	3.7	0.0	0.0	0	0	17	14
	II							0	0	10	21
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	68.0	0.4	55.2	10.5	6.4	4.6	0	16	260	89
	II							0	20	246	99
वर्षों की सं. NUMBER OF YEARS	I	26						24			
	II							24			

माह MONTH		पवन की दिशा के दिनों की संख्या का प्रतिशत – PERCENTAGE No. OF DAYS WIND FROM: उ N	उपू NE	पू E	दपू SE	द S	दप SW	प W	उप NW	शांत CALM
जनवरी JAN	I	2	5	9	4	5	16	25	3	31
	II	8	11	6	2	0	1	21	16	35
फरवरी FEB	I	4	4	6	4	4	18	29	5	26
	II	9	9	5	1	2	2	31	25	16
मार्च MAR	I	4	4	8	5	8	19	30	7	15
	II	12	6	3	1	1	2	29	38	8
अप्रैल APR	I	2	5	10	6	6	16	32	10	11
	II	13	8	3	1	1	2	26	45	2
मई MAY	I	5	10	19	5	6	9	27	9	11
	II	16	15	5	1	2	3	16	36	2
जून JUN	I	3	11	21	6	5	12	25	9	6
	II	12	19	14	3	3	6	18	21	4
जुलाई JUL	I	2	8	23	6	10	17	21	4	9
	II	5	12	18	6	8	13	20	8	10
अगस्त AUG	I	2	9	23	7	7	12	19	6	15
	II	7	14	17	4	5	9	23	8	13
सितम्बर SEP	I	4	9	20	6	6	11	23	7	14
	II	10	13	16	3	2	6	17	15	18
अक्तूबर OCT	I	3	7	10	6	6	10	20	8	32
	II	11	9	7	1	0	2	7	14	49
नवम्बर NOV	I	2	3	3	3	3	11	28	5	42
	II	9	4	2	0	0	0	8	12	65
दिसम्बर DEC	I	1	2	5	2	3	13	29	3	42
	II	6	6	4	0	0	0	12	9	63
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	3	6	13	5	6	14	26	8	21
	II	10	11	8	2	2	4	19	21	23
वर्षों की सं. NUMBER OF YEARS	I	30								
	II	30								

माह MONTH		मेघ (CLOUD) मात्रा (सभी मेघ) सहित दिनों की संख्या – अष्टमांश No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS: 0	T-2	3-5	6-7	8	निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या – अष्टमांश No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS: 0	T-2	3-5	6-7	8	कुहरा FOG 8	दृश्यता (VISIBILITY) सहित दिनों की संख्या No. OF DAYS WITH VISIBILITY: 1 कि.मी. तक UP TO 1 Km	1-4 कि.मी. Kms	4-10 कि.मी. Kms	10-20 कि.मी. Kms	20 कि.मी. से अधिक OVER 20 Kms
जनवरी JAN	I	16	5	4	3	3	25	2	2	1	1	0	1.8	12.7	14.8	0.5	1.2
	II	15	7	4	4	1	24	4	2	1	0	0	0.1	2.0	26.9	2.0	0.0
फरवरी FEB	I	16	4	4	3	1	23	2	2	1	0	0	0.9	6.3	20.7	0.4	0.0
	II	15	5	4	3	1	22	3	2	1	0	0	0.0	1.3	20.3	5.2	1.2
मार्च MAR	I	16	6	5	3	1	26	3	2	0	0	0	0.0	2.0	27.0	2.0	0.0
	II	14	6	5	5	1	25	4	2	0	0	0	0.0	1.3	21.0	8.7	0.0
अप्रैल APR	I	16	5	4	3	0	27	2	1	0	0	0	0.0	3.0	24.7	2.3	0.0
	II	15	6	5	3	1	23	5	2	0	0	0	0.0	1.9	22.6	5.0	0.6
मई MAY	I	18	6	4	3	0	26	3	2	0	0	0	0.0	3.7	22.5	3.6	1.2
	II	9	10	6	4	2	20	6	5	0	0	0	0.1	3.6	23.8	3.5	0.0
जून JUN	I	7	5	7	7	4	15	7	5	2	1	0	0.1	2.2	24.7	3.0	0.0
	II	0	4	10	11	5	10	9	10	1	0	0	0.3	3.1	23.1	3.5	0.0
जुलाई JUL	I	0	2	6	13	11	5	7	11	7	1	0	0.0	0.9	24.5	5.6	0.0
	II	0	1	5	16	9	1	7	17	5	1	0	0.2	1.8	22.1	6.9	0.0
अगस्त AUG	I	0	1	4	15	11	4	5	12	9	1	0	0.0	1.3	23.1	0.4	0.2
	II	1	0	5	16	9	1	7	17	5	1	0	0.0	0.9	19.6	10.4	0.1
सितम्बर SEP	I	4	4	6	10	6	9	6	8	6	1	0	0.0	0.8	21.7	7.3	0.2
	II	2	4	8	11	5	3	10	12	4	1	0	0.0	0.8	17.5	10.6	1.1
अक्तूबर OCT	I	16	6	4	3	2	24	3	3	1	0	0	0.0	1.2	23.7	6.1	0.0
	II	12	9	5	3	2	16	10	4	1	0	0	0.0	0.2	21.2	8.9	0.7
नवम्बर NOV	I	19	5	3	2	1	28	1	1	0	0	0	0.0	7.6	21.5	0.9	0.0
	II	17	7	3	2	1	27	2	1	0	0	0	0.0	1.3	26.5	2.2	0.0
दिसम्बर DEC	I	19	5	3	3	1	29	1	1	0	0	0	1.3	15.7	13.9	0.1	0.0
	II	16	7	4	3	1	28	2	1	0	0	0	0.0	2.9	25.9	2.2	0.0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	149	54	53	68	41	241	42	50	27	5	0	3.8	57.4	262.8	38.2	2.5
	II	116	86	64	81	38	200	69	75	18	3	0	0.7	21.1	270.4	69.1	3.7
वर्षों की सं. NUMBER OF YEARS	I	27					27						27				
	II	27					27						27				

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SECTION – C.1

SCOPE OF WORK, SUPPLY AND SERVICES, TERMINAL POINTS & EXCLUSION

1.0.0 COMPRESSED AIR SYSTEM

1.1.0 SCOPE OF WORK

Design, engineering, manufacture, inspection and testing at vendor's/ sub-vendor's works, painting, forwarding, proper packing, shipment and delivery at site, Erection & Commissioning, civil works as required, functional guarantee, testing and handing over of Compressed Air System shall be as per details in different sections of this specification.

1.1.1 SCOPE OF SUPPLY

The equipment and services to be provided by bidder under this contract are detailed herein. Any item though not specifically mentioned but required for safe and satisfactory operation of system and for any modification or changes for system shall be treated as included and shall be supplied within the quoted price and no extra shall be admissible on such account

1.1.2 One (1) No. Instrument Air Compressor (Oil Free Screw type) of minimum 36 NM3/Min capacity at 8 Kg/sqcm (min) discharge pressure with electric motor drive, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.

1.1.3 One (1) No. Air Drying Plant Heat of compression (HOC) Rotary type/Dual Tower Type of min. 36 NM3/min. capacity connected to above IA compressor with all instruments, control panels and other accessories as specified.

1.1.4 One (1) No. Service Air Compressor (Oil Free Screw type) of minimum 36 NM3/Min capacity at 8 Kg/sqcm (min) discharge pressure with electric motor drive, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.

1.1.5 Three (3) Nos. Air Receivers (two (2) nos adjacent to compressor house and One (1) No. in TG Hall B-C Bay) of minimum ten (10) Cu.M capacity each with instruments, relief valve, drain connection with automatic trap stations and other accessories as specified.

1.1.6 One (1) No Air Receiver of minimum two (2) Cu.M capacity near DM plant with instruments, relief valve, drain connection with automatic trap stations and other accessories as specified.

1.1.7 One (1) No. Electronic Dew point meter.

1.1.8 Pipes and fittings for Compressed air system - 1Lot. (Refer LP specification in Vol-IIB, Section-C.2)

1.1.9 All air and water application valves for Compressed air system - 1Lot. (Refer LP specification in Vol-IIB, Section-C.2)

1.1.10 Field instruments as specified -1 Lot.

1.1.11 All instruments necessary for performance testing of compressors as well as air drying plants.

1.1.12 Control and Instrumentation – Individual compressor control shall be through compressor mounted PLC / microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR.

1.1.13 Maintenance tools and tackles, start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – Lot

1.1.14 Any other item not included above or in specification but required to complete for Compressed Air System.

1.1.15 The maximum velocity to be considered in compressed air shall be 6.0 m/s(under Average pr. & Temp. Conditions).

1.1.16 Civil works:-Minor dressings of foundation blocks; equipment grouting; supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by successful bidder.(please refer Annexure-VIII for Civil Tech. requirement)

1.1.17 Any item not mentioned above, but mentioned in other clauses of this specification unless explicitly written in exclusions and beyond terminal points.

1.1.10 Painting work: Please refer Vol-IIB, Section-C.2

1.1.2 SCOPE OF SERVICES:

Scope of services by bidder will include but not necessarily limited to the following:

a) Erection & Commissioning, conducting performance guarantees and handing over of complete compressed air system.

b) Civil works:-Minor dressings of foundation blocks; equipment grouting; supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by successful bidder.

c) Pre- Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder.

d) Erection of all foundation bolts/ anchor bolts etc. as required for any equipment. In case these are not erected when foundation is being cast refer point no (b) above.

e) Inspection & testing, Performance Requirements and functional guarantees.

f) Making Good/Repairing/replacement of and damaged done by bidder to adjacent structure, pipes etc. while erecting equipment's related to system

g) Electrical scope as per enclosure in the specification (refer Vol-IIB,section-C.3)

h) Training of plant Owner's personnel and O&M operators' personnel on plant operation and maintenance.

NOTES:

1) Basis of design, all calculations, equipment selection criterion, layout drawings/schemes/G.A. drawing and documents like data sheet/Technical particulars etc. are subject to Customer & BHEL approval during detail engineering stage.

2) Bidder to clearly note that the instruments, valves etc as shown in the P&I Diagram is the bare minimum and any additional instruments/valves required to complete the system in line with technical Specification shall be supplied by the bidder without any commercial implication.

3) Quality Plans attached are indicating minimum requirements for inspection and testing. Bidder shall note that quality plan is subject to Customer & BHEL approval during detail engineering stage.

4) List of Makes is enclosed in the Technical Specification. Bidders are requested to quote as from suppliers list, however please note that Makes of equipment's/items shall be subject to BHEL & Customer approval during detail engineering stage.

5) Bidder to confirm that there is no deviation from the tech specification and furnish signed no deviation certificate enclosed as Annexure-I of the Technical Specification.

6) If any deviation is there then same shall be indicated separately under the heading "**Schedule of Technical Deviation**" enclosed as per Annexure II of the Technical Specification along with Cost of Withdrawal. In case nothing is mentioned under the column Cost of withdrawal then during bid evaluation no price implication will be admissible for withdrawal of deviations. Bidders shall also note that the deviation in any other form except above is not acceptable (i.e. in data sheet or other Annexure or elsewhere in the offer) and same shall not be considered for review/evaluation purpose/comments and it would be assumed that the system/material/equipment has been offered strictly in line with specifications/requirements.

1.1.3 TERMINAL POINTS FOR COMPRESSED AIR SYSTEM

1.1.3.1 Bidder will terminate compressed air IA and SA pipe at downstream of air receiver with isolation valve as per enclosed tender drawing (Pl. refer drawing no.1150-001-PO-A-045)

1.1.3.2 Terminal point for Supply of Cooling water and for return line from compressor house shall be referred from enclosed drawing no. PE-401-555-ASK1. Further interconnection from these terminal points shall be in bidder's scope

1.1.4 EXCLUSIONS :

1.1.4. MCC/Switchgear for power supply to Air Compressors and other drives and panels.

1.1.4.2 Civil works including construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe / cable trenches.

1.1.4.3 Lighting and ventilation of compressor house.

1.1.4.4 Monorail hoists/Cranes as necessary for handling of equipment after erection.

1.1.4.5 Compressed Air Distribution Piping running from compressed air IA and SA pipe at downstream of air receiver with isolation valve outside the compressor house.

VOLUME IIB

SUB-SECTION: C.2

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

1. GENERAL DESCRIPTION

The compressed air system is comprised of the instrument air system and the plant air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while plant air is required for general plant services.

2. DESIGN CRITERIA

2.1 System Design Criteria

Compressed air system includes the following:

- One (1) no. Instrument air compressor (working) and One (1) no. Plant air compressor (working), including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.
- In addition, individual plant air compressor may be used for instrument air system in case of instrument air compressor failure. Refer P & I diagram attached for detail arrangement. The valves for the same shall be operated manually.
- One (1) no. air-drying plant (working) (ADP) suitable for connecting to instrument air compressor.
- Intake air filters.
- Air Receiver:

  (1) Two (2) nos. air receivers, (i.e., one for each compressor near compressor house,

  (2) One (1) no. unit air receiver ((instrument air) in 'BC' bay)) and

  (3) One (1) no. air receiver (instrument air) for DM plant.
- Heat of Compression type air-drying plant (ADP).
- All interconnecting piping, valves, fittings, supports/hangers, control air tubing (complete with valves and fittings between air receiver, compressor and local panel for each compressor), cooling water piping & valves for safe and satisfactory operation of air compressors.
- Controls & interlocks.
- All instruments including the electronic on line dew point meter with suitable sampling connection and isolation valve at the outlet of the Air Drying Plant.

2.2 Equipment Design Criteria

AIR COMPRESSORS

2.2.1 The capacity of IA compressor shall be 36 NM^3/min. Delivery pressure will be minimum be 8.0 kg/cm^2 (g) at the outlet of the IA compressor. Delivery pressure will be 7.5 Kg/cm^2 (g) at ADP outlet. Compressor will be designed to deliver the nominal capacity at the required delivery pressure.

2.2.2 The capacity of Plant air compressor shall be 36 NM^3/Min. Delivery pressure will be 8.0 Kg/cm^2 (g) at the outlet of the SA compressor. Air compressors will be oil free screw type.

2.2.3 The compressors' capacity will be designed for 45^0 C DBT and 75% RH at atmospheric pressure at site. Site elevation is 106.5 M above mean sea level.

2.2.4 Testing of compressor will be as per ISO: 1217.

2.2.5 Air compressors will be designed for continuous operation with high efficiency to satisfy the performance requirement.

2.2.6 The continuous motor rating (at 50^0 C ambient) will be at least ten percent (10%) above the maximum load demand of the driven equipment under the entire operating range. When the driver is not directly coupled to the compressor, due consideration will be made for losses in power transmission, in addition to the above margin.

2.2.7 Satisfactory operation in parallel will be ensured without any uneven load sharing, undue vibration, noise etc.

ROTORS

2.2.8 Rotors will be one-piece construction with a suitable carbon steel forged corrosion resistant-coated material to minimise leakage and wear.

2.2.9 The rotors will have an asymmetric profile, so as to keep leakage losses to a minimum and ensure high efficiency.

2.2.10 Highly precise timing gears will be mounted on the rotor shafts to maintain the rotors in correct relative position.

2.2.11 These gears will be designed to counteract the axial forces incurred in compression.

2.2.12 Rotors shall be dynamically balanced.

AIR DRYING PLANT

2.2.13 Air-drying plant shall be of heat of compression desiccant type (conventional twin tower or rotary drum type), drying by absorption method.

2.2.14 Quality of outlet air from ADP shall be in accordance to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air" as follows.

a) Dew point at outlet of the air drying plant will be minus (-) 40^0 C at atmospheric pressure.

b) Dust particle size in instrument air will be less than **5** micron.

c) Oil content of Instrument air will be less than 1-ppm wt/wt at 20 degree C with the system pressure at 8-kg/ cm^2 (g).1

2.2.15 Desiccant shall be silica gel / activated alumina as per manufacturer's standard.

2.2.16 Material of Construction (MOC) of rotary drum type HOC dryer shall be as per reputed manufacturer standard.

AIR RECEIVER

2.2.17 The capacity of air receiver (3 nos., i.e., one for each compressor near compressor house and 1 nos. unit air receiver) shall be 10 M^3 (nominal) and of 1 no. air receiver for DM Plant shall be 2 m^3.

2.2.18 The air receivers will be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.

2.2.19 Design Pressure for the air receiver shall be 10 kg/cm^2 (g).

INTAKE FILTER

Dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the cylinders. The filtering efficiency shall be 99 %, down to 10 microns. Sound suppressing characteristics will be considered in the filter design.

PIPING & VALVES (WITHIN COMPRESSOR HOUSE

All interconnecting compressed air piping shall conform to IS: 1239 (Heavy Grade) galvanised. The maximum velocity to be considered in compressed air shall be 15.0 m/s (under Average pr. & Temp. conditions). All cooling water piping will be MS conforming to IS: 1239 (Part-I) (Heavy Grade). Fittings for air piping shall be conforming to IS: 1239 / IS: 1879 and Grade equivalent that of parent pipe Grade. Compressed air piping from air compressor to after cooler and other lines handling hot air will be suitably insulted so as to restrict surface temperature to 60 deg. C. The pipe joints will be screwed coupling type for sizes up to 50 NB and above 50 NB the same will be flanged.

2.2.20 All the distribution valves shall be ball valve type. Necessary auto drain shall also be provided at strategic points.

2.2.21 Water Piping shall be M.S. Conforming to IS-1239 Part -1 ERW heavy grade.

2.2.22 Blanked flanged connection (with isolation valve) shall be provided for both IA & SA Header at the Power House end so that interconnection can be done by the user with the existing pipeline, if found necessary in future.

2.2.23 VALVES

a) Compressed Air Services:

- ♦ All airline valves shall be ball valve type. Cast steel body with Stainless steel internals shall be provided for valve size 65 Nb and above with flanged end. Forged carbon steel body with Stainless steel internals shall be provided for valve size 50 Nb and below with screwed.

b) Water Service:

- ♦ Cast iron valves with GM internals as per IS-780/equivalent and other applicable standards above 50 mm size. Gunmetal valves as per IS-778/equivalent up to size 50mm.

c) Auto drain trap for each air receiver shall be provided.

d) Moisture traps at strategic locations shall be provided in the distribution network.

3. LAYOUT CONSIDERATIONS

- Air compressors will be located indoor in a separate compressor room and EOT crane arrangement will be provided so that the heaviest component can be handled during maintenance.
- The air receivers will be located outdoors adjacent to the compressor room. Necessary maintenance access will be provided to air receivers as per layout requirement. Unit air receiver shall be located suitably in powerhouse area and DM plant air receiver will be located in DM Plant area.
- Complete ADP equipment shall be preferably mounted on a skid and located indoor.

4. OPERATION, CONTROL & INSTRUMENTATION

- The necessary instrumentation and control has been provided for safe and trouble free operation of compressed air system.
- Individual compressor control shall be through microprocessor based control system as per manufacturer's standard and only limited control(only start/stop operation facility for compressors) & monitoring shall be through Station C&I part of DDCMIS through non redundant link.
- Depending upon operational requirement each compressor can be selected and operated in following mode
- Local Mode: Individual compressor is operated from Local Integral Control System.
- Remote Mode: Individual compressor is operated (only start/stop) through DDCMIS OWS.
- All the process inputs (digital or analog), other than specific to compressors are taken directly to DDCMIS for monitoring.
- The connectivity of Integral compressor control system with DDCMIS shall be provided through Hardwired / Soft link depending upon manufacturer's product standard.

5. POWER SUPPLY ARRANGEMENT

- The power supply (rated voltage, frequency, and phase) of the equipment's will be 3.3 KV, 415 V +/- 10%, 3ph, 50 Hz +5% to -5%. (Please refer Vol-IIB, Section C.3 Electrical portion)

COMPRESSED AIR SYSTEM

1.00.00 SYSTEM DESCRIPTION

1.01.00 The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants, Service Air compressors & their motor drives, air receivers for each Air compressor, instrumentation and control, control panels, interconnecting compressed air piping in the compressor house, Instrument Air Piping network, service air piping network and Unit Instrument Air receivers (One for each SG/TG unit).

1.02.00 The Air compressors & Drives, instruments, control panels and ADPs shall be located indoor inside the compressor house and the air receivers shall be located outside the compressor house. The compressor house shall be provided with an electrically (with pendent control for long travel, cross travel and lifting) operated, overhead traveling type (EOT) crane.

1.03.00 In addition to the air receivers mentioned above, One no. Unit Air receivers for instrument air system shall be provided, for main plant systems to cater to the requirements of Instrument air requirement of respective SG (Steam generator) & auxiliaries and TG (Turbine Generator) and its auxiliaries. The Unit Air receivers shall be located in "BC" bay of TG building area.

1.04.00 Further, a dedicated air receiver shall be provided near Demineralising Plant to meet the instrument air requirement of Water Treatment plant if included in the scope of works in Part-A of technical specification, Section-VI B.

1.05.00 Air from Instrument air compressors shall be dried in respective Air Drying Plants in compressor house and delivered to the Air receivers. From the Compressed air piping header at the downstream of Air receivers, one instrument air piping header of main plant and one for balance of plant shall be provided. Distribution of instrument air network shall be provided as per the tender drawing and as detailed out under "Terminal Points" in Part-A of technical Specification, Section-VI B.

1.06.00 A separate service air header shall be tapped off from the pipe header at Service Air receiver outlet and distributed as per the tender drawing and as detailed out under "Terminal Points" in Part-A of technical Specification, Section-VI B.

1.07.00 Generally instrument air compressors are to be used for supplying instrument air application and service air compressors for service air duty. However the valves & piping shall be arranged, as shown in the relevant tender scheme so that interchange is possible during exigency. The instrument air header piping & valves at ADP outlet in compressor house shall be provided such that all the instrument air compressors may be interconnected and the entire system can be used as a station facility.

2.00.00 **DESIGN CRITERIA / BASIS AND PERFORMANCE GUARANTEE**

2.01.00 All the equipments shall be designed for continuous duty and for intermittent operation. Frequent start/stop of the system shall not result deterioration in performance nor damage to the equipment.

2.02.00 The compressors and Air Drying plants shall operate under the following ambient conditions.

(i)	Minimum temperature	10 deg.C
(ii)	Maximum temperature	50 deg. C
(iii)	Design condition (temperature & Relative humidity)	45 deg.C & 75% RH
(iv)	Height above MSL (m)	As given in Plant information

2.03.00 The design ambient conditions for the motors shall be as mentioned in relevant Electrical sub-sections.

2.04.00 **Selection of Capacity of Instrument Air Compressor**

a) Instrument air Compressor shall be designed to meet the Instrument air requirement of all the equipments/plant/systems to be supplied by the Contractor and to meet instrument air requirement of Employer's systems /plant as follows:-

Sl.No	Continuous Requirement	Quantity (in NM^3/min)
1)	For Steam Generator & its auxiliaries	**A**
2)	For TG & its auxiliaries	**B**
3)	For Employer's Water Treatment Plant	**C**
4)	For Station C&I System	**D**

Capacity of each instrument air Compressor = **2 x (A+B+C+D) NM^3/min**

Where C = 1.5 NM^3/min

While calculating the air requirement of Bidder's equipments/plant/systems, for continuous requirements of instrument air, no diversity factor shall be considered and they are to be assumed to be of "Simultaneous Requirements". The intermittent requirement of instrument air, if any shall be converted into continuous requirement by considering frequency of such

requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.4.

b) Service air Compressor shall be designed to meet the Service air requirement of all the equipments/plant/systems to be supplied by the Contractor and to meet service air requirement of Employer's systems /plant as follows:-

Sl.No	Continuous Requirement	Quantity (in NM^3/min)
1)	For Steam Generator & its auxiliaries	**E**
2)	For TG & its auxiliaries	**F**
3)	For Employer's Water Treatment Plant	**G**

Capacity of each service air Compressor = 2 x (E+F+G) NM^3/min

Where G = 1.5 NM^3/min

While calculating the air requirement of Bidder's equipments/plant/systems, for continuous requirement of service air, no diversity factor shall be considered and they are to be assumed to be of "Simultaneous Requirements". The intermittent requirement of service air if any shall be converted into continuous requirement by considering frequency of such requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.4. The Service air requirement of mill reject shall not be included while sizing the compressor capacity, as separate & dedicated compressors are to be provided for the same.

c) The compressor capacity & discharge pressure of instrument air system and service air system shall be identical. Further the minimum capacity of each compressor shall not be less than that specified (if specified) in Scope of works in Part-A of technical specification.

2.05.00 The capacity of air drying plant shall be equal to the capacity of the individual air compressors. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air".

2.06.00 Discharge pressure available at the outlet of Air drying Plant shall be minimum 7.5 Kg/cm2 (g) or more as per the requirement of Contractor.

2.07.00 The discharge pressure of compressor shall be minimum 8 Kg/cm2(g).

2.08.00	The heat exchangers are to be designed considering maximum Cooling water temperature of 36 deg C. The cooling water quality shall be passivated DM water as shown in equipment cooling water system.
2.09.00	The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-10 deg C.
2.10.00	Noise level shall not exceed 90 dBA to a reference level of 0.0002 microbar when measured at a distance of 1.5 meter above the floor. Required acoustic enclosures may be provided to meet the above condition. The discharge blow-off silencer and intake silencers shall be designed to meet the above noise limitation level.
2.11.00	Parallel operation of compressors shall be possible without any undue vibration and noise.
2.12.00	The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors.
2.13.00	The maximum velocity to be considered in compressed air and cooling water piping shall be as mentioned elsewhere in Subsection titled "Low Pressure Piping" in Part-B of this Technical Specification. .
2.14.00	The lifting capacity of EOT crane of Compressor house shall be 120 percent (%) of the weight of the heaviest part to be lifted during erection or operation or maintenance inside the compressor house.
2.15.00	All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminium cladding/cover.
3.00.00	**DESIGN & CONSTRUCTION**
3.01.00	The minimum requirements of design and construction features of various components of Compressed air system are described below.
3.02.00	The motor drives shall be as per relevant Electrical sub-section of this Technical Specification.
3.03.00	**Air Compressors**
3.03.01	Compressors shall be multi stage, oil free, screw type.
3.03.02	Multiple compression chambers shall be designed to ensure minimum unbalance and arranged in compact manner suitable for easy accessibility and maintenance of the compressors.

3.03.03	The Compression chamber, housing two precision made screw type rotors, for each stage shall be designed with large port for fast filling and low velocities.
3.03.04	Casing shall be cooled by means of water or oil as per manufacturer's standard practice. Suitable arrangement for cleaning of the cooling jackets during maintenance of compressor should be provided.
3.03.05	Rotors shall be of Dynamically balance d, one piece design with asymmetric profile, to keep leakage losses to a minimum and ensure high efficiency.
3.03.06	Highly precise timing gears to maintain rotors in correct relative position shall be shaft mounted, oil lubricated and designed to counteract the axial forces incurred in compression.
3.03.07	Bearings shall be lubricated anti-friction type, designed to suit radial and axial loads and minimum operating life of 40000 running hours.
3.03.08	Shaft Seals of floating restrictive ring type design to prevent air and oil leakage along the shaft into the elements. The shaft seal rings and retainers shall be free for radial self adjustment on the rotor shafts.
3.03.09	The safety valves shall be provided on low pressure and high pressure stages to safeguard low pressure & high pressure circuit. Inlet throttle valve shall be provided to throttle the incoming air during idling period.
3.03.10	A direct shaft driven positive displacement type oil pump or a separate motor driven oil pump shall be provided. The lubrication system shall consist of Lube oil reservoir, lube oil pumps, suction strainers for pumps, supply & return system, oil cooler and twin full-flow (2 x 100%) oil filters, required instruments etc. The filters with replaceable elements and filtration of 10 microns nominal or finer shall permit cartridge replacement and re-pressurizing during operations.
3.03.11	The motor rating (at the design ambient temperature specified for the electric drive in the relevant sub-sections) shall be atleast 110 percent of the power required at design condition of compressors or blowers and shall not be less than the power required at any other ambient conditions specified in "Design Criteria/Basis" above.
3.03.12	Couplings shall be of non-lubricated flexible element spacer type and coupling guards shall be provided.
3.03.13	The inlet Air-filter & silencer shall be of dry type with replaceable type filtering media, high efficiency suitable for outdoor duty. Minimum dust concentration of 30mg/M3 may be considered. Filtering efficiency shall be minimum 99% down to 10 microns or larger over the entire capacity range. Maximum pressure drop across filter at design flow rate in new condition be 250 mm of water column.

3.03.14	The discharge blowoff silencer shall be located at the downstream of discharge blowoff valve.		
3.03.15	The instrumentation, Controls and panels shall conform to the requirements specified in subsequent clauses of this sub-section.		
3.03.16	The intercoolers, aftercoolers, oil coolers shall conform to the requirements specified in subsequent clauses of this sub-section.		
3.03.17	Each Compressors shall be provided with Name Plate, Base plate, anchor bolts and shimpacks, anti-vibration pads, eye bolts, operation and maintenance tools.		
3.03.18	The material of construction of various components shall be as follows:		
	(a) Compression chamber	:	Cast iron coated with corrosion resistant material.
	(b) Rotors	:	Forged Carbon steel or Stain less steel coated with corrosion resistant material.
	(c) Timing gears	:	Alloy steel
	(d) Shaft, Shaft seals/ retainer rings	:	Stainless steel
	(e) Safety valves	:	Stainless steel/Bronze/Gun metal
	(f) Inlet throttle valve & housing	:	Stainless steel or Aluminium
	(g) Air & piping	:	Galvanised steel
	(h) Oil piping	:	Stainless steel
	(i) Cooling water piping	:	Galvanised steel
	(j) Valves in Oil lines	:	Stainless steel
	(k) Valves water lines	:	SS / Bronze/Gunmetal.
3.04.00	**Intercooler, After cooler & Oil Coolers**		
3.04.01	Intercoolers, After-coolers and Oil coolers shall be of water cooled & shell-and-tube type with water on the tube side. Intercoolers & after-coolers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.		

3.04.02	Outlet temperature of air from intercooler shall be suitable to suit the equipment and outlet temperature of air from the compressor house outlet header shall be limited to 45 deg.C. However, the instruments or the pneumatic devices requires air temperature less than 45 deg.C., the same shall be achieved at the outlet header.
3.04.03	Coolers shall be provided with removable tube bundle design in accordance with design code TEMA Class C and shall be constructed with removable shell cover.
3.04.04	The coolers shall be constructed and arranged to allow removal of tube bundles without dismantling piping or compressor components.
3.04.05	Oil Coolers shall be equipped with vent & drain connections on oil and water sides. Oil temperature control valve with manual override feature or bypass construction shall be provided to maintain constant temperature. Vent & drain connections for intercoolers and aftercoolers shall be provided.
3.04.06	Design pressure of coolers shall be selected based on the maximum air /oil / water pressure that may be encountered during operation. The shut-off head of cooling water supply pumps shall be of the order of 8 Kg/cm2(g).
3.04.07	The coolers shall be designed for maximum heat load and atleast 10 percent deisgn margin shall be provided in the number of tubes.
3.04.08	Adequately sized safety valves shall be provided for both intercoolers and after coolers.
3.04.09	Each intercooler and aftercooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.
3.04.10	Electrically operated automatic drain trap stations with bypass and isolating valves shall be provided for moisture separators for automatically draining of condensed moisture. The drain trap may be of full bore ball valve operated by capacitance type level switch. Manual draining facility shall also be provided in the drain trap.
3.04.11	Cooler shells, channels and covers shall be of steel (SA 285 Gr C or equivalent).Tube sheet shall be of Brass or SS and the tubes shall of Admiralty brass or Aluminium brass or SS 304.
3.04.12	For the instrument air compressors offered with "Heat of compression" type air drying plants, the after coolers shall be provided at downstream of Air Drying Plant.

3.05.00	**Air Receivers**
3.05.01	There shall one air receiver for each compressor near compressor house, one receiver for DM plant (2 M^3)capacity if included in the scope of works in Part-A of technical specification) and one Unit Instrument air receiver for each unit. The air receiver in the DM plant area as stated above shall be supplied and installed by the bidder including nozzle connections with pipe so as to enable the employer to route it further for his DM plant.
3.05.02	Capacity of each of the air receivers in the compressor house shall be of minimum 10 M^3 (nominal). The capacity of the Unit air receivers shall be minimum 10 M^3 (nominal) or to suit the emergency storage requirement if any for any of the Bidder's requirement whichever is higher.
3.05.03	Receivers (other than unit air receivers) shall be outdoor located and vertical cylindrical vessel with dished ends.
3.05.04	The design pressure and temperature shall be minimum 10 Kg/cm2 (g) and 50 deg.C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.
3.05.05	Air receivers are to be provided with gasketted inspection manhole of minimum 500 mm diameter with cover plate, lifting handle, davit cap etc. Opening shall not pierce any seam & shall be as far as possible away from any welded seam.
3.05.06	Receivers shall be of welded construction with minimum number of joints. Longitudinal seam in adjacent sections shall not be in same line. Welding shall be as per relevant codes. Filler material to have composition & structure as that of material welded. Welding electrodes to be approved by Employer. Electrodes to be dried before use.
3.05.07	Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be atleast 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure.
3.05.08	Each receiver shall be provided with drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves.
3.05.09	The material of construction of shell, dished ends, flanges etc of the air receivers shall be of carbon steel as per IS:2062 or equivalent.
3.06.00	**Air Drying Plants**
3.06.01	One number Air drying plant shall be provided for each Instrument air compressor. Drying shall be by adsorption process through a desiccant medium.

3.06.02	Air Drying (ADP) Plant may be of "Open Through type (Blower reactivated)" OR "Heat of (HOC) Compression type".
3.06.03	Regeneration of desiccant shall be achieved by "open through" or "Heat of compression" method without any air purge loss.
3.06.04	Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in case of "Heat of compression type ADP" and air from blower shall be used for regeneration after heating by electrical heater in case of "Open through type ADP".
3.06.05	Each ADP shall be provided with two adsorber towers each sized for design drying cycle of minimum 8 hours. After this period the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.
3.06.06	In "Open Through" type ADP, for regeneration of desiccant, atmospheric air shall be filtered, heated through an electric heater and passed through the desiccant before exhausted to atmosphere The reactivated desiccant shall be cooled through same atmospheric air without heater in operation. In case of HOC type drier, the reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.
3.06.07	Each ADP shall be provided with 2 numbers of 100 percent capacity pre-filters and 2 numbers of 100 percent capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand atleast 50% of static pressure as differential pressure. The pre-filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.
3.06.08	The electric heaters (2x100% capacity for each ADP) shall be provided with thermostatic control for heater and relief valve for safety and shall be flanged type to facilitate easy replacement of element.
3.06.09	Each electric motor driven blower (2x100% capacity for each ADP) shall be provided with individual dry type filters at inlet.
3.06.10	The adsorber tower shall be designed with sufficient cross sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be

provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Persplex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.

3.06.11 The coolers/heat exchangers/ dehumidifiers of ADP shall be designed & constructed as per the requirements specified for " Intercoolers, After coolers & Oil coolers" above.

3.06.12 All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers,/ coolers etc associated with ADP shall be designed in accordance with Section VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketted manholes/handholes and relief valves.

3.06.13 Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle. Design calculation with curves shall be submitted for approval of Employer.

3.06.14 Adsorption capacity and density to be considered for silica gel shall not be more than 10% and 550 kg/M3 respectively. In case of activated alumina the same shall be 8% (max) and 900 kg/M3 (max.) respectively.

3.06.15 In case of Heat of compression type, adsorbers shall be sized so that even when the compressor is operating at partload, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.

3.06.16 Complete ADP equipments shall preferably be mounted on a skid.

3.06.17 Required sample connections in piping be provided for sampling of air at desired locations.

3.06.18 Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided.

3.06.19 The material of Construction for various components of ADP shall be as follows:-

(a)	Adsorber vessel	Carbon steel
(b)	All internals of adsorber vessles	SS 304
(c)	Cooler shells, channels and covers, Cooler Tube sheet & tubes	Same as that in intercoolers/ aftercoolers
(d)	Blower casing	Carbon steel

	(e)	Blower blades & shaft	Stainless steel
	(f)	Relief valves	Brass or SS
	(g)	Desiccant	Silica gel or Activated Alumina
	(h)	Air piping	Galvanised steel
	(i)	Valves in Air Line	CI or Cast steel or Forged steel body with stainless steel trim
	(j)	Valves in water pipelines	SS / Bronze / Gunmetal

3.06.20 HOC dryers of single rotating drum type design using packed dessicant with in-built regeneration and adsorption compartments are also acceptable in place of specified twin-tower type dryers, if the design ensures specified performance guarantee. In case, the Contractor offers such a type, the same shall be of proven design and shall meet the conditions stipulated under "EQUIPMENT SOURCING CRITERIA FOR BOUGHT OUT ITEMS" in relevant sub-section of Part-B, of Technical Specification. The control & instrumentation requirements specified is applicable for such design also. Further for such design of HOC dryer, the contractor shall supply two sets of spare drum (with required bearings) assembly packed with desiccant and one set of spare drive assembly (for dryer) consisting of motor, gear boxes, drive shaft & couplings in addition to the applicable items specified under "Mandatory Spares" elsewhere in Technical Specification within the contract price.

3.07.00 **Interconnecting Piping, Fitting and Valves**

The inter-connecting piping & valves within compressor house for compressed air & cooling water etc shall be designed in line with the specification furnished in subsection titled "Low Pressure Piping" of Part-B of this Technical Specification.

3.08.00 **E.O.T. CRANE**

3.08.01 The crane shall be of electrically operated, pendant controlled, overhead traveling type. The Span and runway length shall suit the compressor house building.

3.08.02 The design and construction features of crane shall be as described Annexure-I of this sub-section.

4.00.00	**CONTROL PHILOSPHY**
4.01.00	**GENERAL**
4.01.01	The minimum requirements are specified herein and the same shall be elaborated by contractor. The Contractor shall include controls & instrumentation to facilitate safe, reliable and efficient operation for the system. The controls, protection, interlock and instrumentation system offered by the contractor shall be subjected to approval of the Employer during post award engineering stage.
4.01.02	Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.
4.01.03	On tripping of working equipment, the standby equipment shall come into operation automatically in case of very low air pressure in the system.
4.01.04	All abnormal conditions used for tripping the compressor or any other equipment shall be provided with pre-trip audio-visual indication/annunciation in the control panel.
4.01.05	An electrically operated automatic valve shall be provided on cooling water supply line of each compressor & dryer (if applicable) which will automatically shut off the cooling water supply, in case any of the compressor/dryer is not running for more than set time duration. Suitable interlock shall also be provided for opening the valve before starting of any of the compressor.
4.02.00	**Screw Compressors**
4.02.01	Each compressor shall be in the control panel to operate either in Base duty (Auto Load-Unload) or Standby duty (Auto On-Off) mode.
4.02.02	In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve.
4.02.03	In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor shall be started in unloaded condition. and the compressor shall be fully loaded. When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by a timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system

pressure does not drop and compressor continues to idle for more than a pre-set time.

4.02.04 The control system shall provide warning to the operator that a hot-start condition exists for the motor driver and adequate cool-down period has not occurred after the motor was shut down.

4.02.05 The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor:-

(a)	"Air temperature high" at inlet to last stage	Alarm & trip
(b)	"Low lube oil pressure"	Alarm & trip
(c)	"High Lube oil supply temperature"	Alarm & trip
(d)	"High oil filter differential pressure"	Alarm
(e)	"Low lube oil level in lube oil sump"	Alarm
(f)	"High inlet air filter differential pressure"	Alarm & trip
(g)	"Low cooling water flow to air compressor"	Alarm

4.03.00 **Air Drying Plant**

4.03.01 Sequential operation of the adsorber towers & air compressors shall be controlled automatically with a provision for manual take over.

4.03.02 Change over of tower from drying mode to regeneration mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor. Automatic operation during regeneration, starting and stopping of blowers, starting and stopping of heaters, etc shall be timer controlled. During the process, in case, operation is taken over manually from the panel through push button or selector switch, the sequential operation shall start with the manual initiation for each of the steps.

4.03.03 The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air temperature", "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.

5.00.00	**PAINTING**
5.01.00	All the Equipments shall be protected against external corrosion by providing suitable painting.
5.02.00	The surfaces of stainless steel, Galvanised steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting.
5.03.00	The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot-blasting etc as per the agreed procedure.
5.04.00	For all the steel surfaces exposed to atmosphere (outdoor installation), a coat of chlorinated rubber based zinc phosphate primer followed up with undercoat of chlorinated rubber paint shall be applied. Then, intermediate coat consisting of one coat of chlorinated rubber based paint pigmented with Titanium di-oxide and top coat consisting of two coats of chlorinated rubber paint of approved shade and colour with glossy finish shall be provided. Total DFT of paint system shall be of the order of 100 -120 microns. For all the steel surfaces inside the building (indoor installation), a coat of red oxide primer followed up with undercoat of synthetic enamel paint shall be applied. The top coat shall consist of two coats of synthetic enamel paint and total thickness shall be of the order of 100 -120 microns.

LOW PRESSURE PIPING

1.00.00 **EQUIPMENT SIZING CRITERIA**

1.01.00 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

1.02.00 For all L.P. piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.

1.03.00 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following:

a) **Water Application**

	Pipe Size	Water Velocity in m/sec Below 50 mm	50-150 mm	200 mm & above
(a)	Pump suction	------	1.2-1.5	1.2-1.8
(b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5
(c)	Header	------	1.5-2.4	2.1-2.4

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value:

(i)	Carbon steel pipe	100
(ii)	C.I Pipe/ Ductile Iron.	100
(iii)	Rubber lined steel pipe	120
(iv)	Stainless steel pipe	100

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For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/ sump/ reservoir from which the pumps draw water.

(b) **Compressed Air Application**

Compressed air 6.0 m/sec.(under Average Pressure & Temp. conditions)

1.04.00 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.

1.05.00 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.

1.06.00 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.

1.07.00 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.

1.08.00 All high points in piping system shall be provided with vents along with valves. All low points shall be provided with drains along with valves. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.

1.09.00 Material of construction for pipes carrying various fluids shall be as specified elsewhere.

1.10.00 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.

1.11.00 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.

1.12.00 Threaded joints shall be provided with Teflon sealant tapes.

1.13.00 Following types of valves shall be used for the system/service indicated.

SYSTEM	TYPES OF VALVES					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	x	x	x	x	x	
Air		x	x	x	x	

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	Drains & vents x x x Fuel oil (if any) x x x x x
1.14.00	Recirculation pipes along with valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (p&ids). The recirculation pipe shall be sized for minimum 30%design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.
2.00.00	TECHNICAL SPECIFICATION
2.01.00	GENERAL
	Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers / supports, tanks etc.
2.02.00	Pipes and fittings
2.02.01	All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness as specified in the following clauses and or respective codes for pipes and fittings shall be adhered to. The bidder shall furnish the pipe sizing/ thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.
2.02.02	Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.
2.02.03	Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.
2.02.04	Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).
2.02.05	Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the

	thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.
2.02.06	The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/ expansion joint etc. shall be provided as may be necessary depending on layout.
2.02.07	Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
2.02.08	For rubber lined ERW pipes, beads shall be removed.
2.02.09	Inspection holes shall be provided at suitable locations for pipes 800 Nb and above as required for periodic observations and inspection purposes.
2.02.10	At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
2.02.11	For large size pipes/ducts, at high point and bends/change of direction of flow, air release valves shall be provided. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code. Transient analysis /surge analysis where ever specified and required shall be conducted in order to determine the location , number and size of the Air-Release valve on certain long distance/high volume piping systems, if applicable within the scope of work of the package.
2.03.00	***Material***
2.03.01	Alternate materials offered by Bidder against those specified. shall either be equal to or superior to those specified, The responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
2.03.02	No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
2.03.03	All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockists are not acceptable.
2.03.04	All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable references to enable identification of the certificate that certifies the material.

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2.03.05	Material of construction for pipes carrying various fluids shall be as follows:	
	1 Raw water, ash water, circulating Water, aux. cooling water, clarified Water, service water, air pre-heater Wash water, clarifier sludge and Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW drain water	IS-2062Gr.B/ASTMA36/ASTM A-53 type 'E' Gr.B / IS-3589 Gr. 410 /IS-1239 Heavy. For equipment cooling water system wherever DM water is used or alkaline solution is used for pipes 50NB and below, pipe material shall be stainless steel to ASTM A312 Gr. 304 sch. 40 Seamless.
	2 Demineralised water, (condenser Make up water, Boiler fill and Deaerator Fill water, equipment cooling Water piping from overhead tank to Suction header of DMCW and chemical dosing system to Primary circuit of equipment Cooling water (DMCW System), ECW overhead tank make-up water	Stainless steel to ASTM A-312, Gr.304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50mm and below
	3 Drinking water galvanized/ IS 1239 heavy	ASTM A-53 type E Gr. B galvanized/IS 3589 Gr 410 Galvanized to IS- 4736 or equivalent.
	4. Instrument air & plant air. galvanized/ IS 1239 heavy galvanized to IS- 4736 or	ASTM A-53 type E Gr. B galvanized/IS 3589 Gr 410 equivalent.
	~~5. (Condensate) spill water/~~ Deaerator Drain	~~ASTM A 106 Gr. B~~
	~~6. Oil piping~~	~~API 5L~~
2.03.06	In water lines, pipes upto 150mm Nb shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr.B /IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS:1239 Grade Heavy except for demineralised water, drinking water and condensate spill lines.	
2.03.07	Pipes of above 150mm Nb shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr.B/ASTM-A-36. However, larger pipes, i.e. 1000mm Nb and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr.B and shall meet the requirements of AWWA-M-11 (for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).	

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2.03.08	In demineralised water service, the pipes upto 50 Nb shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness. Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
2.03.09	Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410 / IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B / IS: 3589, Gr. 410 / IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).
2.03.10	Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
2.03.11	Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
2.03.12	If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.
2.04.00	**Piping layout**
2.04.01	Piping shall be grouped together where practicable and routed to present a neat appearance.
2.04.02	Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
2.04.03	Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8m above roadways/railways. When several pipe lines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. if the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
2.04.04	Pipe lines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare

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	drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipes and submit to Employer for approval.
2.04.05	All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc. Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
2.04.06	Piping shall generally be routed above ground but where specifically indicated/approved by the Project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.
2.04.07	Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.
2.04.08	All local instruments shall be located on pipe lines as to render them observable from the nearest available platforms.
2.04.09	Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.
2.05.00	**Slope/Drains and Vents**
2.05.01	Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. In addition to the system requirement all low points in the pipelines shall be provided with suitable draining arrangement and all high points shall be provided with vent connections where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vent shall not be less than 15mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15mm for line size up to 150mm, not less than 20mm up to 300mm and not less than 25mm for 350mm to 600mm pipes and not less than 50mm for 600mm and above pipes.
2.05.02	Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.
2.06.00	**Pipe Joints**
	In general all water lines 65mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

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2.06.01	Screwed (a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS: 554 unless specified otherwise. (b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, along with the nascent threaded metal portions at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test. (c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately. (d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate paste. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing. (e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due

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	to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.
2.06.02	**Welded**
	(a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.
2.06.03	**Flanged**
	(a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.
	(b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.
	(c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.
2.07.00	**Bends/elbows/mitre bends/ Tees/ Reducers & other fittings**
2.07.01	Unless otherwise specified elbows shall be of long radius type.
2.07.02	For pipe sizes up to 65Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.
2.07.03	For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 350Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.
2.07.04	Mitre bends are not acceptable in case of rubber lined mild steel pipes.
2.07.05	For pipe fittings such as reducers and tees, the material shall be to astm-a-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fitting shall conform to the dimensional standard of ANSI B-16.9. However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.

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	For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
2.07.06	Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any) Class-S, for sizes up to and including 50mm NB, i.e., the fitting shall be of seamless construction. However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.
2.07.07	In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.
2.08.00	**Flanges**
2.08.01	Flanges shall be slip on type. Welding of flanges in tension is not permitted.,
2.08.02	All flanges and flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.
2.09.00	**Specific technical requirement of laying buried pipe with anti corrosive treatment** The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.
2.09.01	**Trenching** (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822. (b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained. (c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000mm between the top of the pipe and finished grade. (d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with is: 5822 to provide an acceptable bed for placing the pipe. (e) *Coating and Wrapping shall be done as under*

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2.09.02	**Preparation and cleaning of piping** (a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine. (b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager. (c) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230mm for joints, which shall be coated manually at site after laying, welding and testing the pipe. (d) On the internal surface for pipes 1000 Nb and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.
2.09.03	**Coating and wrapping** (a) Buried piping shall be coated and wrapped, as per specification, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are: (1) Coating primer (coal tar primer) (2) Coating enamel (coal tar enamel) (3) Wrapping materials. (b) All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable. (c) Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated Kraft outer wrap or finish coat (d) Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of. Coats and wraps shall be decided based on soil corrosivity/resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available. (e) Total thickness of completed coating shall not be less than 4.0 mm.

	(f) Alternatively, the anti-corrosive protection can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to AWWA-C-203. These-tapes shall be applied hot over the cold coal tar primer preferably in steps of 2mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm minimum.
2.09.04	**Trench bed preparation and back filling** Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.
2.09.05	**Laying of galvanized steel (GI) pipes** All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joint shall be applied with Zinc silicate paste. All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and " anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.
2.10.00	**Cleaning and flushing**
2.10.01	All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.
2.10.02	Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.
2.10.03	After erection, all water lines shall be mass flushed with water. The cleaning velocities in water lines shall be 1.2-1.5 times the operating velocities in the pipelines.
2.10.04	All compressed air pipe work shall be cleaned by blowing compressed air.
2.11.00	**Surface preparation and painting** Pipes shall be cleaned both internally and externally thoroughly by blast-cleaning or power tool cleaning method as indicated above.. In case of oil piping, cleaning will have to be done by pickling. No painting is required on galvanized pipe surface or galvanized steel surface. However, necessary color banding for identification as per color code shall be done. **External surface of piping shall be cleaned and prepared as indicated below.**

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2.11.01	**Primer painting** (a) After the surface is prepared two coats of red oxide (zinc chromate/zinc phosphate) primer conforming to IS-2074/IS-12744 or equivalent shall be applied. Primer coat shall be immediately applied without any time lag after the surface preparation. (b) Any equipment which has been given the shop coat of primer shall be carefully examined after its erection in the field and shall be treated with a touch up coat of primer wherever the shop coat has been abraded, removed or damaged during transit/erection, or defaced during welding.
2.11.02	**Finish painting** (a) Paint to be used shall be synthetic enamel paint conforming to IS-2932 or equivalent. Finish painting shall be carried out in three coats consisting of one intermediate coat and two finishing coats. Dry film thickness (DFT) of painting inclusive of primer thickness shall be at least 150 micron. (b) The primed surface shall be cleaned of dust/dirt/grease etc. without scratching or in any way damaging the primer coat. The intermediate coat shall be allowed to dry before applying the finish coat or as recommended by paint manufacturer. (c) Paint shall be applied by brushing. It shall be ensured that brush marks are a minimum and the requirements of workmanship is as specified in IS-1477. (d) Paint used shall be stirred frequently to keep the pigment in suspension. Paint shall be of the ready mix type in original sealed containers as packed by the paint manufacturer. No thinners shall be permitted. (e) No painting shall be done in frost/foggy weather or when the humidity is high to cause-condensation on the surface to be painted. (f) The dry film thickness (DFT) after the painting shall not be less than 150 microns.
2.11.03	**Other requirements** (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc. (b) The color of the finish paint shall be as per approved color-coding. (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site. (d) The dry film thickness of paint shall not be less than 0.15 mm.

2.11.04	Color code for identification The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.
2.12.00	**Specification for hangers and supports**
2.12.01	All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.
2.12.02	While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.
2.12.03	Hanger for piping 65mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.
2.12.04	Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS: 226/or equivalent. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. The structural steel work shall be as per IS: 800/BS: 4360. Insulation protection saddles shall be used at support point of all insulated piping.
2.12.05	The support shall be so interspaced as to minimize sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.
2.12.06	The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.
2.12.07	All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
2.12.08	At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.
2.12.09	All components of hangers/supports shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.
2.13.00	**Design/Construction/Material Particulars of Gate/ Globe/Check Valves/ Globe Stop Valve/Butterfly valve**
2.13.01	GENERAL (a) All valves shall be suitable for the service conditions i.e flow, temperature and pressure, at which they are required to operate.

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	(b) The valves as well as all accessories shall be designed for easy disassembly and maintenance. (c) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion. (d) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type. (e) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced. (f) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined. (g) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required. For valves of size 350mm and above either bevel or spur gearing shall be provided to facilitate manual operation. (h) The valves coming in vacuum lines shall be of extended gland type and/or water sealed. (i) The actuator-operated valves shall be designed on the basis of the following: (1) The internal parts shall be suitable to support the pressure caused by the actuators; (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc. (3) All actuator-operated valves shall be provided with hand operated gearing mechanism also. (4) All actuators operated valves shall open/ close fully within time required by the process. (j) Valves coming under the purview of IBR shall meet IBR requirements. (k) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items: (1) Hand wheel (2) Position indicator (for above 50 mm NB valve size)

(3) Bypass valves and gear operators for valves of size 350 NB & above.

(3) Draining arrangement wherever required.

(l) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.

(m) Check valves shall be used for non-return service. They shall be swing. check type or double door (Dual plate)check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening /closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600mm NB

(n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

(o) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.

(p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(q) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer.

(r) All valves except those with rising stems shall be provided with continuous mechanical position indicators; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.

(s) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS- 1538 for fitting shall be applicable.

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2.13.02	**VALVE BODY MATERIAL** Valve body material for various services shall be as follows: Valve body material for water application like circulating water, Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65NB and above; gun-metal for sizes 50 Nb and below. For compressed air application, valve material shall be galvanized cast carbon steel or galvanized forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below. DM water: SS body and disc along with SS internals. Condensate: Cast Carbon Steel / Forged Carbon Steel.
2.13.03	The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards. Standards and Codes AWWA-C-504 — Rubber seated butterfly valves. BS-5155/EN-593 — Cast iron and carbon steel butterfly valves for general purpose. IS-778 — Gun-metal gate, globe and check valves for general purpose. BS-5154 — Copper alloy globe/globe stop and check and gate valves for general purpose. IS-780 — Sluice valves for water works purpose (50-300 mm size) IS-2906 — Sluice valves for water works purpose (350-1200 mm size) IS-5150 — Cast iron wedge and double disc gate for general purpose. BS-5152 — Specification for cast iron globe valves. BS-5153 — Cast iron check valves for general purpose.

	IS-5312	Swing check type reflux (non-return) valves.
	ANSI B 16.34	Standard for valves.
	API-594	Standard for Dual-check valves.
	API-600	Steel gate valves.
	ANSI-B-16.10	Valves face to face and other relevant dimension.
	API-598	Valves inspection test.

2.13.04 **End Connections**

The end connections, shall comply with the following:

Socket welding (SW) - ANSI B 16.11

Butt Welding (BW) - ANSI B 16.25.

Threaded (SC) - ANSI B 2.1

Flanged (FL) - ANSI B 16.5& AWWA-C-207(steel flanges), ANSI B 16.1 (Cast Iron flanges)

2.13.05 All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).

2.13.06 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.

2.13.07 All gun metal body valves shall have screwed ends.

2.13.08 All flanged end valves/specialties. shall be furnished along with matching counter flanges, fasteners, gaskets etc. as required to complete the joints.

2.14.00 **Check Valves**

2.14.01 Check valves shall comply with the following characteristics:

(a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);

(b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.

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	(c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.
2.14.02	Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.
2.14.03	All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.
2.14.04	Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.
2.15.00	**Globe Valves**
2.15.01	The globe valves shall have the following characteristics: Straight conveyed flow. Right angle Preferably, the valves shall be of the vertical stem type.
2.15.02	Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.
2.15.03	The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.
2.15.04	For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.
2.15.05	All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.
2.16.00	**Gate valves** All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate. Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

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2.17.00 **Air Release Valve**

(a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.

(b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.

(c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS: 210 Gr. FG 260. and spindle shall conform to high tensile brass.

(d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/ butterfly valve.

2.18.00 **Butterfly valves**

2.18.01 **Design/Construction**

(a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition. Bidder has to clearly indicate the material offered in the bid. No change shall be entertained during detailed engg.

(1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable

(2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.

(3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.

(4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

(5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

(6) The operating mechanism shall be mounted directly on or supported from the valve body.

(7) All valves shall be complete with:

Position indicator (located in a visible place)

Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off"

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

CLAUSE NO.	TECHNICAL REQUIREMENTS

Valves-350Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures along with suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

2.18.02 **Material of Construction (Butterfly Valves)**

Materials and other design details shall be as indicated below :

(a) **Cast Iron Butterfly Valves**

Body & Disc	ASTM A48, Gr. 40 with 2% Ni/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated
Shaft	BS 970 431 S: 291 / EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
Seat ring	18-8 Stainless steel
Seal	Nitrile Rubber

(b) **Stainless Steel Butterfly Valves**

Body & Disc	ASTM A 351, Gr. CF8M
Shaft	ASTM A 182, Gr. 316
Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) **Carbon steel Butterfly Valves**

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304
Disc & Seat Rings	EPT/BUNA-N/Neoprene

CLAUSE NO.	TECHNICAL REQUIREMENTS

Testing of valves shall be as per AWWA C – 504 or BS – 5155 as applicable. For fabricated body butterfly valves all the longitudinal and circumferential weld seams on valve body shall be 100% radiographed or ultrasound tested.

2.18.03 **Proof of Design Test (Type Test) for Butterfly Valves**

Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual P.O.D. test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504.

2.19.00 **MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)**

(a) The materials shall generally comply with the following:

(1)	**Cast Steel Valves**	
	Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
	Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
	Trim.	ASTM A 182 Gr. F6
(2)	**Stainless steel valves**	
	Body & Bonnet	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
	Disc	-do-
	Trim.	ASTM 182 Gr. F. 316
(3)	**Cast iron valves**	
	Body & bonnet	BS 1452 Gr.14/IS-210 Gr.FG 260
	Seating surfaces and rings	13% chromium steel
	Disc for non-return valves	BS 1452 Gr.14/IS-210 Gr FG 260
	Hinge pin for non-return Valves	AISI 316

CLAUSE NO.	TECHNICAL REQUIREMENTS

		Stem for gate globe valves	13% chromium steel
		Back seat	13 % chromium steel
	(4)	**Gun Metal valves**	
		Body and bonnet	IS 318 Gr. 2/ Equivalent Standard
		Trim.	-do-

(b) Cast iron body valves shall have stainless steel stem and seat.

(c) Material for counter flanges shall be the same as for the piping.

2.20.00 **Float operated valves**

(a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) DESIGN AND CONSTRUCTION FEATURES

The following design and construction feature of the valve shall be the minimum acceptable.

(c) Valves shall be right-angled or globe pattern.

(d) Valves shall be balance piston type with float ball.

(e) Leather liner shall not be provided.

(f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or IS: 210 Grade 200 or equivalent, and Float shall be of copper with epoxy painting of two (2) coats.

(g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.

(h) The valves shall have flanged connections.

2.21.00 **PAINTING OF VALVES:**

Two (2) coats of primer followed by three (3) coats of enamel of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of paining shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

SUB-SECTION – A-26

PIPING VALVES AND FITTINGS

PIPING VALVES AND FITTINGS

1.00.00 CODE & STANDARDS

1.01.00 The Design, manufacture, shop testing, erection, testing and commissioning of piping and valves shall conform to the latest revisions of the following codes and Indian Standards, in addition to other standards mentioned elsewhere in the tender documents subject to any modification and requirement as specified hereinafter.

IS : 458	-	Concrete pipes (with and without reinforcement).
IS : 554	-	Pipe thread for pressure tight joints.
IS : 778	-	Gunmetal gate, globe and check valves for general purpose.
IS : 14846	-	Sluice valves for water purpose.
IS : 783	-	Code of practice for laying RCC pipes.
IS : 1239	-	Mild steel tubes and fittings - Part I & II.
IS : 1363	-	Black hexagon bolts, nuts and lock nuts.
IS : 1364	-	Precision and semi-precision hexagon bolts, screws, nuts and lock nuts.
IS : 1536	-	Centrifugally cast (spun) iron pipes for water, gas and sewage.
IS : 1537	-	Vertically cast iron pressure pipe for water, gas and sewage.
IS : 1538	-	Cast iron fittings for pressure pipes for water, gas and sewage.
IS : 1703	-	Ball valves (horizontal) plunger type including floats for water supply purposes.
IS : 2062	-	Structural steel fusion welding quality.
IS : 2379	-	Colour for the identification of pipe line.
IS : 2685	-	Code of practice for erection, installation, and maintenance of sluice valves.
IS : 2712	-	Gaskets.
IS : 2825	-	Code of unfired pressure vessels.

	IS : 3006	-	Acid resistant SWG Pipe.
	IS : 3114	-	Code of practice for CI Pipes.
	IS : 3042	-	Single faced sluice gates (200 to 1200 mm).
	IS : 3589	-	Electrically welded steel pipes for Water gas & sewage (200 to 2000 mm).
	IS : 3952	-	Cast Iron butterfly valves for general purposes.
	IS : 4038	-	Foot valve for water works purposes.
	IS : 4192	-	Part-I Rubber lining.
	IS : 4736	-	Hot dip zinc coating on steel tubes.
	IS : 4984	-	High Density polyethylene pipes.
	IS : 4985	-	Unplasticised PVC Pipes.
	IS : 5312	-	Swing check type reflux (non-return) valve Part-I.
	BS : 5156	-	Standard for Diaphragm valve.
	BS: EN 593	-	Industrisal Valves – Metallic Butterfly Valves
	BS : 5142	-	Cl globe valve.
	ASTM-A 106	-	Gr.C Seamless carbon steel pipe.
	ASTM - 53	-	Seamless carbon steel.
	AWWA-C-504	-	Rubber seated butterfly valve.
	AWWA M11	-	Steel Pipe – A Guide for design and installation.
	ANSI:B - 16.5	-	Steel pipe flanges and flanged fittings.
	ANSI:B - 31.1	-	Power Piping code

2.00.00 SCOPE

The equipment & material to be supplied under this section shall include but not be limited to the following.

a) Pipes, bends, elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system.

b) Gaskets, ring joint, bracking rings, jointing material etc. as required.

c) Instrument tapping connection, stub and thermo-wells.

d) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifice nozzles etc., pressure accumulators as necessary.

e) Valve and gates, to start/stop and regulate flow.

f) Strainers.

g) Anchor block (for buried/over-ground piping), support brackets, clamps, support trestles, hangers etc. for the piping under the scope of contract.

h) Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal points.

i) Secondary steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for under ground/above ground pipes.

j) Painting anti-corrosive coatings, etc. inside and outside of pipes as necessary.

k) ~~All embedded parts required for all tanks/water retaining structures made of RCC including puddle pipes shall be supplied by the contractor.~~

3.00.00 **DESIGN, CONSTRUCTION AND ERECTION**

3.01.00 **Piping and Fittings (General)**

3.01.01 **Design**

All piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. The minimum thickness for pipes and fittings shall be adhered to. Higher thickness in equivalent material is acceptable. However, no credit will be given for higher thickness.

3.01.02 All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 25 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

3.01.03 All piping systems shall be properly designed to take care of hydraulic shocks and pressure surges which may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolts, etc. for the safeguard of the piping systems under above mentioned conditions. External and internal attachments to piping shall be designed so as not to cause flattening of pipes, excessive localised bending stresses or harmful thermal gradients in pipe walls.

3.01.04 Piping and fittings shall be manufactured by an approved firm of repute. They should be truly cylindrical of clear internal diameter specified, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects. They shall allow ready cutting, chipping or drilling, welding etc.

3.01.05 All rubber lined pipes shall be seamless or bead removed ERW pipes.

3.01.06 Inspection holes shall be provided at suitable locations for pipes 800 mm Nb and above as required for periodic observations and inspection purposes.

3.01.07 Material of construction for pipes carrying various fluids shall generally be as below:-

S.No	Service	Recommended Material
1.	~~Raw water~~	~~Carbon Steel~~
2.	~~Clarified water~~	Carbon steel
3.	Filtered Water	a) SS-304 for the line from filtered water pumps upto DM Plant. b) GI pipe for the pipe feeding to potable water system.
4.	Sea Water	a) Stainless steel–316L or cupro-nickel alloy suitable for sea water application for sizes up to 100 NB or below. Above 100 NB: The piping systems handling sea-water shall be of carbon steel having i) coating of high build solvent free polyurethane (PU) of adequate thickness (minimum 2mm DFT) on the internal surface of the pipes as per AWWA-C-222.ii) 100% solvent free epoxy of 1500 microns ,iii)Vinyl

S.No	Service	Recommended Material
		Ester glass flake filled coating of 1000 microns. The pipes which cannot be coated internally, shall be of stainless steel construction confirming to ASTM-A-312 GR. 316 L.
5.	Acidic Water	Rubber lined Steel
6.	Decationised Water	Rubber lined Steel
7.	Demineralised Water	SS -304
8.	Acid (Conc Hydrochloric acid) (5 – 30%)	Polypropylene lined steel
9	Acid (Dilute Hydrochloric acid) (less than 5%)	Rubber lined Steel
10.	Acid (Sulfuric) a) Strong (Conc) b) Dilute (upto 10%)	 SS – 304 L Polypropylene lined steel
11.	Alkali (Sodium Hydroxide) a) Strong (5% and above) b) Dilute (below 5%)	 Stainless Steel Rubber lined Steel /Stainless steel
12.	Alum Solution	Rubber lined Steel
13.	Lime slurry/Solution/ Suspensions	Galvanised Steel
14.	Coagulant aid Solution	Rubber lined Steel
15.	Liquid and Gas Chlorine (Under Pressure)	Seamless Carbon Steel Schedule 80 (Heavy Duty)

S.No	Service	Recommended Material
16.	Chlorinated Water	Rubber lined Steel for above ground & HDPE pipe for below ground
17.	Wet Chlorine gas (Under Vacuum)	Polypropylene
18.	Sludge (From Clarifier /tube settler/lamella clarifier)	Cast Iron (Class A as per IS: 1536) / Ductile Iron
19	Air	Galvanised Steel
20	Waste effluent from DM plant vessels & chemical solution tank's etc.	Rubber lined Steel for above ground & HDPE pipe for below ground
21	Resin water slurry	Stainless steel Type-304
22	Backwash/Rinse water from discharge of Backwash pumps in DM plant	SS-316
Note: Irrespective of the recommended piping material as mentioned above, Bidder shall supply the material of pipes indicated in Scope of Works (Part-A) and in tender Drawings.		

3.01.08 However the portion down stream of the isolation valves of pipe lines conveying flushing water shall be of the material & type as that of the chemical pipelines which is being flushed.

3.01.09 **Minimum sizes for various pipelines are indicated in the tender drawings/data sheet**. **Bidder to provide the same as specified.** However, for pipe lines where sizes are not indicated, sizing shall be done based on the following velocities as indicated below:.

Sl.	Description	Velocity in meters/ second		
		Pipe size Below 50mm	**Pipe Size 50 to 100 mm**	**Pipe Size 200 mm & above**
a)	Pump suction	1.2 - 1.5	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	1.5 - 2.4	1.5 - 2.4	2.1 - 2.4

			Velocity in meters/ second		
d)	Compressed air below 2 Kg/cm^2(g)	15 – 20	20 – 30	25 – 35
e)	Compressed air 2 Kg/cm^2(g) & above	20 – 30	25 – 40	35 – 45
f)	Suction to compressor/ Blowers	7 – 8	7 – 8	7 – 8

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels (Other than Cold water channel of Circulating Water System) under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

3.01.10 The following " C" Value shall be used in WILLIAM & HAZEN formula for calculating the friction loss in piping systems.

i)	Carbon Steel pipe	- 100
ii)	Carbon Steel pipe with internal lining	- 120
iii)	C.I Pipe / Ductile Iron	- 100
iv)	Rubberlined steel pipe	- 120
iv)	PVC / HDPE / GRP pipes	- 140
v)	Stainless Steel	- 100

3.01.11 For calculating the pump head, atleast 10% margin shall be taken over the pipe friction losses.

3.02.00 Material & Dimensional Standards for Piping

3.02.01 All piping system shall be capable of withstanding the maximum pressure and temperature in the corresponding line. The pressure rating of individual piping system component such as valves, flanges etc shall however be not less than that specified.

3.02.02 The Steel pipes (Welded type) for the services of water/clarified water/ Filtered water / Sea water shall conform to the following standard or codes.**:**

Pipes up to 150 NB: IS:1239 Part-I (Heavy grade-Black), ASTM-A-53 Grade B (Welded) -Schedule 80 up to 2 inch size and Schedule 40 above 2 inch nominal size.

Pipes 200 NB and above: IS:3589 - Grade 410; ASTM - A53, Type-E Grade B (Welded) – Schedule 40.

However, condenser polisher headers for condensate polishing plant shall be of seamless carbon steel A 106 Gr.B all welded construction with 300 lb flange connection. Inlet and discharge end shall be prepared for field welding.

3.02.03 (a) The thickness of the pipes shall be selected based on the design pressure of the system (maximum test pressure or maximum surge pressure due to transients). Corrosion allowance of 2mm shall be included for unlined/ un-coated pipes and 1 mm for lined/coated pipes and negative tolerance specified by the Standard/Code shall be added to arrive at the final thickness. Thickness selected shall also meet the requirements of AWWA – M11 (for deflection & buckling criteria considering water filled for compacted soil) in case of buried pipes. However the final thickness shall not be less than that specified as per IS: 3589 as indicated below.

Sl	Nominal Pipe Size (mm)	Outside Diameter (mm)	Wall thickness (mm)
	200 NB	219.1	4.5
	250 NB	273	5
	300 NB	323.9	5.6
	350 NB	355.6	5.6
	400 NB	406.4	6.3
	450 NB	457	6.3
	500 NB	508	6.3
	600 NB	610	6.3
	700 NB	711	7.1
	800 NB	813	8.0
	900 NB	914	8.8
	1000 NB	1016	8.8
	1200 NB	1219	10
	1400 NB	1422	12.5

Sl	Nominal Pipe Size (mm)	Outside Diameter (mm)	Wall thickness (mm)
	1600 NB	1626	14.2
	1800 NB	1829	14.2
	2000 NB	2032	16
	2200 NB	2235	17.5
	2500 NB	2540	20

(b) Spirally welded pipes as per API – 5 LS or IS:3589 are also acceptable for pipe of size 400 NB and above

(c) Preferably all steel pipes shall be supplied from the approved manufactures from their works. However, for Pipe Sizes 600NB and above, Bidder may fabricate pipes at site. Pipes to be fabricated by the bidder shall be rolled and butt welded from plates/coil conforming to ASTM A – 53 type E Gr. B / IS 2062 Grade 410 WC or Equivalent, of required thickness (as defined above) at site. Bidder shall clearly bring out their proposal regarding this aspect in their bid. The site-fabricated pipe (finished product) shall meet the required quality specified in the design Standard (IS:3589) with regard to Mechanical, Chemical Properties, Tolerances etc. However, for such site fabricated pipes, the Hydrostatic Test Pressure shall be 1.5 times the design pressure or 2 times the working pressure as the case may be. Other Testing requirements for such site-fabricated pipes shall be as per relevant Table in Sub-section-III E of Part-B of this Technical Specification.

3.02.04 Pipes for the Air Service shall conform to the above Clauses 3.02.02 & 3.02.03 and shall be galvanised to IS:4736.

3.02.05 Pipes to be used for the rubber lined construction shall conform the above Clauses 3.02.02 & 3.02.03 and inside surface shall be completely debeaded and made suitable for lining.

3.02.06 Other piping materials shall conform to the following standards.

1) IS:4984 – PE-80 & PN-16-High density polyetheylene pipes.

2) IS:4985 - Class-4 - PVC Pipes.

3) ASTM A-106, Gr. C, Schedule 80 - Seamless carbon steel pipe.

4) ASTM A-312 Grade TP-316 Schedule 40 - Stainless Steel pipes (SS 316)

5) ASTM A-312 Grade TP-304 Schedule 40 (min) (ANSI B36.19) – SS 304

6) ASTM A-312 Grade TP-304L Schedule 40 (min) (ANSI B36.19) – SS 304 L

7) ASTM D 3517 & ASTM D 4024 - GRP pipes

3.02.07 Fittings:

1) Fittings to be used with carbon steel pipes shall conform to IS:1239 Part-II (Heavy grade) for sizes upto 150 NB. For sizes 200 NB & above steel fittings shall conform to ASTM A 234 Gr. WPB.

2) For stainless steel fittings above 50 NB the same shall conform to ASTM-A-403, GR. WP 304 (316 for sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.

3) Unless otherwise specified elbows shall be long radius type.

4) For pipe sizes upto 65 NB long radius forged elbows or seamless bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter. For steel pipes 80 NB and above, seamless long radius forged elbows are used unless otherwise indicated in the drawings. For pipe size 350 NB and above meter bends may be used. The bend shall be 1½ times the nominal pipe diameter. 90^0 meter bends shall be in 5 pieces (4 cuts) 45^0mitre bends shall be in 4 pieces and $22½^0$ in three pieces. Fabrication of meter bends shall be as detailed in BS 2633/BS534.

5) However inside surface of all the fittings used for the rubber lined application shall be debeaded and made suitable for rubber lining.

6) Galvanized pipe application all the fittings shall be galvanised as per IS:4736.

7) Fittings to be used in other type of piping shall conform to relevant IS/BS ANSI Standards and in conformity with the parent pipe standard.

8) Unless otherwise shown eccentric reducers shall be installed with straight side at the top of piping connection.

3.03.00 **Design of Piping Systems**

3.03.01 Pipes 50 NB and smaller shall have socket welded joints for chlorine line. For water, air and other services where steel pipes are used, joints of this size range shall be screwed/flanged type.

3.03.02 All unlined steel pipes 65 NB and above (other than CI pipes and air service pipes) shall be jointed by butt welding.

3.03.03	All rubber lined pipes shall have flanged joints.
3.03.04	Steel pipe flanges shall be generally slip on flat face type. Weld neck flanges shall be used when flange follows immediately after a butt welding or where it is required with respect to service conditions. When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.
3.03.05	All the piping flanges and counter flanges & their drilling shall conform to ANSI B 16.5 of relevant pressure & temperature class. However wherever the interference is involved with the Owner's pipe, the flange/interconnection details shall be designed to match the piping and the details of which will be intimated later. Flanges shall conform to ANSI B.16.5 class 150 (minimum). However Stainless Steel Flanges shall be fabricated from SS Plates to ASTM-A-240, Gr. 304 (316 For Sea Water Application, if iny) or equivalent
3.03.06	The field joints of internally lined/coated smaller size pipes (diameter 150 to 400 NB) shall be of flanged type to avoid manual coating/lining at joints.
3.03.07	For easy handling & removal of equipments, valves etc. and for maintenance purpose, break up flanges for 65 NB and above sizes and suitable type of compression flexible coupling for flanged joints of 50 NB and below size shall be provided. The over-ground piping wherever routed inside building, shall have a clear head room of minimum 2.1 meter from operating floor.
3.03.08	Pipes shall be generally be routed above ground but where specifically indicated/specified the pipe may be laid in trenches or buried. Burried piping shall be generally installed so that the top of pipe is 1.0 meter below the ground level unless otherwise specifically mentioned. Full length of buried piping shall be provided with 100 mm thick sand bed.
3.03.09	Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line may be supported from the building structures. No support shall be taken from the brick wall. Outdoor, pipes other than buried pipes shall run on steel trestles. Crossing of the road shall be on a pipe bridge with a clear height of at least 7 meters over the road surface. All the steel structure for the pipe bridge, and the supporting posts/trestles along with all necessary hangers clamps, connecting steel, fixing bolts, nuts etc. shall be supplied and erected by the Bidder.
3.03.10	Butt welding edge preparation shall be done as per ANSI B 16.25.
3.03.11	All welding electrodes and welding rods including special ones, if any shall be furnished by the Bidder.

3.03.12 Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes above 350 the mitre bends shall conform to BS:534. The bend radius shall be used for all pipes 1.5 times the nominal pipe diameter.

3.03.13 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the ENGINEER.

3.03.14 A detailed Hydraulic transient analysis based on the method of characteristics shall be carried out for such piping system **if included in the scope of supply**. This study shall be carried out by a reputed consultant/Institute. The following shall be based on the results of the hydraulic transient study.

- Pump discharge valve closing time and pump stopping sequence.
- Conditions arising due to stopping/tripping of pumps
- Size, location and quantity of air release valves in the make-up water piping shall be provided by bidder.
- Pump discharge valve opening time during start-up condition and pump starting sequence.

The report of transient analysis should consist of methodology adopted, characteristics curves/data for various boundary conditions, complete input data used for execution of software for various events and the results of the programme. The report shall be submitted to the Owner for approval. Based on the recommendations of such a study. Bidder shall take corrective measures and provide suitable surge suppression device in the piping system.

3.03.15 Pipe coming under purview of IBR should meet its requirements and getting the IBR approval shall be under Vendors scope

3.03.16 **Internal & External Protection Of Pipes**:

For rubber lined pipe, lining should be applied in two (2) layers, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be 65 + 5 A class.

Painting and application procedures for over ground Piping shall be as follows:

a) For Indoor Piping

1) Surface preparation shall be done either manually or by any other approved method.

2) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns.

3) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns.

4) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns.

Total DFT of paint system shall not be less than 150 microns.

b) For Outdoor Piping

1) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard.

2) Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

3) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

4) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 100 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.

Total DFT shall not be less than 300 microns.

Outside surfaces of steel pipes and fittings that are buried underground and laid inside a Hume pipe (in Road/pipe or trench crossings) shall be given protective coating as per Annexure-I enclosed with this section.

4.00.00 VALVES & GATES

4.01.00 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines. **Unless otherwise**

specified all the Valves shall be supplied with counter flanges by the Contractor.

4.02.00

(a) All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the relevant design standard. Non standard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed. The pressure rating of individual piping system component such as valves, flanges etc shall however be not less than that specified.

(b). All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.

4.03.00 **Valves in Raw water, Clarified, Filtered and Sea water application**:

4.03.01 Unless otherwise mentioned in tender drawings, either Butterfly type or sluice/gate valves shall be used for isolation purposes.

4.03.02 **Sluice/Gate valves** :

a) Sluice /Gate Valves shall conform to BS:5150(BS:5163 PN 16) PN16, IS:14846 of rating PN 1.6 (min.). Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS:14846 /BS:5163). Flanges shall be designed as per ANSI B 16.5 Cl. 150 (min.) to meet with the piping flanges. Valves shall be of outside screw and rising stem type. Gate valves for sizes below 50 NB and below shall conforms to IS:778 Class-2/ANSI B16.34 straight, rising stem; without side screw. For sea water application the Body, Bonnet, Wedge, Yoke etc shall be of ASTM A 439–Gr D2.

b) Sluice/Gate valves shall be provided with the following accessories in addition to the standard items:

01) Hand wheel

02) Manual Gear reduction unit operator for valves 200 NB and above

03) Bypass valve for valve of sizes 350 NB and above.

04) Draining arrangement wherever required.

05) Arrow indicating flow direction.

06) Position indicator.

D)	Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer
E)	Disc of globe valve may be provided with renewable rubber seating ring.
F)	Handwheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

4.03.05 However, valves in the flushing water lines shall be of type and material specified for the chemicals which is being flushed by the line.

4.04.00 Valves for Decationsed, Deanionsed and Demineralised water application

4.04.01 Butterfly valves or Saunder's patented diaphram valves shall be used for the services of deanionised, decationised and demineralised water application for isolation purposes.

4.04.02 The diaphragm valves shall conform to the following requirements.

i)	Design Standard	:	BS:5156 or equivalent of required rating/class. (minimum rating of valves should be PN 10).
ii)	Type	:	Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
iii)	<u>Material of Construction</u>		
iv)	Body, Bonnet	:	Cast Iron IS:210 Gr.FG.260 or equivalent Or Cast steel ASTM A-216 Gr WCB.
v)	Body lining	:	Soft Natural rubber, Ebonite Polypropylene
vi)	Diaphragm	:	Reinforced rubber, hypalon/approved . equalent
vii)	Handwheel	:	Cast Iron
viii)	Compressor	:	Stainless Steel
ix)	Stem & Bush	:	Stainless Steel

x)	Hand wheels shall be marked with the direction of closure.
xi)	Valves shall be provided with a position indicator to show the open and closed condition.
xii)	Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per relevant International Standard

4.04.03 The butterfly valves shall conform to Cl.4.03.03 above except to the following requirements.

1. Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene.
2. Disc shall be lined with PVDF, polypropylene, or natural rubber. Disc of SS-316 is also acceptable.
3. Seat rings shall be of Nitrile rubber or Hypalon.

4.05.00 Valves for Acid & Alkali Services

4.05.01 Valves shall be Saunder's patented diaphragm type. The valves shall conform to Cl. 4.04.02 above except that Diaphragm shall be of reinforced TEFLON, EPDM/Black Butile/approved equivalent for acid services and reinforced Neoprene/Hypalon/ approved equivalent for alkali services.

4.06.00 Valves for Lime Slurry / Solutions & Resin transfer lines

4.06.01 Plug valves shall be used for the application of lime slurry /lime solutions.

4.06.01 The plug valves for lime slurry/solution lines shall conform to the following requirements.

i)	Design Standard	:	BS:5353 Class 150 or Equivalent
ii)	Type	:	Flanged and non lubricated plug valves.
iii)	Material of Construction		
iv)	Body	:	Cast Iron IS:210 Gr.FG.260 or equivalent
v)	Plug	:	Staineless Steel AISI 316
vi)	Body Sleeve or Seat	:	PTFE

e)	Gland / Gland nut	:	Bronze/ Brass
f)	Packing	:	Teflon

d) Butterfly type Valve /Ball Valves (Isolation of Chlorinated Water in PVC pipes)

a)	Body	:	PVC
b)	Shaft	:	Carbon Steel nickel plated
c)	Disc / Ball	:	PVC
d)	Seating ring	:	Viton
e)	Packing (Ball Valve)	:	PTFE
f)	Bush / O –ring (Butterfly type)	:	EPDM, PVDF

e) Diaphragm Valves (Isolation of Chlorinated water in lined steel pipe):

These valves shall conform to Cl 4.04.02 above.

4.09.00 Valves in Sludge pipe line application

Sluice valve/knife edge type slide valves shall be used in the sludge and drain pipe line.

4.09.01 The Valves shall conform to the following requirements:

i)	Design Standard	:	IS:780/IS:2906 rating PN 10 (min).
ii)	Type		Double Flanged or wafer body, outside screw and rising stem type.
iii)	Material of Construction		
	Body	:	Cast Iron : IS:210 Gr. FG 260
	Stem	:	Stainless Steel AISI 420
	Disc	:	Cast Iron IS:210 Gr. FG 260
	Packing	:	PTFE
	Gland & Gland nut	:	AISI 420

	Hand wheel	:	Cast Iron
iv)	The flanged type valves shall have flanges conforming to ANSI-B 16.5 Cl-150.		
v)	The valves shall conform to the other requirements specified in Cl. 4.03.02(b) & 4.03.02(c).		

4.10.00 Valves for Air pipe line application

4.10.01 For Air services, globe valves diaphragm value or Ball valves may be used for sizes 50 NB and below.

4.10.02 For sizes higher than 50 NB, either Butterfly valve, diaphragm value or Ball valves shall be used.

4.10.03 Globe valves shall generally conform to Cl. 4.03.12 (b) above.

4.10.04 Ball valves shall conform to the requirements stipulated in Cl.4.03.12 (a) above. However, Body material shall be leaded Tin Bronze (IS:318 Gr.2) or stainless steel (AISI:304/316).

4.10.05 Butterfly valves shall conform to the Cl.4.02.05 to 4.02.09 of this section. However, the body & Disc shall be either cast iron lined with elastomer such as PVDF or PTFE or stainless steel construction (AISI 304/316).

4.11.00 Non-return valves (Check valves)

4.11.01 Non return valves shall be of swing check (reflux) type or dual plate type.

4.11.02 The valves shall conform to the following specifications.

i)	Design Standard	:	IS:5312, BS:1868, BS:5153 API 594/ API 60(6D) or Equvalent
ii)	Type	:	Flanged Swing check Type or Dual plate type of lugged wafer design
iii)	Material of Construction (For non corrosive application)		
	Body & Cover Hinge Disk/Door	:	Cast Iron : IS:210 Gr. FG 260 Cast Iron BS:1452 Gr.220 or Eqvt
	Hinge Pin and Door/Disc Pin	:	Cast steel ASTM A 216 Gr. WCB. High tensile Brass IS:320 HT 2 or

			BS:2872 eqvt
	Disc facing ring	:	Stainless steel
	Body Seat ring	:	Stainless steel
	Bearing bushes	:	Leaded Tin Bronze IS:318 Gr.2
	Bolts	:	Carbon Steel
iv)	Material of Construction (For Sea water)		
	Body & Cover Hinge Disk/Door	:	Austenitic Ductile Iron ASTM-A-439, D-2 (Internals epoxy painted).
	Hinge Pin and Door/Disc Pin	:	SS-316
	Disc facing ring	:	SS-316
	Body Seat ring	:	SS-316
	Bearing bushes	:	Leaded Tin Bronze IS:318 Gr.2
	Bolts	:	SS-316
v)	For the application of alum, lime, coagulant aid solution, corrosive water (DM water, Decationised/Deanionised water), and air, the body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Eqvt. material. Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI 316) for the above application.		
vii)	For Hydrochloric acid services, the valves shall be of lined construction as specified in (iv) above, or of Hastalloy 'B' construction and Body/Disc facing ring shall be of resilient materials such as natural rubber, PTFE or viton.		
viii)	For alkali and sulphuric acid services, the complete valve shall be stainless steel construction (AISI-316).		
ix)	Dual Plate type check valves shall be of double flanged. However for smaller sizes upto 150 mm NB, lugged wafer type is also acceptable. The material of construction of spring in dual type valve shall be of INCONEL or better.		

4.11.03 Flanges shall conform to ANSI B 16.5 Cl.150 to match with the piping flanges as specified elsewhere.

4.11.04	Body shall be permanently marked with an “arrow” inscription indicating the direction of motion of the fluid for all the check valves.
4.11.05	Check valves for Raw / Clarified / Filtered water may be offered in Gun metal construction & with threaded ends for sizes 50 NB and below conforming to IS:778 or Equivalent.
4.11.06	For Chlorine gas and Chlorinated water application check valve of Lift Ball type may be used in PVC construction (in case of PVC pipes). In case of rubber lined pipes, the check valves of swing check type shall be lined construction as referred in Cl 4.11.02 (v) above.
4.12.00	The safety valves / relief valves at the down stream of positive displacement type metering pumps shall be of the standard type manufactured by the pump manufacturer and the material of construction shall suit to the fluid handled.
4.13.00	**Gates**
4.13.01	Design standard for gates shall be IS:3042 or Equivalent. For sizes not covered under IS::3042, the gates shall generally as be per IS:13349.
4.13.02	The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS:3042.
4.13.03	Material of Construction a) Frame and Door : Cast Iron IS:210 Gr.260 b) Spindles, bolts & nuts : M.S. to IS:2062 c) Face & seat rings : Gun metal (as per IS:3042).
4.13.04	All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.
4.13.05	Each of the gates shall be provided with hand wheel, and a position indicator.
4.13.06	The gates for DM plant drains/Condensate Polishing Plant shall be rubber lined to a minimum thickness of 4.5 mm.
4.14.00	**Automatic Air Release Valve**
4.14.01	The automatic air release cum vacuum breaker valves shall be of automatic double air valve with two orifices and two floats conforming to IS14845. The float shall not close the valve at higher air velocities. The Orifice Contact joint with the float shall be leak tight joint. An isolation valve shall be provided for each release valve. The Air release valve in the makeup water pipelines shall be provided with a suitable enclosure with locking arrangement so that the same is not tampered.

4.14.02 The valve shall efficiently discharge the displaced air automatically form ducts/ pipes while filling them and admit air automatically into the duct / pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/ pipes during normal working at the normal working pressure.

4.14.03 Material of construction of automatic air release valves shall be as follows.

i)	Body & Cover	:	Cast iron IS-210 Gr. FG 260
ii)	Ball, small orifice	:	Nitrile Rubber
iii)	Ball, large orifice	:	Vulcanite(ebonite)
iv)	Splash Cover	:	Cast iron IS-210 Gr. FG 260
v)	Ball seat	:	13% Cr. Stainless steel
vi)	Spindle	:	SS 316
vii)	Gasket		Nitrile Rubber

Note: However, for sea-water the air release valves shall be of body material ASTM-A-439 (D2-NI) and spindle shall be of SS-316.

4.15.00 STRAINERS

4.15.01 Basket Strainers

a) Basket strainers of duplex design shall have the following materials of construction.

i)	Body	:	Fabricated mild steel : IS:2062 (Tested quality) for raw/clarified/filtered water application and Austenitic Ductile Iron to ASTM–A-439 Gr D2 for sea water
ii)	Strainers	:	Wire shall be stainless steel (AISI:316) 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel (SS-316) construction.
iii)	Drain plugs/ Nuts	:	SS-316

b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.

c) Suitable Vent and drain valves shall be provided for the strainers.

d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.

e) Pressure drop in clean condition shall not be more than 4.0 MWC.

f) Duplex Strainer shall be provided with lifting lugs and suitable mounting arrangement.

g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness 65 ± 5°A)

4.15.02 **Y-Type Strainers**

a) Y-Type strainer for water application shall be constructed of following materials :

i)	Body	:	Cast Iron IS:210 Gr. FG 260 for raw/clarified/filtered water application and Austenitic Ductile Iron to ASTM–A-439 Gr D2 for sea water
ii)	Strainers	:	Wire shall be stainless steel (AISI:316) 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel (SS-316) construction.
iii)	Drain plugs/ Nuts	:	SS-316

b) Y-Type strainers shall also conform to Cl. 4.14.01 (b), (c), (d), (e) and (f).

c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS:210, Gr.FG 260) and lined with soft or hard rubber to a thickness of 3 mm.

d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

4.15.03 Strainers for the application of chlorine gas (Wet / Dry) and liquid chlorine shall be of standard make and type of the chlorination plant manufacturer and material of construction shall be suitable for the duty conditions.

4.16.00 **Resin Traps**

The resin traps for the Ion exchange vessels shall be provided for the collection of Ion exchange resin shall conform to the following:

a) The body shall be of mild steel (IS:2062) and lined internally with rubber (Hard/Soft rubber), Saran or polypropylene. The internals (rod and screen) for all resin traps shall be of AISI 316 construction. All screen components shall be welded at each intersection of wire and support rod for good strength, Resin traps screen opening shall not exceed 120 percent of the associated process vessel under drain/backwash collection header nozzle screen opening and shall be suitably selected to retain even the minimum size of the resin selected for the process.

b) The resin traps shall be provided with a draining arrangement with a valve for collection of trapped resins. Resin trap body shall have lifting lug for easy handling during maintenance/erection.

4.17.00 **General Requirements for Valves, Gates, Strainers ~~and Resin traps~~**

a) All the equipments shall be of proven design for the duty conditions and the contractor or manufacturer shall have sufficient experience in using the above equipments in water treatment application in the plants supplied earlier by them.

b) In case owner desires, the experience list/feed back from the users shall be made available to owner for any or all the equipments during the detailed engineering phase.

c) Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the contractor.

d) Valves, Strainers etc for the Chlorination Plant shall be got approved by the Chief Controller of Explosives-INDIA, by the contractor.

e) Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.

f) The various equipments shall be installed so that they are easily approachable for the operating and maintenance personnel. Generally Valves shall be located about 1.2 metre to 1.5 metre from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The position indicator for such valves shall be also provided along with the stand.

g) However valves which are provided (in the burried pipe line) with a valves chamber shall have manual operator/Hand wheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient

operating space within the chamber shall also be provided for easy operation of such valves.

h) All the valves, strainers, resin traps etc. shall be provided with external painting as that of the interconnected piping as specified in Clause 3.03.14 above. However, surfaces such as Stainless Steel, aluminium, copper, brass, bronze and other non-ferrous materials shall not be painted. No paint or filter shall be applied until all repairs, hydrostatic tests and final shop inspections are completed, but shall be applied prior to shipment.

5.00.00 TESTING FOR PIPING, VALVES & FITTINGS

5.01.00 TESTS AT SITE

All piping, valves, Gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of two hours.

All valves/gates (Manual/Automatic) shall be operated through-out 100% of the travel manually and as well as from control panel (if applicable) and these should function without any trouble whatsoever.

ANNEXURE-1

COATING & WRAPPING FOR PIPES

1.00.00 INTENT

This specification covers the supply of material, application, inspection, testing including supervision of coal tar protection tape for MS pipes.

2.00.00 CODES AND STANDARDS

a) AWWA C-203-97 : AWWA standard for coal tar protective coatings linings for steel water pipe lines-Enamel and Tape-Hot applied.

b) SSPC-SPI & SP 10 : Steel structure painting council (SP-I solvent cleaning and SP-10 near white blast cleaning).

c) NACE RP-02-74 : Recommended Practice,, High Voltage Electrical Inspection of pipeline coating prior to installation.

e) IS 10221 : Code of practice for coating and wrapping of underground mild steel pipelines.

3.00.00 SOURCING OF COATING MATERIAL & AGENCY

The Coating material and agency for application of Coating shall meet the requirements stipulated under **"Proveness of Major Equipments**" in Subsection-II of Part-A of Section VI, Technical Specifications. (if applicable)

4.00.00 COATING SYSTEM & THICKNESS

4.01.00 The Coating System & thickness shall conform to the requirements specified in clause 4.02.00 (a) or 4.02.00 (b) below.

4.02.00(a) The wrapping & coating system shall consist of applying pre-wrapping solution on the cleaned surface, followed by the application of anti-corrosion protection tape spirally or circumferentially on the surface keeping proper tension and maintaining good adhesion with an overlap of 12-13mm. The minimum thickness of coating shall be 4.0 (Four) mm.

4.02.00 (b) The wrapping & coating system shall consist of applying the primer, a coat of coal tar enamel having a minimum thickness of 2.4 mm and one wrap of glass fibre mat followed by a coal tar enamel and wrap of glass fibre mat followed immediately by

an outer wrap of coal-tar impregnated glass fibre felt. The minimum thickness of coating (without the outer wrap) shall be 4.0 mm.

5.00.00 TECHNICAL REQUIREMENTS

5.01.00 (a) General (Applicable for Coating system as per 4.02.00 (a))

a) The coating and wrapping operation shall include surface preparations, application of pre-wrapping solution (primer) and application of layer of anti-corrosion protection tape. The above operation shall be performed under the supervision of and performed by personnel skilled in the application of same type of pre-fabricated tapes.

b) Inspection of the coating and wrapping of the pipes shall be performed by qualified inspectors.

5.01.00 (b) General (Applicable for Coating system as per 4.02.00 (b))

a) The coating and wrapping operation shall include surface preparations, application of primer, heating and applying the coaltar coating and wrapping of glass fibre mat and white wash over external surface of finished coating. The above operation shall be performed under the supervision of and performed by personnel skilled in the application of coaltar enamel coating and wrapping.

b) Inspection of the coating and wrapping of the pipes shall be performed by qualified inspectors.

5.02.00 Surface Preparation

a) Before the pipe is blasted, all oil, grease or other contaminants shall be removed by flushing with a suitable solvent (in accordance with SSPC-SP-I) and wiping with clean rags. The use of dirty or oily rags or dirty solvent will not be permitted.

b) Prior to cleaning operation, the pipes shall be visually examined to ensure that all defects, flats and other parts damaged have been repaired or removed.

c) The abrasive blast material shall be free of impurities such as clay, dirt, debris, oil, grease, salts or other contamination.

d) All metal surfaces shall be cleaned by blasting. Blasting operations shall remove all rust scale and other impurities from the steel surface. The surface shall be

blast cleaned to near white metal finish as per SSPC SP10. Shot blast operation, if adopted shall be done using automatic abrasive blasting equipment.

e) Pipes shall be visually inspected immediately after every blast cleaning operation for surface defects such as slivers, laminations, leafing, scores, indentation, slugs or any other defects considered injurious to the coating. Such defects shall be reported to OWNER and on permission from OWNER; such defects shall be removed by filling or grinding in such a way as not to “blue" the steel.

f) The cleaned and blasted pipe shall be protected from and shall be maintained free of oil, grease and dirt that might fall on the pipe.

5.03.00 **PRIMER**

a) The primer shall be cold applied immediately after the pipes have been blasted and cleaned.

b) Prior to application of the primer, the drum or the container of the solution is to be shaken well before being used.

c) Application of the primer shall be by hand brushing, spraying or other suitable means and shall be in accordance with the instruction for application. It shall be applied at a rate recommended by the MANUFACTURER, in a uniformly thick film free from runs, drips, bubbles, sags, dust, grease or foreign matter. Primer shall completely cover the circumference of the pipe and all surfaces which are to be coated. Any excess of primer shall be brushed out immediately before the primer sets. The priming coat shall not be applied when the pipe is wet or moist.

d) During periods of cold weather, when the temperature of the steel is below 7^{o}C or at any time when moisture collects on the steel, the steel shall be warmed to temperature of approx.30-38^{0}C, which shall be maintained long enough to dry the pipe surface prior to priming.

e) All missed spots or areas covered with insufficient primer shall be touched up immediately by hand brushing. Primer which has been applied too heavily such as the base of the welds shall be brushed out before the primer sets.

f) During the application of the priming coat, the primer of the container shall be stirred regularly.

g) During or after drying of the primer coat, the pipe shall be handled with care. All reasonable precautions shall be taken to prevent excessive dust deposition on primer pipe.

h) The freshly primed pipe shall be permitted to dry on racks until it is no longer wet, sticky or tacky. The dryness of the primer shall be checked at the bottom of the plate.

i) Pipes on which the primer after being applied becomes contaminated by dust before it is dry or which becomes dead shall be reprimed, or shall be re-cleaned and re-primed. In no case shall third application of primer be made without having removed all the previous coats. The cost of re-cleaning and re-priming shall be borne by the bidder.

5.04.00 Requirement of Pre-Fabricated Tape

5.04.01 Pre-fabricated tape shall conform to the following specification.

Compound	:	Plasticised coal tar base
Reinforcement	:	Synthetic substrate (FRP tissue reinforced with glass fibres).
Separator	:	Plastic
Thickness	:	Minimum 4.0 mm without any tolerance (in one or multiple layers)
Min. Weight	:	1.25 kg/sq.m/mm thickness.
Adhesion Test	:	It should pass as per AWWA-C-203-97 Section-4.6.8 or IS-10221-1982.
Holiday Test Voltage	:	It should pass @ 15 kV (Max.) for 4mm thickness.
Direct Impact Test	:	It should pass as per BIS.DOC.SMDC 29 (3624) and AWWA-C-203 and IS-10221.

Insoluble content in Petrol

as per (%by weight) IS-2796:1996 : 95% minimum

5.04.02 **Application of Pre-fabricated tape.**

a) The tape shall be hot applied.

b) The pipe line shall be thoroughly cleaned of all oil and grease by flushing with a suitable solvent such as gasoline or xylene (Kerosine will not be permitted)and wiping with clean rags. The solvent cleaning shall be as per SSPC-SP-1.

c) The degreased pipe surface shall be blast cleaned to SSPC-SP-10 with a steel brush to remove rust, oil, grease and old coating, if any, etc. The degree of cleanliness to be achieved shall be same as required in the case of conventional coat and wrap system.

d) Then the primer (pre-wrapping solution) shall be applied on the cleaned surface of the pipe with a brush in such a manner that it covers the pipe surface well.

e) When the primed pipe surface gets tacky but not DRY, the tape shall be applied spirally on the surface keeping proper tension and maintaining good adhesion with an overlap of 12/13 mm.

f) The inside layer of the tape shall be applied on the pipe, while the other surface of the tape (i.e. the substrate side having plastic separator) shall remain outside and face the surrounding atmosphere.

g) The tape while being unrolled shall be warmed up by a blow lamp or a gas flame - the surface to be applied on the pipe being heated. The heating shall be done just to soften the compound when a film shall appear on surface - Excessive heating is to be avoided.

h) Sufficient time (at least 48 hours) is to be allowed before undertaking adhesion test.

5.05.00 **Requirements of Coal Tar Enamel**

5.05.01 Preparation

I) The coal tar enamel, prior to being cut, shall have its surface freed from all contamination of whatever nature and shall be cut into pieces.

ii) Enamel shall be delivered to the heating kettles entirely free of all contaminants including, pieces of metal, wood, grass, leaves, sand or gravel.

5.05.02 Heating

i) The coal tar enamel shall be heated in the kettles provided in sufficient number to maintain a continuous supply of hot enamel. Kettles shall be of the mechanically agitated type.

ii) The kettles or patch pots shall be equipped with fuel oil, kerosene or gas burners.

iii) Kettles or patch pots from which enamel is drawn into the coating machine shall be introduction of, and inclusion, of other undesirable matter which will affect the application or the property of the coating. These strainers shall be located where they can be easily cleaned.

iv) Each kettle shall be equipped with an accurate easily readable thermometer.

v) While heating, flames from the burners shall be kept low until the enamel on the bottom of the kettle has melted and then agitators shall be started. The flames shall be increased gradually until about one half of the charge has been melted. Full heat shall then be applied until the optimum application temperature has been reached as per instructions of the MANUFACTURER of the enamel. The burners shall than be adjusted to maintain the optimum application temperature of enamel.

vi) Enamel in patch-pots shall be heated with the same care as described above.

vii) All enamel conveying lines shall be insulated or heated if required using suitable means to maintain the application temperature of coal tar enamel.

viii) The maximum temperature to which the enamel can be heated and the maximum time the enamel may be held in the kettles at application temperature shall be in accordance with the enamel manufacturer's recommendations.

ix) Coal tar enamel preparation and supply shall be as per AWWA-C-203-97.

5.05.03 Interruption

i) In the event of an interruption or short shut-down due to weather conditions or other unavoidable causes, the burner flames shall be decreased immediately. The temperature of the charge shall be reduced to approximately 40 degree C less than the application temperature until operation starts-up again. The kettle lids shall be kept tightly closed during

the shut-down period and the mechanical agitators kept in continuous operation. The enamel shall be drained into suitable clean containers.

ii) Care shall be exercised to ensure that the enamel in the mechanically agitated kettles is brought back to the optimum temperature before application is resumed. Enamel which has been previously heated to application temperature then drawn from the kettle or patch-pot may be reheated provided it has been kept clean.

5.05.04 Coating Of Straight Sections of Pipes (Coaltar Enamel, Inner Wraps and Outer wrap**)**

i) Enamel shall be applied by pouring on the revolving pipe and spreading to the specified thickness. Enamel shall be applied so that each spiral resulting from the spreading operation shall overlap the preceding spiral producing a continuous unbroken layer free from defects, skips or holidays. Operators shall be required to make all necessary adjustments to ensure a continuous layer of enamel without undue loss of temperature at point of application.

ii) Defects such as bubbling or foaming shall be a cause for shutting down operations until air pockets have been removed from pumps and supply lines and required adjustment have been completed.

iii) The first coat of coal tar enamel, glass-fibre mat shall be applied in a continuous end-feed machine, or in a lathe-type machine or by other suitable wrap-application equipment. The roll of glass-fibre mat shall be under tension sufficient to embed the mat in the enamel before the later sets or cools. The second coat of hot coal-tar enamel shall then be applied simultaneously with the second layer of glass-fibre mat in manner similar to the one described above. The impregnated outer wrap shall then be applied immediately behind the glass fibre reinforcement in a tight uniform spiral.

iv) The overlap at the edges of all wrappings shall be atleast 13 mm. The wrapper shall be applied neatly and smoothly with bleed out between laps and shall be free of wrinkler and buckles.

v) The coating shall be continuous for the full length of the pipe, however cut-back of maximum length of 225 $\pm$ 25 mm on each end of the line pipe shall be provided.

vi) When the protrusion of weld seam interferes with this thickness, the thickness of the coating above weld seam shall meet the requirements specified in AWWA-C-203-91.

5.05.05 Coating & Wrapping of Field Joints, Bends & Fittings

I) In general the procedure to be followed for surface preparation, priming and Coating & Wrapping shall be the same as that specified for straight sections of the pipe except that the application of the coal tar enamel & inner & outer wraps may be manual. However the total thickness of coating & wrapping of the field joints, bends& fittings shall not be less than that of the straight section of the pipe.

ii) At all the field erected joints, the overlap between the two pipe pieces or bends shall not be less than 50 mm.

5.05.06 White Wash

The final white wash coat over the outer wrap shall be applied immediately following final inspection and acceptance of the coating and wrapping on each pipe.

5.05.07 Materials

a) Primer

The primer shall be fast drying synthetic primer for cold application certified to meet AWWA-C-203.

b) Coal Tar Enamel

The coal tar enamel shall compose of a specially processed coal tar pitch combined with inert mineral filler. The coal tar enamel shall conform to AWWA-C-203. The enamel shall contain no asphalt of either petroleum or natural base.

c) Inner Wraps

The inner wrap glass fibre reinforcement material shall have a nominal thickness of 0.5 mm (0.020 inch) and shall conform to AWWA C-203. The glass fibre reinforcement material shall be reinforced in the longitudinal direction.

d) Outer Wrap

The outer wrap material shall be a coal tar impregnated asbestos felt or glass fibre felt. The material shall conform to the requirements of AWWAC-203-91 Section-2.4.

Samples of the proposed fibre glass reinforcement and impregnated outer wrap along with test certificates as per AWWA C-203 shall be submitted to the OWNER for approval prior to the start of the coating operations.

e) The white wash used as a final coat shall be manufactured in accordance with the "White Wash Formula" as specified in AWWA C-203, Section 2.6.

5.06.00 Inspection

In addition to the requirements specified in Sub-section III-E of Part-B of this Technical Specification, following shall also apply.

5.06.01 General

a) The Owner representative shall test the coating and any repair subsequently made to it. The testing shall be carried out at prior to laying of pipes in the trench.

b) Final acceptance of all coating and wrapping work shall be determined by Owner's representative Pipes which have been cleaned and primed or coated and wrapped without having been inspected and approved by the Owner's inspector shall be rejected.

5.06.02 Holiday Detection

a) All coated and wrapped pipes shall be subjected to a test with an electric holiday detector as specified in AWWA-C-203-97.

b) The holiday detector shall be supplied, correctly operated and always maintained in good working condition along with adequate supply of spare parts. Any delay caused by the incorrect functioning of the holiday detector will not be entertained.

c) The operating voltage of the detector shall be determined by NACE RP-02-74.

d) Any pipe having three (3) or more holidays shall be rejected. Similarly any pipe having any one holiday bigger than 0.1 square metres shall be rejected. Any defective places shall be plainly marked with chalk immediately after they are detected visually or by the holiday detector.

e) For pipe with pre-fabricated tape, the test voltage which the pipe should pass with holiday detector kit at voltage 15 kV for 4 mm thickness coating.

5.06.03 Measuring Coating Thickness

a) All pipes shall be tested for thickness as per AWWA-C-203-97.

b) The thickness shall be measured by pushing the point of an approved pit depth gauge or microtester through the coating and wrappers.

c) The specified minimum thickness shall be present both at the pipe or any other point.

5.06.04 Testing the adhesion of the coating

a) At least two tests a day shall be carried out on finished coating after 72 hours from completion of coating. The test shall be carried out as per AWWA-C-203-97 /IS 10221.

b) The areas where the coating has been removed for testing by the inspector shall be repaired by the Contractor at his own expense.

PAINTING SPECIFICATION TO BE FOLLOWED BY BIDDERS FOR COMPRESSED AIR SYSTEM

14.00.00 SPECIFICATION FOR SURFACE PREPARATION & PAINTING

14.01.00 Surface preparation methods and paint/primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified, specific approval shall be obtained by the contractor in writing from the employer for using the substitute material.

14.02.00 All paints shall be delivered to job site in manufacturers sealed containers. Each container shall be labelled by the manufacturer with the manuacturer's name, type of paint, batch number and colour.

14.03.00 Unless specified otherwise, paint shall not be applied to surfaces of insulation, surfaces of stainless steel/nickel/ copper/brass/ monel/ aluminum/ hastelloy/lead/ galvanized steel items, valve stem, pump rods, shafts, gauges, bearing and contact surfaces, lined or clad surfaces.

14.04.00 All pipelines shall be Colour coded for identification as per the NTPC Colour-coding scheme, which will be furnished to the contractor during detailed engineering..

14.05.00 SURFACE PREPARATION

14.05.01 All surfaces to be painted shall be thoroughly cleaned of oil, grease and other foreign matter. Surfaces shall be free of moisture and contamination from chemicals and solvents.

14.05.02 The following surface schemes are envisaged here. Depending upon requirement any one or a combination of these schemes may be used for surface preparation before application of primer.

	SP1	Solvent cleaning
	SP2	Application of rust converter (Ruskil or equivalent grade)
	SP3	Power tool cleaning
	SP4	Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer)
	SP4*	Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns
	SP5	Phosphating
	SP6	Emery sheet cleaning/Manual wire brush cleaning.

14.06.00 APPLICATION OF PRIMER/PAINT

14.06.01 The paint/primer manuacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.

14.06.02 Surfaces prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surfaces.

14.06.03 Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.

14.06.04 Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.

14.06.05 Following are the Primer/painting schemes envisaged herein:

PS3	-	Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104.
PS3*	-	Zinc Chrome primer (Alkyd base) by dip coat.
PS4	-	Synthetic Enamel (long oil alkyd) to IS2932.
PS5	-	Red oxide zinc phosphate to IS-12744.
PS9	-	Aluminum paint to IS 2339.
PS9*	-	Heat resistant Aluminum paint to IS-13183 Gr.-I (for temperature 400 ^{o}C - 600 ^{o}C) , IS-13183 Gr.-II (for temperature 200 ^{o}C - 400 ^{o}C) and IS-13183 Gr.-III (for temperature upto 200 ^{o}C)
PS13	-	Rust preventive fluid by spray, dip or brush.
PS14	-	weldable primer-Deoxaluminate or equivalent.
PS16	-	High Build Epoxy CDC mastic `15' .
PS17	-	Aliphatic Acrylic Polyurethane CDE134 ,%V=40.0(min.)
PS18	-	Epoxy based TiO2 pigmented coat
PS19	-	Epoxy based Zinc phosphate primer (92% zinc in dry film (min.), %VS=35.0(min.).
PS20	-	Epoxy based finish paint.

14.06.06 All weld edge preparation for site welding shall be applied with one coat of weldable primer.

14.06.07 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.

14.07.00 Primer/Painting Schedule

Sl.No	Description		Surface Preparation	Primer Coat			Intermediate Coat			Finish Coats			Total Min. Painting DFT (Microns)	Colour Shade
				System	Coat	Min. DFT / coat (Microns)	System	Coat	Min. DFT/ Coat (Microns)	System	Coat	Min. DFT/ Coat (Microns)		
1.	All **insulated** Pipings, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.		SP3/SP4	PS 9*	1	20	-	-	-	PS9*	1	20	40	As per NTPC Colour shade/ coding scheme
2.	All uninsulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.	Design temperature <60 °C	SP3/SP4	PS 5	2	25	-	-	-	PS 4	3 $	35 $	155 $	
		Design temperature 60 °C-200 °C	SP3/SP4	PS 9*	1	20				PS 9*	1	20	40	
		Design temperature > 200 °C	SP3/SP4	PS9*	1	20	-	-	-	PS9*	1	20	40	
3	Constant Load **Hanger** (CLH), Variable Load Hanger (VLH) and other supports		SP4*	PS19	1	40	-	-	-	PS17	1	30	70	
4.	**Valves**													

	Cast /Forged	Design temperature <60°C	SP1/SP2/ SP3	PS9	1	20				PS 9	1	20	40	
		Design temperature 60 °C-200 °C	SP1/SP2/ SP3	PS9*	1	20	-	-	-	PS9*	1	20	40	
		Design temperature > 200 °C	SP1/SP2/ SP3	PS9*	1	20				PS9*	1	20	40	
5.	All Structural Steel components	Outside TG building and in SG envelope	SP4*	Inorganic Ethyl Zinc Silicate	1	75	PS18	1	75	a))Epoxy coat b)Final coat of paint PS17	2 1	35 30	250	
		Within TG building	SP4*	-do-	1	35	PS18	1	35	a))Epoxy coat b)Final coat of paint PS17	2 1	25 30	150	
6.	Weld Edges		SP6 (Hand cleaning by wire brushing)	PS13 (Weldable primer)	1	25	-	-	-	-	-	-	-	

$ The first 2 finished coats (total min.DFT of 70 microns) shall be done at shop and the 3rd finish coat (min.DFT 35 Microns) shall be applied at site.