NTPC Limited

(A Government of India Enterprise)

LOT 1A PROJECTS

PART – B
(DETAILED TECHNICAL SPECIFICATION)

SUB-SECTION-I-M
(MECHANICAL SYSTEM)

SECTON – VI

TECHNICAL SPECIFICATION

FOR

FLUE GAS DESULPHURISATION (FGD)

SYSTEM PACKAGE

BIDDING DOCUMENT NO. : CS-0011-109(1A)-2

PART – B (DETAILED TECHNICAL SPECIFICATION)

SUB-SECTION-I-M (MECHANICAL SYSTEM)

SUB-SECTION-I-M1

FLUE GAS DESULPHURISATION SYSTEM

FLUE GAS DESULPHURIZATION (FGD) SYSTEM

1.00.00 GENERAL

The design/specifications/sizing of various plants/systems/equipment offered for Flue Gas Desulphurisation (FGD) System shall comply with the requirements detailed hereinafter:

1.01.00 **System Description**

The Flue Gas Desulphurisation (FGD) System shall be based on Wet Limestone Forced Oxidation process. The FGD system shall be installed downstream of the Induced Draft (ID) fans (Employer's scope).The flue gas shall be drawn from air preheater outlets of the balanced draft, pulverised coal fired Steam Generator and guided through adequately sized duct work into the specified number of independent gas streams of each Electrostatic Precipators. The flue gas after the Electrostatic Precipitators shall be led to the suction of the ID fans. The flue gas temperature may approach the economiser outlet temperature of about 300°C in case the regenerative airpreheaters fails to operate. The Contractor shall take this aspect into account while designing the Flue Gas Desulphurisation (FGD) System.

1.02.00 **Service Conditions**

The Steam Generators, being provided by Employer, are designed to burn pulverised coal having properties as indicated in Sub-section-II-A (Project Information), Part-A, Section-VI. Also HFO/HPS/LSHS and LDO shall be used during startup and at low loads for warm up and flame stabilization as specified in respective Project Information Chapter. The design of Steam Generator shall not call for any oil support for flame stabilization beyond 40 % BMCR load when firing any coal. Further, the frequency and duration for startup and low loads operation may be quite long during the first year of unit commissioning and operation. The Steam Generator has been designed for cyclic/two shift operation. Expected numbers of Steam Generator start-ups during 25 years of design life are as follows:

	Type of Starts	**Number of Starts**
a.	Hot start (after 8 hours of unit shut down)	**4000**
b.	Warm start (after 36 hours of unit shut down)	**1000**
c.	Cold start (after 72 hours of unit shut down)	**150**

The Contractor, shall take into account the entire characteristics of expected combination of fuels to be fired and the expected numbers of Steam Generator start-

ups while designing the FGD system.

1.03.00 **Design Criteria**

1.03.01 The Flue Gas Desulphurisation (FGD) System shall be designed to meet all the conditions specified above. Representative coal and ash analysis for the expected coal and oil are given in Sub-section-II-A (Project Information), Part-A, Section-VI for each project. The FGD system and all the associated auxiliaries shall be designed to comply with the requirements stipulated under 'Guarantee Point' and 'Design Point' conditions indicated in Sub-Section-V, Part-A, Section-VI of the Technical Specification for the respective projects. The values indicated for FGD sizing shall be considered as minimum design criteria. These shall be modified to more conservative values if Contractor experience warrants the same. However, no credit shall be given to the Contractor for this during evaluation of the bids. Utilization of these values in no way relieves the Contractor of his responsibility to meet all the guarantee requirements. The Contractor shall also furnish along with his offer the detailed calculations and data along with his Bid to establish as to how the Bidder will meet the efficiency requirements both at design and guarantee point as specified in FGD sizing criteria.

1.03.02 The FGD system shall be installed downstream of the ID fans and shall be based on wet Limestone Forced Oxidation Process. The FGD system shall be designed to achieve the required SO_2 capture without the use of oxalic acid or any other additives. The FGD System shall be designed so as to be in operation whenever the Steam Generator is in operation.

However, provision shall be made by the Contractor for facilitating operation of unit with emergency FGD bypass. This shall also facilitate the online maintenance of absorber system and associated equipment's. The arrangement of the flue gas system shall allow complete isolation of the absorber from the gas side, with the unit in operation. For this purpose. Motorized Guillotine type gates has be provided at (i) hot gas inlet to Booster Fans, (ii) Outlet of Booster Fans and (iii) in the bypass duct (common Flue Gas Duct going towards the existing Chimney). Further, Quick opening Bi-plane motorized/pneumatic damper along with 2x100% seal air fans shall be provided in the by-pass duct by the Contractor. The same shall also be taken into account while designing the control & logics for the FGD System.

1.03.03 The wet absorber system shall be designed to maintain the required SO_2 removal.

1.03.04 In order to be compatible to all possible modes of operation, the design of the FGD plant shall enable short start-up times, compatible with load changes in the Steam Generator and shall ensure reliable mode of continuous operation.

1.03.05 The flue gas desulphurization plant (FGD) shall be designed to be operated with limestone as specified in Sub-Section-V, Part-A, Section-VI of the Technical Specification.

1.03.06	The FGD and the ancillary facilities shall be suitable for unlimited operation with all transients and at any load point between the minimum and maximum load point of the Steam Generator. Further, the FGD plant shall be suitable for an unlimited operation at any pollutant concentrations between minimum and maximum without exceeding the emission values of SO_2 emission of less than 100 mg/Nm_3 (6% O_2 dry).
1.03.07	In case of failure of the SG and ancillary equipment, the FGD plant shall be brought automatically to the off-load operation without restriction by the current load case by suitable measures.
1.03.08	In case of a power failure all items of equipment (e.g. minimum one agitator in absorber and limestone slurry tank, flue gas damper upstream & downstream of FGD, Process water pump & lube oil system of Booster Fan & Ball Mill) which may cause irreversible damage to the FGD System shall be connected to the emergency power supply system to be provided by the Contractor. Bidder shall furnish a list of all such Auxiliaries in their bid proposal.
1.03.09	In case of shutdown and outage periods, draining and flushing of limestone slurry and gypsum slurry pipe work, tanks and all other items being in contact with limestone slurry or gypsum slurry shall be possible without restriction and without necessity of extensive or unusual preparation and activity. Draining and flushing which are required even during short time outages or an emergency shutdown shall be started automatically and by remote control from the Control Room.
1.03.10	AII items or equipment which are subject to wear, abrasion or failure (e.g. nozzles, pumps, pipe work, etc.) shall be designed and installed for easy replacement, repair and maintenance.
1.03.11	The design and the construction shall be performed so as to avoid stress corrosion cracking, galvanic or other types of corrosion. Especially when using two different alloys, appropriate measures shall be taken to avoid corrosion. This is subject to approval by the Employer.
1.03.12	All items of equipment including flue gas ducts, expansion joints, etc. shall be designed considering thermal and mechanical strength as a function of the maximum temperature which might occur in case of a failure of any upstream equipment.
1.03.13	Waste water which might be generated during flushing and cleaning procedures of the equipment (e.g. lime slurry bins, pipes, trucks, etc.) shall be collected in sump and shall possibly be reused in the wet absorber.
1.04.00	**Justification of Proposed Design**
1.04.01	All the design procedures, systems, and components proposed shall have already been adequately developed and have demonstrated good reliability under similar or more arduous conditions elsewhere.

1.04.02 The Bidder shall submit with the offer, comprehensive information on how the L/G ratio, mass balance, spray nozzle cone angle, spray nozzle arrangement, limestone consumption etc. of the proposed design has been arrived at. The Contractor shall also submit alongwith the offer, a detailed write up on the proposed design features with recent design modifications, if any, and their specific advantages over the previous designs.

1.05.00 **Statutory Approval**

The engineering, design, supply and installation of FGD system and the associated auxiliaries shall comply with the applicable safety code and regulation of the locality where the system is being installed.

1.06.00 **Location & Layout Requirements**

1.06.01 The Contractor shall offer the best design to accommodate the Flue Gas Desulphurisation (FGD) System and Lime stone & Gypsum handling & storage system within the confines of the space available. The location of FGD System and associated facilities shall be decided by the Bidder after visiting the Project site.

1.07.00 **Capital Overhaul of FGD System**

Employer envisages to carryout the capital overhaul of units once in three (3) years. The design and materials for various equipments/auxiliaries etc. shall be selected by the Contractor keeping in view the above requirement of the Employer, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.

1.08.00 **Maintenance**

1.08.01 The Contractor shall provide adequate handling facilities & approach as for carrying out on-line and off-line maintenance of the FGD system and its auxiliaries. In order to carry out on-line maintenance, it shall be possible to readily disassemble, repair and reassemble the equipment supplied in the shortest period.

1.09.00 **Noise level**

The equivalent weighted average of sound level measured at a distance of 1.5 m above floor level in each elevation and one meter horizontally from the base of any equipments furnished and installed under these specifications, expressed in decibel to a reference of 0.0002 microbar, shall not exceed 85 dB(A).

2.00.00 EQUIPMENTS AND SYSTEMS SPECIFICATIONS

Specified hereafter are the minimum acceptable functional requirements of the Employer, and all components, equipments and systems for the Flue Gas

Desulphurisation System shall be designed to cater to these requirements. Compliance to various stipulations of the Technical Specifications, functional requirements of Employer and utilization of various parameters and their values in the specification by the Contractor shall in no way relieve the Contractor of his responsibilities to meet all guarantee requirements or of providing completely safe and reliable operating equipment/systems.

The complete FGD system and the associated auxiliaries shall be designed by the standard industrial practices. The FGD system shall be designed to achieve the required SO_2 capture without the use of oxalic acid or any other additives. Only field proven materials for similar application shall be used for the system. The complete installation of liners shall be made under the supervision of the liner supplier as per their guidelines.In the execution of the welds contractor must ensure that welding material has same corrosion resistance as the actual plate surface.

Alloy to carbon steel welds must either be hidden behind a covering strip of alloy material, or be executed by a special welding procedure ensuring the same quality at the weld surface as the alloy lining. All welding which shall be in the contact with process fluids shall be executed under the supervision of the designer/manufacturer.

3.00.00 FLUE GAS SYSTEM

3.01.00 The entire flue gas system, flue gas ducts, absorber etc. shall be designed to meet the following conditions:

1.	Design internal pressure at 67% yield strength (mm wc)	+660 and -150 mmwc or maximum conceivable head of Booster fan (if provided), whichever is higher
2.	Design Inlet Gas Temperature (deg.C)	150
3.	Short temp excursion temperature of inlet gas (for approx. fifteen (15) minutes at a time) (deg. C)	300
4.	Inlet Dust Burden in Gas (mg/Nm3)	200
5.	Maximum flue gas velocity through the Absorber (M/sec)	Not more than 4 m/s at Design Point Conditions
6.	Recirculation Slurry pH	Not less than 5.5 under all operating conditions

3.02.00	**Design**
3.02.01	The flue gas ducts shall be sized and designed to meet all the criteria as specified in Cl. No 16.00.00 this subsection.
3.02.02	All ducts with operating temperature above 60^0C shall be insulated in accordance with cl. No. 17.00.00 of this sub section.
3.02.03	The duct layout shall ensure that there is no accumulation of acid mist on the duct floor.
3.02.04	The duct to Absorber inlet shall be made of Carbon steel of minimum 7mm thickness. The duct to Absorber inlet shall be made of Carbon steel of minimum 7mm thickness. The duct from Absorber outlet to bypass duct shall be made of Carbon steel of minimum 7mm thickness with 2 mm (minimum) thickness lining / cladding / wall paper of Alloy C276 / Alloy 59 or better material.
3.02.05	In addition to the base offer as described above, the bidder may also submit an alternate offer for a different material / lining of duct from Absorber outlet to stack, if the bidder has previous experience of the same. The bidder should have supplied a similar design of duct in previous installations for similar application. Bidder shall indicate the applicable price implication for such an alternate offer in the relevant Bid Proposal sheet. The Bidder shall also furnish details of the previous installations of such system and bring out all the technical features of the system proposed. Bidder to note that application of lining material in the ducts shall be carried out under the supervision of designer/manufacturer. Bidder to note that application of lining material in the duct shall be carried out under supervision of Designer/Manufacturer.
3.02.06	Wherever required, expansion joints of proven design shall be provided in the ducts to take care of differential expansion in the system. The material chosen for expansion joints shall suitable for the duty conditions and the corrosive atmosphere of the FGD system and shall be field proven for similar applications. The expansion joints shall be guaranteed for faultless material and workmanship, for a minimum guaranteed life of not less than 20000 hrs. of operation. During Guarantee period any defects noticed in the expansion-joints due to faulty material and workmanship shall be rectified by the Contractor free of cost.
3.02.07	The Contractor, shall take into account the entire characteristics of expected combination of fuels to be fired, for the complete load range of operation and the expected numbers of Steam Generator start-ups while designing the Chimney flue liner. The chimney flue liner cladding shall be made of 2 mm thick Titanium (Grade 2 as per ASME SB265) or C-276 alloy over 8 mm thick (minimum) mild steel base metal of flue liner. Cladding shall be done to achieve the required quality as per ASTM B 898-11. External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm thick Titanium / C-276 sheet over insulation.

The stack shall be designed as per the latest guidelines of EPRI Wet Stack Design Guide. The design of wet ducts and stacks system shall consider the Stack liquid discharge (SLD), Corrosion/chemical attack, Condensate collection system and its drainage etc.

3.03.00 Gates & Dampers

3.03.01 The arrangement of the flue gas system shall allow complete isolation of the absorber from the gas side, with the unit in operation. Guillotine gate type damper shall be provided by the Contractor before the suction of each Booster fan. A gas tight, motor operated Guillotine gate shall be provided by the Contractor at the outlet of each Booster fan. A gas tight, motor operated Guillotine gate shall be provided by the Contractor in the bypass duct (flue gas duct connecting the existing chimney).

3.03.02 All gates/dampers shall be designed to withstand the operating flue gas temperature without distortion.

3.03.03 There shall not be any backlash, play, etc. with linkage mechanism, actuator and final control element.

3.03.04 Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

3.03.05 Outlet dampers of seal air fans shall be pneumatically operated, suitable for remote manual operation.

3.03.06 All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves.

3.03.07 A quick acting biplane damper shall be provided by the Contractor in the bypass duct (flue gas duct connecting the existing chimney) for quick opening to allow bypass to come into operation in case of emergency. The damper shall be capable of quick opening during emergency conditions within a time of 10-20 secs. Bidder should indicate the required opening time for bypass damper for emergency operating condition.

3.03.08 All the gates shall be designed for tight shut off. The Guillotine gate type dampers mentioned at Clause No. 3.03.01 above shall have a guaranteed gas tightness efficiency (on flow) of not less than 99.95% along the duct as well as from the duct to atmosphere or from atmosphere to the duct, depending on the pressure in both the damper open and damper closed condition without the use of seal air fans of the damper. The bypass damper shall have a guaranteed gas tightness efficiency (on flow) of not less than 99.5% and 100% leak tight with seal air fans under operation. The gas tightness shall be demonstrated at shop for minimum one type of damper of each type and size.

3.03.09 The dampers shall be pneumatically operated and controlled from the control room. Provision shall be made for giving signal automatic bypass controls of the absorber in case of failure of the absorber spray system or the GGH. The dampers shall have provision for manual operation, through a hand wheel. The force required for manual operation of the gate shall not exceed 35 kg (max.) at the rim of the hand wheel.

3.03.10 The isolating gates shall be provided with locking devices to permit locking in fully closed position.

3.03.11 **Pressurization Fans:**

a) All gates shall be provided with 2x100% pressurization fans to achieve 100% sealing efficiency.

b) The location and scheme for pressurization system shall be subject to Employer's approval.

3.03.12 All gates shall be designed to withstand the operating air and flue gas temperature without distortion.

3.03.13 All guillotine gates shall be located in horizontal duct to avoid fly ash build up when in closed position and shall be of top entry type.

4.00.00 BOOSTER FAN:

4.01.00 The Booster Fans shall be located downstream of the ID Fans (Induced Draft Fans) in the inlet duct to Absorber shall be capable of handling the pressure drop in the FGD system & ducting and wet stack of 150 m height also considering the exit loss from wet stack over the entire load range with any one or both Booster fans in operation in conjunction with one or both ID fan in operation while firing the specified range of fuels. Additionally a pressure loss of 100 mm wcl (excluding margin) shall be built up in booster fan design criteria as mentioned below to take care of pressure loss due to future installation of De-Nox system.

Booster Fans shall be sized such that they satisfy the criteria stipulated below.

4.01.01

S.N.	Description	Booster Fan
1	Type of fans	Constant speed, axial type.
2	No. of fans per unit	Two
3	Fan sizing criteria with all the following conditions occurring together :	Booster Fan to be sized for one (1) Booster Fan stream in operation taking into account following factors occurring

			together:
	(i)	Flue Gas Flow through fan	920 m^3/sec for all 800 MW units 724 m^3/sec for 660 MW units of Mouda, Tanda , Nabinagar STPP & Barh-I 802 m^3/sec for 660 MW units of Meja 893 m^3/sec for 660 MW units of Solapur 297 m^3/sec for 250 MW units of Nabinagar TPP
	(ii)	Power supply frequency	47.5 Hz
	(iii)	Pressure at Booster Fan suction	0 mmWc
	(iv)	Gas temperature (degree Celsius)	150
4.02.00	The fans shall also fulfill following sizing criteria in addition to those mentioned at clause 4.02.01 above		Each fan to be sized with following conditions occurring together.
	(i)	No. of fans in operation	2
	(ii)	Flue gas flow through each fan	727 m^3/sec for all 800 MW units 600 m^3/sec for 660 MW units of Mouda, Tanda , Nabinagar & Barh-I 645 m^3/sec for 660 MW units

			of Meja 678 m^3/sec for 660 MW units of Solapur 237 m^3/sec for 250 MW units of Nabinagar TPP
	(iii)	Margin over flow	20%
	(iv)	Margin over pressure requirement	44% over the calculated value
	(v)	Power supply frequency	50 Hz
	(vi)	Pressure at Booster Fan suction	0 mmWc
	(viii)	Gas temperature (degree Celsius)	150
	(viii)	Flue gas control	Blade pitch control

Note to 4.02.01 & 4.02.02: Booster fan shall have a minimum stall margin of 10% over the Design duty points.

4.02.01 Both fans shall operate with highest possible efficiency which shall be nearly equal at the Guarantee point flow and test block points.

4.03.00 Fan components along with servo/blade pitch control mechanism shall be designed to withstand and continuously operate with the maximum air or flue gas temperature that these fans will be required to handle. Fan component shall also be designed to withstand the excursions in flue gas temperature up to 300 degree Celsius, which may persist for about 30 minute duration. Such temperature excursion will not inhibit the safe and smooth operation of fans or cause any damage or increased maintenance.

4.04.00 The construction of Booster fans shall also comply with following requirements

DESCRIPTION	Booster Fans
Type of fan blades	stream lined, aerofoil shaped section
Blade material	Nodular Cast Iron or High Wear Resistant Steel with or without Hard coating as per the proven practice of the fan manufacturer
Fan rotational speed	600 rpm (max.)
Air/Flue gas flow	blade pitch control
Fan critical speed	not less than 125% of fan maximum operating speed
Fan component design*	to withstand torsional stresses three (3) times the normal full load motor torque at all speeds
Fan casing material thickness	Abrasion and wear resistant, high BHN steel having minimum 8.0mm thickness or 12mm mild steel with liner of thickness 10mm (min.)
Fan Housing design	for shut off head of fan

*Note :

(a) Contractor shall submit detailed calculations, for Employer's approval, to confirm compliance with above requirements for all fan components, specifically for fan shafts, impeller hubs and impeller as a whole. Areas of high stress concentration and residual stresses, like welded attachments shall be avoided on the fan rotor/shafts. Combined static, dynamic as well as residual stresses shall be demonstrated to be within allowable limits. These fan components shall last the life of the plant with such combined stresses present in them.

(b) Although employer envisages to install highly efficient electrostatic precipitator to control particulate emission, however. Bidder shall select the Booster fan components such as blades, hubs, casing etc. to encounter the high dust burden of the order of 250 mg/Nm^3. The minimum wear life of Booster fan components shall not be less than 25000 hours of operation from the date of commissioning.

4.05.00 **Fan Bearings**

(a) Bearing shall be provided with oil bath to prevent damage in case of complete loss of plant auxiliary power when the fans must coast down

without power.

(b) Size oil reservoir in bearings housing for maintaining lubrication for extended periods in case of oil circulation system is out of service.

(c) Cooling air circulation to be provided across main bearing

(d) Adequte numbers of duplex Pt-RTD (100 ohm at 0 degree Celsius) and temperature indicator shall be provided for each bearing. Local as well as remote monitoring features shall be provided.

(e) For mounting of vibration pads/pickups, flat surfaces shall be provided both in X and Y directions, by the Contractor on the bearing housing.

4.06.00 **Fan balancing**

(a) The fans shall be statically and dynamically balanced before shipment.

(b) Balancing of each fan shall be checked and adjusted at site, if necessary.

(c) Natural frequency of all fan components shall be established by vibration testing to ensure that no part of the wheel is adversely excited by any force generated at operating speeds.

(d) The fan blade shall be subjected to natural frequency test. The other components of fan wheels need not be subjected to natural frequency test if supplier can prove that these component are very rigid and have very high natural frequency compared to the operating frequency of respective fans giving justification.

4.07.00 Booster fans shall meet following operational requirements.

	Description	**Booster Fans**
(a)	Mode of operation	i) two fans in parallel.
		ii) one fan (one stream in operation)
(b)	Fan control system	i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner
		ii) The final control element shall not have any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Boiler MCR

(c) Vibration — For mounting of vibration pads/pickups (in the Employer's scope) flat surfaces shall be provided, both in X & Y directions, by the Contractor on the bearing housing in such a way,so that welding/screwing of the pads shall be possible.

(d) Bearingmetal temperature monitoring — Shall be possible from remote as well as locally, using atleast 2 nos. of duplex platinum RTD's (100 ohms at0 deg. C) per bearing

4.08.00 The fans shall be suitable for parallel operation and sharing the load capacity over the entire range of operation without hunting. Pulsation shall be avoided by suitable design of fans and

4.09.00 **Fan Casing :**

(a) The fan casing shall be split to provide easy removal of the fan hub/impeller for replacement and repairs.

(b) The sections shall have gasket joints to ensure airtight sealing.

(c) Access doors shall be provided in each suction chamber casing and diffuser.

4.10.00 **Drain Connection:**

Drain connections shall be provided at bottom most point of the fan housing to the nearest trench.

5.00.00 ABSORBER

The unit shall be provided with an independent/dedicated absorber.

5.01.00 The contractor may offer either a spray type absorber, with single or multiple levels of spray, or an absorber with gas bubbling through the slurry, as per Bidders/Colaborator's proven practice. Only proven system in successful operation in previous installations supplied by the contractor shall be offered.

A Spray System (if offered)

(i) The contractor shall provide spray system and minimum spray levels required to meet the stipulated guarantee and design requirement. The spray system (including slurry recirculation pump & nozzles) shall be sized to achieve a desired L/G ratio required to meet the guarantees SO_2 removal efficiency, with redundancies specified

under this clause.

(ii) In case the contractor offers an absorber with multiple levels of spray nozzles, each spray level shall be provided with independent 2x100% pumps. Alternatively, the contractor may offer a spare spray level with each spray level served by an independent 100% capacity pump. In case the contractor offers a single level of spray, one number of standby pump of the same capacity & head as the working slurry recirculation pumps shall be provided. The contractor shall provide spray system / spray levels only as per his proven practice, which should be in successful operation elsewhere.

(iii) The slurry recirculation pumps shall have a minimum margin of 10% on flow and 10% on frictional head, over the actual requirement for meeting the guarantee and design point conditions. All slurry recirculation pumps including motors shall be of the same size and type.

(iv) The slurry recirculation pumps shall have motor driven knife gate valve at pump suction and discharge side.

(v) The slurry recirculation pumps shall be wear-resistant and equipped with flushing devices to prevent sedimentation and shall be designed and installed in a manner to allow easy replacements, repair and maintenance. The slurry recirculation pumps shall be equipped with oil level indication, coupling guard and collecting equipment for leakage, made of resistant material. Single mechanical seals with automatic flushing with a connection for additional manual flushing shall be provided.

(iv) The slurry pumps shall also comply with the requirements stipulated in Clause 8.00.00 of this sub-section.

(v) Sufficient redundancy, as per the proven practice of the contractor, shall be provided in the spray nozzles. Minimum 10% spare nozzles shall be provided at each level.

B Bubbling Type Absorber

(i) In case the bidder offers an absorber with gas bubbling through the slurry, the complete gas distribution system to the slurry shall be in bidder's scope. No re-circulating pump and spray header and nozzles shall be required in such case. However, 2x 100% Cooling Pumps instead of Slurry Recirculation shall be provided. The spray headers & piping for cooling pump discharge shall be made of Alloy 59 or C276 and nozzles shall be made of Silicon Carbide or ceramic or equivalent having a minimum guaranteed life of 20,000 hrs. The Cooling Pumps shall be installed inside a building.

The sparger and gas riser tubes shall be made proven material which shall have a minimum life of 5 years.

Minimum 10% redundancy, shall be provided in the Sparger Tubes.

5.02.00 Absorber Recirculation Tank

Sufficient number of agitators, as per the proven practice of the contractor, shall be provided for thorough mixing of the re-circulating slurry. In case the Contractor's Absorber includes side entry agitators, the contractor shall offer and demonstrate mixing arrangement such that n-1 number of agitators are sufficient to avoid the slurry settlement in the absorber tank in case of one agitator under breakdown (n-total no. of working agitators). In case vertical agitators in Absorber are offered, one complete mechanical assembly of agitator shall be supplied as warehouse spare for each Absorber.

5.03.00 Absorber Oxidation Systems

5.03.01 The contractor may offer either a grid type oxidation system or a sparge jet oxidation system or lance type or air rotary sparge system or jet air sparger system for oxidation of sulfite sludge to sulfates, or any other proven system as per the practice of the FGD vendor.

5.03.02 The oxygen required for oxidation shall be supplied by 2x100% oxidation air blowers for each absorber. The compressor/blower shall be sized to supply at least 2.5 times the stoichiometric air requirement for spray tower process & at least 4.0 times the stoichiometric air requirement for Bubbling Type process or the actual requirement, whichever is higher, under the following condition, all occurring simultaneously. The natural oxidation of sulfite by residual oxygen in flue gas shall not be considered for this purpose.

Load	**Design point Flow**
Flow	Minimum 2.5 times for spray tower process & 4.0 for Bubbling Type process the stoichiometric requirement
Head	For spray tower process actual requirement considering choking/ blockage of minimum 10% of the oxidation nozzles / sprayers or minimum 8500 mmwc whichever is higher. For Bubbling Type process actual requirement considering choking/ blockage of minimum 10% of the oxidation nozzles / sprayers or minimum 3500 mmwc

whichever is higher.

Margin on Head	10% under above conditions.
Ambient Conditions	45ºC / 60% RH.

5.03.03 Oxidation nozzles / spargers shall have a minimum redundancy of 10% or as per the contractor's proven practice whichever is maximum.

5.03.04 The oxidation system shall be complete with a quenching system to cool down heated oxidation air in order to prevent any scaling or buildup that could occur at the sparger tips due to localized evaporation of recycled slurry.

5.04.00 Gypsum Bleed Pump

Each absorber shall be provided with 2x100% Gypsum Bleed Pumps for supply of gypsum slurry to Gypsum Dewatering system. Each Gypsum bleed pump shall be sized to bleed-off the gypsum slurry from the absorber with slurry solid concentration not exceeding 30%, under the following conditions, all occurring simultaneously:

Load	Design point
Flow	100% of gypsum produced at Design point condition
Head	As per system requirement
Margins	Flow -- 15% Head – 20%

The pumps shall be designed to meet the stipulations of Clause No.9.00.00 of this Sub-Section.

Provision shall also be provide in the Gypsum Bleed Pumping system by provision of tap off, valves etc. for pumping the gypsum bleed to alternate source.

5.05.00 Emergency Spray System

An emergency cooling system for automatic spray of quenching water for a sufficient time (minimum 15 min) at the inlet to the absorber, in case the gas temperature exceeds the design temperature due to failure of upstream equipment's shall be provided to protect the FGD and all other sensitive downstream equipment against high flue gas temperatures. The water shall be supplied from an elevated tank (emergency water tank) installed near to the absorber. The tank volume and the

injection lances/nozzles shall be designed to protect the inlet duct and the lining of the absorber. The inlet duct shall be sloped towards the absorber.

5.06.00 Design

5.06.01 The design and arrangement of the absorber shall be field proven for successful long-term operation in conjunction with a coal fired power plant.

5.06.02 The design of flue gas ducts and inlet and outlet hoods of the FGD as well as guide vanes and baffle plates shall ensure a homogeneous flue gas flow with respect to the distributions of:
(i) temperature
(ii) velocity
(iii) dust content
(iv) slurry injection and distribution.

The above shall be proven by two phase Computational Fluid Dynamics simulations (liquid and gas). The scope of modelling shall include flue gas path inside the absorber vessel including inlet and outlet duct. Homogeneity shall be ensured, if the deviation from average is less than $\pm$10%. Further, in the Absorber outlet hood no internals such as guide vanes and baffle plates shall be allowed.

5.06.03 The fabrication of the absorber vessel shall follow common practice as there shall be no longitudinal seams located behind any attachment or obstruction which would prevent inspection of the welds. Nozzles, access ways, and their reinforcements shall not be located in or on any seam. Inaccessible gaps or hollow beams shall be avoided.

5.06.04 The absorber shell shall be designed for pressure loads, piping forces and moments, wind and seismic loads and all other loads imposed on the absorber. Bracing and reinforcement shall be adequate to prevent deflection and vibration. Internal supports for mist eliminator sections, etc. shall be designed to withstand the flooded weight of the supported section. The absorber and its structural supports shall be designed for the maximum operating loads including design positive & negative internal pressure, static head, external attachment loads (such as exerted by piping) wind load using the allowable stresses permitted by the applied standards.

5.06.05 It shall be possible to reach the SO_2 emission guarantees, at Guarantee point condition, with at least one spray level continuously out of service (in case the absorber is equipped with several spray levels) or one spare pump continuously out of service.

5.06.06 Three stage chevron type Mist Eliminators (ME) made of polysulfone or stainless steel shall be provided at the exit of the absorber. Provision shall be made for continuous washing of both ends of the first & second stage and the front section of the third stage of mist eliminators. Wash water arrangement shall also be provided at the back end of the second stage of mist eliminator. If the mist eliminator washing system is designed for cyclic washing of different sections, all the valves required for cycling shall be motorized or pneumatically operated. The automatic valve for the spray system shall be easily accessible on a platforms close to the mist eliminator.

Entrained slurry shall be collected by mist eliminators downstream of the slurry spray system to avoid carry-over of slurry to the stack.

The ME system shall be equipped with washing and drain provisions, where drains are directed into the absorber. Washing provisions shall include external and internal piping systems with replaceable nozzles, water pressure booster pumps (if required) complete with all piping, valves, instrumentation and controls. The mist eliminator wash piping/header shall be constructed of rubber lined carbon steel or glass fiber reinforced plastics. Polypropylene or PVC is also acceptable for mist eliminator wash headers provided Contractor or its Collaborator has proven experience for the same. Ease of replace ability and placement of the mist eliminator on maintenance platforms is an important requirement. The ME shall be designed to allow for efficient cleaning in process. Test ports shall be provided downstream of the mist eliminator to enable performance testing.

The mist eliminator system shall be capable of withstanding high velocity spray water jets typically employed during manual cleanings. The ME shall be constructed in individual cells. The design shall safely avoid ME vibration and/or humming. The individual cells shall be sized so that no more than two maintenance personnel are needed to handle them manually when they are fully scaled or plugged, and the cells shall be capable of passing through the access doors for the mist elimination section. Easy access for placement and replacement of the mist eliminator shall be incorporated in the design of the mist eliminator arrangement and the absorber vessel.

Walkways shall be arranged and also measures shall be taken as appropriate to permit the internal components to be disassembled and reassembled during repairs without the necessity for time-consuming preparatory work. The headroom shall have a height of more than 2200 mm. The mist eliminator support beams shall be designed to act as maintenance walkways approximately 300 mm wide and shall allow for a minimum 500 Kg/m2 load. The support beam/walkways shall provide personnel access to all mist eliminator modules, wash headers and wash nozzles.

Adequate number of viewing ports with flushing devices connected to automatically operating washing system shall be delivered at following locations:

(i) upstream of 1st stage
(ii) between 1st and 2nd stage
(iii) downstream of 2nd stage.
(iv) downstream of 3rd stage

The regular flushing shall be done in a defined time sequence.

5.06.07 The absorber oxidation tank shall be provided with an over flow line (for spray tower process) complete with sealing pot, over flow and drain line. The absorber over flow shall be taken to a sump in the absorber region, from where the slurry shall be pumped back to the absorber by a sump pump.

5.06.08 Materials used shall be suitable for the chemistry of the absorber process and resist abrasion from any particulate contained in the incoming flue gas and from the

	particulate of desulphurization process.
5.06.09	All equipment located in the gas path or connected to such equipment shall be designed to withstand the maximum inlet gas temperature fluctuations. There shall be no damage whatsoever to any equipment as a result of these fluctuations.
5.06.10	The raw gas inlet duct of the absorber shall be equipped with a flushing device of the side walls and the ground, which shall operate continuously as well as intermittently.
5.06.11	The absorber vessel shall be made of minimum 7 mm thick carbon steel. The absorber oxidation tank, absorber tower & absorber outlet duct shall be provided with 2 mm (minimum) thickness lining / cladding / wall paper of Alloy C276 / Alloy 59 or better material.
5.06.12	The material of process equipments of flue gas desulphurization system shall be appropriate for the chloride content and pH level at which the process is to operate.
5.06.13	All internal members shall be lined with minimum 2 mm Alloy 59/ C276 . All metallic fasteners which are provided inside the absorber/absorber wet-dry interface ducting shall be of Alloy 59/ C276.
5.06.14	The absorber wet-dry interface shall be made of solid Alloy 59 or C276 of minimum 6 mm thickness.
5.06.15	The other bridges (supports) shall be lined with minimum 2 mm Alloy 59/ C276.
5.06.16	Lining material and technical application requirements shall be furnished by manufacturer experienced with similar FGD plants. Proof of such experience shall be provided by the Contractor.
5.06.17	The spray headers (if provided) and air supply headers shall be made of FRP or Carbon Steel with rubber lining (minimum 10 mm natural rubber lining), corrosions and erosion resistant in the inner and outer side (Silicon Carbide coating on metal/FRP surface exposed to slurry). Optionally ceramic coating is also acceptable provided bidder/Collaborator has proven experience for the same. The slurry spraying system shall be made of material resistant to erosion and corrosion. During the lifetime of the plant, only the nozzles shall be replaced. The distribution system of the slurry shall be hydraulically optimized. The spray nozzles shall be of silicon carbide or ceramic or equivalent having a minimum guaranteed life of 20,000 hrs. The design of the spray nozzles shall be such that rapid wear, encrustation and plugging are avoided. Nozzle pipes and slurry spray nozzles shall be with bolted flanged connections. Nozzle pipes shall be installed easily to be removed partially through absorber modules.
5.06.18	In case the absorber is equipped with several spray levels they shall be designed as follows:

(i) The last spray level upstream the mist eliminator shall be operated only in counter-flow.
(ii) Depositions at downstream spray level and mist eliminator by co-flow injection of slurry shall be avoided.
(iii) The spray lances shall be equipped with bars for installation of scaffolding without any offset. The spray levels shall be designed for a load of min. 500 kgf/m^2.
(iv) A flushing device of the spray levels with water shall be installed. Flushing shall take place if spray levels are out of operation.

5.06.18 The absorber shall be self-supported from the bottom to suit site conditions. Absorbers which are externally supported from the structure are also acceptable provided Bidder or its Technology Collaborator has proven experience of supplying such Absorbers which are operating for more than 5 years. The absorber shall have adequate stiffening arrangement on the external side. Internal stiffeners shall be used only where it is not possible to provide proper external stiffening with approval of employer.

5.06.19 It should be possible to build platforms inside the absorber for access to all parts of the absorber during maintenance. In case the contractor offers a multiple spray level design, minimum distance of 1.5 m shall be maintained between individual spray levels. Arrangement shall be properly designed to facilitate access for maintenance and replacement of spray nozzles.

5.06.20 The spray piping, mist eliminators and its supporting structure shall be designed to carry sufficient load during maintenance.

5.06.21 The bottom of the absorber sump shall be designed so that there will be **an** easy entrance for a man with a wheelbarrow. Therefore the arrangement and dimensions of the inspection door of the absorber at ground level shall be designed to allow for this. The bottom of the absorber sump shall be designed in such a way that complete drainage of the absorption liquid/slurry is possible and is accessible without damage of lining/rubber.

5.06.22 In case of Spray Tower System, Suction screens shall be installed inside the Absorber vessel to protect the Slurry recirculation pumps. In case Bubbling type, suction strainers shall be installed at the suction side of Gas Cooling Pumps. For the agitators a flushing system for start ups shall be provided.

5.06.23 It should be possible to discharge the absorber sump into the emergency drain tank within 2 hours.

5.06.24 At the head of the absorber two manholes shall be provided to reduce the draught of the stack during outage.

5.06.24 Equipment's required for internal & external inspection shall be furnished by the contractor in brand new condition. List of all such items shall be furnished along with the Bid. The formation of agglomeration, deposition & caking shall be avoided. For

areas, where this might occur, (e.g. mist eliminators, spray levels) the Contractor shall submit a cleaning procedure including the required safety measures as part of the inspection concept.

6.00.00 LIMESTONE GRINDING AND SLURRY PREPARATION SYSTEM

6.01.00 Type

A common limestone and slurry preparation system is envisaged for each project. Contractor shall supply wet limestone grinding and slurry preparation system complete with all auxiliaries and slurry storage tank of proven design.

6.02.00 Limestone Silo:

6.02.01 The Contractor shall provide 2X100% Limestone storage silos each silo having minimum 24 hours storage capacity equivalent to the requirements of FGD system of all the units operating at Design point. The storage silo shall be complete with supporting steel structure, platforms, staircase, air canons power operated gates, gravimetric feeders, level switches, air relief devices, etc..

6.02.02 The storage silos and hopper cones shall be fabricated of minimum 10 mm thick carbon steel with a SS lining of grade SS304 of minimum 4 mm thickness in the complete cones to ensure reliable discharge of material. The design of storage silos shall confirm to IS 9178 (Part 1 to 3). The storage silo shall be capable of feeding the limestone by means of gravimetric feeder to the wet ball mills. The top of the unloading hopper shall be equipped with a grate to protect the downstream equipment from gravel lumps or tramp waste.

6.02.03 Each Silo shall be provided with sufficient no. of level transmitters.

6.02.04 Each silo shall be provided with minimum 3nos. of air canons at necessary location, capable of removing the jamming/clogging/blockage in the silos.

6.02.05 For dust free operation each silo should be provided with a covering arrangement and a self cleaning bag filter system of suitable capacity containing blower, automatic/on-load cleaning system, etc.

6.02.06 For each silo facilities shall be provided for unloading the bunker, through feeder, to a truck at ground level, along with all necessary chutes and diversion chutes.

6.02.07 Lime stone silo with hopper may be fabricated at factory in segments, transported and welded at site.

6.03.00 Bunker Shut-off Gates

6.03.01 A bunker outlet chute shall be provided for feeding limestone from bunker to the feeder. The size of the opening chute shall be sufficient to ensure proper flow of the limestone. There shall be no reduction of section in the bunker outlet chute from

bunker to feeder. The inlet chute shall be provided with suitable poke doors/holes in order to remove jamming/blockage. A motorized bunker shut-off gate shall be provided at the inlet to each feeder.

6.03.02 All parts of the gate in contact with limestone shall be of stainless steel construction.

6.03.03 The shut-off gates and its actuator shall ensure 100% closing of the gate even with 'bunker full of limestone'.

6.03.04 Facility shall be provided to open/close the bunker outlet gate, through actuator, from remote as well as local.

6.03.05 In addition, a hand wheel with proper access shall also be provided for manual operation of the gate. The force at the rim of the hand wheel shall not exceed 35 kg with bunker full of coal.

6.03.06 For each bunker facilities shall be provided for unloading the bunker, through feeder, to a truck at ground level, along with all necessary chutes and diversion chutes.

6.04.00 Gravimetric Feeders

6.04.01 Gravimetric feeders shall be sized to meet 110% of the maximum mill capacity.

6.04.02 The limestone feeder belt shall be of seamless rubber construction. It should be possible to adjust the belt tension from outside without opening the feeder body.

6.04.03 All parts in contact with limestone except belt shall be of stainless steel construction.

6.04.04 The feeder shall have adequate instrumentation to detect `loss of flow'.

6.04.05 The feeder shall have a motor/pneumatic operated gate at the outlet.

6.05.00 Wet Ball Mill

6.05.01 There shall be 2X100% tube mills for grinding of limestone. Each mill shall be sized to meet 110% of the maximum limestone requirement of all the units in a project operating under the following conditions, all occurring together.

(i)	Load	Design point flow
(ii)	Flow	110% of limestone requirement of two absorbers at Design point
(iii)	Input Limestone Size	1" (max.)
(iv)	Output Fineness	Output Fineness 90% or higher (as per the requirement of absorber) through 325 mesh (for spray tower process) OR 90% or higher (as per

	the requirement of the absorber) through 200 mesh (for bubbling process)
	(v) Mill Wear Part Conditions — Near Guaranteed Wear Part Life.
	(vi) Limestone bond index(kWh/sh.T) — 13 (min)
6.05.02	All integral auxiliaries of the mills like hydro-cyclones, separator tank & mill circuit pumps shall be sized to meet the above conditions. A 100% stand-by pump shall be provided for the mill circuit pump.
6.05.03	The mill hydro-cyclone set shall have sufficient redundancy. A minimum 10% spare hydro-cyclone shall be provided in each set of hydro-cyclone. Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose. The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The hydro-cyclone shall be provided with replaceable rubber lining of thickness 12 mm for the feed chamber and 12 mm for the overflow launder.. The liners shall have a minimum wear life of not less than 7000 hrs.
6.05.04	All parts of the mill including mill body, trunnion, hydro-cyclones, integral pipes, mill circuit pumps and other parts in contact with limestone slurry shall be provided with replaceable rubber wear liners. The wear liners or wear parts shall have a minimum guaranteed wear life of not less than 8000 hrs without reversal of the liners. The guaranteed capacity and fineness of the mill shall not be affected within the guaranteed life of the mil wear parts.
6.05.05	The material of the balls shall be chosen to ensure that the balls do not lose their original shape and to ensure minimum ball consumption. The contractor shall also guarantee ball consumption per ton of limestone throughput. The contractor shall furnish the minimum ball diameter below which the balls shall be replaced.
6.05.06	Facility shall be provided for on-load loading of steel balls to the mill.
6.05.07	The ball mill shall be driven by a motor through a peripheral gear/ central drive system. An auxiliary motor shall also be provided for inching of mills after trip and during maintenance.
6.05.08	The lube oil system shall have 100% stand-by arrangement for lube oil pumps and oil coolers of each circuit with independent pump / cooler. Wherever required duplex oil filters shall be provided.
6.05.09	The mill auxiliaries like separator tanks, mill circuit pump, hydro-cyclones and all connecting pipes handling limestone slurry shall have replaceable rubber linings.

6.06.00 Limestone Slurry Preparation / Storage Tank

6.06.01 The contractor shall provide two (2 nos.) slurry storage tank, common for all mills. Each tank shall be sized to meet 12 hours continuous limestone requirement of all the units operating at Design point. For tank volume calculation, solid concentration (by weight) in the slurry shall be assumed, not more than 20% or actual required whichever is lower.

6.06.02 The storage tanks shall be equipped with sufficient number of agitators, to avoid settling of limestone, as per the proven practice of the supplier. The agitators shall be designed to meet the requirements stipulated in Cl. No. 11.00.00 of this Sub-Section.

6.06.03 The limestone mill circulation tanks shall be installed indoor beneath the hydro cyclone stations. The slurry storage tank shall be located outdoor.

6.06.04 The slurry preparation tank shall be CS construction with replaceable chlorobutyl/bromobutyl rubber lining of minimum 5 mm thickness.

6.07.00 Limestone Slurry Supply Pumps & Piping

6.07.01 2x100% centrifugal type limestone slurry pump shall be provided for each unit. Each limestone slurry pump shall be sized to supply the limestone requirement of one (1 no.) unit, under the following conditions all occurring together.

(i)	Load	Design point
(ii)	Flow	110% of one absorber requirement with the limestone requirement at Design point.
(iii)	Head	As per system requirement.
(iv)	Margins	Flow 10% (minimum) Heads 15% (minimum)
(v)	Solids Concentration	Max. 30% by weight or actual as per suppliers practice, whichever is minimum.

6.07.02 The limestone slurry pumps shall be designed to meet the requirements stipulated in Cl. No.8.00.00. of this Sub-Section.

6.07.03 The limestone slurry pipes shall be sized to minimize erosion and avoid settling of the limestone at part load operation. The slurry pipes shall be lined with replaceable wear resistant natural rubber lining of minimum 10 mm thickness. Additional thickness of 2 mm in rubber lining shall be provided at bends.

6.07.04 Automatic flushing equipment for all lime slurry pumps and pipes shall be supplied.

7.00.00	**GYPSUM DEWATERING SYSTEM**
7.01.00	A common gypsum dewatering system for all the units operating at Design point is envisaged. Contractor shall supply a two stage gypsum dewatering system, consisting of a primary stage of sets of hydro-cyclones and secondary stage of vacuum belt filters for dewatering of gypsum from absorber up to less than 10% moisture. All the equipments supplied shall be proven design with previous installations for similar capacities.
7.02.00	The Contractor shall provide 2x100% gypsum dewatering system with each stream sized to dewater 110% of the maximum gypsum produced by all the units operating at Design point. All other stipulations with respect to sizing and design of the dewatering system, auxiliaries and other systems shall be in line with this specification.
7.03.00	**Primary Dewatering Hydro-cyclones**
7.03.01	Each set of primary dewatering hydro-cyclone shall be sized to dewater the gypsum slurry produced by the unit operating at Design point with an additional 10% margin. The outlet water content in the gypsum shall be as per the requirement of the vacuum belt filters.
7.03.02	Each set of primary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service.
7.03.03	The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Hydro-cyclone Waste Water tank via secondary hydro-cyclone feed tank and secondary waste water hydrocyclone as shown in the relevant tender drawing.
7.03.04	Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.
7.03.05	The hydro-cyclone shall be of proven design. The primary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose. The feed chamber shall be provided with a minimum rubber lining thickness of 12mm. The liners shall have a minimum wear life of not less than 7000 hrs.
7.04.00	**Vacuum Belt Filters**
7.04.01	Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum:

a. Capcity — 110% of gypsum produced by Absorbers of all the units operating at Design point.

b. Outlet Moisture — 10% max.

c. Gypsum Purity — 90% (minimum)

d. Chloride content — < 100 ppm

7.04.02 The vacuum belt filter shall be proven design in operation for similar capacities. The filter cloth shall be polyester or polypropylene as per the proven design of the supplier and shall be guaranteed for a minimum life of not less than 7000 hrs.

7.04.03 The complete frame of the filter and all parts in contact with gypsum shall be made of corrosion resistant material or shall be provided with corrosion resistant liners of proven design.

7.04.04 In case, the contractor offers a design with an underlying belt for carrying the filter cloth, the same shall be endless, factory vulcanized rubber belts. The belt shrouds and the sealing belts shall provide a leak tight arrangement to prevent overflow of gypsum slurry. The sealing belt shall have minimum life of not less than 7000 hrs.

7.04.05 The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.

7.04.06 The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation as per the supplier's proven practice. The belt filter shall have an automatic cloth tensioning mechanism.

7.04.07 The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum. For cake washing only clarified water shall be used. For this purpose, one (1) clarified water storage tank (minimum 1 hr storage) shall be provided along with 2x100 cake washing pumps for each Vacuum Belt Filter . One stage of cloth washing arrangement shall also be provided along with 2x100 cloth washing pumps for each Vacuum Belt Filter.

7.04.08 The filtrate from gypsum slurry and from cake washing shall be taken to a common or separate vacuum receiver tank(s) as per the proven practice of the supplier. Each belt filter shall have an independent vacuum pump.

7.04.03 Gypsum cake from each belt filter shall be discharged through a hopper onto belt conveyor being provided by the Employer.

7.04.04 A 2 m (min.) wide platform shall be provided around each belt filter for easy approach & maintenance. Handling facilities for replacement of heavy components

of the belt shall also be provided.

7.05.00 Vacuum System

7.05.01 The filtrate from each belt filter, cake washing & cloth washing shall be taken to a common or separate receiver tank(s) as per the supplier's proven practice.

7.05.02 Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional margin of 10% (min.) over the above capacity shall be provided for each vacuum pump.

7.05.03 The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitations under all operating conditions. The seals shall be of proven design.

7.05.04 Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.

7.05.05 The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.

7.05.06 Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.

7.06.00 Filtrate System

7.06.01 Water from vacuum receiver tank(s) and the secondary waste water hydrocyclone underflow shall be taken to a common filtrate tank for recirculation to the absorber tanks.

7.06.02 2x100% horizontal centrifugal pumps shall be provided for recirculation of filtrate water to absorber. 2x100% horizontal centrifugal pumps shall be provided for wash water requirements of belt filter. Alternatively, wash water pump may take suction from the vacuums receiver tanks. Each pump shall be provided with 100% standby in such a case.

7.06.03 The pump shall be capable of pumping of filtrate water with solid concentration of not less than 10% & particle lumps of 6-7mm. A 10% margin shall be provided in each of the pump.

7.07.00 Waste Water System

7.07.01 The overflow of the primary hydro-cyclones shall be taken to a secondary hydrocyclone feed tank for feeding the secondary waste water hydro-cyclones.

7.07.02 The secondary hydrocyclone feed tank shall be sized to provide a minimum storage

	of 1 hr of primary hydro-cyclone overflow with all the units operating at Design Point and no outflow from the tank.
7.07.03	2x100% horizontal centrifugal pumps shall be provided to feed the secondary hydro-cyclones.
7.07.04	Each set of hydro-cyclone shall be sized to process the maximum discharge from the secondary hydro-cyclone feed pumps. A minimum 10% spare hydro-cyclones shall be provided in each set. Secondary Hydro-cyclones shall be of modular construction and of proven design. The secondary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.
7.07.05	The secondary waste water underflow shall be taken to the adequately sized filtrate tank, while the overflow shall be taken to a waste water Tank.
7.07.06	1x100% Waste water tank shall be provided (in projects where separate Zero Liquid Discharge system for waste water treatment is not in the scope of the contractor) which shall be sized for 8 hrs storage of waste water with all the units operating at Design point and no out flow from the tank. The Waste water Tank shall be complete with Agitator, level transmitters etc. The waste water collection tank shall be of Steel construction with rubber lining. 2x100% horizontal centrifugal pumps shall be provided for pumping the waste water from waste water tank at required pressure to waste water terminal point as indicated in Sub-section IV, Part A, Section VI of the Technical Specification. The material of Casing and impeller shall be rubber lined Cast Iron (IS:210 Gr FG260). Shaft and Shaft Sleeves shall be Stainless Steel-410.
7.07.07	All piping, valves & instrumentation upto the employer's terminal point shall be in the contractor's scope. **Contractor shall provide the complete lime dosing system** (in projects where separate Zero Liquid Discharge system for waste water treatment is not in the scope of the contractor) to correct the pH of the waste water by lime (**83% purity**) dosing shall be provided and after mixing of the effluent (using re-circulation system of the pumping system), the effluent shall be discharged once the waste water has been neutralized to desired pH. A pH monitor shall be provided at the discharge of the pumps for measurement and control. Complete lime storage, feeding & dosing system shall be in contractor scope. The complete waste water neutralization system shall be automated and controlled from the control room.
7.07.07	Contractor shall provide 2x 100% Lime Neutralization tanks (in projects where separate Zero Liquid Discharge system for waste water treatment is not in the scope of the contractor) which shall be of minimum 8 hr capacity made of carbon steel with rubber lining along with 2x100% Lime storage silos. The tanks shall be provided with SS dissolving basket, Agitator of SS construction, drain, over flow and dosing connection, level transmitters, Agitators etc. The storage silos and hopper cones shall be fabricated of minimum 10 mm thick carbon steel with a SS lining of grade SS304 of minimum 4 mm thickness in the complete cones to ensure reliable discharge of material. The design of storage silos shall confirm to IS 9178 or any

	other proven international standards. The storage silo shall be capable of feeding the lime by motorized rotary feeding system to the Lime Neutralization tank.
7.07.09	Contractor shall provide 2x 100% Lime Storage Silos (in projects where separate Zero Liquid Discharge system for waste water treatment is not in the scope of the contractor) for feeding lime to the Lime Neutralization tanks. The lime storage silo shall be of minimum 24 hr capacity equivalent to the requirements of FGD system of 2X800 MW at Design point and shall be complete with supporting steel structure, platforms, power operated outlet gates, level switches, air relief devices, etc.. For dust free operation each silo should be provided with a covering arrangement and a self cleaning bag filter system of suitable capacity containing blower, automatic/on-load cleaning system, etc.
7.07.10	Bucket conveyors shall be provided by the contractor to feed lime to each of the lime storage silos from ground level. The Bucket conveyors shall be sized to completely feed each lime silo within 2hrs. Adequate storage and feeding system required for feeding the lime to the Bucket conveyors is also in the Contractor's scope.
7.07.10	A storage room for storing minimum one (1) month requirement of lime for all the units shall also be provided by the contractor.
7.08.00	**Auxiliary Absorbent Tank**
7.08.01	The Contractor shall provide an auxiliary absorbent tank, for the unit, sized to contain the complete slurry of one absorber tank at its maximum level equipped with all necessary pumps, valves, piping and controls to transfer the tank's contents back to the absorber to refill the absorber sump It should be possible to discharge the each absorber into the emergency drain tank within 2 hours.
7.08.02	The contractor shall provide 2 x100% pump to pump back the slurry from the sump back to the absorber in a maximum time of 8 hours.
7.08.03	Agitation shall be provided to prevent settlement of slurry by side entry agitators with emergency flush start system. Sufficient number of agitators shall be provided in the tank by the contractor to prevent the solids from settling down.
7.08.04	The Auxiliary Absorbent tank shall be made of minimum 7 mm thick carbon steel with minimum 4 mm thick rubber lining of best quality bromine butyl rubber and shall also be equipped with all necessary pumps, valves, piping and controls to transfer the tank's contents back to the absorber.
7.08.05	The Auxiliary Absorbent tank shall be equipped with an opening to enable easy entry of a man with wheelbarrow.
7.08.06	Coarse-screen(s) of suitable material at suction-side of the pumps shall be provided.
8.00.00	**SLURRY PUMPS**

8.01.00	This Clause covers the design, manufacture and erection of all slurry pumps for the FGD system including the Absorber slurry recirculation pumps, Gypsum bleed pumps, Limestone slurry feed pumps, Mill circuit pumps and any other pump handling slurries.
8.02.00	The Contractor shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian / International (ASME / EN / Japanese) Standards.
8.03.00	The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type capable of delivering the rated flow at rated head with margins as specified in the respective clauses. The slurry concentration in the pump shall not exceed 30% by weight except for Mill circuit slurry pumps for which the slurry concentration in the pump shall not exceed 55% by weight.
8.04.00	All the slurry pumps shall be provided with motorized suction and discharge valves. In addition, flushing water lines with motorized valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken form the process water supply
8.05.00	The pump casing should be radially split to allow easy removal of impeller.
8.06.00	All the pump wear parts in contact with the slurry shall be provided with replaceable rubber/elastomer liners suitable for the fluid handled. The Bidder can also offer an hi chrome alloy line pump if the Bidder has previous experience of the same for similar applications. The material used by the contractor shall be proven in previous installations.
8.07.00	For absorber recirculation service a Silicon carbide impeller and SiC lining for casing can also be accepted if the manufacturer has supplied a similar pump for a previous installation for similar service.
8.08.00	The material and thickness of the liners shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 14000 hrs.
8.09.00	The design of the shaft shall ensure that the operating speed is at least 20% above the critical speed of the shaft.
9.10.00	The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy duty ball/roller bearings.
9.00.00	**VERTICAL SUMP PUMPS**
9.01.00	Contractor shall provide sumps of adequate capacity in the each absorber area, limestone grinding area and gypsum dewatering area for containing the over flow

from the respective systems. Contractor shall make arrangements for pumping the drainage water back to the respective system with vertical sump pumps. Agitators shall also be provided to avoid settling of solids in the sump. Adequate redundancy in line with the standard practice adopted by the bidder shall be provided. This Clause covers the design, manufacture and erection of all vertical sump pumps for the FGD system.

9.02.00 The contractor shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian / International (ASME / EN / Japanese) Standards.

9.03.00 The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type with semi open or open impeller. The pump impeller shall be cantilever type and shall not be supported below the base plate for easy withdrawal.

9.04.00 The pump shall deliver the rated flow at rated head with margins as specified in the respective clauses. The pump shall be capable of pumping of filtrate water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.

9.05.00 The material chosen for the pump components shall be suitable for the fluid handled and shall be proven in similar application.

9.06.00 The pumps shall not be supported below the base plate level for easy withdrawal without entering the sump.

10.00.00 SLURRY & PROCESS WATER TANKS

10.01.00 All the slurry tanks (Slurry Tanks, Filtrate Tank, Secondary hydro cyclone feed tank, vacuum receiver tank, Waste water Tank, Lime Neutralization tanks etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 3mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. Tanks shall be made from IS:2062 quality mild steel plates of tested quality. The tanks shall be of welded construction. Interior surface of the tanks shall lined with replacable chlorobuty/bromobutyl rubber lining of minimum 5 mm thickness and the outside surface shall be coated with paint as approved by the Employer. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc. Coarse-screen(s) at suction-side of these pumps shall be provided.

11.00.00 AGITATORS

11.01.00 Agitators shall be supplied in tanks and vessels to prevent caking and settlement of particles out of the slurry, e.g. in the absorber vessel, limestone mill recycle tanks, limestone slurry tank, Auxiliary Absorbent tank, and sumps etc.

11.02.00 All agitators shall be designed for continuous operation unless otherwise specified.

	Horizontal agitators shall be used for Absorber. Vertical agitators can also be used for Absorber, if it is only the standard & proven practice of the Contractor for the offered Absorber design. In other vessels and tanks vertical agitators are also acceptable if they are of proven make and the Bidders standard practice which can be proven by means of suitable references. The design of the agitators shall be of proven type.
11.03.00	Standard type agitators with suitable characteristics shall be used wherever practical. The agitators shall be complete with motor, gearbox, agitator shaft, coupling, safety guards, mechanical seal (for side entry agitators), impeller, support legs, agitator mounting flange including bolts nuts and gasket etc.
11.04.00	All agitator parts and accessories in contact with the stirred fluid shall be constructed of materials specifically designed for the conditions and nature of the stirred fluid and be resistant to erosion and corrosion.
11.05.00	The material for the shaft (which is continuously in contact with slurry) and agitator blades of the Absorber Agitators shall be made with Alloy 926 or better material. For Agitators in other tanks, agitator blades shall be made with Alloy 926 or better material & shaft can be rubber lined. This does not release the Contractor of the responsibility for selecting the correct materials.
11.06.00	Each agitator and its associated equipment shall be arranged in such **a** manner as to permit easy access for operation, maintenance and agitator removal without interrupting plant operation. It shall be possible to remove the sealing devices of the Agitators of the absorber vessel without having to drain completely the absorber.
11.07.00	To prevent mechanical blocking load start-up after standstill of pumps, piping and agitators for slurries shall be applied with C-hose connection.
11.08.00	Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the agitators and their components.
11.09.00	Static and dynamic (as far as applicable) balancing of all agitators shall be carried out after assembly.
11.10.00	All agitator parts and components shall be designed and calculated for fatigue life, considering maximum bending loads, induced by fluctuating hydraulic forces and torsional loads, based on the installed motor power. For side entry agitators the alternating bending moment resulting from impeller and shaft weight has to be considered additionally.
11.11.00	All exposed moving parts shall be covered by guards.
11.12.00	Side entry agitator shall be flange mounted.
11.13.00	The shape of the impeller blades of side entry agitators shall be designed to avoid wear on the impellers which will affect the agitator performance as specified for a minimum period of 2 years of continuous operation under design conditions for the range of coal & limestone specified in the specification. In order to avoid excessive wear impeller tip speeds must not exceed 12 m/s.
11.14.00	Belt drives (if applied) shall be properly designed to provide a minimum lifetime of 2 years under design conditions

12.00.00	**SLURRY LINES AND VALVES**
12.01.00	Slurry pipes shall be designed to keep the velocity above the settling velocity under all operating conditions. The contractor may provide a recirculation line with motorized isolation valve for the above purpose.
12.02.00	All the pipes handling slurry shall be provided with replaceable rubber lining of proven quality. The Contractor can provide slurry pipes of size lower than 3” made up of FRP material (silicon carbide coating on slurry exposed surface) if it has previous experience of providing the same.
12.03.00	The isolation valves provided in all the slurry lines shall be of knife gate type/butterfly type unless specifically mentioned. Motorized actuators shall be provided for valves requiring frequent operation as indicated in the relevant scheme.
12.04.00	The valves shall be of proven type and the contractor shall submit a detailed valve schedule for employer’s approval. Reference list for previous installations for similar application shall also be furnished to the employer.
12.05.00	Bidder shall provide all necessary arrangements for purging & flushing of all the process pipelines, equipments etc.
13.00.00	**PROCESS WATER STORAGE TANKS & PUMPS**
13.01.00	Two (2) Process water Storage tanks (each tank catering to the requirements of all the units operating at Design Point) along with two numbers of 2x100 % Booster water pumps, if required, (Each pump catering to the process water requirements of all the units operating at Design Point) along with all necessary piping, valves, control & instrumentation to feed the clarified water shall be provided by the Contractor. Process water Storage level shall be automatically controlled at operating level by controlling the water flow from the makeup water from terminal point. The process water storage tank shall be designed to store 15 minutes of total maximum water required for the entire FGD process (including absorber system and mist eliminator washing system, limestone grinding and slurry preparation system and gypsum dewatering system, etc.) for the units operating at Design point. All the process water storage tanks shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.50 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the bidder. Tanks shall be made from IS:2062 quality mild steel plates of tested quality. The tank shall receive water supplied (as identified in Subsection titled “Terminal points” in Part-A of Technical Specification) by Employer. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.
13.02.00	2x100% Process Water Pumps shall be provided for each unit connected to each of the Process water Storage tanks along with all necessary piping, valves, control &

	instrumentation. Each pump catering to process water requirement of one unit. The capacity of the pumps shall be such that it shall meet the maximum process water requirement of each unit. A further 10% margin shall be provided over the above capacity for all the above pumps.
13.03.00	2x100% Mist Eliminator Wash Water Pump for each unit connected to each of the Process water Storage tanks along with all necessary piping, valves, control & instrumentation shall be provided by the Contractor. Alternatively, Contractor can use process water pumps for mist eliminator washing if it is the standard & proven practice of the Contractor or its Technology Collaborator. Each pump shall cater to maximum mist washing requirement of one unit. The capacity of the pumps shall be such that the total capacity of working pumps is sufficient to meet the maximum wash water requirements of mist eliminators of the absorber. A further 10% margin shall be provided over the above capacity for all the above pumps.
13.03.04	Two (2) clarified water Storage tanks along with two numbers of 2x100 % clarified Booster water pumps from terminal point shall be provided by the Contractor. The two tanks shall be interconnected with an isolation valve.
13.03.05	2x100% clarified water Pumps connected to each of the clarified water Storage tanks for each dewatering stream. Each pump catering to clarified water requirement of each dewatering stream.
13.03.06	The type of pumps shall be horizontal centrifugal type designed for continuous operation with semi open or closed impeller. Casing, Gland and Stuffing Box shall be of 2.5 Ni Cast Iron to IS:210 Grade FG 260 or equivalent. Impeller, Wearing rings (as applicable) shall be of Stainless Steel -316 grade and Shaft & Shaft sleeves shall be of SS-410 grade. Pump re-circulation line shall be provided for pumping system. Pumps shall be provided with accessories such as Y-type suction strainers, Coupling guard, drain plugs, vent valves etc.
13.03.07	All the Process water tanks (Process water Storage tanks, Clarified water tank, Emergency water storage tanks etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 3mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. Tanks shall be made from IS:2062 quality mild steel plates of tested quality. The tanks shall be of welded construction. Interior surface of the tanks shall lined with replacable chlorobuty/bromobutyl rubber lining of minimum 4 mm thickness or with vinly ester based flake glass lining of minimum 3 mm thickness and the outside surface shall be coated with paint as approved by the Employer. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.
14.00.00	**APPROACH and Handling Facilities**

14.01.00	Proper approach shall be provided for access to all equipments during normal operation and maintenance. Unless otherwise specified, platforms, staircase and ladders shall follow the stipulations specified elsewhere in this specification.
14.02.00	Equipments requiring monitoring during regular operation shall be approachable from the ground floor through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5m height from the nearest platform. Below this height a vertical ladder with minimum clear width of 600 mm may also be acceptable.
14.03.00	Platform with a minimum clear width of 1000 mm shall be provided all around the lowest absorber spray levels and mist eleminators. Similar platforms shall be provided at subsequent elevations if they are more than 3000 mm apart from each other. An adequately sized manhole with platform (min. 2 sq. m) shall be provided above each spray level. Ladders/staircase shall be provided for the access to the platform.
14.04.00	The absorber slurry recirculation pumps, gypsum bleed pumps and limestone feed pumps shall be mounted on the ground level. Suitable approach and platforms shall be provided for all the valves required during regular operation.
14.05.00	A 1500 mm space shall be provided around all pumps, except absorber recirculation pumps, where a 2000 mm space shall be provided.
14.06.00	Platform with a minimum width of 1500 mm shall be provided all around the pulverizers and feeders. Approach along with suitable platforms shall be provided for ball loading hoppers.
14.07.00	A 1000 mm wide platform with suitable approach shall be provided around each hydro-cyclone.
14.08.00	A 2000 mm wide floor/platform shall be provided all around each belt filter.
14.09.00	Contractor shall provide motorized hoists and trolleys for all items requiring maintenance and weighing 500 kg or more. All auxiliary structures, monorails, runway beams for all lifting tackles, hoists etc., are included in Contractor's scope of supply. Access ladders with suitable platform shall also be provided for approach to all motorized hoists/trolleys mounted on their runway beams for the maintenance of hoists/trolleys. Items weighing more than 50 kg and required to be replaced for maintenance shall be provided with manual hoists/trolleys with runway beams/supporting structure etc.
14.10.00	The regular basement floor is not acceptable in FGD area. Further local Pits/trenches shall be avoided as far as possible.

14.11.00 Handling arrangement of milling system, Booster fans, Slurry recirculation pumps, oxidation blower, belt feeder system etc. complete with crane/monorail along with removal space for maintenance shall be provided by the Contractor.

14.12.00 Approach for removal of equipment for maintenance shall be provided.

14.13.00 All other safety requirements as per the Factories Act, National Electricity code shall be complied with while developing Layout.

14.14.00 Cable trenches/slits, if unavoidable, shall be provided with adequate cushioning of sand and the same shall be covered with PCC.

14.15.00 Each Equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of Factories Act and Statutory bodies/insurance companies.

14.16.00 Minimum Headroom (free height) under all floors, ducts, walkways and stairs shall be 2.50 M.

14.17.00 Inter-connecting pipes/cables between various facilities of FGD plant shall be routed on the steel trestles to be provided by the Contractor. The clear head room for the same shall be minimum 8 M.

15.00.00 ELEVATORS

15.01.00 Elevators shall be designed based on following criteria :

(i)	Type of service	One (1) no. Passenger cum goods elevator per Absorber & for Mill Building
(ii)	Design/construction/installation codes	(a) Latest edition of IS:14665 (All parts) AND also meeting any additional requirements of IS:4666, IS:1860 and IS:3534. (b) Any other equivalent code, subject to Employer's approval.Load carrying capacity
(iii)		1000 kg (minimum).
(iv)	Rated speed	1.0 m/s.
(v)	Total Travel	As per FGD supplier's recommendations subject to Employer's approval.

(vi)	Number of floors to be served	As per requirement and subject to Employer's approval
(vii)	Entrance	As per requirement and subject to Employer's approval
(viii)	Entrance and platform size	As per design/installation codes at (ii) above
(ix)	Drive/motor	As per Electrical Specifications.
(x)	Method of control	As per Electrical Specifications.
(xi)	Machine room and lift Shaft	Pressurized dust proof or Airconditioned machine room as per the requirement of lift manufacturers.
(xii)	Position of machine room	Directly above the lift shaft.
(xiii)	Power Supply	As detailed in Electrical Specification

15.02.00 Landing doors of the elevators shall have fire resistance of at least one hour. These doors shall also be smoke tight as far as possible.

15.03.00 Construction of the elevators shall specifically meet all requirements of the codes indicated at Cl. 15.01.00 (ii) and shall have following additional features:

(i)	Flooring of Cabin	:	6 mm thick Checkered Plate flooring.
(ii)	Design, Construction and finish of car & car door	:	Car inside enclosure including inner side of door shall be of stainless steel plate of grade SS:304 of bright finish.
(iii)	Car entrance and landing doors	:	As per BS:476 (Part 20 & 22)
(iv)	Door construction	:	Hollow metal construction from 16 guage thick steel sheet spray painted.
(v)	Signals	:	Car position informer in car both visual and audio, hall position indicator at all floors, telltale lights at all floors, battery operated alarm bell and emergency light with suitable battery, charger & controls.

(vi) Type of Indicators : Soft touch keys and digital luminous display in car operating panel and on all floors landings. (All fixtures in stainless steel face plates).

15.04.00 Technical requirements of Electrical items shall be as per details given in Electrical Sub-Section, Part-B.

15.05.00 Provide sound reducing material below machines in machine room.

15.06.00 Provide special corrosion resistant treatment on all elevator components. The protective treatment shall be subject to Employer's approval.

15.07.00 Elevators shall have provisions to meet following operational requirements:

(i) Selective collective, automatic operation with or without operator through illuminated push button station located inside the lift car.

(ii) Power operated with automatic opening/closing car and landing doors.

(iii) Two push buttons, one for upward movement and the other for downward movement at each intermediate landing, and one push button at each terminal landing shall be provided in order to call the car.

(iv) Push buttons shall be fixed in the car for holding the doors open for any length of the time required.

15.08.00 Fireman's switch shall be provided for each elevator.

16.00.00 DUCT WORK AND DAMPERS :

16.01.00 **Duct Work**

16.01.01 **Sizing Criteria :**

1. Allowable velocities in the duct work.

Maximum gas velocity shall be 15 m/sec at Design point condition.

16.01.02 **Loads for Duct and Structure Design**

The duct design shall take into account following loads all occurring together:

1. Wind loads as specified.
2. Dead weight including weight of insulation, lining, wash water and the vertical live load.

3. Ash load :

All ducts to be designed for one tenth of duct full of ash. The ash density for the purpose of loading shall be at least 1300 kg/m^3.

4. Expansion joint reaction.

5. Seismic Load

6. The following minimum load factors shall be applied to the design loads:

Temperature (Deg.C)	:	27	38	93	149	205	260	316	321
Load Factor	:	1.00	1.02	1.12	1.19	1.25	1.29	1.34	1.42

16.01.03 **Duct Design Pressure**

All flue gas ducts shall also be designed for ± 660 mm w.g., or maximum conceivable pressure of the relevant fans, whichever is higher at 67% of yield strength of material

16.01.04 **Duct Slope**

All ducts shall have a sufficient slope with respect to horizontal so that any chance of accumulation of ash particles or water in the duct can be avoided under all normal/abnormal operating conditions. The inlet duct shall be sloped towards the absorber.

16.01.05 **Type of duct construction:**

The duct shall be of rectangular cross-section and shall be of all welded construction. For rectangular ducts following requirements shall be complied with:

a) Minimum 7 mm thick steel plates for gas ducts & Duct stiffening shall be by means of rolled sections of duct material.

b) A corrosion allowance of 1.5 mm shall be considered for stress calculation for the flue gas ducting.

c) Duct stiffening shall be by means of rolled sections. No internal stiffeners shall be used for ducts from Absorber outlet to chimney inlet.

16.01.06 **Insulation & Lagging**

a) Thermal insulation shall be applied to all air/gas ducts to comply with the requirements of as specified at clause no 18.00.00 of this chapter.

b) Acoustic insulation shall be used, if required, in gas ducts to restrict the noise level to specified values.

16.01.07 **Specific Requirements**

a) The stiffeners provided on the ducts walls shall be of such a design and layout that no rainwater can accumulate on the duct surfaces.

b) The flanges at the bolted joints shall have adequate stiffeners to avoid damages to the flanges.

c) All necessary wall boxes and floor collars shall be provided where the ductwork pass through walls, floor and roof.

d) The floor collars shall be fitted with a high combing to prevent water and dust falling through the hole.

e) The ductwork shall be fitted with a steel hood to cover the opening.

f) Weatherproof flashing shall also be provided wherever necessary.

g) The configuration and design of ducts shall be coordinated with the pulveriser parts removal requirement.

h) Air and gas ducts shall not counter internal bracings, which cause excessive pressure drop.

i) Duct plates shall be designed for one-way beam action over stiffeners and considered fully continuous over all supports.

j) Bidder to ensure proper draining facilities for the complete system including proper drainage of acidic fluids from the ducts so as to avoid any accumulation of acidic fluids.

k) The deflection of the plate, assumed continuous, shall be less than one-half the plate thickness.

16.01.08 **Duct Work Structure**

a) Ductwork sections between expansion joints shall be investigated with regard to their ability to transmit loads to supports. Care shall be exercised to identify uplift condition.

b) Internal stiffeners:

(i) Duct shape shall be maintained by providing internal stiffening elements at or near supports. However, these internal stiffeners shall be used, if and only if, it is not possible to provide external stiffeners.

(ii) Internal stiffening elements shall consist of trusses, preferably comprised of extra-strong steel pipes (min. dia. 76.2 mm) acting in conjunction with external stiffeners. Such internal stiffeners for the flue gas duty between boiler and ESP shall be provided with erosion protection shields.

(iii) The number of internal trusses shall be limited to the minimum required for structural integrity and shaped so as to offer least resistance to gas flow and to minimize the accumulation of fly ash in the bottom of duct.

(iv) Conceptual data of internal stiffeners of the ducting shall be furnished along with the offer.

(v) All the detailed design data shall be furnished to the Employer before the duct support column foundation data submission.

c) Corner angles shall be used on all inside corners of all ducts to provide adequate continuity.

d) Inside welds of corner angles to duct plate shall be continuous and seal welded. Where inside surface of ducts will be coated, welds shall be full throat.

e) Field welding and all connections of bracing (stiffening elements) to stiffeners shall be well designed in order to develop full strength of the members. The gusset plates shall be of 10 mm minimum thickness.

f) The duct, plates, trusses, stiffeners, bracings and ductwork shall be designed as structures in accordance with relevant Indian Standards.

g) All openings in ducts shall be reinforced for all design loads.

h) Ductwork supports may be hangers or sliding bearing, guides and anchorages. A coefficient of sliding friction of 10% can be used with self-lubricated plates such as "LUBRITE" or "MECHANITE", a coefficient of sliding friction of not less than 35% shall be used for steel-on-steel contact. The allowable bearing stress for self-lubricated plates shall be 70 Kg/sq.cm.

16.01.09 **Fabrication Requirements**

a) Fabrication shall be as per IS specification for Design, fabrication and erection of 'Structural Steel for Building.

b) Welding shall be in accordance with Section IX of ASME code.

c) Ducts shall be strength welded and seal welded to produce a gas tight duct. Alignment holes shall be provided in mating flange sections.

d) Ducting shall be detailed and fabricated in a few pieces as practical, taking into account, shipping and erection considerations.

e) Materials improperly detailed or fabricated necessitating extra work during erection on field, shall be the responsibility of the Contractor.

17.00.00 THERMAL INSULATION AND CLADDING

17.01.00 Thermal Insulation along with aluminum cladding shall be provided for all the equipments/surfaces having skin temperature more than 60degree Celsius. The specification of the insulation including type, density, thickness, heat conductivity and finish shall be designed based on criteria specified below. The insulation thickness shall be designed based on following criteria.

Criteria		**Design Conditions**
(i)	Ambient Temperature	45°C
(ii)	Surface wind velocity	0.25 m/sec.
(iii)	Emissivity of Aluminium	0.2
(iv)	Cladding surface temperature	60°C (max.)
(v)	Thermal conductivity of insulation material	Not less than the Maximum values as per IS:8183
(vi)	Pipe/Equipment wall temperature	Maximum fluid design temperature
(vii)	Overall heat transfer coefficient and insulation thickness	To be calculated as per ASTM C 680-89

However, the minimum insulation thickness, however, shall not be less than 75 mm.

17.02.00 Material and application of insulation material, protective cladding, wire mesh etc. shall be conforming to latest edition of following codes:

(a) IS:8183

(b) IS:3677

(c) IS:3144

(d) IS: 14164

(e) IS:280

(f) ASTM-B 209

17.03.00 Insulation material for all equipments, ducting, etc. shall conform to following requirements:

Parameters	**Requirement**
(i) Material	(a) Lightly resin bonded mineral wool of best grade conforming to IS:8183. (Hand made mattresses is not acceptable). Material shall be rock wool only. Slag wool or slag wool inclusion shall not be accepted.
	(b) Lightly resin bonded glass wool mattress, having density 64 Kg/m³ (min.), self stitched in shop can also be accepted for temperature less than 400°C.
(ii) Bulk density of lightly resin bonded mineral rock wool mattresses	
(a) For use upto 400°C -	100 Kg/m³
(b) For use above 400°C -	150 Kg/m³
(iii) **Physical requirements -**	
Following shall be met by testing as per relevant clauses of IS:3144.	
(a) Shot content	5% by weight (maxm.), size of any shot not to exceed 5 mm in diameter

	(b) Bulk density	To comply with 16.03.00(i) & (ii) above.
	(c) Weight gain by moisture absorption	2% (maxm.)
	(d) Sulphur Content	Not exceeding 0.6%
	(e) Alkalinity as percentage of Na_2O	Not exceeding 0.6%
	(f) Maximum oil content	Not exceeding 0.3% by weight
	(g) Total carbon content	Not exceeding 0.3% by weight
	(h) Settlement	Nil (When tested as per Cl. 21.1 & 21.2 of IS:3144)
	(i) Handability	Fully handable, without any lump formation and disintegration of material
	(k) Loss of weight after combustibility test	Not exceeding 5% by weight

17.04.00 The Insulation mattress shall be rated incombustible when tested by the method prescribed in clause 15 of IS:3144 and shall meet the requirement of the Mercantile Marine department, Lloyd's Register of shipping, underwriter, fire hazards codes and other International standards.

17.05.00 In addition to requirements as mentioned above, insulation material (and protective covering) shall:

(a) Be fresh, incombustible, rust proof, non hygroscopic,

(b) Be capable of withstanding continuously and without deterioration the maximum temperature to which they will be subjected.

(c) Not react chemically, either to itself or with other components.

(d) Not sustain any fungi, or vermin and must not pose health hazards.

18.06.00 The Mineral wool shall:

(a) Pass standard combustibility test both immediately after application and after subjected to maximum operating temperature for not less than 100 hrs.

(b) Not suffer permanent deterioration as a result of contact with moisture due to condensation and shall be free from objectionable odor.

(c) Not cause corrosion of the surface being insulated or of cladding on it under normal site conditions.

(d) Not suffer any quality deterioration under specified service conditions (both cold/hot face temp.) of use.

17.07.00 The use of insulation of finishing materials containing asbestos in any form is not permitted.

17.08.00 Insulation mattress/section shall be supplied in thickness of 25,40,50 and 75 mm. Insulation of higher thickness shall be made up in multiple layers using mattress/slabs of thickness specified above. However, if the required thickness is such that by using above mattress/slabs the calculated thickness is not achieved, the mattress/slabs in increment of 5 mm shall be acceptable for outer layers. The min. thickness however, shall not be less than 25 mm and number of layers shall be minimum and innermost layer shall be thickest.

17.09.00 **Sheathing Material**

Sheathing material for all insulated surfaces, equipments, piping etc. confirming to ASTM B-209-1060 temper H-14 or IS:737 Gr 19000/H2, shall be provided. The thickness of aluminium sheathing to be used shall be 22 SWG (0.71mm).

17.10.00 Binding and lacing wires shall be 20 SWG Galvanised Steel wire

17.11.00 All Straps and bands shall be Galvanized Steel. Bands shall be 20 mm wide and 0.6 mm thick. For securing Aluminum sheathing material, stainless steel or anodized aluminum bends shall be used.

17.11.01 Screws shall be of galvanized steel, check headed, self tapping type. Above 400 degree Celsius temperature, screws shall be stainless steel.

17.12.00 Hexagonal wire mesh netting shall be 10-13 mm aperture and atleast 0.56mm diameter conforming to following Galvanized Steel wire.

17.12.01 Non metallic components like 3 mm thick mill board, aluminum pigment sealant, white glass cloth, insulating cement, neoprene washer shall be provided.

17.13.00 **Application of Insulation**

17.13.01 **General**

(a) All surfaces to be insulated shall be cleaned of all foreign materials such as dirt, grease, rust etc. and shall be dry before the application of insulation.

(b) Before applying the insulation the contractor shall check that all instrument tapping, clamps, lugs and other connections on the surface to be insulated have been properly installed as per the relevant erection drawing.

(c) All flanged joints shall be insulated only after the final tightening and testing.

(d) The insulation shall be applied to all surfaces when they are at ambient temp. Ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied so as to avoid breaking/telescoping due to alternate periods of expansion and contraction.

(e) All cracks voids and depressions shall be filled with finishing cement, suitable for the equipment operating temp. so as to form a smooth base for the application of cladding.

17.13.02 All the refractory and insulation materials required for complete field application of insulation, cladding etc. covered under these documents and specifications shall be furnished with the equipment. They shall conform to the requirements of the various relevant ISI standards or other approved equivalents. All items such as insulating cement, sealing material, insulation material, screws, washers, etc., needed to complete the work in the course of the application of insulation and refractory shall be furnished. All insulating materials shall be chemically inert in both the dry and wet state and shall withstand the full working temperature conditions to which they are exposed without any deterioration. The gas ducts shall be insulated with mineral wool block or mineral wool blanket and all other equipment operating at elevated temp. not enclosed in the boiler casing shall be insulated with calcium silicate blocks, mineral wool blocks or mineral wool blanket insulation.

17.13.03 **Application on Piping**

(a) All vertical pipes shall be provided with the suitable insulation supports to prevent collapsing/crushing of insulation due to its self weight. Support rings shall be provided on all vertical piping with a difference in elevation of 4 meter or above, and there shall not be more than 3 m straight length between support rings.

(b) Longitudinal joints of insulation mattress sections of horizontal piping shall be on the bottom or at the sides of the pipe.

(c) When more than one layer of insulation mattress/section is required on piping the circumferential joints on adjacent layers shall be staggered by at least 150 mm and longitudinal joints shall be staggered by at least 50 mm.

(d) The mattress type insulation shall be formed to fit the pipe and applied with the mattress edges drawn together at the longitudinal joints and secured by lacing wire. Pipe section insulation shall be fitted on pipe using binding wires.

(e) Where insulation is applied in two or more layers each layer of mattress shall be backed with hexagonal wire mesh. For the first layer of insulation and in case of single layer insulation, hexagonal wire mesh shall be provided on both the surface of the mattress. For pipe sections, the sections shall be held in place by binding wires without any wire mesh.

(f) The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of the insulation. Any gap in the insulation shall be filled with loose mineral wool or finishing cement.

(g) Insulation mattress/section ends shall be terminated at a sufficient distance from the flanges to facilitate removal of bolts.

(h) The insulation shall be held in place by fastening over with binding wire for insulation surface with diameter upto and including 550 mm and with metal bends for insulation surfaces with diameter over 550 mm. The fastening shall be done at intervals of 250 mm except where specified otherwise. The ends of the binding wires shall be hooked and embedded in the insulation. The straps shall be mechanically stretched and fastened with metallic clamping seals of the same materials as the strap.

(i) Insulation for application on bends and elbows shall be cut into mitred segments, sufficiently short to form a reasonably smooth internal surface. After the application of insulation material place, insulating cement shall be applied as required to obtain a smooth surface.

(j) Weather hoods shall be provided for insulated piping passing through floors/walls.

(k) All pipe attachments coming on horizontal pipes, inclined pipes and bends shall be insulated along with pipe such that there will be no insulation applied to hanger rod and the component connecting hanger rod to pipe attachment. All pipe attachments exposed to weather shall be provided with weather proof covering.

(l) Upstream of all drain lines and the lines connected to steam traps, shall be insulated upto and including first isolating valve for heat conservation. Rest

of such lines such as downstream of the drain valves, traps etc. and other lines such as safety valve discharges, vents, etc. shall be insulated for personnel protection.

17.13.04 **Application on Valves and Fittings**

(a) All valves fittings and specialties shall be insulated with the same type and thickness of insulation as specified for the connected piping with the special provisions and or exceptions as given below.

(b) All valves and flanges shall be provided with removable box type of insulation covered with box fabricated from aluminium sheets of thickness same as the connected pipe cladding. Adjoining pipe insulation shall be bevelled back to permit removal bolts and nuts or bands. The portion of the valve which can not be covered by box type insulation shall be filled by loose insulating material of packing density at least equal to that of the insulating material of adjoining pipe. The insulation for valves/flanges shall be applied after the finishing has been applied over the connected piping. The cladding shall be applied in such a manner that the bonnet flange can be exposed easily without disturbing the complete insulation and cladding.

(c) Flanges on lines having temperature upto and including 150 deg.C shall not be insulated.

(d) Union shall not be insulated.

(e) Expansion joints, metallic or rubber, shall not be insulated unless otherwise specifically indicated.

(f) Safety valves shall be insulated.

17.14.00 While applying mineral wool blanket insulation:

(a) Provide expended metal or hexagonal wire mesh on both sides for single layer mattress and on first layer in case of multilayer insulation. Subsequent layers of multilayer insulation to have only one side wire netting.

(b) The edges of adjacent blankets to be leased together, by appropriate lacing wire as per Clause 16.08.00.

(c) Any gap between joints between insulation layers shall be filled by loose mineral wool confirming to IS:3677.

(d) All insulation to be secured by 1.63 mm dia wire netting over blankets with ends of wire tightly twisted, and pressed in to insulation surface.

(e) Impelling pins shall be placed on centers not exceeding 300 mm.

17.15.00 Flue Gas ducts with external stiffeners shall have first layer of insulation between the stiffeners and a second layer of insulation over stiffeners so that stiffeners are also insulated and a level surface is achieved. Other requirements are same as given in Clause 18.09.00.

17.16.00 **Application of Metal Cladding**

All insulated surfaces of the FGD shall be provided with metal cladding in accordance with the following requirements.

(a) All insulation procedure of metal cladding shall have prior approval of the Owner.

(b) All insulated surfaces of FGD shall be covered with aluminium cladding.

(c) Cladding for FGD components are to be finished with plain aluminium sheeting of thickness not less than the values specified. Wherever an inner casing plate is necessary to effect a gas tight enclosure, the plate shall be of mild steel of required thickness, but not less than four (4) mm suitably stiffened and supported.

(d) Cladding on straight surfaces shall be finished with aluminium sheeting of at least 20 SWG thicknesses suitably pressed along diagonals to form diamond shape or otherwise formed.

(e) Cladding for insulated circular surfaces will be constructed from aluminium sheets of thickness not less than 20 SWG.

(f) Weather proof flashings shall be installed where the panels intersect with columns and at other similar joints.

17.17.00 **Application**

All metal cladding shall be fabricated and installed to ensure a neat appearance and no open ended sections of cladding shall be left uncovered. The following provisions shall also be complied with:

(a) All closures, flashings and seals required shall be provided and installed.

(b) An asphalt and craft paper moisture barrier shall be provided to the aluminium cladding for all out door applications. Such moisture barriers shall be fixed to the inner surface of the cladding or shall be cemented to the outside surface of the insulation before application of cladding.

(c) All the used in the out door cladding shall be provided with Neoprene washers.

(d) All openings and joints in outdoor cladding for piping connections, supports or access shall be suitably flashed and weather-proofed. Where such flashings or weather-proofing can not effectively control the entry of moisture, then such openings and joints shall be weather-proofed by application of aluminium pigmented sealer.

(e) Cladding on the top surfaces of the FGD, duct work and equipment shall be suitably reinforced to prevent damage by personnel walking thereon.

17.18.00 **Protection of Equipment during insulation application**

All equipment and structure shall be suitably protected from damage while applying insulation. After completion all equipment and structures shall be thoroughly cleaned of insulating materials which might have fallen on them.

18.00.00 TYPE TEST

18.01.00 Full scale type tests using actual equipment shall be conducted by the Contractor for the equipment mentioned in the subsequent clauses below:

18.01.01 Full range and full scale performance testing shall be conducted at shop on one number each of the following Fans as per BS 848, Part-1:

(a) Booster Fan

The performance testing at shop shall be conducted using actual fans

18.01.02 Leak tightness testing of dampers for each type and size of damper at shop to demonstrate the guaranteed gas tightness efficiency (on flow). The minimum guaranteed gas tightness efficiency of dampers shall not be less than that indicated in clause no. 3.03.08 of this Sub-Section.

18.02.00 The Bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of Bid Proposal Sheet (BPS) and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Employer's Engineer.

18.03.00 The type tests shall be carried out in presence of the Employer's representative. Contractor shall inform the Employer about his readiness for conducting the type test and issue such notice to the Employer 30 days in advance, along with schedule of the type tests. The Contractor shall obtain the Employer's approval for the type test procedure before notifying the Employer about his readiness for conducting the type

	test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
18.04.00	Irrespective of the requirement of conducting the type tests under this contract, The Contractor shall submit the reports of the type tests carried out for the equipments listed above in clause no. 18.01.00 and These reports should be for the tests conducted on the equipment for the model / type / size / rating to those proposed to be supplied under this contract and the test(s) should have been either be conducted at an test facility/shop/independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all of the specified type tests under this contract, in which case the type test charges shall not be payable for the type tests waived by the Employer.
18.05.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

SUB-SECTION-I-M2

AIR CONDITIONING & VENTILATION SYSTEM

1.00.00 GENERAL

1.01.00 This section of specification covers details of system specifications, detailing the areas to be air conditioned, basis of design, brief description of the system, equipment and services to be furnished by bidder.

The Design, Engineering, Supply, Construction, Erection, and Testing & Commissioning of all the equipments & works listed here shall be on the basis of single point responsibility in bidder's scope of work for satisfactory completion of the system in all respect.

2.00.00 AREAS TO BE AIR CONDITIONED

2.01.00 The areas to be air-conditioned shall be as follows:

a) Air cooled condensing units (D-X type) type air conditioners with AHU of suitable capacity with 100 % redundancy (as per actual heat load calculation) shall be provided for each FGD Control room building and ZLD control room building (if provided).

b) Cassette and Hi-wall Air-conditioners for Other auxiliary control room /control room buildings not listed above but covered in the scope of Bidder.

3.00.00 AREAS TO BE VENTILATED

3.01.00 (i) Unitary Air Filtration (UAF) units of min. capacity 75,000 m3/hr or capacity calculated considering 8 air changes per hour whichever is higher, shall be provided for Non-Air Conditioned areas of FGD and ZLD (as provided) control building (e.g. Switch gear rooms, cable galleries, etc.)

(ii) Mechanical Ventilation (using Roof extractors/ Supply and/or Exhaust fans) shall be provided for various other areas/buildings in the scope of bidder as under:

a) Grinding system building
b) Gypsum dewatering building
c) Recirculation pump & Oxidation blower/compressor building.

(iii) Toilets etc in above building (i) & (ii). Any other area not listed above but covered in the scope of Bidder.

iv) For other miscellaneous areas/ buildings not listed above but covered in the scope of Bidder, mechanical type ventilation system using Supply and/or exhaust air fans/ roof exhausters shall be provided.

3.02.00 All non-air conditioned areas covered under this package shall be ventilated by a combination of supply/exhaust fans and fresh air in-take / back draft louvers as detailed below:

S.No	Area	Type of Ventilation system
(i)	General area like pump house, buildings etc	Combination of Supply air fan & Exhaust air fans
(ii)	MCCs and Switchgear room etc	Supply air fan & Back draft dampers
(iii)	Battery rooms & Oil rooms and fumes/odor generates	Combination of Supply air fan & Exhaust air fans. Motors shall be flame proof.
(iv)	Toilet/pantry etc	Propeller type exhaust air fan

4.00.00 EQUIPMENT DESCRIPTION – AIR CONDITIONING SYSTEM

4.01.00 **Condensing Unit (Air-Cooled D-X type)**

Condensing unit

Type : Air cooled scroll type

Vibration isolators : Steel spring / Neoprene rubber cushy foot type with isolation efficiency not less than 85%.

Compressor

Type : The Compressor shall be scroll, serviceable, either hermetic type or semi-hermetic type with automatic capacity control (minimum 3 steps).

Type of drive : Motor driven, direct or through V-belt.

Refrigerant : The refrigerant shall be R-134a/ R-410A/R-407C or any other environment friendly refrigerant.

Accessories : High/Low pressure cutouts, oil pressure switches, relief valves, pressure gauges at each stage, lube oil and control oil pressure gauges, suction & discharge stop valves, Muffler, Crank case heaters, oil filters, magnetic oil separators, temperature indicators for lube oil/heaters, oil level indicators, safety thermostat for crank case heater, vibration isolators, etc.

Motor Rating : 10% more than the power required by the compressor at 50 deg C design ambient temperature.

	Capacity : Minimum capacity shall be suitable for the identified/selected at evaporating temperature and condensing temperature and shall be indicated.
4.02.00	**Air Handling Unit (AHU)**
4.02.01	Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs shall be provided.
4.02.02	The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24g) galvanized steel sheet (thickness of galvanization as per manufacturer's standard) , with 25mm thick polyurethane foam insulation of minimum 38 Kg/Cum density in between. Suitable reinforcements shall be provided to give structural strength to prevent any deformation/buckling.
4.02.03	Sloping condensate drain pan shall be made of minimum 1.2 mm thick Stainless Sheet Steel. It shall be isolated from bottom floor panel through 25mm thick heavy duty treated for Fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.
4.02.04	Cooling coil (min. 4 row deep) shall be made of seamless copper tubes with aluminium fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.
4.02.05	All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.
4.02.06	**Centrifugal fan for AHU**
	a) Fan Type : Double Width Double Inlet (DWDI) Centrifugal Type
	b) Fan impeller : Backward curved blades
	c) Casing material : GI /Mild steel with minimum thickness of 3 mm.
	d) Impeller material : Carbon steel
	e) Shaft : EN 8 Steel

f) Fan bearings : Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.

g) Critical speed : First critical speed of rotating assembly shall be at least 25% above the operating speed.

h) Drive : Motor driven with removable belt guard. Motor driven with removable belt guard. Motor rating (at 50 deg.C ambient) shall be atleast fifteen percent (15%) above the maximum load demand of drives at the design duty point.

i) Fans : For AHUs of capacity 50,000 CMH and above, Bidder may offer two (2) Nos. centrifugal fans of equal capacity for each AHU provided all such AHUs are accommodated within the space identified by the Employer.

4.02.07 **Mixing Box:**

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU. Further, wherever return air is led back directly to AHU room, no mixing box is required.

4.02.08 **Pan Humidifier:**

Pan humidifier shall be made of 22 gauge SS 304 tank, duly insulated with 25 mm thick resin bonded fiber glass insulation (min. 24 Kg/m3 density) with 0.5 mm GSS cladding. The humidifier shall be complete with stainless steel immersion heaters, safety thermostat, float valve with stainless steel ball, sight glass, overflow and drain connections, steam outlet nozzle and float switch. Step controller shall be provided for switching on / off heater banks as per system requirement.

4.03.00 HI-WALL SPLIT/CASSETTE AIR-CONDITIONERS

4.03.01 Hi-wall Split/cassette air conditioners shall in general consist of the following:

i) Casing

ii) Hermetically sealed rotary/scroll Compressor

iii) Condenser and condenser cooling fan

iv) Evaporator along with fan

v) Cooling coil

vi) Filters

vii) Piping, valves, refrigerant strainer, etc.

viii) Controls, instruments, control panel/starter panels.

ix) Vibration isolator pads, etc as required.

x) Refrigerant as per manufacturer practice.

4.03.02 Indoor unit of Ceiling Mounted Cassette Type Unit (Multi Flow Type):

The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

Unit shall have four way supply air grills on sides and return air grill in center.

Each unit shall have high lift drain pump and very low operating sound.

4.04.00 **SPLIT/PACKAGED AIR CONDITIONERS**

4.04.01 Split/packaged air conditioners shall in general consist of following:

I. Casing
II. Compressor
III. Condenser
IV. Evaporator and condenser cooling fan
V. Cooling Coil
VI. Filters
VII. Piping, Valves, refrigerant strainer etc.
VIII. Control, instruments, control panel/starter panels.
IX. Vibration isolator pads, ducting (if applicable) etc as required.

5.00.00 EQUIPMENT DESCRIPTION - VENTILATION SYSTEM

5.01.00 Unitary Air Filtration

5.01.01 Each modular unitary air filtration shall consist of Casing, Tanks, Fans, Distribution plates, Moisture eliminator and water repellant type nylon filter with frame and support, Header and standpipe with support, Spray and flooding type nozzle. Screen type suction strainer, Pumps, Necessary controls & Instrumentation, and all other required accessories.

5.01.02 The housing/ casing of air washer unit shall be double skin construction. Double skin panels shall be made of 22G galvanized sheet on outer side and 20G galvanized sheet inside with 25mm thick polyurethane foam insulation of minimum 38 kg/cub. Mtr. Density in between. Frame work for section shall be joined together with soft

	rubber gasket in between to make the joints air tight. The entire fan section shall be mounted on rolled formed GSS channel frame work.
5.01.03	The unitary air filtration tank shall be fabricated from MS plate of minimum 6 mm thick and inside and outside surface of the tank shall be spray galvanized **(minimum 60 microns DFT).** Minimum depth of the tank shall be 600 mm. Tank construction shall be such that the suction screen can be replaced while the unit is operating. Tank shall be provided with overflow, drain with valve, float valve makeup connection with a gate valve backup, quick fill connection with globe valve etc. The overflow pipe shall be connected to drain pipe after isolating valve on drain pipe.
5.01.04	The distribution plate shall be fabricated out of 18G galvanized steel sheets & galvanized steel angle supports with minimum 50% free area.
5.01.05	Unitary air filtration shall be one-bank construction. All header and stand pipes shall be galvanised. Cat walks of suitable width shall be provided for maintenance of nozzle, filter etc.
5.01.06	The spray nozzles shall be of brass or bronze with chrome plating and shall be self cleaning type. The nozzle shall be designed to produce fine atomised spray and shall be properly spaced to give a uniform coverage of the air washer section. The pressure drop through the nozzle should be in the range of 1.4 to 2.4 Kg/cm2.
5.01.07	The eliminator plates shall be of 24G thick GS sheets class 275 or from 100% virgin PVC of minimum finished thickness of 2 mm. The eliminator section made of GSS shall have minimum six bends. The PVC eliminators shall be UV stabilised using Titanium di-oxide and shall withstand the weathering test as per IS:4892 for 500 hrs. Type test report of the compound testing carried out in any reputed laboratory shall be submitted for approval. All supports, tie rods and space bar shall be of either galvanised steel or PVC construction and shall be complete with suitable drip tray and drain pipe.
5.01.08	Air tight inspection doors of suitable size shall be provided for suction chamber. Spray chamber and fan suction for easy accessibility and maintenance and a water marine light be provided for each unitary air filtration.
5.01.09	Suitable number of brass screen shall be provided in the air washer tank to arrest the dirt entering the circulating water pump suction. Suitable GI grid shall be used inside the screen for reinforcement.
5.01.10	The specification for centrifugal fans shall generally be as indicated below. However, the fan shall be of DIDW type for UAF unit.
5.01.11	Saturation efficiency of Unitary Air Filtration units shall be minimum 60%.
5.02.00	**Centrifugal Fan**
5.02.01	The casing shall be of welded construction fabricated with heavy gauge galvanised sheet steel or MS sheet with spray galvanization (**minimum** 60 micron DFT). The minimum thickness of casing shall be 3 mm. It shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed air-tight. Split casings shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required. The impeller shall have die-formed backward-curved blades tie welded to the rim and back plate to have a non overloading characteristic of the fan. Rim shall be spun to have a smooth contour. If required intermediate stiffening rings shall be

provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts.

5.02.02 The bearing shall be self aligning, heavy duly ball, roller or sleeve bearing. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside.

5.02.03 Inlet guard shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanised wire mesh of 25 mm square.

5.02.04 Base plate with necessary number of spring type vibration isolators or ribbed neoprene rubber pad or cushy foot mounting shall be provided. The vibration isolators should have a minimum of 70% efficiency.

5.02.05 The first critical speed of the rotating assembly shall be at least 25% above the opening speed.

5.02.06 The fans shall be provided with V-belts and sheaves. All belts shall be sized for 150% rated HP. All V-belt shall be equipped with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. Motor rating (at 50 deg.C ambient) shall be atleast fifteen percent (15%) above the maximum load demand of drives at the design duty point.

5.03.0 Roof Ventilators (If applicable)

5.03.01 The roof extractors shall be “COWL” type.

5.03.02 Impeller shall be of axial flow type, cast Aluminium in one piece and dynamically balanced. Casing shall be heavy gauge sheet steel construction of 3 mm thick for impeller upto 750 mm diameter and 5 mm for fans with impeller of diameter 750 and above. In casing, access door with locking arrangement be provided.

5.03.03 The cowl shall be designed for weather protection of the fan also inside of the roof on which the extractor is installed. Galvanised bird screen of 15 mm Square be provided with the cowl. All accessories, steel supports as required will be provided.

5.03.04 The speed of the fan be limited as per limitation given above for axial fans.

5.03.05 All accessories rain protection exhaust hood, transformation piece, vibration isolators, steel supports vibration isolators, bird screen, etc. as required shall be provided.

5.03.06 The vibration level for fans shall be as per ISO: 14694.

5.04.00 Centrifugal Pumps

a)	Type	:	Horizontal Centrifugal, Axially or radial split type casing pump or end suction, top discharge horizontal centrifugal pump
b)	Impeller	:	Closed type
c)	Material of Construction		
	i) Casing	:	2% Ni Cast Iron : IS:210 Gr. FG-260

	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 316
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	Asbestos free
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm
	x) Other requirements	:	To refer to **Annexure-I** titled "Horizontal Pumps" of this sub section.

5.05.0 Axial Fans

5.05.01 These fans shall have fixed / variable pitch cast aluminum blades of aerofoil design.

5.05.02 The fan casing shall be of heavy gauge sheet steel construction.

5.05.03 Necessary rain protection cowl, inlet and outlet cones, bird protection screen, adjustable damper, vibration isolators, back draft dampers etc. shall be provided.

5.05.04 The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm for fan with impeller diameter of 450 mm or less. The first critical speed of rotating assembly shall be atleast 25% above the operating speed.

5.05.05 All other accessories like supporting structure etc. as required shall be provided.

5.05.06 Fans of capacity 1000 m^3/hr & lower shall be of propeller exhaust type.

6.00.00 BALANCE EQUIPMENT SPECIFICATION

6.01.00 **Material of Construction for Piping & Fittings**

a)	Piping for Chilled and Condenser water lines	:	Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 NB with thickness as indicated in **Annexure-II**
b)	Refrigerant piping :	:	Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).
c)	Drain piping	:	Same as (a) above & galvanized as per IS:4736.

d) Fittings : 1) The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above.

2) For sizes 50 NB and below, the material shall conform to ASTM A-105.

3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5

4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534.

5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5

6.02.00 **VALVES**

6.02.01 Valves shall have full sizes port and suitable for horizontal and as well as vertical installation.

6.02.02 Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.

6.02.03 All safety /relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

6.02.04 Valves shall be furnished with back seating arrangement for repacking while working under full working pressure.

6.02.05 Manual gear operators be provided for valves of size 200 NB and above.

6.02.06 All valves shall be supplied with companion flanges, nut, bolts & washers, etc.

6.02.07 The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.

6.02.08 Gate valves shall be of Cast Iron body (confirming to IS:210 Gr FG 220/equivalent) for sizes 65 NB and above conforming to fIS :14846. Gun Metal construction for sizes less than 65NB shall be as per IS:778. Butterfly valves shall conform to latest revision of BS:5155 or equivalent standard of required class/rating.

6.03.00 **AIR FILTERS**

6.03.01 **Pre Filter**

1) Type : Flange / Cassette

2) Pre-filter shall contain washable non-woven synthetic fiber or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium

expanded metal on exit side or G.I. wire mesh on both sides.

3) **Other requirements : (as applicable)**

a) Suitable aluminium spacers be provided for uniform air flow;

b) Casing shall be provided with neoprene sponge rubber sealing.

c) Capable of being cleaned by water flushing.

d) Density of filter medium shall increase in the direction of air flow in case of metallic filter.

e) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.

4) **Efficiency :**

Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76 / EN-779.

5) Minimum thickness : 50 mm

6) Face Velocity : Not more than 2.5 m/sec.

7) Pressure drop : Initial pressure drop - Not to exceed 5.0 mm WC at rated flow.

Final pressure drop - Upto 7.5 mm WC.

8) Location : a) At the suction of each AHUs

: b) At the suction of each Fresh air fan

6.03.02 **Fine Filters (Microvee type)**

1) Type : Flange / Cassette

2) Fine filter shall contain washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.

3) Other requirements :

a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame.

b) Capable of being cleaned by air or water flushing.

c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.

4) Efficiency : Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE–52-76 / EN-779.

5) Minimum thickness : 150 mm or 300 mm.

6) Face Velocity : Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.

7) Pressure drop : Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.

8) Location : i) At the discharge of each individual AHU.

ii) At the discharge of each Fresh air fan.

6.04.00 **LOW PRESSURE AIR DISTRIBUTION SYSTEM**

6.04.01 Material of air distribution system shall be through galvanized steel sheet (Conforming to Class 275 of IS :277) or Aluminium alloy (grade 19000 / SIC or 3100 / NS3 of IS:737). GI Sheets should be galvanized and galvanizing shall be of 275 gms/sq.m. (total coating on both sides) both for site fabricated and factory fabricated ducts.

6.04.02 **Thickness of rectangular ducts shall be as follows:**

Larger Dimension of duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet (mm)
up to 750 mm	0.63 (24 G)	0.80
751 to 1500	0.80 (22 G)	1.00
1501 to 2250	1.00 (20 G)	1.50
2251 & above	1.25 (18 G)	1.80

6.04.03 **Thickness of round ducts shall be as follows:**

Diameter of Round duct (mm)	Thickness of GI sheet(mm)	Thickness of Aluminium sheet (mm)
150 to 500	0.63	0.80
501 to 750	0.80	1.00
751 to 1000	0.80	1.00
1001 to 1250	1.00	1.50
1251 & above	1.25	1.80

6.04.04 **Duct Fabrication and Supports:**

a) Duct fabrication shall be as per the latest relevant BIS/SMACNA standard.

b) Ducts for A/C system may be **site fabricated or factory fabricated**.

c) The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams/roof beams/columns with provision of necessary auxiliary or special steel members or by hooks or can be provided by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder. Where ever ducts are running outside the building and or at locations where it is not possible to support the ducts from ceiling/floor due to non-availability of the same, the base steel frame/truss work and other auxiliary steel members, hooks, rods, etc. for supporting the duct work shall also be provided by the Bidder.

d) Where the sheet metal duct connects to the intake or discharge of fan units a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass.

e) All curves, bends, off-sets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.

f) Wherever duct passes through a wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space.

g) Wherever pipe hangers or rods pass through the ducts, light and streamline easement around the same shall be provided to maintain smooth flow of air.

h) Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.

6.04.05 Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control of system. The same shall be minimum 16 gauge GS

sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.

6.04.06 **Factory fabricated ducts :**

i) All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I.

ii) Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

iii) All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply:

a) Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

b) All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

c) All edges to be machine treated using lock formers, flangers and roll-bending for turning up edges.

d) Sealant dispensing equipment should be used for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for the ducts over 2" w.g. static pressure

iv) All transverse connectors shall be 4-bolt slip-on flange system with built-in sealant, if any. To avoid any leakage additional sealant shall be used.

v) Factory fabricated ducts shall have the thickness of the sheet as follows:

Sl.No.	**Size of Duct**	**Sheet Thickness**
i)	upto 750 mm	0.63 mm
ii)	751 mm to 1500 mm	0.80 mm
iii)	1501 mm to 2250 mm	1.00 mm
iv)	2251 mm and above	1.25 mm

6.05.00 Diffusers, Grills & Dampers :

6.05.01 Supply air diffusers/grills with factory fitted volume control dampers be provided for all air-conditioned areas.

6.05.02 Return air diffusers of air-conditioned areas shall be without volume control dampers.

6.05.03 The diffusers/grills shall be of extruded Aluminum of minimum 1.2 mm thick with powder coating. The colour of power coating shall be as per the interior décor.

6.05.04 Supply air grills shall be of double deflection type and return air grills shall be of single deflection type.

6.05.05 All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.

6.05.06 The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.

6.05.07 Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of Baffles wherever required shall also be provided.

6.05.08 Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.

6.05.09 All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames.

6.05.10 All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.

6.06.0 Thermal and Acoustic Insulation

6.06.01 A) <u>Application with Glass Wool / Rockwool</u>

(i) All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive (CPRX compound of Shalimar Tar Products / Loid bond 83 or Equivalent) be applied @ 1.5 Kg /Sqm on the surface.

(ii) Insulation material (either expanded polystyrene foam or Glass Wool/ Glass fiber / Rockwool) shall be struck to the surface. All the joints shall be sealed with bitumen.

(iii) Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side or alternatively aluminum foil can be used which can come as lamination over insulation.

(iv) Insulation Finish of types specified under shall be provided thereafter..

B) <u>Application with Nitrile Rubber</u>

(i) All surfaces to be insulated shall be properly cleaned.

(ii) A suitable adhesive such as SR 998 or equivalent shall be applied over the surfaces to be insulated and insulation material surfaces.

(iii) Insulating material shall than be pasted onto the surfaces in a manner to avoid stretching and any air entrapment within.

(iv) Two layers of Glass Cloth with a suitable adhesive as SR 998 or equivalent shall be then applied over the insulating material to avoid surface weathering.

C) <u>Application with Polyurethane Foam & Polyisocyanurate Foam</u>

i) All surfaces to be insulated shall be cleaned.

ii) A suitable adhesive such as CPRX or Loid Bond 83 or equivalent shall be applied over the surface to be insulated and insulation material surfaces.

iii) Insulating material with aluminum foil lamination shall then be pasted onto the surface in a manner to avoid stretching and any air entrapment within.

iv) Two layers of Glass Cloth with a suitable adhesive as Loid Bond 130 shall be then applied over the insulating material, to avoid surface weathering.

v) Insulation Finish of types specified under shall be provided thereafter.

6.06.02 **Type of Insulation & Finish**

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
1.	Supply & return air duct of AC System	Resin bonded glass wool or	Roll /Slab	50	F-3
		Closed Cell Elastomeric Nitrile Rubber	sheet	19	As per manufacturer std.
		or Polyisocyanurate Foam	Slab	30	F-3
2.	Refrigerant (Suction and liquid lines)	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
		or Rigid Polyurethane Foam	Pipe Section	50	F-1 (a)
3.	AHU drain pipe	Closed Cell Elastomeric Nitrile Rubber	tube	19	As per manufacturer std.
		or Rigid Polyurethane Foam	Pipe Section	50	F-1 (a)
4.	AHU condensate pan (insulation if required)	Mineral wool or resin bonded glass wool	Slab	25	As per manufacturer std.

Sl. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish (mm)
5.	Chilled water piping, valves & specialties	Resin bonded Mineral wool or resin bonded glass wool	Pipe section	75	F-1/F-3
		or Rigid Polyurethane Foam	Pipe Section	50	F-3
6.	Chiller (insulation if required)	---------- As per manufacturer std.----------			
7.	Chilled water pumps	Resin bonded Rockwool wool or resin bonded glass wool	Slab	75	F-1/ F-3
		or Rigid Polyurethane Foam	Slab	50	F-3
8.	Expansion tank with associated piping	Resin bonded Rockwool wool or resin bonded glass wool	Slab/ Pipe section	75	F-1/ F-3
		or Rigid Polyurethane Foam	Slab	50	F-3
9.	Acoustic insulation of duct	Resin bonded Glass wool	Slab	25	As per specifications
10.	Exposed air duct	Resin bonded Glass wool/Rockwool	Roll/Slab	50	F-4
		or Polyisocyanurate Foam	Slab	50	F-4(a)

6.06.03 **Specification for insulation shall be as follows: -**

Insulation Material	**Code**	**Thermal conductivity (w/m/^{o}C**	**Density Kg/m^3**
Resin bonded glass wool	IS:8183	0.049 at 50°C 0.043 at 50°C	i) 24 (For Glass wool) ii) 48 (For Rockwool) iii) 48(For acoustic insulation)
Mineral wool pipe section. Min.Gr.2	IS:9842	0.043 at 50°C	144
Closed Cell Elastomeric Nitrile Rubber		0.036 at 20°C	40 – 60
Polyurethane Foam Polyisocyanurate Foam	IS12436	0.03 at 50 ^{o}C 0.03 at 50 ^{o}C	34 $\pm$ 2 34 $\pm$ 2
Note : Insulation used for HVAC application shall be CFC/HCFC free			

6.06.04 **The specification for various finishes shall be as follows**

a)	**Finish F-1 (with Resin Bonded Glass Wool/Resin Bonded Mineral Wool)** Step-1 Wrapping of Poly-Bonded Hessain (PBH – to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or Equivalent compound.
	Step-2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.
	Step-3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thick, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.

aa)	**Finish F-1(a) (With Polyurethane Foam & Polyisocyanurate Foam)** Wrapping of two layers of 7 mil 10 x 10 mesh glass cloth dipped in suitable adhesive such as SR 998 or Loid Bond 130 equivalent
b)	**Finish F-2** Step-1 Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX/ Loid Bond 83 or Equivalent compound.
	Step-2 Same as Step-2 of Finish F-1 above.
	Step-3 Same as Step-3 of Finish F-1 above.
c)	**Finish F-3** Step-1 Same as Step-1 of Finish F-2 above
	Step-2 The polythene shall be covered with 26 gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.
d)	**Finish F-4** Step-1 Same as Step-1 of Finish F-1 above. Step-2 Same as Step-2 of Finish F-1 above. Step-3 Same as Step-3 of Finish F-1 above. Step-4 Application of 3 mm thick coat of suitable water proofing compound and wrapped with fibre glass RP tissue followed by final coat of 3 mm thick water proofing compound over the RP tissue. Step-5 After the above treatment, 22G Aluminium sheet cladding, properly stiched at all joints shall be provided over the external surface.
dd)	**Finish F-4(a) (With FR Closed Cell Chemically Cross Linked Polyethylene)** Application of aluminium sheet 22G cladding to be provided over the XLPE insulating material. Cladding sheet is held in position with SDST screws @ 150 mm C/c over tongue-in-groove joints applied with a felt for sealing joint against water ingress. All sheet joints to be done in a manner to shed water.

6.06.05 For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm and above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation by encasing the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is to be maintained.

6.06.06 **ACOUSTIC INSULATION**

a) All ducts up to a distance of 5 meters from AHU shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M. density and 30 gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre-to-centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.

b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be inline with the requirements specified above.

7.00.00 PLANT CONTROL

7.01.00 Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from employer. The descriptions in the sub-sections of the control & instrument sections shall also be referred to.

7.02.00 **Control Scheme for Air-Conditioning System**

7.02.01 Contractor shall provide microprocessor/PLC/GIU based control system for control and monitoring of air conditioning and ventilation system as per manufacturer's standard practice. Control and monitoring of air conditioning and ventilation system from FGD and ZLD (as provided) control system is also acceptable.

7.03.00 **Air Handling Unit**

a) Humidity sensor and gyserstat located in the return air duct shall actuate the PAN humidifier to obtain the desired degree of humidification.

b) Humidity and temp. sensor shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

c) Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (airstat - located in front of the each heater in the supply air duct)

d) AHU shall be started either locally or from the main control room of AC system by means of Remote / Manual selection facility.

e) The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Fire Detection System.

7.05.00 **Cassette /Hi-wall Split Air Conditioners**

Control and interlocks for these type of units shall be as per manufacturer's standard practice.

7.06.00 **Miscellaneous Control Requirements**

a) The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.

b) Relative humidity and temperature measurement of all control rooms and all major air-conditioned areas shall made be available in FGD and ZLD (as provided) control system

8.00.00 PAINTING:

8.01.00 All the Equipments shall be protected against external corrosion by providing suitable painting.

8.02.00 The surfaces of stainless steel, Galvanized steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting. The Contractor shall clean the external surfaces and internal surfaces before Erection by wire brushing and air blowing. 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.

8.03.00 For all the steel surfaces (external) exposed to atmosphere (outdoor installation), one(1) coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats of synthetic enamel paint, with 25 microns as thickness of each coat, shall be applied.

8.04.00 For all the steel surfaces inside the building (indoor installation), One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat shall be applied.

8.05.00 For centrifugal fans - Casing shall have hot dip/ spray galvanization (**minimum** 60 micron DFT).

8.06.00 However, for all parts coming in contact with acid fumes (in Battery rooms), a coat of epoxy resin based zinc phosphate primer of minimum thickness 30 to 35 microns followed up with undercoat of epoxy resin based paint pigmented with Titanium dioxide of minimum thickness of 25 microns shall be applied and a top coat consisting of one coat of epoxy paint of approved shade and colour with glossy finish of minimum thickness of 25 microns.

9.00.00 CODES & STANDARDS

9.01.00 The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.

9.02.00 Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

Annexure –I

GENERAL SPECIFICATION FOR HORIZONTAL PUMPS

1) **SCOPE**

This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2) **CODES AND STANDARDS**

The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

3) List of Applicable Standards.

IS : 1520 : Horizontal Centrifugal Pumps for clear cold fresh water

IS : 5120 : Technical requirements of roto dynamic special purpose pumps

API : 610 : Centrifugal pumps for general refinery service.

IS : 5639 : Pumps Handling Chemicals & corrosion liquids

IS : 5659 : Pumps for process water

HIS : Hydraulic Institute Standards, USA

ASTM-1-165-65 Standards Methods for Liquid Penetration Inspection.

In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

4) **DESIGN REQUIREMENTS**

a) The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve. The operating range of the pump shall be 40% to 120% of the duty point unless otherwise mentioned elsewhere. The maximum efficiency of pump shall preferably be within ± 10% of the rated design flow as indicated in data sheets.

b) The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of about 15% more than the design head.

Annexure –I

c) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

d) Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

Speed	Antifriction Bearing	Sleeve Bearing
1500 rpm and below	75.0 micron	75.0 micron
3000 rpm	50.0 micron	65.0 micron

The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment surface.

e) The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

f) The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

g) Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

h) The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

5) **DESIGN CONSTRUCTION**

a) Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.

Annexure –I

b) **Pump Casing**

Pump casing shall have axially or radially split type construction as specified. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

c) **Impeller**

Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled.

The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

d) **Impeller/Casing Wearing Rings**

Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

e) **Shaft**

The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

f) **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

Annexure –I

g) **Bearings**

Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 20,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

h) **Stuffing Boxes**

Stuffing box design should permit replacement of packing without removing any part other than the gland.

Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

i) **Mechanical Seals**

Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

j) The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

k) **Pump Shaft Motor Shaft Coupling**

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

Annexure –I

l) **Base Plate**

A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

m) **Assembly and Dismantling**

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

n) **Drive Motor (Prime Mover)**

The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

ANNEXURE-II

PIPING THICKNESS: Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The thickness as mentioned below are the minimum specified nominal thickness as per IS: 3589. Tolerance as code shall be applicable.

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

SUB-SECTION-I-M3

COMPRESSED AIR SYSTEM

COMPRESSED AIR SYSTEM

1.00.00	**SYSTEM DESCRIPTION**
1.01.00	The compressed air system shall consist of Air compressors & their motor drives, Air Drying (ADPs) Plants, air receivers for each Air compressors, instrumentation and control, control panels, compressed air piping, Instrument Air Piping network, service air piping network and Unit Instrument Air receivers (One for each unit)
1.02.00	A dedicated air receiver shall be provided near ZLD Plant to meet the instrument /service air requirement of ZLD Plant if the location of ZLD Plant is far away from compressor house.
1.03.00	Air from 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 common header to be provided to meet the service and instrument air requirement for FGD and ZLD Plant (as provided)
2.00.00	**SCREW AIR COMPRESSORS**
	The minimum requirements of design and construction features of various components of Compressed air system (screw type air compressor, air dryer, air receiver, etc.) are described below.
2.01.00	**CODES AND STANDARDS**
2.01.01	The design, manufacture, testing and performance of the various components of the Rotary Screw type Air Compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727 and CAGI).
2.01.02	Other International Standards like American/BS/DIN etc. equivalent or superior to above mentioned standards are acceptable. Where IS specification is not available, the equipment shall conform to one such International Standard, which shall be indicated in the proposal.
2.01.03	The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.
2.02.00	**DESIGN AND CONSTRUCTION**
2.02.01	The compressor shall be oil free multistage, horizontal, water cooled, rotary screw type, heavy duty, rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.
2.02.02	The rotor and shaft shall be of single piece construction, made of forged steel (AISI C1141 or equivalent). The stator (casing) shall be of Cast-Iron (IS-210 grade) Construction with integral jacket cooling. The rotors shall be dynamically balanced to reduce vibration.
2.02.03	The seal rings and retainers shall be of stainless steel construction and be free for radial self adjustment along the rotor shafts.
2.02.04	Bearings shall be high precision antifriction type IS- 25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement.
2.02.05	Lubrication system shall be as per manufacturer standard practices
2.03.00	**Gear Box**
2.03.01	Gears shall have a rating of AGMA-12 or equivalent. Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position.

3.00.00	**PERFORMANCE REQUIREMENT**
3.01.00	Air Compressors (screw /Centrifugal type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement as specified in the Data Specification Sheet.
3.02.00	The power rating of the driver shall be selected such that a minimum margin of **10%** is available over the power required to deliver rated capacity against rated pressure.
3.03.00	As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room.
3.04.00	Compressor frame shall have minimum 10% extra capacity. Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). Compressor shall be provided with IGV at the suction flange.
4.00.00	**INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW)**
4.01.00	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.
4.02.00	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.
4.03.00	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.
4.04.00	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.
4.05.00	Design pressure shall be 8 Kg/cm2 (g) or based on shut-off head of cooling water pumps.
4.06.00	The coolers shall be designed for maximum heat load and atleast 10 percent design margin shall be provided in the number of tubes.
4.07.00	Adequately sized safety valves shall be provided for both intercoolers and after coolers.
4.08.00	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.
4.09.00	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.
4.10.00	Cooler shells, channels and covers shall be of carbon steel (SA 285 Gr C / SA 516 Gr 70 / equivalent).Tube sheet shall be of Brass or SS and the tubes shall be of Admiralty brass or Aluminium brass or Copper or SS 304.
4.11.00	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.

5.00.00	**AIR RECEIVERS**
5.01.00	The design pressure and temperature shall be minimum 10 Kg/cm^2 (g) and 50 deg.C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.
5.02.00	Air receivers are to be provided with gasketted inspection manhole of minimum 500 mm diameter with cover plate, lifting handle, davit cap etc.
5.03.00	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.
5.04.00	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.
5.05.00	Each receiver shall be provided with drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves.
5.06.00	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.
6.00.00	**INTAKE AIR FILTER AND SILENCER**
6.01.00	Filters with multiple elements quick removal type for easy cleaning shall be provided at suction of each air compressor and also be of heavy-duty dry type.
6.02.00	The filters shall be complete with integral silencers. Separate silencers, if specified, shall be provided. The filtering elements shall be easily removable for cleaning.
6.03.00	The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.
7.00.00	**AIR DRYING PLANTS**
7.01.00	One number Air drying plant shall be provided for each air compressor. Drying shall be by adsorption process through a desiccant medium.
7.02.00	Air Drying (ADP) Plant may be of "Open Through type (Blower reactivated)" OR “Heat of (HOC) Compression type".
7.03.00	Regeneration of desiccant shall be achieved by "open through" or "Heat of compression" method without any air purge loss.
7.04.00	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".
7.05.00	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.
7.06.00	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.
7.07.00	Each ADP shall be provided with two (2) numbers of 100 percent capacity pre-filters and two (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.
7.08.00	The electric heaters (if required) (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.
7.09.00	Each electric motor driven blower (2x100% capacity for each ADP) shall be provided with individual dry type filters at inlet.
7.10.00	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.
7.11.00	The coolers/heat exchangers/ dehumidifiers of ADP shall be designed & constructed as per the requirements specified for “Intercoolers, After coolers & Oil coolers" above.
7.12.00	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.
7.13.00	Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.
714.00	Adsorption capacity and density to be considered for silica gel shall not be more than 10% and 550 kg/m^3 respectively. In case of activated alumina the same shall be 8% (max) and 900 kg/m^3 (max.) respectively.
7.15.00	In case of Heat of compression type, adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.
7.16.00	Complete ADP equipment shall preferably be mounted on a skid.
7.17.00	Required sample connections in piping be provided for sampling of air at desired locations.
78.18.00	Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided.
7.19.00	The material of Construction for various components of ADP shall be as as per manufacturer’s proven standard.

7.20.00	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 **"proven-ness criteria" in relevant sub-section of Part-A, of Technical Specification. The control & instrumentation requirements specified is applicable for such design also.**
8.00.00	**INTERCONNECTING PIPING, FITTING AND VALVES**
	The interconnecting 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.
9.00.00	**CONTROL PHILOSPHY**
9.01.00	**GENERAL**
9.01.01	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.
9.01.02	Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.
9.01.03	On tripping of working equipment, the standby equipment shall come into operation automatically in case of very low air pressure in the system.
9.01.04	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.
9.01.05	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.
9.01.06	The following indications shall be made available in the control panels for repeating the same in main plant Control System / Panels. (a) Status of each compressor (b) Instrument air pressure low/high (c) Service air pressure low/high (d) Dew point of instrument air (e) Status of each ADP
9.01.07	Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.
9.01.08	Unless otherwise mentioned in the relevant electrical sub-section, automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.
9.02.00	**Screw Compressor**
9.02.01	Each compressor shall be in the control panel to operate either in Base duty (Auto Load-Unload) or Standby duty (Auto On-Off) mode in case of Screw and unload/modulate/energy optimization (Auto Dual Mode) in case of centrifugal

9.02.02 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.

9.02.03 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 should start 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.

9.02.04 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.

9.02.05 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

9.03.00 Air Drying Plant

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

9.03.02 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.

9.02.03 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.

9.02.04 For rotary drum type Air drying plant, control philosophy as per manufacture's standard and proven practice is also acceptable.

10.00.00 **PAINTING**

All the equipments shall be protected against external corrosion by providing suitable painting.

The surface of SS, galvanized steel, Gun metal, Brass, Bronze and non-metallic components shall not be applied with any painting.

The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shot blasting etc as per standard procedure.

SUB-SECTION-I-**M4**

FIRE DETECTION & PROTECTION SYSTEM

FIRE PROTECTION AND DETECTION SYSTEM

1.00.00 GENERAL DESCRIPTION

1.01.00 A comprehensive Fire Detection and Protection System covering all the areas of the power plant including Employer's facilities/ system /buildings (if applicable) is included in the scope of the Contract.

1.02.00 The complete Fire Detection and Protection Systems shall be as per the guidelines/ codes/ standards / rules of TAC/ NFPA / IS: 3034 / OISD etc. and all the systems, equipments and installation shall be got approved from TAC accredited professional(s)-India.

2.00.00 HYDRANT SYSTEM

Hydrant system shall consist of piping, hydrant valves, landing valve, water monitors, hoses, branch pipes, nozzle, hose boxes, etc.

2.01.00 **Areas to be Covered**

Complete FGD area, ZLD area (as provided) and other auxiliary buildings / areas under the scope of the Bidder.

3.00.00 HVW AND MVW SPRAY SYSTEM

3.01.00 **General**

It shall consist of: Spray pumps, pressurization arrangements, water mains network, deluge valves, alarm valves, flow switches, isolation valves, Y-type strainers, spray nozzles/projectors, spray nozzles piping network, detection system, instrumentation, local control panels, cables etc.

3.02.00 **Areas to be covered by HVW Spray System**

i) All transformers For FGD and ZLD (as provided) System having oil capacity above 2000Ltrs & located with-in plant boundary.

3.03.00 **Areas to be covered under MVW Spray System**

i) All cable galleries/ cable vault/ cable spreader room in Bidder scope of work under FGD and ZLD (as provided) System.

4.00.00 FIRE EXTINGUISHERS AND FIRE STATION EQUIPMENTS

4.01.00 **Fire Extinguishers**

As indicated in Bidder's Scope, Part-A.

5.00.00 FIRE DETECTION, ALARM AND CONTROL SYSTEM

5.01.00 **Codes and Standards**

a. The design, manufacture, testing, performance, etc. of the various components of the analog addressable Fire Detection and Alarm System shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

b. Unless otherwise specified, the Fire Detection and Alarm System and the components shall conform to the latest applicable Indian or IEC Standards. Equipment complying with any other authoritative National Standards such as British, USA, VDE, etc. will also be considered, provided the parameters specified are equivalent or better than the corresponding IS.

c. The Contractor shall be solely responsible for obtaining the required approval and clearance for the different components and systems of the Fire Detection and Alarm System from the following authorities, as applicable:

i. Department of Atomic Energy (Certification of safety from Radioactivity).

ii. Central Building Research Institute, Roorkee.

iii. Central Mining Research Station, Dhanbad.

iv. Local Fire Authorities.

d. The equipment and the system shall be of types approved by any of the following bodies, as applicable:

1. Loss Prevention Council, (LPC), U.K.
2. National Fire Protection Association, (NFPA), USA
3. Under-writers laboratories, (UL), USA
4. Factory mutual(FM)

5.02.00 **Areas to be covered under Fire detection and alarm System**

a) **Multisensor type detection system (Above and below the false ceiling or below the false flooring as the case may be)**

i) All switchgear / MCC/battery rooms of FGD and ZLD (as provided) control room building, various auxiliary buildings (if applicable), etc.

ii) Cable galleries of FGD and ZLD (as provided) control room building protected by MVW spray system. Further, multisensory detectors shall also be provided inside all cubicles/panels of control room, control equipment room and UPS / Battery charger areas.

iii) Above and Below false ceiling areas of all air-conditioned rooms of FGD and ZLD (as provided) control room building, various control rooms of auxiliaries as defined in Sl. No. (i) above and return air ducts of inert gas protected areas.

b) **Linear heat sensing cable detection system**

Gypsum and lime conveyor of FGD system and Cable Galleries covered under MVW Spray System.

c) **Quartzoid bulb heat detection system**

Equipments protected by HVW spray system, conveyors protected by MVW spray system.

5.03.00 General requirements for all types of Detectors

5.03.01 Detectors shall be housed or mounted in suitable enclosure in such a way that their performance is in no way affected. Special maintenance procedures if any required for the satisfactory operation of the detectors shall be clearly stated in the bid.

5.03.02	Necessary mounting accessories shall be provided for all the detectors.
5.03.03	In case the detectors are offered with their output (on sensing a fire) in the form of an electrical contact, it shall be noted that the contact shall be 'NC' type such that under fire conditions, this contact will open to initiate the fire alarm system.
5.03.04	Detectors shall preferably be designed as plug-in units, which fit into various bases according to place and type of mounting. This would also enable interchangeability.
5.03.05	Detectors shall be provided with the necessary compression type cable terminating glands for the incoming cables of flameproof type or PVC/metallic flexible/rigid conduits.
5.03.06	Depending upon the environmental conditions in which detectors are installed, chlorinated rubber based or epoxy or equivalent paint shall be used for finishing the surface of the enclosure.
5.03.07	The coverage or the zone of protection afforded by the detector and recommended height of mounting shall be furnished by the Bidder. The bidder shall furnish the test certificate in support of this.
5.03.08	Any metal parts used for detector construction shall be inherently resistant to corrosion or shall be plated or otherwise suitably treated to afford protection against corrosion. The plating or treatment shall in no way affect the detector performance.
5.03.09	Any plastic material or any sealing compound used in the detector shall be such as it will not deform or fail under the maximum temperature to be expected.
5.03.10	No detector shall contain any moving parts subject to wear and tear and must be able to operate afresh after each alarm release, without its exchange or adjustment.
5.03.11	The detector shall be located where the largest combustion gas concentration can be expected.
5.03.12	Adequate compensation and considerations shall be made for effects for wind velocities such as air-conditioning system and exhaust fans where dilution of particles of combustion is greater.
5.03.13	The exact location of detectors shall be coordinated with other services like air-conditioning grills, light fittings, cable trays etc. to provide aesthetically pleasing appearance. The return air paths of air-conditioning shall be avoided for detector location.
5.03.14	The detectors shall not be affected by temperature, humidity; air flow or by drift failures and shall not give any false alarm due to above.
5.03.15	The detectors shall not be sensitive to vibrations. Any special mounting arrangements required to counteract vibration shall be included in the contractor scope.
5.03.16	The quantity of multi- sensor detectors in each zone shall be based on the coverage factor of 25-sq. meter per detector. However the actual quantity of detectors required, taking into consideration obstructions due to floor beams, ventilation, doors, windows etc., shall be worked out and supplied (based on the actual layout) and installed by the contractor.
5.03.17	The detectors shall not give false alarm due to high humidity, temperature, and velocity of air in the surroundings and static electricity conditions.

5.03.18 Process actuated switch devices such as pressure switches, flow switches, level switches, etc. shall be provided with suitable individual addressable interface (local or remote) units or modules so that these devices are addressable from the panel.

5.05.00 **Linear Heat Sensor Cables**

Application	Detection of Stationary fire
Type	Digital
Operating voltage	24 V DC
Approval	FM/UL
Conductor material	Steel
Insulation	Heat sensitive polymer
Outer Sheath	Black or colored PVC or flouropolymer suitable for the application environment

Installation features for LHSC

1. Mounting arrangement have been indicated in tender drawing.
2. The detection zone/loop divisions of LHSC system shall match with MVW spray zones. Conveyors where LHSC shall be installed shall be divided into no. of various zones whereas conveyor for which IR detector is installed shall be considered as one zone.
3. Linear heat sensing cable detector shall run in a zigzag fashion (with an included angle of 90 deg) on each top cable tray, bottom tray and every alternate intermediate trays of each section of cable tray without undue sagging and interfering the normal operations. All supporting materials for mounting of LHSC shall be provided by the bidder.

5.06.00 **Addressable Analog Intelligent Detectors**

In addition to the features specified under the item General requirements for all types of Detectors, the Addressable Analog Intelligent Detectors shall be provided with the following features:

a) Detectors not specifically listed for sensitivity testing from the control panel are not acceptable due to the expense involved with manual testing as required by NFPA 72E.

b) The detector shall be suitable for two-wire operation and two-way communication on the intelligent analog signaling circuit.

c) The detector shall display a steady LED when in the Alarm State. The LED shall flash when in stand by or normal mode.

d) Each detector in a loop shall have short circuit isolator suitable for style-7 wiring as per NFPA-72.

e) Address and sensitivity assignments shall be set preferably electronically. However, dip switches / rotary switches for the same are acceptable. The detectors shall be assigned a sensitivity level based on environment, time of day or any programmable function as required by the system user, and shall respond at that level whether in the "on line" or "default" mode.

f) The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system.

g) The detectors furnished shall be listed for use in environments as covered by Factory Mutual and UL and shall be installed according to the requirements of NFPA 72E for open area coverage.

5.07.00 **Multi sensor Detectors**

5.07.01 Multi sensor detectors shall incorporate a heat detection element and a photoelectric detection element. Both the elements shall be incorporated in a single unit. Both the elements shall be operative at all times and the fire signal shall be available from any or both elements combined together.

5.07.02 The detectors shall be sensitive to very low smoke densities of the order of say 0.05 g/m^3. Also it shall be possible to adjust this sensitivity on a step less basis over a range so that the optimum sensitivity could be selected at site to suit the conditions of installations. The coverage area of the smoke detection under standard NFPA test conditions shall not be less than 80-90m^2.

5.07.03 The detectors shall be complete with a mounting base that includes a terminal box into which the detector can be plugged in. Terminals for looping of the cables shall be provided.

5.07.04 All detectors shall be provided with built-in response and indicating lamps which shall give local visual indication, when it has operated in dense smoke conditions. The failure of lamp shall not prevent the function of detector.

5.07.05 In areas such as false ceiling where detectors themselves are not easily accessible, the remote response indicators outside the enclosed areas shall be provided to indicate the fire condition.

5.07.06 It shall be possible to replace any type of detector head by a different type detector without requiring change in cabling/panel wiring and condition of the zone, originally covered by the detector.

5.08.00 **System Configuration**

5.08.01 The Addressable Fire Alarm panel shall be able to communicate with repeater annunciation panel located at different places. The detectors or other devices of any other unit/area shall be addressable only from the respective Addressable Fire Alarm Panel, so that each of the Addressable Fire Alarm Panel is under the control of designated operating personnel at that location.

5.08.02 At least one spare loop shall be provided in each of the addressable type fire alarm panel located in FGD and ZLD (as provided) control equipment room with complete loop card and all other accessories so that Employer can expand the system in future. Further, at least 10% of loop capacity be left free in each of the connected loop in all the panels, so that, additional devices may be connected to the system in any of the loop by Employer in future.

5.08.03	FGD and ZLD (as provided) Fire alarm system shall be provided with necessary interface hardware and software for communicating fire alarms from this fire alarm panel to the main plant fire alarm control panel through potential free contacts.
5.09.00	**Analog Addressable Fire Detection and Alarm System**
5.09.01	General Requirements
5.09.02	This specification in general covers the functional requirements, and general design aspects of Microprocessor based, Analog Addressable Fire Detection Alarm / Annunciation and Control System.
5.09.03	The following description intends to describe only the brief hardware and functional requirements, scope of hardware requirements etc. but the actual configuration of the system shall be in line with the prevalent normal practices in the industry and shall conform to latest product range of selected manufacturer. The fire detection and control system offered shall be complete in all respects for the safe and reliable operation of the entire system. Any additional hardware/software than those mentioned herein required to make the system complete shall be included in the scope of the Bidder.
5.09.04	All the system and its equipment specifically detectors, interface modules, panels, power supply, battery chargers etc. shall be furnished from a single source and the same shall be new and latest state of the art products of manufacturer engaged in the manufacture of Integrated Microprocessor based Analog Addressable Fire Detection and Alarm System.
5.09.05	All equipments such as detectors, panels etc shall be approved and listed by UL/FM/LPCB/VDS.
5.09.06	All types of smoke detectors shall be of analogue addressable type. Conventional detectors with interface modules are not acceptable. Each zone of LHSC detector and each IR detector shall be provided with interface module.
5.09.07	All the fire detection systems, process actuated switch devices such as pressure/flow/temperature switches and relays of control functions shall be hooked up with the analogue addressable fire detection and alarm system. Required addressable interface units shall be provided for various switch devices by the bidder to make them addressable.
5.09.08	The wiring shall be of class-A as per NFPA-72.
5.09.09	Bidder shall provide isolators at the start & end of the loop.
5.09.10	The complete system shall include, but not be limited to the following : a) Master system CPU. b) Analog Addressable Fire Detection and Alarm System panels including alarm modules, system supervisory control modules, auxiliary output control modules etc. c) Power supplies, batteries and battery chargers. d) Analog addressable type smoke detectors.

e) Non addressable type conventional detectors (Linear heat sensing cable detector/ infra red type heat detector) and switching devices each with its own addressable interface modules.

f) Software and hardware as required for complete operation of the system.

g) Complete Wiring/cabling including its conduits/trays/fixtures etc.

i) The fire alarm control panel shall function as a communication interface between central processing unit and sensors. This panel shall have facility to process the input signal and to control all the input data received from initiating and indicating devices.

j) Fire alarm control panel shall have filters to ignore false alarm and increase sensitivity to real fire from sensors. The sensitivity of each detector should be automatically raised if detectors are gradually polluted due to dust and dirt entering inside the detector. If detectors are more polluted the control panel shall give a warning. The trouble report shall indicate the location of device requiring service.

k) Fire alarm control panel shall have printer to print out the alarm/ trouble occurrences.

l) The CPU shall serve as the systems central processor. Software shall be designed especially for fire alarm annunciation system applications and shall monitor status of processing alarms according to priorities, controlling/processing communications and synchronizing all system activities.

n) The system shall be able to recognize and indicate an alarm condition in a degrade mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.

o) All devices shall be individually identifiable for its type, its zone location, alarm set value, alarm and trouble indication by an unique alpha numerical label.

p) The software logic modules and system database shall be programmable using a MS - Windows compatible program (latest version) on PC at site and required hardware shall be included in scope of supply. The system software programme shall be password protected and shall include full upload and download capability and during program upload or download through the PC, the capability of alarm reporting shall be retained. The software shall be downloaded to a PC for editing. The software shall enable Employer to add the spare loop provided in the fire alarm panels or addition of additional devices/detectors in any of the fire alarm panel.

q) The system shall support the use of Color Graphic display terminal for the display of information in an appropriate format.

r) The system shall include software for system data base, historical event log, logic, and operating system. The system shall require no manual input to initialise in the event of a complete power down condition. It shall return to an on line state as an operating system performing all programmed functions upon power restoration.

s) Activation of any fire alarm initiating device shall display (LCD alpha numeric display) message in describing the device originating the alarm condition at the Central monitoring station, at alarm panel, simultaneously at the repeater annunciation panel and shall initiate the associated protection systems & other related control functions. Similarly activation of any supervisory circuit, (supervised

valve closure, air pressure abnormal, fire pump trouble, water pressure low, etc.) or receipt of trouble report (primary power loss, open or grounded initiating or signaling circuit wiring, battery disconnect etc) shall display at the fire alarm control panel the origin of supervisory condition or origin of trouble condition as the case may be. It shall also record the occurrence of the event, the time of occurrence and the device initiating the same.

t) System configuration shall be menu driven and capable of being operated by, a person with no previous computer programming experience.

5.10.00 **System Functional Requirements**

5.10.01 The fire alarm panel shall evaluate the signals received from the detectors and shall handle the following functions:

1. System self monitoring and fault signaling.
2. Transmission of alarm and fault signals to the respective fire alarm panels and as well as in the repeater panel in fire station. Further, the panel shall activate a hooter/sounds in each of the area locally provided with fire/smoke detection system. Further, the system shall enable operation of spray system from the panel through monitoring station when the system operation is selected under remote, manual mode.
3. Initiate control functions like stoppage of conveyor, closure of fire doors, shutdown of draft fans, air-conditioning and ventilation plant/ equipment, opening smoke extraction vents, switching on smoke extraction equipment, emergency lighting etc.
4. Triggering stationary extinguishing systems such as clean agent system.
5. Supervising of unauthorised removal of a detector head from its base and giving a fault alarm on the control panel.
6. Supervising and monitoring the detection cabling, to indicate fault conditions in case of open/short circuit in the wiring.
7. Supervising by a separate annunciation window, changeover from mains supply to battery supply. “Mains On” indication shall be continuously on, as long as the main supply is available.
8. Facilitating simulation of fire conditions to enable the testing of circuits (without creating actual fire) under the test mode from the fire Alarm panel.
9. The control unit shall contain all the systems main switches lamps and fuses. Switches and lamps shall be easily identified even in closed casings.
10. All the circuits from the detectors to the panels and the circuits from panels to the actuating/operating devices of the respective extinguishing system shall be of closed loop type and shall be supervised for open-circuiting and short-circuiting of cables. The cable fault shall be audio-visually annunciated on the panels. Separate hooters with different tones shall be provided for ‘fault’ alarms and ‘fire’ alarms.
11. Actuate solenoid valve in spray system in case of fire from respective fire alarm panel. For achieving this if any additional hardware is required like relays, power supply and cables, the same may be provided.

5.10.02

Analog Addressable Fire Detection and Alarm System shall also meet the following functional requirements:

i. Each of the system shall support analog addressable detectors of all types, non-addressable type detectors/devices along with its addressable interface units/modules, Video display units etc.

ii. Each of the devices and/or detectors shall be individually, uniquely and continuously addressable by the panel to which it is connected.

iii. Detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning and tested by a single technician using the field test routine. Sensitivity of each of the detectors made available in the panel shall be adjustable from the panel.

iv. The system shall be capable of self-adjustment to compensate for the accumulation of contaminants that would change the detector sensitivity in either a more or less sensitive direction to prevent false indications or failure to alarm in the actual fire conditions. The system shall annunciate a trouble condition when any analog addressable smoke detector reaches 80% of its alarm threshold due to gradual contamination, signaling the need for service and eliminating unwanted alarm.

v. Continuous supervision/monitoring of all the circuits and its components shall be made available from the panel for open, short circuits and grounding.

vi. The system shall be able to recognize and indicate and alarm condition in a degraded mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.

vii. The system shall be programmable at site and required hardware shall be included in the scope of supply. The system software Programs shall be password protected and shall include full upload and download capability. During program upload or download the system shall retain the capability for alarm reporting. The system shall download to a PC for program editing. The software shall eligible employer to add the spare loop provided in the fire alarm panel or addition of additional devices/detectors in and of loop in any of the fire alarm panel.

viii. The system shall support the use of color interactive History Reporting video display terminal for the display of information in an appropriate format.

ix. The system shall include software for system database, historical event log, logic and operating system. The system shall require no manual input to initialize in the event of a complete power down condition. It shall return to an on line state performing all programmed functions upon power restoration.

x. Software logic modules and system database shall be programmable using a windows compatible program on PC. It shall be possible to program or edit the system database off site after down loading from the panel.

xi. All detectors shall incorporate internal automatic temperature compensation to overcome the effects of either high or low ambient temperatures in the installed environment on the detector sensitivity. The detectors shall be tested at a specified frequency by raising the detector sensitivity level to the alarm threshold, to check the operation of the detector without system alarming

automatically by the control panel.

xii. In an alarm or trouble condition the following shall occur on the monitoring station:

1. Sound an audible.
2. Write details of the actuation to a system log file on the PC.
3. Print the details of the actuation to the system printer.
4. Activate the color graphic display system controls, providing functions such as zooming, scrolling of Alarms, troubles, etc.

xiii. System configuration shall be menu driven and capable of being operated by a person with no previous computer programming experience.

5.11.00 **Panel Display Requirements.**

System display shall consist of minimum 80 character back lighted alphanumeric LCD display readable at any angle. Thirty-two character customer defined custom messages shall describe the location of the active device. In addition to the above, the following features shall be available.

a. The system shall be capable of programming to allow troubles occurred and restored in the system to be automatically removed from the display queue, eliminating the necessity for individual acknowledging of these events. This feature shall not affect the historical logging of events as programmed.

b. As a minimum an LED display for “Alarm”, “Audible Silenced”, “Supervisory”, “Trouble”, “Security”, “Power On”, And “Partial System Disabled”.

c. Touch activated membrane switches for “Alarm Acknowledge”, “Audible Silence”, “Supervisory Acknowledge”, “Security Acknowledge”, “Reset”, “Display Hold”, And “Display Next”.

d. All membrane switches shall be tactile with audible feedback when pressed.

5.12.00 **System Software Requirements**

i) The software shall control the operation, function and display of the graphic system and provide for automatic boot up and run from the hard disk drive of the computer.

ii) All project specifics actuating device programming shall be capable of being carried out on site via password access.

iii) The system shall monitor all alarm, supervisory; trouble and security conditions detected by the fire alarm control panel and provide separate disk based files, for each condition. These logs may be enabled, disabled, or cleared with password access.

This log information is not to be lost upon power failure or fire alarm control panel reset. A utility file shall be provided to sort the log data by date or by device and display this information either on the screen or the system printer.

iv) Selective memory storage up to 800 events, shall be stored in flash memory and displayed, printed or downloaded by classification for selective event reports.

a. Software shall allow selection of events to be logged, including; inputs as alarms, troubles, supervisors, securities, status changes and device verification; out puts, as audible control and output activation; action, as reset, set sensitivity, arm/disarm, override, password, set time and acknowledge.

b. Audible and visual indications shall be generated when memory is 80% and 90% full to allow downloading of data. The system shall be programmable circular logging, assuring that at least the last 400 events will always be stored in non-volatile memory.

v) Software has driven logic for adjusting the alarm threshold windows on detectors to compensate for accumulating contamination and keep detector response sensitivity constant. The software shall compensate for either over-sensitized or desensitized units, raising a system flag when a detector approaches the allowable limits of adjustment, indicating a requirement for cleaning.

a. Values shall be stored in non-volatile memory allowing activation of all tracking functions within 90 sec of system initiation from a "cold boot". During the boot sequence, alarms from detectors programmed with the feature shall be suppressed.

When the full data history is active all devices shall be checked and any active alarms displayed.

b. The control panel shall place each detector in the system in an alarm condition, transparent to the system user, every twenty-four hours as a dynamic check of the accuracy of the alarm threshold setting. Upon reception of the alarm report, the system detector shall be restored to its pretest state.

c. The system shall be capable of monitoring the stage of detectors and displaying a message when a detector is approaching the limits of adjustment as a result of contaminates. A second message shall be displayed when the detector reaches the limits of adjustment due to these contaminate.

d. The system shall be capable of recognizing that a detector has been cleaned, initiating a series of tests to determine if the cleaning was successful and display a detector cleaned message, readjusting that detectors normal sensitivity setting reference.

vi) When an alarm or trouble is registered at the fire alarm control panel the graphics system shall display the first screen image for the first actuated device. The system shall be capable of zooming in for further information if required. At all times when in the alarm or trouble mode the fire control panel status i.e. number of current alarms and or troubles is to be displayed on the graphics screen.

5.13.00 **Power Supply for Fire Alarm Panels & Repeater Alarm Panel**

5.13.01 One set of 24V DC redundant power supply system comprising of 2 x 100% chargers and 1 x 100% batteries shall be provided for fire alarm panel and repeater alarm panel. The

batteries for fire alarm system shall be sealed maintenance free lead acid type. The battery backup for each fire alarm panel and repeater alarm panel shall be 24 hours and 30 minutes (in alarm conditions). At least 25% of the devices shall be considered to be active in alarm conditions. Each of the redundant chargers shall be sized to meet connected load requirements and keep the connected batteries full charged (Float Mode). Furthermore, the charger shall be sized to enable the boost charge of a fully discharged battery in 10 hours while feeding the load.

5.13.02 The batteries shall be sized as per relevant IEEE standard. For battery sizing calculation, an aging factor of 0.8, a temperature correction factor (based on temperature of 4 deg. C), voltage drop of 2V in cables. Capacity factor, Float Correction Factor, as per Battery Supplier Standard, shall be taken into consideration, if applicable and ambient temperature shall be considered as the electrolytic temperature. The sizing of the battery shall be as approved by Employer during detailed engineering.

5.13.03 The battery chargers and batteries shall be placed at a suitable location inside the fire alarm panel with partitions.

5.13.04 The detailed specification related to power supply system of fire detection & protection system shall be as specified in other sections of the technical specification.

5.14.00 **Control & Instrumentation requirements**

5.14.01 Not Used.

5.14.02 Not Used.

5.14.03 The specification related to Basic design criteria, Measuring Instruments, Process connection & piping, Control panels, Type test requirements etc shall be as specified in other sections of the technical specification.

5.15.00 **Cabling for fire alarm system**

All instrumentation cables twisted & shielded, FRLS PVC insulated and sheathed data highway / fibre optical cables, short term fire proof cables including prefabricated cables (with plug-in connectors) etc shall be provided by Contractor.

The contractor shall follow the cable philosophy as below:

Application		Type of cable
From	**To**	
PLC cabinets	PC, Printers etc.	As Mfr.'s Standard. However, connection between PLC and the remote I/Os shall be through fibre optic cable by Bidder if length is>300 M & coaxial cable if length<300 M
Detectors (including detectors mounted inside panels) /Any loop device	Detector (including detectors mounted inside panels) / Isolator/ Interface unit	Shielded, Twisted, PVC Cu. FRLS cables type "S" Refer Note 2, 3, 4 and 5 below.
Detectors (including detectors mounted inside panels) / Isolator / Interface Unit	JB	Shielded, Twisted, PVC Cu. FRLS cables type "S" Refer Note 2, 3, 4 and 5 below.

JB	Fire alarm Panel	Shielded, Twisted, PVC Cu. FRLS cables type "S" Refer Note 2, 3, 4 and 5 below.

Notes:

1. 10% spare pair shall be provided for all cables having more than four pairs.
2. Type "S" cable shall be multicore control cable having overall shielding & specification similar to instrumentation cable except insulation thickness and voltage grade which shall be 1100 V. Type "S" cable shall also satisfy requirements of Article 760 of NFPA 70.
3. Over and above, contractor may note that short term fire proof cables shall be provided for coal handling plant and inert gas protected areas. Short term fire proof cables shall be Mineral insulated copper conductor and copper sheathed type satisfying requirements of Fire resistance, safety in the industrial application areas mentioned in the specification and also, shall be approved by UL standards and certified by LPCB. The contractor shall provide all the cables so as to complete the system
4. Cable size of 2 core 1.5 sq.mm shall be used for loop wiring in-case of both control cable and short term fire proof cable.
5. Cable size of 2 core 2.5 sq.mm shall be used to provide power supply to various devices in the loop in-case of both control cable and short term fire proof cable.
6. The detailed specification of instrumentation cables and optical fiber cable shall be as specified in other sections of the technical specification.
7. Detector cables outside the building shall be corrugated steel taped armoured laid through cable trays wherever available and for rest of the areas, cable shall be buried at 600 mm depth with sand filling and brick covering at the top.
8. Detector cable within the building shall be either unarmoured & laid through galvanized iron (GI) conduits or armoured cables, as per the standard and proven practice of the manufacturer.

5.16.00 **Detection System for Conveyors**

i) **Linear Heat Sensor Cables:**

a) The LHS cable detector for each conveyor to be provided for both forward and return conveyors and shall be mounted as per the standard practice of the manufacturer/ supplier. Suspension of LHSC through flexible chains is a preferred arrangement. Further, LHS cable shall also be provided for return side of conveyors inside the bunker house.

b) The detection zone/loop divisions of LHSC system shall match with the MVW spray system.

c) Upon detection of fire either by QB detector or LHSC detector, the spray system shall be initiated. It shall also initiate spray system for the two adjacent zones after a time delay settable at site.

d) The LHSC detector shall be provided with suitable interface unit, which shall generate/ make the signal compatible with fire alarm panel.

(e.) Type: Digital, Operating Voltage: 24V DC, Conductor Material: Steel, Approval: FM/UL

5.17.00 **Detection System of Cable Galleries**

i) In cable galleries, MVW spray system shall be actuated either by detection of fire by Linear Heat sensing cable detectors or by fire signal from Multisensor detection system. Apart from the automatic operation of spray system in the detected zone, the adjacent two zones shall also be sprayed with water automatically after a set time delay simultaneously.

ii) LHSC detector shall run in a zig-zag fashion (with an included angle of minimum 90° atleast) in each of the top tray, bottom tray and in every alternate trays. The mounting arrangement of LHSC detector shall be as per manufacturer's standard practice.

iii) The detection zone/ loop divisions shall match with MVW spray zones.

5.18.00 **Multisensor Detection System**

i) Upon detection of fire, multisensor detector shall be annunciated in the respective panels and shall activate a local hooter/sounder in the areas where fire is activated and this fire signal shall be employed to initiate the fire extinguishing system of that area such as automatic MVW spray system of cable galleries, fire extinguishing system of Control rooms/Control Equipment Rooms.

ii) Cross zoning of the signal from two adjacent multisensor detectors shall be employed to initiate the fire extinguishing system of inert gas protected areas and MVW spray system of cable galleries.

iii) Multisensor detector shall be provided for return air ducts of main plant, which shall consist of intake probe, detector housing, and exhaust pipe etc. The detector shall be mounted outside the duct.

iv) The design coverage area for detectors (to be considered) shall not exceed 25 Sq.M. for each detector.

6.00.00 PIPING AND VALVES

6.01.00 **General Data for Pipes etc.**

i) Mild steel as per IS:1239 (Part-I) medium grade (upto 150 NB) & as per IS:3589 Gr 410 (above 200 NB) or Equivalent for pipes normally filled with water.

ii) Mild steel as per IS:1239 (Part-I) medium grade (upto 150 NB) & as per IS:3589 Gr.410 (above 200 NB) or Equivalent and galvanised as per IS:4736 for pipes normally empty and periodically charged with water and foam system application.

iii) Pipe protection shall be as follows :

To prevent soil corrosion buried pipes / pipes in trench shall be properly lagged with corrosion protective tapes of coal tar type as per IS:15337 or AWWA C 203. The total thickness of protective tapes to be applied on buried pipes / pipes in trench shall be 4.0mm. This can be achieved by using 4.0mm thick tape in single layer or 2.0mm thick tape in double layer.

iv) Pipe thickness:

a) For Pipe sizes upto 150 NB and above: As per IS:1239 Part-I medium grade.

b) For Pipe sizes 200 NB and above refer Annexure-I.

v) All valves shall be as per applicable IS/BS codes & approved by TAC for specific fire protection system and shall be provided with locking arrangement (with locks) in open or close condition. Further, all gate/butterfly valves of size 200 mm & above shall be provided with spur gear reduction unit.

vi) All the flanges and counter flanges shall conform to ANSI B 16.5 Cl 150.

vii) Strainer Body as per IS:2062 (tested).

viii) Pipe Fittings

1) The material shall conform to ASTM A 234 Gr WPB or ASTM A 105 or equivalent and dimensional standard conforming to ANSI B 16.11 (socket & threaded type), ANSI B 16.9 (for butt welded fittings) and ANSI B 16.5 (for flanges and flanged fittings) as the case may be. Further, galvanised malleable cast iron fittings as per IS:1879 in Cast iron fitting as per BS-1641 are also acceptable.

2) **Grooved couplings :** Vendor may also use mechanical grooved couplings type fittings in GI pipe lines for HVW / MVW spray system. All materials and products shall be either Underwriters Laboratories (UL) Listed or Factory Mutual (FM) Approved and installed in accordance with NFPA Standard 13 / equivalent Standard.

3) The fittings shall be galvanised as per IS : 4736 for galvanised pipe application. In case of branching connections from GI mains for spray piping network, socket may be welded for more than two pipe reduction instead of standard tees.

4) Fabricated fittings shall not acceptable up to pipe size to 300 NB. For sizes 350 NB and above, fittings may be fabricated as per BS:2633/BS:534.

ix) Welding of galvanised iron pipes/fittings would be permitted provided the same is carried out by means of special electrodes suitable for the above application and the same shall be approved by Employer. After, welding, welded portions shall be applied with three coats of zinc silicate treatment/rich paint over one coat of suitable primer. Further, the Contractor shall provide proper zinc paint at the point of welding.

7.00.00 PAINTING

7.01.00 All the Equipments shall be protected against external corrosion by providing suitablepainting.

7.02.00 The surfaces of stainless steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting.

7.04.00 **All Steel Surfaces (external) exposed to atmosphere (outdoor installation)**

(i) **Surface Preparation :** The steel surfaces to be applied with painting shall be thoroughly cleaned before painting by wire brushing, air blowing, etc.

(ii) **Painting:** One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with three (3) coats synthetic enamel paint, with 25 microns as thickness of each coat. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

7.05.00 **All Steel Surfaces (external) inside the building (indoor installation)**

(i) **Surface Preparation :** The steel surfaces to be applied with painting shall be thoroughly cleaned before painting by wire brushing, air blowing, etc.

(ii) **Painting:** One (1) Coat of red oxide primer of thickness 30 to 35 microns followed up with two (2) coats synthetic enamel paint, with 25 microns as thickness of each coat. For plant at coastal area, epoxy resin based zinc phosphate primer followed by epoxy resin based paint pigmented with titanium di-oxide shall be used in place of enamel paints.

7.06.00 **Deluge Valves, Alarm Valves, Foam monitors, Water monitors, Foam Proportioning equipments, Foam makers, etc.**

Painting of all equipments /.components of FDPS package shall be as per manufacturer's standard practice or as detailed below whichever is superior in quality.

Environment	Paint scheme	Total DFT
Normal / Mild Corrosive Environment	Primer- zinc filled epoxy Finish – Aliphatic Polyurethane (shade RAL3000)(P.O Red)	Min 125 microns
Corrosive Environment (as in coastal areas)	Primer- zinc filled epoxy Intermediate – Epoxy MIO Finish – Aliphatic Polyurethane (shade RAL3000)(P.O Red)	Min 200 microns

ANNEXURE-I

PIPING THICKNESS:

Pipes for sizes 200 NB & above shall confirm to IS: 3589 Grade 410. The final thickness shall not be less than that specified as per IS: 3589 as indicated below.

Nominal pipe Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)
200 NB	219.1	6.3
250 NB	273	6.3
300 NB	323.9	7.1
350 NB	355.6	8.0
400 NB	406.4	8.0
450 NB	457	8.0
500 NB	508	8.0
600 NB	610	8.0

Annexure-II

Technical Data:

1. **Hydrant Valve**	Oblique female type as per IS:5290
	MOC: Body/bonnet/stop valve/valve seat/trim : SS304/SS316
2. **Water monitor**	As per IS:8442 Type-I, Size: 75mm, Nozzle dia: 38mm
	MOC: Water barrel/reducer/elbow: CS (seamless)/SS Nozzle: Copper alloy / SS confirm in to IS:3444
3. **Water branch pipe & nozzle**	As per IS:903 / IS:2871
	MOC: Branch pipe: SS316 (Gr 4 of IS:3444) (both ends) Nozzle : SS316 (Gr 4 of IS:3444), Size: min 16mm & max 25mm
4. **Water line Gate / Sluice Valve**	- Design Code: a) IS:14846 or BS:5150 (for valves coming inside fire water pump house) b) BS:5150 (for valves at other locations) - Pressure rating: PN1.6 (as per IS:14846) / PN16 (as per BS:5150) -Working Pr. :12Kg/cm2
	MOC: Body/bonnet/Yoke/Wedge : CI to IS:210 FG-200 Spindle: SS to ASTM-A-276 type 410
5. **Butterfly Valve**	Design Code: Double flanged or lugged wafer type of low leakage rate confirming to BS:EN:593/API-609/AWWA C-504 Pressure class: PN 16
	MOC: Body & Disc : Cast Iron, Shaft : SS 410 / SS 420 Seat Rings : EPDM

SUB-SECTION-I-M5

EQUIPMENT COOLING WATER SYSTEM

EQUIPMENT COOLING WATER SYSTEM

1.00.00 **BRIEF DESCRIPTION OF SYSTEM**

1.01.00 The Equipment Cooling Water System shall be provided for Flue Gas Desulphurization system Auxiliaries as described.

1.02.00 The Equipment cooling water system shall be common for all the three units. The cooling system for Flue Gas Desulphurization system Auxiliaries shall be of closed circuit type with demineralised (DM) water in the primary circuit. CW blowdown water tapped from CW pump discharge header would be used in the secondary circuit for cooling the primary circuit DM water. Hence all materials of construction used in primary and secondary side of the equipment cooling water system should be suitable for the water quality. The scheme shall be as per relevant tender drawing listed elsewhere in the specification. The DM cooling water pumps shall be provided as indicated in the relevant tender drawing. However, bidder can use secondary circuit ACW water pumps as process water pumps or bidder may envisage separate booster pumps after PHE for FGD process water (as applicable) .

1.03.00 Quality of water

(a) Primary circuit - Demineralised (DM) water

(b) Secondary circuit - Condenser cooling water

1.04.00 The pH of DM water in the closed loop shall be continuously monitored and controlled at around 9.5. The control shall be achieved by dosing sodium hydroxide in DM water overhead tank. The dosing shall be done manually by operating dosing valve.

2.00.00 **SYSTEM DESIGN**

2.01.00 The ECW system design for Flue Gas Desulphurization system Auxiliaries shall be as follows:

A centralized/combined ECW system is envisaged for all FGD system auxiliaries . In the primary circuit , Demineralised cooling water (DMCW) pumps shall discharge cooling water through plate type heat exchangers (PHE) for cooling of the FGD system auxiliaries . The outlet header from plate heat exchangers shall be suitably branched off to supply cooling water to the to the individual Flue Gas Desulphurization system Auxiliaries coolers. No booster pumping system shall be provided in the primary system. Outlet from these auxiliary coolers shall be connected back into a common return header and led back to the suction of DMCW pumps to complete the closed loop primary cooling circuit.

2.02.00 The secondary circulating water system shall receive water through a tapping from CW blow down from the CW pumps discharge header. This water will be further

pressurised by a set of auxiliary cooling water booster pumps and fed through the plate type heat exchangers and the discharge secondary water from PHEs shall be used as process water for FGD system.

2.03.00 For the primary cooling circuit, an overhead tank of minimum (normal) capacity of 5 Cu.M shall be provided by the bidder. Outlet of this tank shall be connected to the closed circuit return header . The normal capacity of the tank shall be at 60% of the tank height.to serve

2.04.00 Frame of each plate type heat exchanger shall have about 25% extra capacity i.e. the frame shall be able to accommodate about 25% extra plates.

2.05.00 Self cleaning Filters

To prevent fouling on the secondary cooling waterside of the PHE, self-cleaning type filters, (2 X 100%) shall be provided by the bidder on the secondary cooling water inlet header to the PHE.

2.05.00 Make up to the closed loop primary circuit shall be taken from the DM water transfer pumps located near DM water storage tank and emergency make up from the discharge of condensate transfer pumps. The make-up would be given to overhead storage tank.

2.06.00 Required orifices shall be provided in the primary and secondary circuit of Equipment Cooling Water system for balancing of pressure.

3.00.00 **CONSTRUCTION FEATURES**

3.01.00 **Pumps and Heat (PHE) Exchangers**

3.01.01 The general design and construction features of various pumps of the Equipment Cooling Water System shall be as per the Annexure titled "**General Specification For Pumps**" enclosed with this sub-section.

3.01.02 Specific features of various pumps and plate type heat exchangers of ECW system shall be as follows :-

A) Pumps (ECW System)

i) Type : Horizontal Centrifugal type

ii) Casing : Axially split type.

iii) Impeller type : Closed

iv) Speed : 1500 rpm (max.)

v) Drive transmission : Direct

vi) Seal : Mechanical seal for primary water pumps and Self water/gland for secondary side

vii) Lubrication : Oil/Grease/Self liquid.

viii) Coupling : Spacer type.

ix) Drain plug, vent, priming connection, ; Required.

x) Coupling guard, lifting lugs : Required

xi) Operating range : 40% to 120% of rated flow

xii) Pump characteristic : Non-overloading type & stable

xiii) Parallel operation : Required.

xv) Material of Construction:

	Primary Side DM Cooling Water Pumps	**Secondary side Auxiliary Cooling Water Pumps**
a) Casing	ASTM-A-351 CF8M	2.5% Ni CI to IS 210 GR FG-260
b) Impeller	ASTM-A-351 CF8M	Bronze to IS 318 Gr. I/II or SS – 316 / CF8M
c) Impeller Wearing Rings	SS-316	High leaded bronze to IS-318 Gr.V / SS -316 in case of SS Impeller.
d) Casing wearing rings	--------As per manufacturer's Standard -----	
e) Shaft	SS-316	SS-316
f) Shaft Sleeve	SS-410	SS-410
g) Gland	----------	2.5% Ni CI to IS 210 GR FG-260
h) Lantern Ring	SS-316	Bronze
i) Gland packing	----------	Teflon Impregnated /Manufacturer's standard (Non-Asbestos type)
i) Mechanical Seal	Manufacturer's Std	----------

j) Base plate	---------- MS fabricated - IS:2062 ----------	
k) Stuffing Box	----------	2.5% Ni CI to IS 210 GR – FG-260
l) All fasteners	Stainless steel	Stainless steel

B) Plate type Heat Exchangers - Design Parameters

(i) Type : Plate type, single pass

(ii) Design pressure : Maximum expected pressure to which PHE may be subjected plus 5% additional margin. Maximum expected pressure shall be based on the shut-off head of pumps (either the secondary or primary side whichever is maximum) plus the suction pressure of the pumps.

Material of Construction

(i) Heat transfer plate : SS-AISI-316

(ii) Compression / Fixed plates : IS:2062

(iii) Movable pressure plate : IS-2062

(iv) Guide rail : IS-2062 with stainless steel cladding

(v) Support Beam/Column : IS 2062

(vi) Plate gasket : Nitrile Rubber

(vii) Nozzle : Carbon steel

(viii) Flanges : Carbon steel

(ix) Nozzle flange Gasket : 3 mm wire inserted Red Rubber.

(x) Nozzle flange Bolts/ Nuts : SA 193 B7/SA 194 2 H.

(xi) Name plate : AISI-316

(xii) Tightening Rods : IS-1367 or equivalent

Other Features:

(i) Double sealing arrangement should be provided at outer edge and around ports to avoid intermixing of fluids. The inter-space should be vented to atmosphere.

(ii) Plate thickness should be adequate to withstand all operating conditions but not less than 0.6 mm.

(iii) Frame of exchanger should be designed so that 25% additional plates can be added in future.

(iv) Flanges shall be per ANSI B 16.5 for equivalent.

(v) Thickness of pressure and frame plates as per ASME sec. VIII Div. I.

(vi) Minimum corrosion allowance for heat exchanger parts shall be 1.6 mm.

(vii) After pressing all the plates shall be tested by light box/vacuum/air chamber test as per manufacturers' standard practice.

(viii) The corrosion allowance for the heat exchanger plate such as pressure parts (support plates), nozzles, sliding channels and frame shall be 1.6mm (minimum).

3.02.00 **Piping, Valves /Tanks:**

Construction features of Piping, Valves and tanks shall be as per the sub-section titled "Low Pressure Piping" of this Technical specification

3.03.00 Self cleaning strainer**:**

(a) Body of filter shall conform to IS:210Gr. FG260 or ASTM-A-515 Gr. 75/IS: 2062 and internally painted with epoxy.

(b) Strainer element shall be constructed of perforated stainless steel plant linked with stainless steel (SS316) screen for fresh water and SS316L grade SS screen for sea water.

(c) The mesh size shall be selected on the basis of average clearance between the plates of the plate heat exchanger.

3.04.00 **Construction features of ECW overhead tank**

Sl. No.	Description		Tech. Particulars
I.	Quantity	:	One (1)
II.	Capacity	:	5 Cu.M (Minimum.)
III.	Type	:	Horizontal Dished ends
IV.	Design Pressure	:	Atmospheric

	V.	Design Standard	: ASME Boiler and Pressure Vessel code Section-VIII/IS:2825 (Class 3)
	VI.	Material of Construction	: Plates to IS:2062/ ASTM A36.Minimum shell thickness shall be 6mm.
	VII.	ACCESSORIES	
	(a)	Vent, overflow and drain	: Required (Overflow drain to be taken upto '0' M plant drain)
	(b)	CO_2 absorber for vent	: Required
	(c)	Seal for overflow	: Required
	(d)	Manhole & approach ladder/platform/	: Required
3.05.00		**Construction features of Alkali dosing tank.**	
	Quantity per Unit		: One (1)
	Useful Capacity of Each Tank		: Suitable for the system (Minimum 500 lt)
	Size (Dia. x Height)		: Adequate
	Type		: Vertical cylinder, dished bottom
	Design Pressure		: Atmospheric
	Design Standard		: ASME Boiler & Pressure vessles Code Section-VIII. Div.I/ IS:2825 (Class-3)
	Material of Construction		: MS Plates to IS:2062/ ASTM A36. with rubber lining of 4.5 mm thick & Minimum shell thickness shall be 6mm. OR SS plates of minimum thickness of 3 mm .
	Dissolving Basket		: AISI-316,
	Agitator		: stainless steel 316SS construction along with drive motor of suitable rating and protection class. (With Slow speed reduction gear unit)
	Accessories		
	(a)	Vent, overflow and Drain	: Required

	(b)	Sample Connection	: Required
4.00.00	**SIZING / DESIGN CRITERIA**		
4.01.00	**Pumps**		
	a)	Flow	: <u>Secondary Water pumps:</u> Design flow – less than or equal to maximum flow available indicated in Annexure-II. <u>Primary Water pumps.</u> Design flow of all Flue Gas Desulphurization system Auxiliaries coolers..
	b)	Head	: As per system, requirement +10% margin on friction head.
	c)	Motor rating	: Continuous motor rating (at 50 degree C ambient) for all pumps shall be at least ten percent (10%) above the maximum power requirement at any condition of the entire characteristic curve of the pump.
	d)	No. of Primary side pumps	: As indicated in Part A of the specification.
	e)	No. of Secondary water pumps	: As indicated in part A of the specification
	f)	Re-circulation control Valves, Piping & Pressure break down orifice.	: Required
	g)	Additional design requirements	: a) To be referred in the Annexure sub-section titled "General specification for horizontal pumps" enclosed with this section.
4.02.00	**Plate Type Heat Exchangers**		
	a)	Design Secondary water Inlet temperature	**:** Not less than 36 deg. C
	b)	Secondary water outlet	**:** Temperature as achieved subject to the maximum ACW flow indicated.
	d)	Overall fouling factor (minimum) (f)	**:** 0.8×10^{-4} Hr M^2 deg C/Kcal

e) No. of heat exchangers/ unit : As indicated in part A of the specification

f) Overall Heat transfer coefficient [U(o)]: As per manufacturer's design

g) Dirty Heat transfer Coefficient [U(d)] : [1 / (1/U(o) +f)]

h) Heat Transfer Area (Sqm) : $\frac{\text{Total Heat Load (in Kcal/hr)}}{\text{U(d) x LMTD}}$

i) Heat transfer area of PHE shall be selected such that each Sq.M of heat transfer plate shall transfer not more than 6500 Kcal/hr.

5.00.00 **INSTRUMENTATION**

5.01.00 All instruments, such as thermowell, temperature element alongwith temperature transmitter, flow element, pressure/DP and temperature gauge/transmitters/sensors/switches, DP switch, pH analyzer, Rotameter etc. alongwith associated devices should meet the requirement as specified in relevant sub-section of this Technical Specification and shall be sufficient to meet all interlock/protection & operation requirement.

5.02.00 Minimum instrumentation required for the Equipment Cooling water system shall be as per tender P & I Diagram wherever included in the specification.

6.00.00 **CONTROL / OPERATION PHILOSOPHY**

6.02.00 The pump suction valves, re-circulation valves and discharge valves shall be motor actuated type to enable remote operation.

6.03.00 Pump suction valves shall be provided with required limit switches for interlock & control.

6.04.00 The pumps shall be designed to operate under discharge valve open and as well as in close condition.

6.05.00 Wherever more than one sump/tank is provided, Suction header shall be interconnected such a way that any of the sump/tank may be selected from the panel for operation.

6.06.00 Any of the pump shall be selectable as standby duty. Standby pump shall come into operation on tripping of working pump or inadequate pressure in the discharge header.

6.07.00 Suction and Discharge valves of pumps shall be interlocked with start/stop of respective pumps.

6.08.00 Local emergency stop provision for each pump shall be provided.

6.09.00	All the working pumps shall be interlocked with the suction level or suction pressure condition as the case may be. Pumps operation shall be interlocked with the high discharge condition so that the pump may not operate at shut-off pressure.
6.10.00	Automatic inlet valves at supply line to each of the tank/sump shall be provided so that the valves shall open and close at low-level and very high-level respectively.
6.11.00	A control valve shall be provided to maintain a constant pressure differential between the main supply and return headers of DM water. The valve will bypass flow to maintain a constant return header pressure to compensate for fluctuations in coolant flow to the process heat exchangers due to modulating control valves on the process coolers or if any cooler goes out of service in DM circuit.
6.12.00	Alarm to indicate high differential pressure across self-cleaning filter strainers, heat exchangers as the case may be.
6.13.00	Manually operating globe / regulating valves shall be provided in the water side of each of the cooler outlet for control of flow as specified in respective equipment specification.
6.14.00	Detailed Interlock & protection logic to be implemented in FGD control system shall be provided by the contractor and the same shall be as finalized during detailed engineering.
7.00.00	**PAINTING**
7.01.00	All the equipments such as pumps, tanks and plate type exchangers of this system shall be protected against external corrosion by providing suitable painting as mentioned below. For painting of valves and piping, relevant section shall be referred to.
7.02.00	The surfaces of stainless steel, Gunmetal, brass, bronze and non-metallic components shall not be applied with any painting.
7.03.00	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.
7.04.00	For all the steel surfaces exposed to (outdoor installation) atmosphere, a coat of chlorinated rubber based zinc phosphate primer of minimum thickness DFT of 50 microns followed up with undercoat of chlorinated rubber paint of minimum DFT of 50 microns shall be applied. Then, intermediate coat consisting of one coat of chlorinated rubber based paint pigmented with Titanium di-oxide with minimum DFT of 50 microns and topcoat consisting of two coats of chlorinated rubber paint of approved shade and color with glossy finish and DFT of 100 microns shall be provided. Total DFT of paint system shall not be less than 200 microns.
7.05.00	For all the steel surfaces inside the (indoor installation) building, a coat of red oxide primer of minimum thickness of 50 microns followed up with undercoat of synthetic enamel paint of minimum thickness of 50 microns shall be applied. The top coat shall consist of two coats each of minimum thickness of 50 microns of synthetic enamel paint and thus total thickness shall be minimum 200 microns.

7.06.00	Internal surfaces of ECW over tank shall be painted with One coat of unmodified epoxy resin alongwith polyamide hardener and minimum two (2) coats unmodified epoxy resin alongwith Aromatic adduct hardener and total thickness of primer and paint should not be less than 400 microns.

Annexure-I to ECW system Specification

GENERAL SPECIFICATION FOR HORIZONTAL PUMPS

(1) **SCOPE**

This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

(2) **CODES AND STANDARDS**

The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

(3) **LIST OF APPLICABLE STANDARDS**

IS : 1520	:	Horizontal Centrifugal Pumps for clear cold fresh water
IS : 5120	:	Technical requirements of rotodynamic special purpose pumps
API : 610	:	Centrifugal pumps for general refinery service.
IS : 5639	:	Pumps Handling Chemicals & corrosion liquids
IS : 5659	:	Pumps for process water
HIS	:	Hydraulic Institute Standards, USA
ASTM-1-165-65:		Standards Methods for Liquid Penetration Inspection.

In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

(4) **DESIGN REQUIREMENTS**

(a) The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve. The operating range of the pump shall be 40% to 120% of the duty point unless otherwise mentioned elsewhere. The maximum efficiency

of pump shall preferably be within ± 10% of the rated design flow as indicated in data sheets.

(b) The total head capacity curve shall be continuously rising from the operating point towards shut – off without any zone of instability with the highest head at shut-off condition. Shut-off head shall be more than the rated design head by 15 % or more for radial flow pump and 25 % more than the design head for mixed flow/turbine type pumps.

(c) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

(d) Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

Speed	Antifriction Bearing	Sleeve Bearing
1500 rpm and below	75.0 micron	75.0 micron
3000 rpm	50.0 micron	65.0 micron

The noise level shall not exceed 85 dBA overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment surface.

(e) The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements.

(f) Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

(g) The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

(5) **DESIGN CONSTRUCTION**

(a) Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets shall be referred to.

(b) Pump Casing

Pump casing shall have axially or radially split type construction as specified. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves,

piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

(c) Impeller

Impeller shall be closed, semi-closed or open type as specified elsewhere and designed in conformance with the detailed analysis of the liquid being handled.

The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

(d) Impeller/Casing Wearing Rings

Replaceable type wearing rings shall be provided at suitable locations of pumps as per manufacturer's standard practice. Suitable method of locking the wearing ring shall be used.

(e) Shaft

The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

(f) Shaft Sleeves

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

(g) Bearings

Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard

type, if provided, shall be selected for a minimum life 20,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

(h) Stuffing Boxes

Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

(i) Mechanical Seals

Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

(j) The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

(k) Pump Shaft Motor Shaft Coupling

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

(l) Base Plate

A common base plate mounting both for the pump and motor shall be furnished. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so

constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

(m) Assembly and Dismantling

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

(n) Drive Motor (Prime Mover)

Continuous Motor rating (at 50 0 C ambient) shall be at least ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and in no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump. The KW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

Annexure-II

Auxiliary (Secondary) water available

Sl.No	Project	Maximum water available (cum/hr)
1	Kudgi (3 X 800) MW	600
2	Lara (2 x 800) MW	400
3	Gadarwara (2X 800) MW	360
4.	Darlipali (2 X 800)MW	400
5.	Mauda II (2 X 660)MW	300
6.	Solapur- (2 X 660)MW	300
7.	Tanda –II (2 X 660 MW	300
8.	Nabinagar (3 X 660 MW)	475
9.	Meja (2 X 660) MW	300
10.	Barh-I (3 X 660) MW	495
11.	Nabinagar -4 X 250 MW	250

SUB-SECTION-I-M6

LIME STONE & GYPSUM HANDLING SYSTEM

1.0.0 INTRODUCTION

This section of the specification provides the detailed technical requirements for the Limestone Handling System.

2.0.0 CODES AND SPECIFICATIONS

2.1.0 All plant, equipment, systems and works covered under this contract shall comply with the latest editions including amendments of applicable codes, standards, statutes, regulations and safety rules as on the date of submission of bid. Particular care shall be exercised in observing compliance to the rules and regulations governing the locality where the plant is to be installed. Contractor's obligations in this regard shall not be limited to only those codes and standards mentioned in this contract. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.

2.2.0 In the event of any conflict between the applicable codes and standards and the requirements of this contract, the more stringent of the two shall govern.

2.3.0 The specific codes / standards followed for the design of the system are as below and relevant codes are also indicated against each equipment:

CEMA	Conveyor Belt Manufacturing Association
IS:11592 - 2000	Code of practice for selection and design of belt conveyors
IS:1891 - 1994	Conveyor and elevator textile beltings spec.Part.1 General
IS:14386 -1996	Belt conveyors-Traveling Tripper- Motorised for belt widths 650mm to 1600 mm- Dimensions
IS:8531-1986	Specification for Pulleys for Belt conveyors
IS:8598 - 1987	Specification for Idlers and idlers set for belt conveyors
IS 9295 - 1983	Steel tubes for Idlers for Belt conveyors
ISO 5049/1 or IS 800	Code of construction of structural works.
IS 16143 (Par 2& 4)/ ASTM C50// ASTM D2013	Lime stone Sampling System
IS:2062 - 2006	Steel for general structural purposes.
IS:1239 2004 part 1	Spec for mild steel tubes tubular and other wrought steel
IS:3589 : 2001	Steel pipes for water and sewage (168.3 to 2504mm outside diameter)
IS: 325	Three Phase induction motors
ASHRAE :2007	HVAC applications
IS 3832 : 2005	Manual hoist / CPB

IS 3938 : 1983	Electric hoist
IS 3177 : 1999	EOT Crane
IS 4894 : 1987	Specification for centrifugal fan
IS 7155(part 5):1990	Code of Recommended Practice for Conveyor safety

The extraction capacity of dust extraction system shall be based on "American Conference of Governmental Industrial Hygienists"(ACGIH).

3.0.0 SYSTEM DESCRIPTION

The limestone handling system comprises the following:
Unloading, Crushing and Stacking.
Reclaiming and Limestone Bunker Feeding System

3.1.0 **Unloading**, **Crushing and Bunker Feeding System**

Indian Railway rakes consisting type of wagons as specified in RDSO G-33 (Rev-1) guidelines shall transport coal to the power plant. The coal received from wagons shall be unloaded in underground RCC hopper by means of-side discharge type wagon tippler. Side discharge type wagon tipplers are to be employed for unloading IR Coal rake. Side arm chargers are envisaged for placement of wagon on the tippler table & removal of empty wagon from tippler table after tippling. Clear access shall be provided for movement of pay loaders/ bulldozers on the hopper grating of wagon tippler. Gratings over wagon tippler hopper shall be placed and designed accordingly. Apron feeder along with dribble conveyor are employed under each wagon tippler for extracting coal from wagon tippler hoppers.

Indian Railway rakes consisting of Bottom discharge wagons shall also transport coal to the power plant. The coal received from wagons shall be unloaded in underground RCC Track hopper. Paddle feeders complete with all electrical, rails, supporting structures, end stops, cable reeling drums, trailing cables, and necessary arrangement for cabling on floor of track hoppers along with accessories, shall be installed at the bottom of the Track hoppers to scoop the coal from track hoppers and feed coal on to the underground conveyors.

Limestone received through Indian railway rakes will be unloaded in one of these three side discharge wagon tipplers or track hopper.

Alternatively, Two (2) numbers Box feeders/ Bulk material receiving unit/ Truck unloading system/ Surface feeder for unloading of limestone from trucks/ self-tippling trucks/ loader shovels, This unit shall feed limestone onto the conveyor before crusher house. The complete truck unloading system must not have any underground structures/facilities.

A mechanized system shall be provided for unloading of limestone from trucks. The unloaded limestone shall be conveyed up to the limestone conveying stream before the limestone crusher.

3.2.0 Conveying

Limestone shall be conveyed using same conveyors as for coal before being taken to dedicated limestone crusher house.

"As received" limestone shall be fed on the double stream conveyors from where the same shall be conveyed upto the crushers. The crushed limestone shall be conveyed by double stream conveyors up to the limestone storage shed. From the limestone storage shed paddle feeders will extract/ reclaim crushed limestone and feed the same onto double stream conveying system up to the limestone mill bunkers.

3.3.0 **Crushing**

In limestone crusher house, limestone from each incoming Conveyor shall pass through two (2) numbers of (dedicated) Vibrating grizzly/ screening Feeders and two (2) numbers of (dedicated) crushers respectively which shall crush limestone to (-) 20mm size or to suit limestone pulverizer and system. Each stream shall have a set of Rod gates and Rack & Pinion Gates before Vibrating grizzly Feeders to permit maintenance of equipment, hoppers and chutes in one stream without affecting the operation of other stream. Limestone sampling unit shall be provided to sample the limestone from either stream.

A passenger cum goods elevator shall be provided in limestone crusher house.

3.4.0 **Limestone Storage and Bunker feeding system**

Crushed limestone shall be stored in covered ground storage sheds using mobile trippers. The capacity of the storage shed shall be equivalent to limestone consumption for at least 7 days.

Two (2) numbers Travelling trippers shall be provided one each on a conveyors. The Travelling trippers shall operate on rails for stacking the Limestone in the stock yard area. During reclaiming operation the reclaimed Limestone shall be conveyed to the conveyor by the Paddle feeders for Conveying to Limestone Bunkers.

From Reclaim hopper, crushed Limestone of (-) 20mm size would be fed to Limestone bunkers through a series of belt conveyors, passing through various Junction Towers and ploughs/ fixed trippers.

3.5.0 SYSTEM DESCRIPTION: GYPSUM HANDLING PLANT

Double conveyor stream shall be provided for conveying dewatered gypsum from gypsum vacuum belt filter to over ground storage under a shed near plant boundary. The storage shed shall be sized for 7 days of gypsum production with all the units in operation. Gypsum from storage shed shall be loaded to user's trucks using front end loader/ payloader.

4.0.0 MAJOR EQUIPMENT OF LIMESTONE HANDLING SYSTEM AND GYPSUM HANDLING SYSTEM

Specifications for Coal Handling system equipments shall be generally followed for Lime Handling System & Gypsum handling System unless specified otherwise.

4.1.0 BELT CONVEYOR SYSTEM

The belt conveyor system shall confirm to the latest edition of the following standards & codes :

"Belt Conveyors for Bulk Materials" published by Conveyor Equipment Manufacturers' Association.

IS:7155	:	Codes of Practice for Conveyor Safety.
IS:1891 (Part-I)	:	General Purpose Belting
IS:8598	:	Idlers and Idler Sets for Belt Conveyors
IS:4009 (Part-II)	:	Conical Head Grease Nipples
IS:8531	:	Pulleys for Belt Conveyors.

IS:2062 : Hot Rolled Low, Medium and High Tensile Structural Steel

IS:4682 : Codes of Practice for Lining of Vessels and Equipment for Chemical Processes.

IS:11592 : Code of practice for selection and design of Belt Conveyors.

CAN / CASA - M422 M87 : Canadian standard association.

4.1.1 **Belting:**

The belting shall be of either synthetic fabric such as Nylon-Nylon etc. with rubber covers of adequate flexibility to give a troughing angle of 35 deg.

For all the conveyors the number of plies, cover thickness, factor of safety etc. shall be as per the recommendation of belt manufacturer, but not inferior to the figures as tabulated in data sheet. ***Longitudinal joints in the plies of synthetic fabric belts is not permitted.***

4.1.2 **Idlers**

Carrying idlers shall be provided with three equal rolls with troughing angle of 35 deg. and 2 deg. forward tilt (except in case of reversible conveyors). The diameter of the idler roll shall not be less than 152 mm for both carrying side and return side. However for impact idlers roll the steel diameter shall not be less than 139 mm and rubber thickness shall be minimum 25 mm. Roller used in idlers shall be made from ERW steel tube. Wall thickness shall be minimum 4.0 mm without any negative tolerance. The rollers shall be mounted on EN-8 or equivalent material spindles by means of ball bearings of either deep groove type or seize resistant type (SKF/Equivalent), of 30 mm size for carrying idlers and 20 mm size for return idlers. The bearings shall be adequately sealed and lubricated for life. The rolls shall be supported from fabricated steel brackets. Fixing arrangement of rollers with brackets shall be drop-in type. For adjusting the alignment of the idlers, slotted holes shall be provided in idler supporting base plates. Direction of belt travel shall be clearly marked on the brackets of carrying idlers by embossing / punching. Idler rollers shall be waterproof, dust proof and weather proof against a high velocity water jet. All idlers shall be provided with minimum double labyrinth dust seal. All the conveyors shall be provided with one self cleaning type rubber disc return idler located near the head pulley for cleaning the return belt. Transition type troughing idlers shall be used adjacent to all pulleys to permit proper support of the loaded belt near the pulleys without excessive stretch of the belt edges. The transition idlers shall be provided with preferably adjustable concentrator (end) rolls and long center rolls to suit the troughed belt contour between the last regular troughing idler and the adjacent pulleys. The transition length and the number of the transition idlers shall be selected depending upon the tensions, type and size of belt, number of plies and other necessary governing factors.

4.1.3 Belt Cleaners

(i) External Belt Cleaner

Spring loaded scraper type cleaner with modular segmented and replaceable polyurethane scrapers blades complete with main cleaner, pre-cleaner (mounted separately) along with accessories and necessary fines (reject of scrapper) chutes shall be provided for all belt conveyors, tripper head pulley (not applicable for plough type feeding arrangement) and belt feeders at discharge pulleys. The modular units shall be easily replaceable. The scraper assembly shall be easily maintainable from outside without any interference with the chute arrangement and assembly.

(ii) Internal Belt Cleaner

V-plough type belt cleaner made of mild steel flats and hard rubber strips with automatic wear adjustment and necessary accessories shall be furnished for cleaning internal surface of the conveyor belt.

4.1.4 Belt Take-up Arrangement

Automatic take-up of gravity type shall be generally provided with necessary take-up arrangements complete with bend pulleys, take-up pulley, with its supporting / sliding assembly, wire ropes with turn buckle arrangement (to adjust the level) for suspending the separate take - up weight sliding assembly close to the ground, counter weights and other accessories. Suitable guards marked up scale attached to the frame to monitor belt stretch and access/maintenance platforms with handrails all around etc. shall be provided.

4.1.5 Pulleys

The nominal diameter and face width of the pulleys shall be as stated in IS: 8531. The snub pulleys on each conveyor shall be located to provide a belt wrap on the drive pulleys of not less than 210 deg. The pulleys shall be made from mild steel conforming to IS:2062 (Tested Quality). However, for conveyors with in line magnetic separators, the head end pulleys shall have shell and end disc made of non-magnetic stainless steel material. Suitable stiffening shall be provided at all weld location in the shell on all pulleys. All the pulleys shall be mounted on the forged steel shafts of EN-8 or equivalent material of adequate proportion by taper lock arrangement, running in heavy duty roller bearings with proper greasing arrangement. The plummer blocks for pulleys shall be of horizontally split type construction with minimum (4) nos. bolts holding the two split halves and with min (4) nos. foundation bolts. The plummer blocks shall be dust tight with double labyrinth seals. Conical head shape nipples conforming to IS:4009, suitable drain plug and eye bolt shall be provided. Side covers of plummer blocks shall be heavy duty metallic sheets.

4.1.6 Drive Motors

Rating of all drive motors of conveyors shall not be less than 120% of the power required at drive motor output shaft at specified design capacity. The motor rating shall be at 50 deg Cent. Ambient. Single LT drive motors shall be used for conveyor drive ratings up to 160 KW. For conveyor drive rating beyond 160 KW, single HT drive shall be used for conveyors.

4.1.7 Conveyor Bridges

All overground and overhead conveyors shall be located in suitably enclosed bridge structure. Structural steel bridges of adequate width and depth (2700 mm clear head room) shall be provided complete with conveyor bottom deck plates, seal plates, walkways of chequered plates with anti-skid arrangement(s), hand rails (on both sides of each conveyor belt except where equipment (like trippers etc.) traverse over conveyor supports. Side and central walkways for double streams conveyors shall be 800mm and 1100mm wide respectively. The side walkways for single conveyors shall be 800 mm on one side and 1100mm on the other side. All conveyors shall be provided with 12 G steel seal plates throughout the length of the conveyor gallery in such a way that complete gallery bottom surface area forms a single water proof floor and no water / limestone falls down from conveyor gallery incase of cleaning / washing. The conveyors shall be provided with continuous decking plate of minimum 3 mm thickness plain steel sheet. Provision shall be kept with platforms and ladders for crossing over the conveyors at approximately every 100m intervals of route length and minimum one per conveyor.

4.1.8 Belt Vulcanizing Machine

Belt Vulcanizing Equipment shall be suitable for hot vulcanizing of belt splice and shall be of

easy-to-handle type. Equipment should be suitable for vulcanizing of entire splice width in single setting. Equipment should be capable of applying uniform pressure over the splice by pneumatic or hydraulic means. Heating element should be preferably of flexible type.

4.2.0 ELECTRO HYDRAULIC THRUSTER BRAKES

The necessary Electro Hydraulic Thruster (AC) brakes / disc brakes, totally enclosed and fail safe, shall be provided as required for various equipment's. Braking torque shall be adjustable from 0 to 100% of rated braking torque. The thruster brake shall be actuated by compression springs. The electro hydraulic thruster shall be fitted with the brake. Limit switches shall be provided for brake applied/released positions. The windings shall be provided with class-B insulation suitable for 415V ± 10% at 50 Hz ± 5% and combined variation of ± 10%. Brake lining shall be asbestos with inter woven brass wires capable of withstanding 200°C temperature.

Clamp

Electro-hydraulic thruster rail clamp shall be actuated by compression springs, the spring shall apply the clamping force directly on the Rail clamp mechanism once power supply is cut-off. The force transmission mechanism from spring to rail clamp faces shall be very simple with minimum linkages. Manual rail clamp shall be provided with positive locking arrangement and shall apply clamping force directly on rails. The manual rail clamp shall be of proven design.

4.3.0 MONORAILS AND HOISTS

4.3.1 The Monorails & Hoists shall conform to the latest edition of the following standards & codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

IS:3938	:	Specification for Electric Wire Rope Hoist
IS:3832	:	Chain pulley blocks
IS:2429	:	Round steel short link chain
IS:6216	:	Short link chain grade 80
IS:15560	:	Points hooks with shank up to 160 Tonne - Specification
IS:210	:	Cast Iron Castings

4.3.2 For the Hoists with more than 2.0 tonne lifting capacity or more than 10.0 M lift, with the exception of hoists for GTU and bend pulleys motor operated hoist blocks for both long travel and lift shall be provided. Other hoist blocks shall be of hand operated type for both travel and lift. All monorails coming out of the buildings shall be provided with electric hoist blocks, irrespective of load and lift. Minimum 3 meter length of Cantilever from edge of building/cladding, shall be provided in monorails coming out of the building to lower the equipment to ground level clearing the building sidewalls / cladding and any other facilities beneath the floor upto ground level. Clear height shall be maintained when handling one equipment over other, in such case dismantling of any equipment shall not be permitted. The center line of monorail shall not deviate by more than 500 mm from the center of gravity of any equipment that is to be lifted.

4.3.3 The electric hoist shall be designed and constructed in accordance with the latest revision of IS:3938 and shall be suitable for duty class 2. For electric hoists, trolley movement and hoisting shall be effected by using two separate motors. Motors shall be as per technical

requirements discussed elsewhere. However the motors shall be suitable for 150 starts per hour at 40% CDF. Motor operated geared trolley shall have two (2) pairs of wheels, one pair of which shall be driven through motor. An electromechanical brake shall be provided for hoisting as well as cross travel. Brake lining shall be of asbestos

4.3.4 Wire rope shall be of pre-formed type, hemp cored, regular lay 6/36 construction with a breaking strength of 160 -175 kgf/ sq. mm. Minimum number of falls of rope shall be four (4). All running shafts and wheels shall be fitted with ball / roller bearings with a rated life not less than 20 years based on equivalent running time as per IS:3938.

4.3.5 All chain pulley blocks shall be designed to IS:3832, the operating hand chain shall conform to IS:2429 grade 30 pitched and polished and the load chain to IS:6216 grade 80. The chain pulley block shall be suitable for duty class 2. Hooks shall be as per IS: 15560 & with antifriction bearing.

4.3.6 The hoist mechanism shall consist of a grooved rope drum driven by electric motor through gears. Each end of the rope shall be anchored to the drum in such a way as the anchorage is readily available for maintenance. Each rope shall have two (2) full turns of the drum when the hook is at its lowest position and one (1) spare groove when the hook is at its highest position. The leading rope taken by the drum should not slope sideways when slack and it should not be caught between the gear wheel.

4.3.7 Inline magnetic separator shall have motorised hoist for handling / maintenance purpose. Each suspended magnet shall be provided with a dedicated motorised trolley.

4.4.0 CHUTES, SKIRT BOARDS, FLAP GATES, ROD GATE AND RACK & PINION GATE

4.4.1 Chutes

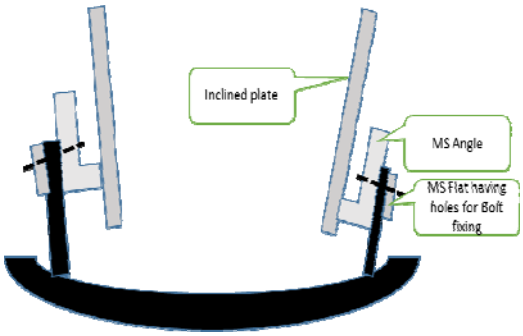
i. Direct impact of material on conveyor belt shall be avoided by providing an inclined surface at 60 degrees valley angle at the feeding point to guide the material in the direction of belt travel. Further, chute construction below flap gate shaft shall be such that there will not be any accumulation of limestone dust between chute and flap gate in that zone. Hoppers and Chutes shall be made of minimum 20 mm thick TISCRAL / SAILHARD / LSLAS07 or equivalent material. Long chutes guiding flow from considerable height shall be provided with impact plates wherever change in direction of flow takes place. Hinged inspection doors of leak proof construction shall be provided for access/ maintenance purpose at approachable heights for chutes and flap gates. All chutes should have one inspection door at every floor and for the ones in between the floors (more then 1.5 meter above the operating floor level) suitable access for trouble free maintenance shall be provided. For sealing of inspection doors labyrinth type arrangement to be provided. In addition to positive locking arrangement, mounting bolts, to tighten the door further against rubber shall also be provided. Bottom sides along with its adjacent sides shall be flanged and made from TISCRAL or equivalent material of 20 mm thickness. The non-striking surface i.e. the covers of the trough shall be of 10 mm thick mild steel and bolted to the flange provided on the trough. Further, the chute boxes not more than 1.5 m in length shall be joined through bolted flange connection to form the chute legs. Adequate care shall be taken to locate the flange joint away from floor level for easy maintenance. Complete chute work in the region of flap gates shall be fabricated from 20 thk TISCRAL or equivalent. In case of vertical chute (valley angle more than 80 degree) complete chute, work shall be of 20 mm thick TISCRAL or equivalent material.

ii. Hoods over the conveyor head pulleys shall be made of suitably stiffened minimum 4 mm M.S. Plates and shall be provided with hinged and gasketed inspection doors with suitable access to them. Further, serrated rubber seal shall also be provided at the very inlet of head chute to minimize dust nuisance.

4.4. 2

Skirt board

Skirt board shall ensure centralised loading of conveyor belt to avoid limestone spillage. Suitable 'Skirt Plates' shall be provided for entire feeding chute and shall be extended minimum 3m ahead of front edge of chute and 500 mm beyond rear edge of chute. The width of the Skirt Boards shall be two-third the conveyor belt width. In the belts where limestone of appreciable lump size (250 mm) is being conveyed, the gap between the bottom of the skirt board and the belt shall be made to increase uniformly in the direction of belt travel. The height of the skirt boards shall be sufficient to contain the material volume as it is loaded on the belt and shall not be less than 750 mm for conveyors. The height of the skirt board for belt feeders/ reversible belt feeders (if any) shall be minimum 1000 mm. The skirt plates shall be fitted with replaceable belt piece having facility of adjusting the pressure on the belt conveyor.



4.4. 3

Flap gate

i. The motor operated 2 position flap gates shall be provided in transfer chutes as specified and shall be complete with electrically operated actuators. The gates shall be of robust construction and suitable for trouble free operation. The face of the flap gate shall be made out of 20 mm thick TISCRAL or equivalent material. The equipment shall be capable of being operated for at least 15 switchings per hour at rated load and thrust and shall be suitable for 10 Nos. consecutive switchings at rated load and thrust. The flap gate travel shall be in the range of 60 deg. to 70 deg. Suitable travel dependent limit switches controlling the travel of the flap gates on either direction shall be furnished. These shall be placed internal to the drive unit and shall be completely dust-proof. The limit switches shall be capable of adjustments to vary the total length of travel of the gates. Suitable thrust dependent limit switches shall be provided in the actuator, which shall trip off the actuator motor in case of excessive thrust due to jamming of the gates during its travel in either direction. The same shall also be integral to the drive unit and shall be dust proof. Approach/maintenance platforms complete with the chequered plate floor, hand rails, ladders etc. shall be provided for all flap gates. The platforms shall be extended for access to dust & debris chute inside buildings.

ii. Provision for alternative manual operation shall also be made using declutchable hand wheel of 500 mm diameter. Limit switch for safety of person operating the hand wheel shall be provided. Manual effort required to operate the flap gate shall not exceed 25 kg. All the actuators in the plant should be selected based on heaviest loading, but the rating shall not be less than 2500 kg with a lever arm of 1.0 m in any case. For standardization purposes, only one standard type of actuator for flap gates shall be provided.

iii. The material of shaft shall be EN-8 or equivalent. The diameter of the shaft shall be suitable for motor stalled condition and associated twisting. However, the diameter of the shaft shall not be less then 150 mm.

4.4.4 **Rod Gate**

Suitable manually operated rod gates shall be provided over rack and pinion gates for their easy operation and maintenance.

4.4.5 **Rack & Pinion Gate**

(i) The rack and pinion gate shall be guided properly and suitable rollers with bearings sealed for life and dust proof shall be provided. Rotary actuator operated rack and pinion gates shall be provided.

(ii) The rack and pinion gates shall be of mild steel construction with liner plate of 10 mm thick TISCRAL or equivalent material. The gates shall be operated by means of double rack and pinion. The material for rack & pinion wheel shall be cast steel and shaft shall be EN.-8. Provision for alternative manual operation (manual effort 25 kg) of motorized rack and pinion gates shall also be made. Limit switch for safety of person operating the hand wheel shall be provided.

4.5.0 DRIVE EQUIPMENT

4.5.1 Gear Box

The gearboxes shall be designed for 24 hours continuous duty. Gearboxes with cooling coils or external cooling are not acceptable. The gears used shall be helical conforming to IS:3681 (latest revision) or worm reduction units or spiral bevel speed reduction units conforming to suitable Indian Standards. The dimensions of the shaft end shall conform to IS:3688 or its latest revision. Above 40 kW drive rating, all gearboxes shall be helical or bevel helical type only. all gearboxes shall have suitable breather plugs, dipstick, drain plug etc.

4.5.2 Flexible / Rigid Coupling

The design of the coupling shall be such that it can take shock and misalignment without sacrificing its efficiency. Geared type flexible coupling shall be used on low speed side for all conveyors and other drive chains where gear box is provided. Other couplings in the drive chains shall be either rigid or flexible type, depending upon the requirement of equipment design.

4.5.3 Fluid Couplings

Fluid couplings shall be provided in all the drive machinery for belt conveyor systems and limestone crushers if the actual power requirement at motor output shaft is more than 40 kW. The fluid coupling for LT motors shall be of traction type and for HT motors, shall be of scoop tube type. Suitable electrically operated actuators shall be provided for scoop tube operation from local as well as remote. Manual operation may also be provided. Separate pump with motor or integral shaft driven oil pump shall be provided for circulating the fluid coupling oil through oil cooler. Forced cooling water supply to oil cooler shall be provided for which cooling water pumps to be provided for group of scoop couplings. **Alternatively, Air cooled type scoop coupling is also acceptable for all conveyors with HT motors for (AHP, LHP, GHP) and crusher scoop couplings.** Suitable interlock using flow switches shall be provided in both oil as well as water lines to trip the drive motor in the event of flow in either lines falling below acceptable levels. Suitable pressure indicators and flow indicators shall be provided in the cooling water lines along with all-relevant valves, and accessories. Necessary isolation valves shall be provided in the oil / water line for

maintenance of any equipment in the line. Necessary interlock shall also be provided so that the HT motor cannot be started from remote / local unless position of scoop tube permits no load start of the motor. Tripping of downstream equipment while the system is under normal operation shall result in scoop tube re-positioning to permit no load run of the concerned HT motor. Temperature switch shall be provided in the oil circuit and shall trip the system in case of high oil temperature. The scoop tube operation must be such so to ensure draining of oil from the operating circuit by providing a double speed motor. The speed (for draining) shall be selected to match the coasting time of down stream equipment/conveyor.

4.6.0 LIMESTONE HANDLING PLANT (LHP) BUILDINGS

4.6.1 All LHP buildings shall have sufficient space to accommodate the entire equipment like head end, drive unit and tail end of various conveyors, chutes, control equipments, MCCs, batteries, supports for conveyor bridges, tensioning arrangements, approach/maintenance platforms with ladders, external / internal stairs, handrails, RCC floors, foundations etc. Moreover, ample space shall be provided for maintenance purposes. Outside stairs to junction towers shall be open type. However, a weather canopy shall be provided at the top.

4.6.2 Building floors shall be washed periodically with water for which necessary slope & drains shall be provided from each floor leading to minimum 4 nos down comers of minimum 273 mm OD each building. However for MCC, control buildings and pump houses, minimum 150 mm dia, 4 nos galvanized MS pipes conforming to IS: 1239 shall be provided. The system shall be designed considering water mixed with limestone. A drain pit shall be provided near each building to collect water/limestone mixture. Overflow from this pit shall be connected to nearest drain. 1 mtr x 1 mtr size dust/debris MS chutes from all the floors to ground floor shall be provided at all buildings/junction towers and limestone crusher house. The plate thickness shall not be less than 6mm. Openings in the floors of LHP buildings (i.e. JTs/CH etc.) shall be provided with curb of 100mm high to avoid water falling down to lower floors.

4.6.3 Floor at ground shall be provided in all junction towers, ground conveyors etc. Level of floor at ground shall be 500 mm above ground/grade level unless noted otherwise. For enclosed ground conveyor 750mm wide plinth protection along with drainage arrangement shall be provided along the conveyor on both sides. Suitable opening at every 50mtr interval shall be provided on either side in a staggered manner for exit / entry of personals. Necessary drains must be provided all along the floors of ground conveyor.

4.7.0 **TRAVELLING TRIPPER AND BUNKER SEALING ARRANGEMENT**

4.7.1 Mobile Trippers on bunker conveyors along with belt sealing arrangement shall be furnished and erected complete with rails, including necessary supporting structures, approach/ maintenance platforms with ladders and hand railings, trailing cables, all electricals including machine mounted local control panel & control panel on one end of Bunker. The Mobile tripper on bunker/yard conveyors shall be motor driven type. The tripper shall have provision for dropping limestone from conveyor onto both sides of tripper to the bunker/storage shed or back to the conveyor for the purpose of skipping intermediate bunkers (as applicable). The rating of tripper travel motor shall be adequate to move the tripper smoothly either in same or opposite direction to belt direction under fully loaded conditions. Adhesive weight requirement and tractive effort calculations shall be subject to approval of Employer. Coefficient of adhesion shall be considered as maximum 0.15. Minimum two drive axles shall be provided for tripper travel. Arrangement shall be provided at the starting point of the tripper to avoid folding of belt. In case of tripper running at a speed more than its rated speed due to chute jamming or other reason, conveyor shall trip and annunciation shall appear.

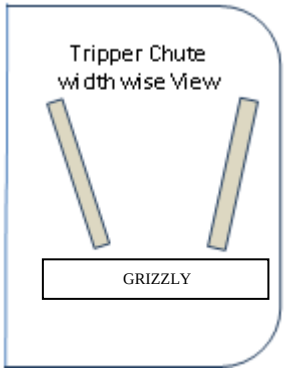
4.7.2 Supply of adequate length of rails to cover the runway length for the motor driven tripper shall be included. The supporting structures for the rails with necessary end stops shall also be supplied under this specification. Suitable belt hold down guide pulley shall be provided over the concave curve of belt over tripper. The travelling trippers shall be provided with fail

safe A.C. thruster operated brake of totally enclosed type which shall engage as soon as tripper travel motor stops. A.C. thruster operated rail clamps along with manual Rail clamps on both side of the tripper shall also be provided. Independent motorized linear actuator shall be provided to operate each flap gate of the tripper chute.

4.7.3 The sealing belt shall be of suitable grade (minimum 2 plies) with 5 mm x 5 mm covers (fire resistant) in line with other conveyor belting. The belt shall rest on 20 x 50 mm MS plates spaced at 200 mm placed 50 mm below floor level, provided over the bunker slot on tripper floor for tripper conveyor. The width of the bunker seal belt shall be at least 100 mm more than the bunker slot opening.

4.7.4 The tripper shall run on rails (90 lbs/yard) with double flanged wheels. Rails for tripper travel shall be mounted on supporting structure of respective conveyors. Suitable system having encoders for monitoring position of tripper in DDCMIS shall be provided. In addition, travel end limit switches and end stops shall also be provided. Suitable access platform of chequered plate with ladders, handrailing and walkways on both sides shall be provided for access/maintenance of equipment on tripper. In addition, crossover platform shall be provided with tripper so that operator can cross the belt through the same. 3mm deck plate continuous shall be provided below carrying idlers on the trippers.

Tripper discharge chute shall be of tapered section as shown in the sketch below.



4.8.0 PLOUGH SYSTEM (IF APPLICABLE)

As an alternate to travelling tripper (Alternate option applicable only for limestone mill bunkers) plough type system may be provided by the bidder. The plough type system shall consist of the following.

i. The system shall feed limestone to one bunker at a time.

ii. The plough shall be retractable type.

iii. Shall meet the capacity of the conveyor (150 TPH).

iv. The scraper/plough would normally be kept up in idle position allowing material to pass through and interfere with next lowered scraper/plough. In case material needs to be discharged scraper/plough will be lowered and fixed to that position till material fill up the bunker. The scraper/plough should be motor/cylinder/coil operated for remote operation.

v. The system must contain containment skirt boards with dust seal along the discharge area.

vi. The system shall be capable of unloading minimum 99% amount of limestone passing under it.

vii. However the system shall be complete from operation, maintenance and safety point of view.

4.9.0 LIMESTONE CRUSHER AND VMS

4.9.1 General

Hammer mill type crusher shall be provided for sizing the input limestone to a size which shall be suited for their limestone pulverizer and system. Crusher shall be supplied complete with accessories and subsystems.

4.9.2 Codes and standards

The design, manufacture, inspection and testing of Limestone Crushers shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Limestone Crushers shall conform to the latest edition of applicable standards and codes. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Employer shall be final and binding.

4.9.3 Design requirements

i. The crusher shall be of hammer mill type and shall be designed based on following clauses and the data sheet enclosed.
ii. The crusher design should be such that the crushing action is accompanied by the minimum of attrition.
iii. Uniform crushing impact shall be assured.
iv. The crusher shall be capable of delivering the normal rated output even when handling damp limestone having maximum moisture content. No clogging or building up of material on the crushing element shall develop.
v. Temperature sensing devices shall be installed on both bearings of each of the crusher to trip the crusher incase temperature goes beyond allowable limit.
vi. Zero speed limit switch shall be provided for protection against any un-crushable material. It shall sense the speed of rotor and shall trip the rotor when actual speed falls below the design speed.
vii. Crusher shall be provided with vibration monitoring (VMS) system. Specification of VMS shall be as specified elsewhere.

4.9.4 Construction requirement

i) ROTOR

The rotor shall consist of Forged steel shaft, with integral discs or key fitted discs on shaft. Hammers shall be held by spring dowel bushes & shall be arranged around the circumference of the rotor. The number of hammers and number of rows shall be selected as per requirements. The rotor shall be balanced statically.

ii) GRINDING WALL

The grinding walls shall be arranged symmetrically around either side of the rotor and carried by spindles supported in bearings attached to the casing. The wall shall consist of grinding wall supports and wear resistant grinding plates/Impact plates bolted on. For product size control, distance between the grinding plates and hammer shall be adjustable.

iii) HAMMER

The hammer shall be in two parts- head and arm. The hammer head shall be of wear resistant steel material. The hammer arm shall be of forged alloy steel. In the event of wear, only the hammer head shall be replaced. Arms shall be selected so that they have long life and do not require frequent replacement.

iv) FRAME /HOUSING

The housing shall be split type. Housing shall be fabricated from MS steel plates of weld able quality and shall be stiffened suitably. Maximum accessibility shall be provided for routine inspection and replacement of parts. For these purposes, the doors shall be of hinge connection with effective dust sealing arrangement. Hydraulically operated top cover of crushers shall be provided for quick inspection and replacement of hammers. The entire inside surface of crusher coming in contact with limestone shall be provided with abrasion resistant liners.

v) DRIVE

The hammer crusher will be driven through Electric motor, scoop type hydraulic coupling and gear box.

The material of construction for major components of crusher shall not be inferior to the quality and standards as mentioned in data sheet.

Design and construction features of hammer mill crushers offered by the bidder shall be similar to the crushers which are already working satisfactorily for same or higher capacity.

4.9.5 Vibration monitoring system should be offered for crushers as indicative below:

Sl.No	Equipment	Type	No.	* No. of location per equip.	Equipment bearing type
1.	Limestone Crusher	Radial ring	4	(2 Nos.) 1 at DE & 1 at NDE	As per manufacturer's design

Vibration shall be measured at each location in Horizontal as well as vertical direction.

4.9.6 Specification of the Vibration Monitoring System

a) Number & type of vibration — One (1), Microprocessor based, monitoring system able to distinguish between high frequency vibration caused by bearing trouble and low frequency vibration caused by imbalance.

b) Number of channels — 16 (Rack mounted in cabinet)

c) Transducer
   a) Velocity pick-up or a peizo-electric accelerometer. Type shall be decided during detail engineering based on the details of equipment to be monitored.
   b) Light weight stud mounting.

		c) Frequency response 1 Hz -10 kHz.
d)	Connecting cable	Low noise fire proof coaxial cable to be laid in flexible conduit.
e)	Monitors (to be located in FGD control room)	Dual channel monitor for each location alongwith : a) Buffered signal output and software for vibration analysis through FGD control desk HMI. b) Recorder signal output
f)	Display	Analogue and digital
g)	Alarm	0-100% full scale adjustable.
h)	Trip	0-100% full scale adjustable.
i)	Test	Functional checking from front inhibiting alarm & trip
j)	Relays	0.25 A at 220 Volts DC or 5 Amp at 240V AC. Independent potential free contacts for alarm & trip purpose.
k)	Signal Conditioner	Individuel 4-20 mA DC analogue output.
l)	Power Supply	240 V ±10% AC, 50 Hz + 3%, -5%

4.10.0 VIBRATING FEEDER

GENERAL

Vibrating feeder shall be provided below the crusher for limestone.

4.10.01 CODES & STANDARD

The design, manufacture, inspection and testing of Vibrating Feeder shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Vibrating Feeder shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Project Manager shall be final and binding. IS:3823 - Dimensions for vibrating conveyors and feeders with rectangular or trapezoidal trough.

4.10.02 DESIGN REQUIREMENTS

The vibrating feeder shall be of electromechanical type and shall be provided to feed imestone to crusher. The drive unit shall be complete with mechanical type of vibrator. The vibrating feeder shall be suitable for lumps size of (-) 250 mm. The feeder shall be designed to feed limestone to the conveyor without material sticking to it. The flow of material shall cease as soon as vibration of the trough or pan ceases.

4.10.03 CONSTRUCTION REQUIREMENTS

The vibrating feeders shall be mounted on the floor or suspended from roof with the help of helical springs made of alloy steel. No rubber/synthetic material for the support shall be acceptable.

Vibrator bearings shall be grease lubricated, double spherical roller type suitable for vibrating equipment. The bearings shall be sized for minimum 8,000 hours of operation.

Vibrating feeders shall be provided with removable abrasion resistant liner plate.The Vibrating Feeder shall conform to the latest edition of standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted:

IS:8723 - Dimensions for vibrating conveyors and feeders

4.11.0 PADDLE FEEDER

4.11.1 Paddle Feeders shall be supplied and erected complete with rails including necessary supporting structures, approach/maintenance platforms with hand railings and ladders, cable reeling drums with trailing cable, cable trays, all electricals including machine mounted local control panel.

4.11.2 **Codes and standards**

i. The design, manufacture, inspection and testing of Paddle Feeders shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Paddle Feeders shall conform to the latest edition of the Indian standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

4.11.3 **Design requirement**

i. Travelling paddle feeders of self-contained, self-propelled design shall be furnished and erected to scoop out limestone from the hopper and each feeder shall be capable of travelling back and forth along the entire length of the hopper and transfer the limestone from the hopper uniformly onto the conveyors below. Each paddle feeder shall have capacity to scoop out limestone at the guaranteed capacity in both forward and reverse motions with no indication of wheel slipping (water tank full). Each paddle feeder shall be designed for guaranteed capacity while handling entire range of lump sizes.

ii. It shall operate on the principle of positive discharge and shall not depend on friction or moisture content.

iii. The Paddle wheel shall be driven by a step less hydraulic drive. Carriage travel shall be achieved through electric motor gearbox (2 speed) and flexible coupling or through hydraulic drive or electric geared motor (2 speed).

iv. All equipment shall be designed to withstand any rate of acceleration imparted by drives or any strain resulting from a sudden change in load. Further, the design of paddle feeder carriage should be such that it does not run off from its rails due to sudden change in load or other reasons.

v. The Contractor shall include in his proposal necessary electricals for paddle feeder and carriage such as motorized cable reeling drum with trailing cables, and end limit switches for protection against over travel of the feeder carriage. Two separate cable reeling drums one for Power cable and one for Control cable shall be provided for each machine. The cable reeling drum and trailing cable of each feeder shall be suitable for the entire length of the hopper upto maintenance bay. Mechanical track stops alongwith buffers on each end of rails and on paddle feeders shall also be provided. For specification of dust suppression equipment for paddle feeder, refer relevant Sub-section of this Specification.

vi. For designing the paddle wheel as well as travel drive, Contractor shall consider the hopper fully loaded with limestone on either side of the paddle wheel to the maximum capacity. The hydraulic system normal average working pressure shall be selected considering the above loading condition. Further hydraulic system shall be designed to stall / trip beyond a certain pressure above the normal average working pressure. The minimum margin between the normal working pressure and the stall / trip pressure shall be 50%. The maximum working pressure for the hydraulic system in Hydraulic power pack shall not be more than 210 bar.

vii. Feeder carriage drive shall be suitably designed so that the forward & reverse movement of carriage can be achieved without stopping the scooping operation. Tank filled with water in DS system shall also be considered for travel drive. Capacity of tank mounted on tail end side shall be sufficient for half an hour operation.

viii. Rail structure shall be designed considering two-wheel support and accounting no frictional force from the other two wheels and considering hydraulic motor stall condition.

ix. For selection and specification of drive motors (other than the hydraulic motor), gearboxes, all types of couplings associated with paddle feeder and other equipment, relevant sections of this specification shall be referred to.

x. Contractor's design of paddle feeder should not incorporate a separate loading table (impact cradle) below the paddle feeders. However, the height of fall of limestone between paddle wheel and conveyor belt shall be kept minimum. Hydraulic components shall be provided with dust proof cover for protection against spillage of lime/ dust. Pressure /Temperature gauges shall be located at convenient locations for continuous observation by operator. Proper oil level gauge to be provided at hydraulic oil reservoir tank.

xi. Three (3) pairs of Control cables shall be provided in the control trailing cable of each machine for connecting Employers telephone and P.A. equipment to be provided on each machine.

xii. For Hydraulic system, in case the oil temperature is high then proper external cooling is to be provided , viz, heat exchanger, before the oil returns back to the oil tank.

4.11.4 **Construction requirement**

i. The paddle feeders shall run on rails mounted on the supporting structures of associated conveyors. Both paddle feeder and carriage drives shall be mounted on the feeder carriage.

ii. The paddle feeder wheel shall comprise of suitable numbers of vanes with cutting edges. The vanes shall be of high strength steel construction with removable TISCRAL / SAILHARD / LSLAS07 liner plates. Vanes shall be easily removable individually. Tip of the vane shall reach inner most point of hopper table.

iii. The feeder carriage shall be of steel construction and of robust design. Skirt plates shall be provided integral with the equipment for collecting the material drawn by the paddle feeder from the storage shed hopper and discharging on to the conveyor belt. Feeder skirts of paddle feeders shall be extended at least by 500 mm on either side of the paddle wheel to avoid spillage of limestone. Necessary baffle/retainer plates for suitably guiding the flow of limestone from storage shed hopper to the reclaim conveyor being fed by paddle feeders shall be provided. Hand railing shall be provided on the top deck of feeder carriage together with an access ladder.

iv. The feeder carriage shall be provided with suitable number of double flange wheels of steel construction, complete with sealed bearing unit. The drive mechanism shall be suitable for continuous reversible motion of the carriage. Start/stop switches shall be provided at the local control panel for the operation of paddle wheel and feeder carriage. The carriage shall automatically reverse its motion, when two paddle feeders operating on the same track come within a predetermined distance. Suitable anti-collision device (infrared and mechanically operated limit switch type) shall be provided. Provision shall be made to trip the limestone conveyor from respective paddle feeder and provision shall be made for tripping of paddle feeder from LHP main control room.

v. Rope actuated stop switches shall be provided along the travelling structure for emergency use.

vi. Suitable indication of paddle wheel 'rpm' shall be provided on the paddle feeder control panel and flow rate indicator of belt weigh scale shall also be duplicated on control panel of paddle feeder. Operating controls shall be mounted at a suitable height such that it can be operated from walkway. Encoder shall be provided on the paddle feeder to give 4-20 mA signal to the DDCMIS to the exact location of the machine.

vii. Suitable rail cleaners shall be provided at the leading as well as trailing side of the feeder carriage for both tracks.

viii. Suitable cable trays/troughs shall be provided along the travel of paddle feeder for supporting and guiding the trailing cables. In order to save flexible cables from damage due to tension/over-tension protection switches shall be provided. Isolating switch to isolate the power supply to the machines shall be provided in each power JB to be located at the center of travel length.

ix. Various equipment of Paddle Feeder assembly shall be easily accessible. It shall be possible to replace electrical, mechanical and hydraulic components of paddle feeder when positioned at hopper. Various drive equipment and hydraulic/other components shall be so arranged that limestone spillage from hopper mouth does not accumulate near/over them.

x. Provision shall be kept for automatic tripping of limestone conveyor in the event of paddle feeder getting dragged (i.e. travel speed in excess of rated speed). Paddle feeder once tripped due to jamming or operation of emergency push button shall not start unless the hydraulic pressure is back to "normal".

xi. Paddle feeders rails should be mounted on continuous running member. The splicing of rails shall necessarily be at vertical support location only. Splicing in between vertical support will not be accepted.

xii. The longitudinal distance between two vertical supports shall be 3000 mm (min.)

4.12.0 LIMESTONE SAMPLING UNIT

4.12.1 The limestone Sampling Unit shall conform to the latest edition of standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

ASTM-D-2234 : Standard Methods for collection of a Gross Sample of Coal.

ASTM-D-2013 : Standard Method of Preparing Coal Samples for Analysis

ASTM-C-50: Standard practice for sampling, sample preparation, packaging and marking of limestone and limestone products.

4.12.2 The Limestone sampling units suitable to give "Samples" conforming to ASTM-D-2234 shall be selected by the Contractor for taking samples from any of the two streams running at guaranteed capacity. The different Equipment selected for Limestone sampling unit shall be such that there shall be no loss of fines and moisture from the samples. The normal input feed size shall be considered as (-) 250 mm for limestone sampling unit before limestone crusher. However occasionally (-) 400 mm lumps may also arrive. Limestone lump size after limestone crusher shall be as per crusher output size.

4.12.3 Primary samplers (separate for each conveyor) shall be rugged, able to withstand severe shock loads and operate trouble free. Belt feeders shall be provided for entire sampling path upto sample collector. For rejects path also, belt feeders shall be preferred. Screw conveyors for the same shall be accepted only where space constraints do not permit distribution of limestone rejects to receiving conveyor below. Sample crushers shall be provided for reducing the main input feed limestone to 95% minus 8 mesh size and 99 % minus 4 mesh size. Single stage crushing shall be provided. There should be no re-circulation of fines in the crushers. 'Lot size' shall be equivalent to limestone quantity handled in 8 hours operation assuming average conveyor loading at 75% of rated conveyor capacity.

4.12.4 Belt feeders shall be positively self cleaning and have dust tight construction. It shall be provided with flanged belt, rubber lagged head pulleys and inspection doors. No chain/belt drives shall be accepted. The crusher's base should be built of reinforced concrete and be sufficiently large in mass. The sample chutes shall have minimum valley angle of 60 degrees to horizontal and shall be of stainless steel plates. The chutes shall be suitable to handle wet sticky limestone as specified elsewhere. The welding of chutes shall be done externally only. The inside surface of the material near welds shall be smooth. Radius at corners not less than 1" shall be provided in chute work. All solid connected members shall be by means of bolting flanges with at least 6 mm thick standard grade neoprene gasket material between the metal flanges. No control gates to regulate the flow of material shall be incorporated in the chute work.

4.12.5 Bias connections shall be provided at suitable locations. The materials rejected from samplers shall be returned to main conveyor stream. Minimum 4 nos. sample collecting bins shall be provided with auto indexing. The bins shall be provided with air tight connection. The system shall be suitable for operation through DDCMIS.

4.13.0 DUST CONTROL AND MISCELLANEOUS SYSTEM

4.13.1 The dust control system to be furnished under this specification is required for control of fugitive dust emissions from dust generation points such as junction towers, truck un-loading points, crushers etc. Dust control is achieved by dust extraction system. Service water system, potable water system, cooling water system & sump pumps shall also be provided. *All pumps/ compressors envisaged to meet dust control and miscellaneous system requirements for LHP/GHP shall be provided with 100% standby.* Each pump houses shall have one no. dedicated over ground tank. Each tank shall be sized for ½ hour storage capacity considering maximum water drawn in order to meet the specified requirement. Tank shall be completely enclosed and provided with man hole and access ladder (internal and external). All areas around tanks shall be paved with concrete and shall have proper drain.

4.13.2 **Service Water and cooling Water System**

Service water and Cooling water distribution system (for scoop coupling) complete with water supply system, valves, quick couplings, hose pipes with nozzle, piping, pumps, drive motors with canopy, couplings with enclosure, electricals, including supporting structures,

handling for equipment's, civil and structural works and necessary accessories shall be provided throughout the limestone handling system.

4.13.3 The Dust Control & Miscellaneous Systems shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted

IS:778	:	Gun Metal gate, globe & check valves for general purpose.
BS:5150	:	Cast Iron Gate Valve for water works purposes
BS:5152	:	Cast Iron Globe Valve for water works purposes
BS:5312	:	Cast Iron Check Valve for water works purposes
S:1239	:	Mild Steel tubes & fittings.
IS:2379	:	Colour for the identification of pipe line.
IS:3589	:	Electrically welded steel pipes for water, gas & sewage (200 to 2000 mm)
IS:5312	:	Swing check type reflux (non return) valves.
IS:1520	:	Horizontal centrifugal pump for clean, cold fresh water.
IS:5120	:	Centrifugal pump for clean, cold & fresh water.
IS 2825	:	Air Receivers.
ANSI B 31.1	:	Code for pressure piping.

Hydraulic institute Standards of U.S.A

4.13.4 Sump pumps alongwith level switches & piping upto nearest Employer's drain (max upto 50.0 mtrs. from outside the building) shall be provided at all locations wherever natural drainage is not possible. The capacity of each pump shall not be less than 50 m^3/hr. Minimum 10% margin on capacity and 20% margin on computed head shall be considered for selection of pumps. Size of the drain pit shall not be less than 2.0 meters x 2.0 meters x 1.8 meters deep. One no. of settling pit shall also be provided before sump pit so that water without heavy limestone particles goes into sump pump pit. High and low level switches shall be provided in the sump pump pit.

4.13.5 Service water connections are to be provided in conveyor galleries and tunnels at 50 meter intervals. Adequate number of these connections shall be provided in all junction towers with minimum one no. at each floor and with minimum two (2) nos. at each floor in limestone crusher house. Each connection shall be provided with one (1) no. 32 NB globe valve and quick coupling. One (1) no. hose pipe with nozzle shall be provided in each building.

4.13.6 Potable water connections are to be provided in all junction towers, limestone crusher house, all tripper floors, and all control rooms/MCC rooms and toilets etc. Water shall be drawn from the water storage tank by electric motor driven pumps and discharged via a pipe work system to the overhead drinking water storage PVC tanks of 250 litres capacities. The drinking water storage tanks shall have provision for maintenance & drain.

4.13.7 Hoists with monorail of adequate capacity shall be provided in the service water/dust suppression/potable water pump houses

4.13.8 The pumps shall be complete with drive motors, base plate and other accessories. Pump casing may be axially or radially split. Impeller shall be made in one piece and securely keyed to the shaft. Wearing surface shall be of hardened material and shall have a hardness difference of at least 50 BHN. The design of the shaft shall take into consideration the critical speed, which shall be at least 20% away from operating speed. Pump bearings shall be of antifriction type. Pump speed shall be less than 1500 rpm for pumps of capacity more than 10 m^3/hr. The power, head and flow characteristics of each pump shall be suitable for parallel operation. The Power characteristics of the pumps shall be of non overloading type. All rotating parts of the pumps shall be statically and dynamically balanced. Design duty point of pump shall match with the average value of maximum and minimum flow rates of the pump in the stable operation zone.

4.13.13 The sump pumps shall be of wet pit types, vertical shaft and impeller shall be specially designed to pass large solids or unscreened liquids. The construction and material shall be suitable for pumping limestone/dust contaminated water with a minimum of maintenance. All bearings of the pump shall be located above the water level.

4.13.14 In general pipe sizes 65 mm NB and larger are to be joined by butt welding and pipe work of size 50 mm NB and below by socket welding/screwed connections. Joints at valves or specialities shall be flanged for sizes 65 mm NB or large and screwed for sizes 50 mm NB and below. All galvanised piping shall be joined by screwed connections. Minimum pipe diameter selected for DS/SW/PW/Cooling Water System (along with branch pipes) shall be 32 NB. However, for dry fog DS system, the minimum pipe size shall be 20 NB.

4.13.15 Valves & Specialities shall be used to start, stop or regulate the flow. All valves/specialities below 50 mm size in service water/dust suppression/ potable water lines should be plug type. Gate/sluice valves shall be used for isolation of flow of pipe lines above 50NB and Globe valves shall be used for regulating the flow. All gate and globe valves of size 65 NB and large shall be bolted bonnet, outside screw, rising type with flanged ends. Valves of size 50 NB and smaller shall be with screwed ends. Non-return valves shall be swing check type. These valves will have a permanent 'arrow' inscription on its body to indicate direction of motion of the fluid.

4.13.16 Strainer shall be of duplex type designed with 3 way valves so that one filter can be cleaned while the other is in operation. Suitable vent and drain valves shall also be provided. Screen opening area shall be at least four times the pipe cross sectional area. Pressure drop in clean conditions shall not exceed 1.5 MWC at full flow.

4.13.17 The dust control and miscellaneous system to be supplied for limestone handling plant may be clubbed with the dust control and miscellaneous system for coal handling plant under this package.

4.13.18 Dust extraction system for Limestone Handling area:

Dust extraction system for limestone handling system shall be dry type comprising of dust collection hoods, ducting, fans, bag filter and dust collection hopper. The limestone dust collected in dust collection hopper shall be periodically emptied back to the conveyor leaving the building.

4.13.19 Limestone storage area dust extraction system:

a) For dust control in limestone storage shed during stacking and handling of limestone, roof extractors, ducting and collection hopper with bag filters shall be provided. The dust collected in the dust collection hoppers shall be periodically emptied back to the reclaim conveyor below the shed.

b) For the paddle feeder provided for the reclaim hopper below the limestone storage shed, the dust extraction system comprising of suction hood, ducting and trolley mounted dust collection hopper with bag filters shall be provided. The dust collection hopper shall be periodically emptied back to the reclaim conveyor.

4.14.0 VENTILATION SYSTEMS

4.14.1 **Mechanical Ventilation system**

The air quantity for mechanical ventilation system shall be estimated based on equipment and solar heat loads and the temperature rise inside the building. Necessary air filters shall be provided to supply only clean air into building. Exhaust air shall be discharged at a suitable height above building. The ventilation system generally consisting of adequate number of supply and exhaust air fans, air filters, ducting along with 3 phase AC motor

drives, electricals, supporting structures, approach/maintenance platforms, civil and structural works and necessary accessories shall be furnished for ventilating the underground portion of junction towers, underground conveyor tunnels. Exhaust fans shall be provided for tripper floor, Toilets, Battery rooms. The exhaust fans for toilets and battery rooms will be propeller type and for tripper floors will be axial flow type complete with rain protection cowl and bird screen.

4.14.2 **Pressurised Ventilation System**

The pressurised ventilation system having adequate nos. of supply air fans with washable metallic pre filters, HDPE fine filters, and self closing flap (gravity louver shutter), ducting along with 3 phase AC motor drives, electricals, supporting structures, access / maintenance platforms shall be provided in all MCC/switchgear room areas of limestone handling plant to be furnished under this specification. The pressurized ventilation system shall be designed considering 15 air changes per hour to maintain these areas pressurised slightly above atmospheric pressure to prevent ingress of dust from outside

4.14.3 Air Conditioning System

Air conditioning system shall be furnished for control room area of main LHP control building (if applicable) and in electrical buildings. It shall be designed considering the equipment heat loads, solar heat loads, heat gain into the room, adequate no. of air changes etc. to maintain a uniform temperature and relative humidity within the air conditioned areas.
2x100% capacity air conditioning units with air cooled condensers shall be provided on the following basis.
a) For areas where air conditioning load is in the range of 5-15 TR, Non-ductable ceiling mounted (cassette type) or wall mounted (high wall type) split air-conditioners of suitable capacity along with adequate redundancy shall be provided.
b) Ductable split/packaged type A/Cs shall only be provided for control rooms where the load varies in the range 15- 25 TR.
c) Central air conditioning system shall be provided for control rooms where the load varies in the range 25-60 TR.

Window ACs shall be provided for RIO room (if applicable). Supply and return air distribution ducting complete with insulation, of resin bonded mineral wool equivalent of density at least 24 kg/m³ and thermal conductivity of max. 0.49 mw/cm°C conforming to IS: 8183 including supporting structures, approach/ maintenance platforms, civil and structural works and necessary accessories shall be provided.

4.14.4 The Ventilation & A/C System shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

IS:3588	:	Specification for electrical axial flow fans.
IS:2312	:	Propeller type AC Ventilation fans
IS:3963	:	Specification for roof-extractor units
IS:4894	:	Centrifugal Fans
IS:655	:	Specification for Metal Air Duct
ARI:210	:	Standard for Unitary air conditioning equipment.
ARI:270	:	Standard for application, installation and servicing of unitary equipment.
IS:8183	:	Specification for bonded mineral wool.
IS:661	:	Thermal insulation for cold surfaces.
IS:4671	:	Expanded polystyrene for thermal insulation purpose.
IS:8148	:	Packaged Air conditioners

4.14.5 **Axial Fans**

Design duty point of the fan shall match with the average value of maximum and minimum flow rates of the fan in the stable operation zone. The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1440 rpm for fan with impeller diameter 450 mm and less. The first critical speed of rotating assembly shall be at least 25% above operating speed. Impellers shall be axial flow type and single piece cast aluminum with aerofoil blades construction and shall be mounted directly on the motor shaft. It shall be finished all over and balanced dynamically. Rain protection cowls will be designed to suit wall exhausters/supply fans for protecting fans/motors from rain. It will be provided with bird screen. Inlet cone or bell and outlet cone shall be provided as required. It should be made of G.I. or M.S.

4.14.6 **Centrifugal Fans**

The fan units shall be centrifugal type with radial bladed impeller. For design, purpose out door ambient temperature shall be taken as 50 deg.C. All fan mountings shall have adequate arrangement for vibration isolation. The reverse flow through non-working fan shall be prevented by dampers. The dampers shall be made out of 18 SWG MS sheets. Design duty point of the fans shall match with the average value of maximum and minimum flow rate of the fan in the stable operation zone. Split casing shall be provided on larger sizes of fans. Casing drain with valves shall be provided wherever required. The impeller shall have die formed curved blades fabricated out of MS heavy gauge welded to the rim and back plate to have a non overloading characteristics of the fan. Rim shall be spun to have a smooth contour. The impeller, pulley and shaft sleeves shall be secured to the shaft by key and/or nuts. The impeller along with driven pulley shall be dynamically balanced. Fan shaft shall be of EN-8 equivalent. The bearings shall be self-aligning heavy-duty ball or roller bearings. They shall be adequately supported. They shall be easily accessible and lubricated properly from outside

4.14.7 **Metallic Filters**

Metallic cleanable filters shall be provided as required. Max. air velocity considered shall be 2 m/sec. Metallic cleanable filters shall consist of V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh. The density of the filter medium shall increase in the direction of airflow. Wire mesh edges shall be suitably hemmed to eliminate the danger of abrasion during handling. Filter medium shall be supported on either side by galvanized expanded metal casing. Filter frame shall be constructed from galvanized sheet of thickness not less than 18 gauge.

4.14.8 **HDPE Filters**

HDPE filters should have an efficiency of 90% down to 5 microns. Velocity across the filter shall be limited to 2.5 m/sec. HDPE filters shall be provided as required. To facilitate periodic cleaning of filters by water washing, tap or service water connection near the filters shall be provided.

4.14.9 **High efficiency filter (for A/C purpose)**

High efficiency filter (for A/C purpose). Filtration efficiency shall not be less than 99% down to 5 microns. Pr. drop across the filter under clean condition shall not be more than 10 mm w.c. The media of the filter shall be made from either special synthetic non-woven bond fiber design or made from micro fiber glass media. It shall be supported with GI wire mesh or aluminum mesh and shall be housed in an aluminum sheet frame. It shall be of washable type several times.

4.14.10 **Packaged Air-Conditioning Unit**

PAC units shall be factory tested and assembled self contained units complete with refrigerant compressor, coils, fans, insulation and wiring. Various parts of PAC units wherever required shall be insulated with expanded polyethylene conforming to IS:4671. The PAC unit shall comprise of an evaporator (indoor air) blower section and an air cooled condenser (outdoor air) section. Heavy gauge steel cabinet finished with paint of approved colour, shall be used to house components of PAC. The evaporator and condenser coils shall be arranged for direct expansion cooling and shall be formed of aluminum fins mechanically bonded to seamless copper tubes and electrically tinned. The inter-connecting refrigerant circuits shall comprise of hermetically sealed scroll compressor and motor with all necessary isolation valves, with adjustable set point, sight glass, copper tubing and pipeline ancillaries. The condenser coils shall be air cooled by propeller type fans complete with safety guards. The condensing coils The evaporator air blower(s) shall be centrifugal forward curved type belt driven by individual motor(s) and suitable for the external static pressure. The fan assembly shall be isolated from the casing by anti-vibration mounts. The fan/motor drive shall be capable of capacity adjustment by pulley changes within +15% of design duty shall be suitably arranged to avoid radiant heat pick-up from solar sources. Condenser capacity control shall be provided by means of fans and 'head pressure' sensing. High efficiency filters shall be provided in the main supply air duct and in the fresh air connection to return air duct.

A separate cubicle shall be provided within the overall casing to house the thermostatic controls, which shall be electric/electronic solid state, prewired and tested. The refrigerant system shall be protected by pressure limiting devices, electric and thermal overloads and unloading facilities to provide the required control range tolerances. A low voltage room thermostat or RTD based temperature sensing device shall be provided for wall mounting. The casing shall be fitted with all necessary coil drains and service connections/ entries. PAC (duty/standby) units shall be selected manually and be ON/OFF switched. The units shall be fully packaged and incorporate integral room air sensing control thermostats and manufacturers work fitted safety interlocks. All controls shall be prewired to unit mounted control/power terminal boxes.

4.14.11 **Ventilation and Air Conditioning system ducting**

All GI sheet metal ductwork required for ventilation and air conditioning system shall be furnished by the supplier. All ducts and plenums unless otherwise noted shall be constructed out of standard quality galvanised steel sheet. All sheet metal ducts shall be fabricated and installed in conformity to the requirements of IS: 655. Steel supports for the ductwork shall be furnished as required. The thickness of ducting steel shall be 1 mm min. For ducting with large size exceeding 1000 mm it shall be 1.2 mm. The flexible connection between fan and ducting shall be on teflon impregnated canvas. The zinc coating on GI sheet shall be 275 gm/m^2

4.15.0 BELT SCALE

4.15.1 The Belt Scales shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

NEMA

NEC **For electronic circuit enclosures.**

IS:11547 Electronic weighing in motion system

4.15.2 The weigh scale shall be automatic and electronic type. It should be designed for continuous automatic weighing, metering and printing of limestone flow. Each belt weigh scale shall

comprise of a belt weigh scale platform with minimum 4 nos. weighing idlers. It shall have unitised construction for ease of installation and shall be fully floating type (without pivot points). Minimum 4 nos. hermetically sealed load cells of precision strain gauge type shall be applied in tension to support the weigh bridge. The load cells shall have 100% overload protection and shall be structurally safe upto to 250% of rated belt scale capacity. Belt scale shall be electronic microprocessor based with its program stored in non-volatile memory. It shall be provided with self diagnostic features for trouble shooting of the entire belt scale system. Fully automatic zero and span calibration facility shall be provided. The flow rate indicator shall have minimum 4 digits. The flow totalizer should have 8 digits display scale with reset facility. Complete belt scale system shall be suitable for 50°C ambient temperature and 100% relative humidity. It shall be suitable for out door installation in a dusty area. The electronic circuit enclosure, sensors housing shall be dust and watertight. The electronic printed circuits shall be encapsulated with epoxy or other suitable material for protection against dust and moisture. Minimum three years battery back up power failure protection shall be provided.

4.15.3 Belt scale shall be designed for a range of 20% to 120% of rated capacity with an accuracy of atleast (±) 0.25 percent throughout its range. Per two (2) belt weighers, the contractor shall furnish one (1) necessary test load chain sets required for calibration and periodic testing of the equipment. The test load chain shall be 'two idler spaces' longer than the weighing length of the weighers and shall be complete with chain reset equipment with weight adding reels of adequate size. The calibrated weight parameter length of the test chain shall be stamped at a suitable location on the body of the equipment. Alternatively, supply of test weights for calibration of belt scales is also acceptable.

4.16.0 IN-LINE MAGNETIC SEPARATOR AND SUSPENDED MAGNET

4.16.1 Inline Magnetic Separators shall be provided for continuous and automatic extraction and discharge of tramp magnetic pieces from limestone being discharged from conveyors as specified. The sets shall be complete in all respects with drives, magnets, inline belts, hoppers, chutes, tramp-iron boxes and all electrical ancillaries like control panels etc. Suspended Magnetic Separator shall be provided for picking up tramp magnetic pieces buried under limestone from moving Conveyor.

4.16.2 Magnet core material shall be pure annealed iron or equivalent high permeability magnetic material. The coil shall be of aluminum wire with class 'H' insulation, to limit the absolute temperature of the winding to 140 deg. centigrade. The oil used for cooling the ILMS and SM shall be silicon based.

4.16.3 The 'Force Index' i.e. the product of flux density in gauss and rate of change of flux density w.r.t. distance, at the bottom of falling material trajectory shall be 100,000 (gauss x gauss/inch) minimum in hot condition for mounting height of 450mm in the conveyors carrying uncrushed limestone & 400 mm in the conveyors carrying crushed limestone. However, the strength of the magnet shall not be less than 1000 gauss in hot running condition at distance of 450mm in the conveyors carrying uncrushed limestone & 400 mm in the conveyors carrying crushed limestone. The minimum strength of the magnet shall be 1000 gauss at the specified mounting height at the centre of Belt width. Contractor shall select magnet width to suit above. Characteristic curve of magnet with the value of flux density varying between 50 mm to face of conveyor belt shall be provided. The cross section of magnet shall be suitably designed to provide sufficient area for magnetising the coil effectively covering full cross section of the discharge material. The magnetic separator shall be located such that it picks-up tramp iron from limestone trajectory after it has been discharged from head pulley.

4.16.4 The tramp magnetic pieces buried under limestone picked up by the magnetic separator shall be discharged suitably to ensure that it falls into the tramp iron chute, which shall be provided upto ground level. All conveyors with magnetic separator at head end shall have non-magnetic SS pulleys. Head pulleys of all conveyors with in line magnetic separator at

head end shall be provided with SS shell and end disc. However, hub and shaft shall be of same materials as in other pulleys (EN-8 or equivalent). The motor and the gear reduction unit for driving the in-line belt shall be adequately sized with minimum 20% margin to avoid any over loading during operation. Suitable zero speed switch shall be provided. No Chain/belt drives shall be accepted. The belt shall be designed to withstand high temperature at the bottom of the magnet and any serious damage due to the impact of the sharp edges of the tramp iron. The belt shall be provided with rubber cleats spaced suitably. The belt shall be of fire resistant grade.

4.16.5 The magnetic separator units shall be supported by suitable structural member from the top by taking support from the operating floor beams with turn buckle arrangement to facilitate the necessary adjustments during operation. Further, electric Hoists operated cross travel arrangement shall be provided to move magnetic separator away to facilitate maintenance of the conveyor discharge pulley/Belt. ON/OFF control push buttons with indicating lamps shall be provided at the local station. The materials of chutes and hoppers associated with magnetic separators above the drive floor shall be SS-304 in the magnetic zone. Other chutes shall be of 1 mtr. sq. dimension and shall be made of MS. Chutes shall have poking doors at all floors to clear jammed material.

4.16.6 Suitable arrangements shall be provided in the magnet for keeping the coil of the magnet dry from atmospheric condensation when the magnetic separator is not in use. Protection against high oil temperature in magnet shall be provided.

4.17.0 METAL DETECTOR

4.17.1 Metal detectors shall be provided at specified location to detect metallic objects in the limestone stream. Metal detectors shall have high reliability with enough sensitivity to detect 25mm aluminum sphere below the burden of limestone in case of synthetic belting. However, for steel cord belting the sensitivity shall be 35mm. It shall also detect other metals, like brass, copper, stainless steel, manganese steel, bars, scraps etc. The equipment shall have provision for automatic static calibration with adjustable sensitivity.

4.17.2 Metal detectors shall be completely solid state using latest state of art technology. It shall be suitable for 50°C ambient and RH of 100%. The search sensor shall be protected from rain and direct sunlight by means of a non metallic covering other than wood. Control unit shall have adjustable controls for sensitivity, ON/OFF push buttons, resettable operation counter, audio-visual alarms local remote selector switch and all other necessary controls for trouble free operation of metal detector. It shall be suitable for mounting on wall, column, structure etc. with IP-65 Degree of protection. It shall be constructed from FRP of thickness not less than 2mm.

4.17.3 The coils shall be protected against being struck by an oversized material. The coils should have adjustment for magnetite/iron in incoming limestone. It should ignore magnetite/iron and shall distinguish between metal pieces and magnetite/iron. In order to counteract interference from external sources such as motors, lightning and radio-transmitters, and to nullify the effect of climate changes/aging, dual receiver coils are to be used. In order to allow passing of steel cord belt and metal belt fasteners without giving alarm and at the same time detecting tramps, suitable arrangements shall be provided. In case a few non-magnetic idlers or non magnetic deck plates are required, the Contractor shall provide these. However, these shall be metallic. Wood is not to be used. LED display of COAST COUNT to indicate the number of pieces of tramp iron detected since last reset shall be provided so that the operator is alerted for the pieces of tramps, if any, between tramp marker and coil before restoring conveyor. TOTAL COUNT, which is not resettable, shall also be provided on the same LED display on demand. The location of tramp metal pieces shall be indicated by sand bag marker.

4.17.4 Fiber glass enclosure (with IP 65 degree of protection) shall be provided for all type of coils. Local control panel shall be provided with IP:65 degree of protection.

4.18.00 **BOX FEEDER OR BULK MATERIAL RECEIVING UNIT OR TRUCK UNLOADING SYSTEM OR SURFACE FEEDER:**

The Box Feeder should be a robust, proven, above the ground for unloading from trucks/ self-tipping trucks or from loader shovels. The unit should be designed for rapid intake and temporary live storage of material before transferring on to the crusher house. The intake and onward discharge capacity to be 200 TPH per Box Feeder.

4.19.00 **BUCKET ELEVATOR SYSTEM**

4.19.01 **General Requirement**

The type (Centrifugal/Continuous) of the Bucket Elevator shall be chosen by Bidder for the material and conditions specified. The Bucket Elevator shall be sized to handle the design capacity at the specified material bulk density & maximum material size. The equipment shall be complete with all necessary sub-systems and components and shall be designed and supplied in conformance with the attached datasheets, site conditions, specific Employer's requirements and applicable International, National, State and Local codes. The Equipment shall be complete in all aspects and all items required for erection/smooth operation shall be in Bidder's scope, unless otherwise noted in exclusions. Sizing of the equipment and components shall be the responsibility of the Bidder, based on the service conditions specified.

4.19.02 **Codes and Standards**

All design, fabrication, testing, supply and erection, if applicable, shall conform to the latest edition of all the relevant standards and regulations issued by the governing bodies.

Bidder shall follow the applicable INDIAN/INTERNATIONAL codes by the following organizations. EN European Norm

IEC International Electro technical Commission

ISO International Organization for Standardization

DIN German Institute for Standardization (To be used when no EN standards exist) Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Employer shall be final and binding.

4.19.03 **Design Requirement**

4.19.04 **Design Criteria**

The equipment shall be designed for continuous twenty-four hour service. The Equipment shall be designed for service in a heavy duty industrial application, handling abrasive materials in a dusty environment.

The Bucket Elevator should be sized to handle the design capacity as indicated on the Data Sheet with the minimum material bulk density and a maximum bucket filling of 75%.

4.19.05 **Casing**

Casing to be self-supported, dust-tight construction and capable of supporting head shaft, drive, and service platform.

Head section is to be split and equipped with handles or lifting lugs for easy removal. Access and inspection doors are to be provided.

Intermediate sections are to have a minimum plate thickness of 4 mm.

Boot section to be fabricated of minimum 6mm steel plate, with front and rear access panels.

A beam is to be provided in casing for servicing internal gravity take-up. The beam may be located either in the boot section or intermediate section as applicable.

4.19.06 Buckets

Size, capacity and type of buckets and appropriate reinforcement necessary for the application shall be adequately sized. Provide pin holes in bottom of buckets for air relief, as necessary, when handling materials such as Lime stone or gypsum. Bucket width is to be a minimum of four times the maximum particle size.

4.19.07 Belting

Belting shall be provided as specified else where in the specification..

4.19.08 Pulley

Drive and guide pulleys shall be provided as specified else where in the specification and shall be at least the minimum recommended for belt conveyor pulleys.

4.19.09 Head Shaft and Bearings

The bearings on head shaft to be antifriction type with one bearing fixed and the other expansion. All bearings are to have an L_{10} life of 60000 hours.

4.19.10 Foot Shaft and Bearings

The tail shaft is to be of hardened steel with tool steel sleeves operating in heat treated white iron bearings. All bearings are to have an L_{10} life of 60000 hours.

4.19.11 Take-up

Take-up shall be screw or internal gravity type with guide rails and weights included.

4.19.12 Drive

Bucket elevator drive should be sized as follows:
Minimum power for drive, either:
100% bucket filling @ minimum material bulk density, or
75% bucket filling @ maximum material bulk density, whichever is greater.

4.19.13 Inspection and Access Doors

Inspection doors and access doors shall be loose-hinged type with quick-opening jamb bar fasteners and gaskets enclosed and retained in the door. Access doors shall be 1.5m minimum.

4.19.14 Dust Vent

A dust collecting vent in the head section and boot section shall be furnished with drilled flanges. Bidder quote is to include recommended vent volumes for the boot and head sections of the elevator. The Pick-Up velocity shall not be greater than 2.5m/sec.

4.19.15 Drive Equipment

The Drive Equipment for Bucket Elevator shall be as specified else where in the specification.

DATA SHEET for each of above system and equipment is as below :

DATA SHEET: BELT CONVEYOR

1.0.0	**GENERAL**		
1.1.0	Design Capacity	110% of rated (guaranteed) capacity for all conveyors.	
1.2.0	Maximum slope	16 deg	
1.3.0	Max. belt Sag between idlers	2%	
1.4.0	Minimum Radius		
	(i) Concave curve	250 m (In case of travelling trippers, the requirement of minimum radius shall be decided based on the space availability)	
	(ii) Convex Curve	50 m	
1.5.0	Limestone Parameters	As specified elsewhere	
2.0.0	**DESIGN & CONSTRUCTION**		
2.1.0	**Belting**		
2.1.1	Type	Synthetic Fabric of Nylon / Nylon	
2.1.2	Cover Grade	a) Flame test : Conforming to ISO:340 b) Drum Friction and Electrical Surface Resistance Test: Conforming to Canadian standard association CAN / CSA M-422- M87 Grade - C.	
2.1.3	Cover Thickness (without –ve tolerances).	Synthetic belting	Steel Cord
	(a) Face	5.0 mm (min.)	8.0 mm (min.) (Inclusive of steel or fabric breaker)
	(b) Bottom	2.0 mm (min.)	6.0 mm (min.) (Inclusive of steel or fabric breaker)
2.1.4	No. of plies	Minimum 3	
2.1.5	Drive Arrangement	Snub drive	

DATA SHEET : BELT CONVEYOR

2.1.6	Factor of Safety	- 10 (Minimum) for N-N belt. - 7 (minimum) for Steel Cord Belt.
2.1.7	Normal Working tension at design capacity	Less than 80% of max. allowable working tension
2.2.0	**Idlers**	
2.2.1	Type	
	(a) Carrying	Three roll, 35 degree troughing, 2 degree forward tilt
	(b) Return	Single Roll, For conveyors upto 400 m c/c length. Two roll with 10 degree angle for conveyors more than 400 m c/c length
	(c) Loading point	Impact type
2.2.2	Spacing	
	(a) Carrying idlers	1.2 m (0.6 m for convex curves).
	(b) Return idlers	3.0 m (for convex curves not more than 1.5 m.)
	(c) Loading point	Minimum six (6) with 400 mm spacing.
	(d) Self-aligning troughing idlers	At 10 m distance from head & Tail pulleys with intermediate spacing 15m
	(e) Self - aligning return idlers	At 10 m distance from Head & Tail pulleys with intermediate spacing 20m. (Not required for conveyors more than 400m c/c long where 2 roll return idlers are provided).
2.2.3	Bearings	
	(a) Carrying	Ball Bearings of deep groove type or seize resistance type of min. 30 mm size, lubricated for life.
	(b) Return	Ball Bearings of deep groove type or seize resistance type of min. 20 mm size, lubricated for life.
2.2.4	Material	
	(a) Roller	ERW Steel tube min. wall thickness 4.0 mm

	(b) Spindle	EN- 8 or equivalent.
2.3.0	Belt Cleaners	
2.3.1	External	Spring loaded scraper type cleaner with modular, segmented and replaceable PU blades with separate main-cleaner & pre-cleaner etc.
2.3.2	Internal	V-Plough type, mild steel flats with hard rubber strips.
2.4.0	Belt Take up	
2.4.1	Type	Automatic Gravity Type.
2.4.2	Location	In relation to the drive to keep belt tension at minimum.
2.4.3	Take-up travel	To suit all operating conditions or (2.5% for synthetic belt and 0.5% for steel/cord belt) of conveyor center to center length whichever is larger. Further the initial location of take-up shall be decided in such a way that it is possible to carryout min. two (2) nos. Vulcanizing Joints without adding any external belt.
2.5.0	Hold Back Device	Integral with gear Box
2.6.0	Pulleys	
2.6.1	General (for all types of Pulleys)	
	Pulley shaft diameter	Margin of minimum 20% shall be Considered on maximum tension at design capacity for arriving at the shaft dia.
2.6.2	Drive Pulleys	
	(1) Lagging	Hot lagged with vulcanized natural rubber
	(2) Lagging thickness	12 mm thick grooved in diamond pattern with grooves 6 mm wide x 6 mm deep
	(3) Minimum angle of wrap	210° degrees
	(4) Maximum Out of roundness	0.5% of nominal diameter
2.6.3	Other pulleys	
	(1) Lagging	Hot lagged with vulcanized natural rubber
	(2) Lagging thickness	12 mm thick plain

2.6.4	Rubber for lagging	
	(1) Type	Natural rubber blended with styrene Butadiene rubber.
	(2) Hardness	55 to 65 durometer (Shore A)
	(3) Elongation	Over 300%
	(4) Strength	160-245 kg/cm^2
	(5) Abrasion loss	250 mm3 (max.) as per DIN 53516
	(6) Specific Gravity	Max. 1.5
	(7) Adhesion Strength	10 kg/cm (minimum)
2.6.5	Bearings for Pulleys	
	(1) Type	Heavy duty roller type
	(2) Casing	Horizontal Split Type
	(3) Sealing	Dust tight with double labyrinth seals.
	(4) Lubrication	Greasing arrangement with conical head shape nipples.
2.6.6	Pulley Material	Mild steel conforming IS:226 / IS : 2062
2.6.7	Shaft Material	Forged Steel shaft EN-8 or equivalent material.
2.7.0	Belt Protection Equipment	
2.7.1	Emergency Stop Switch System	
	(1) Type	Pull chord type (manually reset)
	(2) Location	Both sides of conveyor for entire length
	(3) Spacing	Approx 30 m
2.7.2	Belt Sway Switches	
	(1) Type	Limit switches snap action.
	(2) Spacing	One pair at 50m interval (Minimum two (2) pairs)
2.7.3	Zero Speed Switches	
	(1) Type, Location	Proximity switch, mounted on Bend pulley of GTU.

2.8.0	Drive Motors	
2.8.1	Type	Three Phase Squirrel Cage Induction Motors
2.8.2	Mounting (for conveyors)	Base mounted
2.8.3	Continuous motor rating (Name plate rating) at 50°C Ambient	120% of actual power requirement at motor output shaft at design capacity.
2.9.0	Conveyor Bridges	
2.9.1	Walkways	
	(a) Construction	Chequered plate with antiskid arrangement. Chequered plate steps shall be provided where conveyor slope exceeds 10 degrees. (Totally sealed so that no water falls down while washing.)
	(b) Central walkway width	1100 mm
	(c) Side walkway width	800 mm (for single conveyors, the width of side walkways shall be 800 mm on one side and 1100 mm on the other)
2.9.2	Side Windows	
	(a) Spacing (Center to center)	25.0 m on each side (in staggered fashion)
	(b) Size	1.2 m x 1.5 m
	(c) Window material	Refer Civil Section
2.10.0	Trestles	
2.10.1	Spacing of monkey ladders on trestles	
	(a) Where height of conveyor gallery (walkway level) is 10 m or more.	: On every trestle
	(b) Where height of conveyor gallery (Walkway level) is less than 10m.	: On alternate trestle

DATA SHEET: BRAKES AND CLAMPS

1.0.0	**GENERAL**	
1.1.0	Brakes	(i) For decelerating of conveyors & rotating equipment's. (ii) Brakes are mandatory for H.T. drives involving scoop type coupling.
1.2.0	Rail Clamps	For various mobile equipment travelling on rails.
2.0.0	**DESIGN & CONSTRUCTION REQUIREMENT**	
2.1.0	**Brakes**	
2.1.1	Type	Electro Hydraulic Thruster brakes A.C. operated or Disc brakes.
2.1.2	Braking Torque	Adjustable from 0 to 100% of rated braking torque.
2.1.3	Brake Shoes	Operated directly by spring
2.1.4	Shoe lining	Asbestos with interwoven brass wires.
2.1.5	Max. Temperature for shoe lining	200 degree C.
2.1.6	Thrustor	Class-B insulation, IP-65 protection.
2.2.0	**Clamps**	
2.2.1	Rail Clamp support	Independent from the rails.
2.2.2	Limit Switches	"ENGAGED" & "DISENGAGED" signals.
2.2.3	Clearance between Rail clamp face & Rail surface	Minimum 50 mm
2.2.4	Material for Rail clamp Mechanism	Forged steel
2.2.5	Thruster	Class-B insulation, IP-65 Protection
2.2.6	Type	Electro hydraulic thruster, manual

DATA SHEET: MONORAILS AND HOISTS

1.0.0	**GENERAL**	
1.1.0	Functional Requirement :	To transfer equipment's to maintenance area or outside the building.
2.0.0	**DESIGN & CONSTRUCTION REQUIREMENT**	
2.1.0	**Hoists**	
2.1.1	Drive	
	(i) More than 2.0 tonne or more than 10.0 m lift or hoists coming out-side the buildings	Motor driven for both travel & lift.
	(ii) Other hoists including the hoists for handling takeup pulley and takeup weight	Manual for both travel & lift.
2.1.2	Maximum trolley travel speed for electric hoists	15m/min
2.1.3	Maximum Hoisting speed for electric hoists	6 m/min
2.1.4	Drive Motors	SQIM, Separate for travel & lift
2.1.5	No. of starts for drive motor	150 starts/hr at 40% CDF
2.1.6	Wire Rope	
	(i) Type/Construction	Pre-formed type, hemp cored, regular lay 6/36 construction
	(ii) Breaking Strength	160-175 kgf/sq. mm
2.1.7	Bearing	
	(i) Type	Ball/Roller bearing
	(ii) Life	20 years
2.1.8	Brake	Electro Mechanical type with asbestos lining.
2.1.9	Load Hook	Swiveling type forged circular shank section.
2.1.10	Duty	Class –2
2.2.0	**Monorail location/layout**	
2.2.1	Cross section	I beam
2.2.2	Distance between C/L of monorail & C.G. of equipment to be lifted	Maximum 500 mm

2.2.3	Power Cables Support	Festoon type arrangement
2.3.0	**Manual Hoists**	
2.3.1	Maximum manual effort for operation.	30 kg

DATA SHEET: CHUTES AND HOPPERS

1.0.0	**GENERAL**	
1.0.1	Limestone Parameters	As specified elsewhere
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	**Chutes & Hoppers**	
2.1.1	Minimum Valley Angle	60 degrees
2.1.2	Material :	
	(a) Chute work	
	(b) Sliding zones & adjacent sides	20 mm thk. TISCRAL / equivalent
	(c) No striking/ Non sliding zones	10 mm thk MS
	(d) Chute with valley angle 80 degree and above	All four sides of 20 mm thk. TISCRAL/equivalent material
	(e) In the zone of magnetic field of ILMS (chute above floor over which ILMS is suspended)	SS-304 10 mm thk.
	(f) In the zone of flap gates	20 thk TISCRAL/ equivalent material
	(g) Discharge Hoods over head pulleys	4 mm thk M.S. with rubber curtain
2.1.4	Inspection Doors	Hinged & leak proof construction (min. size 350 x 450 mm)
2.1.5	Chute Construction	
	(a) Corners	One face of removable bolted flange connection
	(b) Joints Bolted	Flange joints of dust tight construction
	(c) Bolt size	Min. M-16
	(d) Bolts spacing	Not more than 125 mm C/C
	(e) Fixing Arrangement	Bolts with plain spring washers
2.2.0	**Skirt Boards**	
2.2.1	Length	Entire feeding chute shall be extended minimum 3 m ahead of front edge of chute & 500 mm beyond rear edge of chute.
2.2.2	Height	Not less than 750 mm

2.2.3	Width		2/3 of belt width
	Side plate		Min. 10 thk TISCRAL/equivalent
	Top cover		6 mm thk M.S.
2.3.0	**Flap Gate**		
2.3.1	Type		Linear actuator operated, 2 position
2.3.2	Travel		60 to 70 deg. (with limit switches on both sides).
2.3.3	Automatic operation		
	(i)	Drive	Dust tight motor driven with suitable linkages
	(ii)	Minimum Actuator Rating	2500 kg with 1 m lever arm
	(iii)	No. of Operation / Hr	15 (with 10 consecutive switchings)
	(iv)	Protection	Travel and Thrust dependent limit Switches.
2.4.4	Manual Operation		
	(a)	Maximum effort	Convenient for single operator by declutchable hand wheel regardless of electrical power.
	(b)	Minimum Hand wheel Diameter	500 mm
2.4.5	Flap gate shaft		
	(i)	Diameter minimum	150 mm
	(ii)	Material	EN-8

DATA SHEET: DRIVE EQUIPMENT

1.0.0	**GENERAL**	
1.1.0	Continuous Motor Rating (Name Plate Rating) at 50 Degree Centigrade Ambient temp. for Electric Motors	
	a) For conveyors of belt conveyor systems	*****120% of actual power at drive motor output shaft at specified design capacity
	b) Mobile trippers travel drive, mono-rail hoists (travel and hoisting), various pumps of DS systems, service water systems, cooling water system, potable water system and Ventilation Fans	*****110% of actual power requirement at drive motor output shaft at guaranteed (rated) capacity.
	*****The actual power at drive motor output shaft shall be calculated after considering all the losses of down the line equipment's of the drive train.	
2.0.0	**DESIGN & CONSTRUCTION REQUIREMENT**	
2.1.0	Gear Box	TYPE
2.1.1	(a) Below 40 kW	Helical, worm, bevel as per requirement without cooling coil
	(b) Equal to and Above 40 kW	Helical / bevel helical without cooling coil
2.1.2	Service Factor	As per accepted engineering practice / manufacturer's recommendations .
2.1.3	Ambient temperature for Thermal rating	50° C Minimum
2.1.4	Mounting	On Machined/Ground Surfaces
2.1.5	Output Rating	
		a) For belt conveyor systems @ Service factor X {1.2 times the actual power requirement at drive pulley shaft at design capacity}
		b) For other equipment @ Service factor X {1.2 times the actual power requirement of the driven equipment }
	@ Service factor shall include all the components considered by the supplier and should be clearly indicated in manufacturer's gear box selection catalogues.	
2.1.6	Duty	24 Hrs. Continuous
2.1.7	Rating	Not less than motor name plate

		rating
2.1.8	Thermal Rating	Corresponding to 50 Deg ambient Temp and in any case shall not be less than motor rating.
2.2.0	Flexible Couplings	
2.2.1	Type	Geared coupling.
2.2.2	Rating	Not less than motor rating.
2.3.0	Fluid Couplings	For all motors having rating more than 40 kW.
2.3.1	Type	
	(a) L.T. Motors	Traction type
	(b) H.T. motors	Scoop tube type.
2.3.2	Rating	Not less than motor nameplate rating

DATA SHEET: LHP BUILDING

1.0.0	**GENERAL**	
1.1.0	Under ground Junction tower (JT)	RCC
1.2.0	Over ground Junction tower	Steel Construction
1.3.0	Control/MCC rooms	RCC
2.0.0	**DESIGN & CONSTRUCTION REQUIREMENT**	
2.1.0	Junction tower & Crusher House	
2.1.1	Space requirement	To accommodate all equipments drive units, head/ tail ends of conveyors transfer chutes etc. and to provide adequate space for maintenance.
2.1.2	Floors	RCC construction with facility to wash the floors. Min. slope of 1:80 for floors in JTs shall be provided towards drain pipes.
2.1.3	Walls/Enclosure	Permanently colour coated cladding
2.1.4	Stairs	Steel construction with minimum 1000 mm width.
2.1.5	Doors & Windows	Steel construction
2.1.6	Monorails	Capacity as per equipment installed
2.1.7	Drainage	From each floor to drain pit suitable to handle limestone slurry.
2.1.9	Vertical bracing	Only along four sides.
2.1.10	Maintenance platform with handrails.	Chequered plate floors Min.1500 mm wide
2.1.11	Flooring	50 mm thick metallic hardener like ironite floor finish.
2.1.12	Level of ground floor	500 mm above ground level.

DATA SHEET: TRAVELLING TRIPPER

1.0.0	**GENERAL**	
1.1.0	Mobile Tripper	Motor driven type rail mounted.
1.2.0	Bunker Sealing Arrangement	Sealing belt type.
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	Mobile Tripper	
2.1.1	Mounting	Rail mounted on rails (90 lbs/yard) with double flanged wheels.
2.1.2	Drive	Motor driven with suitable gearbox. Suitable for minimum 60 starts/hours.
2.1.3	Pulleys	
	(a) Head & Bend Pulleys	As specified elsewhere
2.1.4	Brakes	AC operated electro hydraulic thruster type on either side of tripper.
2.1.5	Clamps	Manual Rail clamps on either side of tripper.
2.1.6	Walkways	Both sides of tripper, 800 mm wide each
2.2.0	Bunker Sealing Arrangement	
2.2.1	Sealing Belt	
	(a) No. of plies	Minimum two
	(b) Top/Bottom cover Thickness	5 mm/5 mm (Fire Resistant)
	(c) Width	At least 100 mm more than bunker slot.
2.2.2	Guide Rollers	As per requirements.
2.2.3	Bunker Slot	
	(a) Width	As per tender drawing
	(b) Cross bars over the slot opening	12 mm x 50mm MS grating

DATA SHEET: DUST CONTROL & MISCELLANEOUS SYSTEM

1.0.0	**GENERAL**	
1.1.0	Dust Control	Dust extraction system
1.2.0	Miscellaneous systems	Service water system, Potable water system, Cooling water system, sump pump and DE system pumps
2.0.0	**DESIGN REQUIREMENT**	
2.1.2	Pumps	2x100% for water
2.6.0	**Service Water System**	
2.6.1	Water connections	
	(a) Conveyor Galleries	every 50 m
	(b) Junction towers	Min. 1 no. at every floor
2.6.2	Connection details	32 NB plug valve
2.6.3	Hose pipes with hose reel	One in each building of 25 mtr. Length with nozzle
2.7.0	**Potable Water System**	
2.7.1	Pumps	2 X 100% electric motor driven
2.7.2	Water connections	
	a) Junction towers	Minimum one (1) no. at each floor
	(b) Tripper floor	Minimum one (1) no. at every tripper bay.
3.0.0	**CONSTRUCTION REQUIREMENTS**	
3.1.0	**Water Supply Pumps for SW/PW/CW/DE**	
3.1.1	Casing	Axial or radially split with drain & vent connection
3.1.2	Impeller	One piece, keyed to shaft along with locking device
3.1.3	Shaft	Critical speed atleast 20% away from operating speed
3.1.4	Shaft sleeves	At bearings & stuffing boxes.
3.1.5	Bearings	Antifriction type
3.1.6	Wearing rings	Renewable type (preferable)

3.1.7	Pump speed	Below 1500 rpm for capacity more than 10 m³/hr.
3.1.8	Head flow characteristics	Suitable for parallel operation.
3.1.9	Materials	
	(a) Casing	Cast Iron to IS:210, FG 260
	(b) Impeller	Bronze conforming to Gr.I of IS:318
	(c) Impeller Wearing ring	Bronze conforming to Gr.I of IS:318
	(d) Casing Wearing ring	Bronze conforming to Gr.I of IS:318
	(e) Shaft	Medium carbon steel
	(f) Shaft sleeve	Stainless steel conforming to AISI-416 hardened.
	(g) Gland packing	Impregnated teflon
3.2.0	**Sump Pumps**	
3.2.1	Type	Wet pit type vertical shaft
3.2.2	Duty	Capacity to handle large solids or unscreened liquid.
3.2.3	Materials	
	(a) Casing and rotor housing	Ni-Cast Iron (350 BHN)
	(b) Rotor	Ni-Cast Iron (350 BHN)
	(c) Shaft	Medium carbon steel
	(d) Gland	Bronze
	(e) Wearing rings	Stainless steel
	(f) Shaft enclosing tube	Carbon steel
3.3.0	**Pipings & Fittings**	
3.3.1	Joints	

	(i) Pipe to pipe	
	Pipe size ≤ 50 NB	Socket welding/screwed
	Pipe size ≥ 65 NB	Butt welding
	(ii) Pipe to valves	
	Pipe size ≤ 50 NB	Screwed
	Pipe size ≥ 65 NB	Flanged
3.3.2	Isolation of flow	Plug / Gate / Sluice valves
3.3.3	Regulation of flow	Globe Valve
3.3.4	Valves	
	(i) Size ≥ 65 NB	Bolted bonnet outside screw rising type.
	(iii) Size ≤ 50 NB	Union bonnet with screwed ends for Globe valve & screwed ends for plug valve
3.3.5	Materials for Pipework	
	(a) For sizes 200 NB and Larger	ERW carbon steel pipes to API-5L-Gr.B/IS:3589 with minimum thickness 6.35 mm
	(b) For sizes 150 NB to 65 NB	ERW carbon steel black pipes to IS:1239 (Part-Heavy class).
	(c) For sizes below 65 NB	ERW carbon steel galvanized pipes to IS:1239 (Part-I) Heavy class.
3.3.6	Materials for Valves & Specialities	
	(a) Cast Iron Valves	65 NB and above
	(i) Body and bonnet	Cast Iron to IS:210, Gr.FG-200
	(ii) Disc for non- return	Cast Iron to IS:210, Gr.FG-200 valves
	(iii) Seating surfaces and rings	13% chromium steel
	(iv) Hinge pin for non return valves	Stainless steel type AISI-316
	(v) Stem for gate and globe valves	13% chromium steel
	(vi) Back seat bush	13% chromium steel
	(a) **Gun metal valves (50 NB & below and upto a working pressure of**	

	10 kg/cm2 (g))	
(i)	Body	Gun metal to IS:318, Gr-2.
(ii)	Trim	Gun metal to IS:318, Gr-2.
(b)	**Duplex Strainer**	
(i)	Body	MS fabricated
(ii)	Strainer	Stainless steel type element AISI-316
(c)	**Pressure Gauge/Switch (to be provided with isolating valves, gauge cock, snubber and syphon)**	
(i)	Dial size	150 mm
(ii)	Accuracy	(+/-) 1% of range span
(iii)	Bourdon	AISI 316 SS
(iv)	Block	AISI 316 SS
(v)	Movement	AISI 316 SS
(vi)	Case and Bezel	Die cast Alum. Weather proof case stove enameled block with screwed type inner bezel of ABS plastic and glycerin filled.
(vii)	No. of contacts	2 NO + 2 NC
(viii)	Type of contact	Adjustable throughout the range.
(ix)	Degree of protection	IP. 65
(d)	**Solenoid valve (to be provided with isolating valve)**	
(i)	Type	2/2 way Diaphragm type pilot operated
(ii)	Diaphragm	molded synthetic rubber
(iii)	Body	Forged brass / SS
(iv)	Pressure	0.5 to 10 kg/cm² (g)
(v)	Protection Class	IP 65
(e)	**Flow Switch (to be provided with isolating valves)**	
(i)	Body	Forged steel

(ii)	Extension Rod/wire	SS-304
(iii)	Sleeve and Sleeve pipe	SS-304
(iv)	Cover	Die cast aluminum
(v)	Max. working pressure	10 kg/cm² (g)
(vi)	Repeatability	± 0.5%
(vii)	No. of contacts	2 NO + 2 NC
(viii)	Type of contact	Adjustable throughout the range.
(ix)	Protection class	IP – 65
(f)	**Level Switch**	
(i)	Type	Displacer operated magnetic type
(ii)	Displacer	SS – 316
(iii)	Wire rope	SS – 316
(iv)	Spring Housing Spring and sleeve pipe	SS – 316
(iv)	Cover	Cast Aluminum
(v)	No. of Contacts	2 NO + 2 NC
(vi)	Type of Contact	Adjustable throughout the range.
(viii)	Protection class	IP – 65
(g)	**Level gauges**	
(i)	Type	Float type mechanical gauge with arrow scale
(ii)	Accuracy	(+/-)1% of full scale range
(iii)	Material of construction	
(aa)	Float & Guide wire	316 SS
(bb)	Elbows	Suitable grade of SS
(cc)	Housing	Mild Steel
(dd)	Cable fastener	SS 304
(h)	**Dry Fog Dust Suppression Nozzles**	
(i)	Type	Fogging, non-clogging type

(ii)	Material	Stainless Steel
(iii)	Nozzle housing	To ensure protection of nozzle against damage.

(i) Y Strainer

(a)	Body	SS 304
(b)	Plug	SS 304
(c)	Filter Element	SS 316, 60 mesh

DATA SHEET: VENTILATION SYSTEM

1.0.0	**GENERAL**	
1.1.0	Mech. Ventilation System	To provide ventilation using fans for specified areas.
1.1.1	No. of air changes per hour	
	(a) For over ground building	Not less than 10 supply air changes
	(b) For under ground building	Not less than 15 supply air changes and 7 exhaust air changes
1.1.2	**Equipment**	
	(1) Underground tunnel	Centrifugal fans/Axial fans
	(2) All other places	Axial fans, roof ventilators
1.3.0	**Air-conditioning system**	
1.3.1	Temperature to be maintained	24 ± 1 deg. C
1.3.2	Humidity to be maintained	60 ± 5% relative humidity
1.3.3	Fresh Air intake	Minimum 1.5 air changes per hour.
1.3.4	Equipment	2 x 100 % roof mounted package AC units along with ducting etc. and 2X100% window AC
1.4.0	**Outside Ambient Conditions**	As per weather data given in project synopsis
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	**Axial Fans**	
2.1.1	Capacity	10% more of actual requirement
2.1.2	Head	20% more of actual requirement
2.1.3	Speed	
	(a) Impeller dia above 450 mm	Max. 960 rpm
	(b) Impeller dia less than or equal to 450 mm	Max. 1440 rpm
	(c) Critical speed	25% above operating speed.

2.2.0	**Centrifugal Fans**		
2.2.1	Capacity		10% more of actual requirement
2.2.2	Head		20% more than actual requirement
2.2.3	Speed		Max. 1500 rpm
2.2.4	Outdoor temperature		50 deg.C.
2.2.5	Rating		Continuous
2.3.0	**Packaged Air-Conditioning Unit**		
2.3.1	Type		Roof top mounting
2.3.2	Service/application		Continuous, round the clock
2.3.3	Capacity		
	(i)	TR	Suitable
	(ii)	CFM	Suitable
2.3.4	Type of compressor		Hermetically sealed scroll compressor
2.3.5	Condenser		Air cooled type
2.3.6	Fan		Forward curved centrifugal fan
2.3.7	Filter		High efficiency filter
2.3.8	Cooling Coil		
	(a)	Type	Direct Expansion
	(b)	Material	Copper
	(c)	Fins	Aluminum mechanically bonded.
2.3.9	Refrigerant Piping		Copper
2.3.10	Insulation for PAC parts		Expanded polyethylene of density at least 15 kg/m³.
2.4.0	**Filters**		
2.4.1.	Metallic Filters		
	(1)	Max. air velocity	2 m/s.
2.4.2	HDPE filters		

	(1)	Efficiency	90% down to 5 microns
	(2)	Max. velocity	2.5 m/s
	(3)	Testing	As per BS 2831 / Sqv.
2.4.3	High Efficiency Filter		
	(1)	Efficiency	99% down to 5 microns.
	(2)	Pr. drop across	10 mm W.C.
	(3)	Testing	As per BS 2831 / Sqv.
2.5.0	Insulation for A/C Ducting Resin Bonded Mineral wool as per IS:8183		
2.5.1	Density		24 kg/m³
2.5.2	Thermal conductivity		0.49 mw/cm deg.C

DATA SHEET : BELT SCALE

1.0.0	**GENERAL**	
1.1.0	Ambient Temperature	50°C
1.2.0	Relative Humidity	100%
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	Type	Electronic load cell type
2.2.0	Operation	Microprocessor based fully automatic
2.3.0	No. of floating idlers	Minimum four (4)
2.4.0	Load Cells	
2.4.1	Type	Strain gauge type hermetically sealed
2.4.2	Minimum Nos.	Four (4)
2.4.3	Overload protection	100 % of rated belt scale capacity
2.4.4	Structural capacity	250 % of rated belt scale capacity
2.5.0	Flow Rate Indicator	Electronic Digital Display Minimum 4 digits
2.6.0	Flow totalizer	8 digit display with reset facility.
2.7.0	Accuracy	For entire range of 20% to 120% of rated capacity Minimum ± 0.25%
2.8.0	Calibration	
2.8.1	Automatic	Zero & span calibration
2.8.2	Manual	With test load chain
	(a) Test load chain length	Two idler spaces more than weighing lengths
	(b) Chain reel equipment	Complete with weight adding facility.

DATA SHEET: ILMS/SM

1.0.0	**GENERAL**	
1.1.0	Type	In line or suspended magnet type as specified.
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	In-line Magnetic Separator / Suspended Magnet	
2.1.1	(a) Location of ILMS	Over discharge pulley.
	(b) Location of SM	Over Conveyor (as per tender drawing)
2.1.2	Force index (As defined earlier)	Minimum 100,000
2.1.3	Strength of magnet at the specified mounting height	1000 gauss.
2.1.4	Mounting height	Mounting height of In Line Magnetic Separator and Suspended Magnet shall be 450mm in the conveyors carrying uncrushed limestone & 400 mm in the conveyors carrying crushed limestone (between top of conveyor belt & surface of magnetic separator)
2.1.5	Magnetic Separator Belt	
	(i) Drive Unit	Adequately sized with 20% margin.
	(ii) Belting	Suitable to withstand high temp. & impact of tramp iron. (FR Grade)
	(iii) Discharge	Into Tramp iron chute.
2.2.0	Tramp Iron Items	
	(i) MS cube of 20 mm size	
	(ii) Brake shoe of Railway Wagon (Cast Iron 15 kg.)	
	(iii) MS plate of 250 x 250 x 100 mm size.	
	(iv) Shovel Teeth and spikes.	
	Material	Carbon Steel
	Size	Typical

	(v) MS round bar of 50 kg with L/D ratio not exceeding 5.	
2.3.0	Control	
	Inline Magnetic Separator / Suspended Magnet	Local and remote
2.4.0	Electric Supply 415V, 3 phase, 50 Hz input	Silicon Rectifier units
2.5.0	Location of silicon rectifier unit	Nearby control/MCC room
2.6.0	Handling Arrangement for inline Magnetic separator/Suspended magnet	
	(a) Height adjustment	With turn buckle arrangement
	(b) Cross-travel	Electric Hoist operated cross travel facility.

DATA SHEET: METAL DETECTOR

1.0.0	**GENERAL**	
1.1.0	**Type**	Coil type
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	Sensitivity	- 35 mm Aluminum sphere below limestone for steel cord belting. - 25 mm aluminum sphere below limestone for synthetic belting
2.2.0	Enclosure	Fiber glass
2.3.0	Control	Through local control panel.
2.4.0	Calibration	Provision for automatic static calibration with adjustable sensitivity.

DATA SHEET: LIMESTONE SAMPLING UNIT

1.0.0	**GENERAL**	
1.1.0	Type	Automatic
2.0.0	**DESIGN & CONSTRUCTION**	
2.1.0	Codes & Standard	ASTM C-50
2.2.0	Uncrushed feed limestone size	(-) 250 mm
2.3.0	Crushed feed limestone size	(-) 20 mm
3.0.0	**CHUTES**	
3.3.1	Min. angle	60 deg
3.3.2	Cross section	Square/rectangular with rounded corners.
3.3.3	Joints	Bolted flanges with 6 mm thick standard grade neoprene gasket.
4.0.0	**CRUSHER**	
4.4.1	Uncrushed (as received) feed limestone size	(-)250 mm
4.4.2	Crushed (as fired) feed limestone size	(-) 20 mm
4.4.3	Output size	ASTM C-50
4.4.3	Stages of size reduction	Single stage crushing
5.0.0	**BELT FEEDER**	
5.5.1	Belt	Flanged type, FR grade
5.5.2	Pulleys	Rubber lagged head pulley
5.5.3	Drive	Electric Motor

DATA SHEET – PADDLE FEEDER

1.00.00	**GENERAL**	
1.01.00	Type of paddle feeder	Mobile, Rotary plough
1.02.00	Input limestone parameters	As described elsewhere in the specification
1.03.00	Location	Underground below ground hopper (Limestone storage shed)
2.00.00	**DESIGN & CONSTRUCTION**	
2.01.00	Paddle Wheel	
2.01.01	No. of paddle wheel vanes	Suitable
2.01.02	Material for Vane liners	TISCRAL / SAILHARD / LSLAS07 (Replaceable)
2.02.00	**Drive Arrangement**	
2.02.01	Paddle Wheel	Step less Hydraulic drive
2.02.02	Feeder Carriage & flexible coupling	Electric Motor with gear box OR Hydraulic Drive OR Electric geared Motor
2.02.03	Minimum No. of starts per hour for drive chain equipment	15 Starts/hour (with minimum 10 consecutive starts)
2.02.04	Paddle wheel speeds	Step less variable
2.03.00	**Paddle Feeder Rails**	
2.03.01	Size	90 lb/yard
2.03.02	Support Arrangement	To be mounted on supporting structure of conveyors with continuous support below rail.
2.04.00	**Feeder Carriage wheels**	
	(i) Nos.	Suitable
	(ii) Type	Double Flange
	(iii) Bearings	Sealed type
2.05.00	Anti Collision Device	Mechanical and Infra red type
2.06.00	Cable Tray Height & width	Min. 300 mm above floor & 300 mm wide all along the length of storage shed hopper on both sides.

2.07.00	Control	Local
2.07.01	**Location of Control Panel**	On the feeder carriage
2.08.00	Idlers for conveyor Belt	As per relevant Sub-section for Belt conveyor system
2.08.01	Spacing of carrying idlers in the loading zone of paddle feeders	600 mm (maximum)
2.09.00	Chute work and hopper	20 mm thick TISCRAL / SAILHARD / LSLAS07

DATA SHEET – LIMESTONE CRUSHER

1.0.0	**GENERAL**	
1.1.0	Type	Hammer Mill type crusher
1.3.0	Material to handle	Limestone
1.4.0	Feed Size	(-) 250 mm, occasionally 1-2% of 400mm size
1.5.0	Product size	To suit limestone pulverizer and system , minimum 90%
1.6.0	Input limestone parameters	As specified elsewhere
1.7.0	Limestone feeding arrangement	Through vibrating screen feeder (However the crusher hall be designed/sized considering zero passage of limestone through screen).
2.0.0	**DESIGN AND CONSTRUCTION**	
2.1.0	Drive arrangement	Electric motor, scoop type hydraulic coupling, gearbox.
2.2.0	Rotor Balancing	Static
2.3.0	Type of sealing	Labyrinth, dust tight arrangement
2.4.0	Type of bearings	Spherical roller
2.5.0	Lubrication	Manual through grease gun OR with recommended grade of oil in which case the Plummer block shall be designed with oil filling, oil draining and visual oil checking facilities
2.6.0	Tramp collection	Required
2.7.0	Output size adjustment facility	Required
2.8.0	Top cover of crushers	Hydraulically operated
3.0.0	**MATERIAL OF CONSTRUCTION**	
3.1.0	Rotor Shaft	Forged steel
3.2.0	Hammer heads	Wear resistant cast alloy steel
3.3.0	Hammer arm	Forged alloy steel
3.4.0	Housing/frame	Steel as per IS:2062
3.5.0	Breaking blocks	Cast steel/MS fabricated
3.6.0	Liners	
	(a) Material	Suitable for duty requirement
	(b) thickness	As required

3.0.00 **OPERATION AND CONTROLS**

3.2.00 3.01.00 This section is intended to cover control/instrumentation and operational philosophy as specified hereinafter complete in all respects, required for Lime stone ~~and Gypsum~~ handling facilities under subject package.

3.3.00 **General Requirements**

The instruments and controls to be furnished and erected under this specification are as required for safe and satisfactory operation of the Lime Handling System, as outlined under mechanical section and as specified elsewhere in the specification. For the equipment and materials procured by the Contractor from his sub-vendors, the Contractor shall study the specification, safety requirements, interface drawings for such equipment and material in detail and shall coordinate his work with his sub vendors and FGD DDCMIS system and supply instrumentation and control to suit the actual Lime stone and Gypsum Handling equipment.

3.3.1 **Standards / Codes**

All construction, installation, workmanship, design & equipment shall conform to acts, rules & regulations of the jurisdiction within which the project is to be located, and to the current edition of the following or equivalent standards or codes, in so far as they apply :

American Iron & Steel Institute (AISI)

American Society for Mech. Engineers (ASME)

American Society for Testing & Materials (ASTM)

American Wire Gauge (AWG)

Institute of Electrical & Electronic Engrs. (IEEE)

Instrument society of America (ISA)

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

United States of America standards (USAS)

Bureau of Indian Standards (BIS)

Conveyor Equipment Manufacturers Association (CEMA)

3.03.00 This Sub-section shall be read in conjunction with Electrical Sub-sections.

3.04.00 **General Construction and Design**

3.04.01 **General Construction**

Control desks/panels and annunciation system shall be as per the requirement of electrical Section. Annunciations, indications, electrical meters and instrumentation shall be provided as specified.

3.04.02 **Design**

The complete lime handling plant shall be controlled from FGD DDCMIS system as detailed elsewhere. Also refer other clauses of this chapter.

The Contractor shall provide a comprehensive control indication and annunciation scheme. Contractor shall furnish block diagram and write-up on the scheme proposed. The final scheme will be approved by the Employer. In general, interlocking shall be achieved through feed-back signals from field equipment. Comprehensive Annunciation and Indication scheme shall be provided such that, it will be possible for the operator to locate and identify the fault from the face of DDCMIS/LVS/Control-Panel/ TFT itself. The scheme shall include the basic remote control instrumentation, indication and annunciation requirements as per various technical specification requirements.

However, the Contractor may offer any alternative proposal which he considers to be equal, superior to the scheme as described in subsequent clauses below for achieving reliable and trouble free operation of the plant, for consideration of the employer.

4.00.00 **OPERATION AND CONTROL PHILOSOPHY**

The lime handling system shall be controlled from the following control points.

4.01.00 **Coal Handling Plant Main Control Room**

Overall, operation of the following equipment of Lime Handling Plant shall be controlled from the main FGD control room through FGD DDCMIS being provided by the Contractor.

(a.) Conveyors, feeders, flap gates, R & P gates, crushers, hydraulic scoop couplings.

(b.) Complete Dust Suppression system, service water system, cooling water system & potable water system.

(c.) Ventilation system (group/individual control as required).

(d.) In line Magnetic separators and Suspended Magnet (ON/OFF control with indication).

(e.) Metal Detectors (ON/OFF control with indication).

(f.) Lime Sampling Units.

(g.) Belt weigher (ON/OFF control with indication)

(h.) Mobile trippers over bunkers/ storage shed (tripper position indications).

(j) Paddle feeder (running status with stop facilities).

4.02.00 **Local Control Panels**

Local control stations for following equipment's shall be provided

(a) Paddle feeders along with its dust extraction system

(b) Mobile trippers over bunkers/ storage shed

(c) Belt Weighers

(d) Metal detectors

(e) Electric hoist - wall mounted control box with pendent push button controls.

(f) In line magnetic separators

(g) Suspended Magnet

(h) Sump Pump

(i) Hydraulic scoop coupling.

(j) Lime Sampling Sytem:- Complete PLC along with interface with FGD DDCMIS

All the above local control panels shall be accessible and located near their respective equipment and shall be complete with all the required controls, interlocks, annunciation's etc. However, for items (j.), above, controls shall be through contractor's PLC. Further, necessary controls, indications and annunciations for all the above equipment shall also be provided at main FGD Control Room as described under relevant clause.

4.03.01 **System Operation**

4.03.01 Lime conveying facilities under subject package shall be operated in association with a coal handling plant being provided by contractor separately.

The lime handling plant being provided by bidder envisages control of complete lime handling system including facilities under subject package by DDCMIS.

Envisaged Operation philosophy of the plant, in general, shall be as elaborated below:

(a.) Lime flow path selection shall be done from CRT/Keyboard to select any one of the following conveying paths.

a. Track hopper to Limestone storage shed

b. Wagon Tippler to Limestone storage shed

c. Limestone storage shed to Limestone bunker

d. Combination of above

The lime handling system operator will select any one of the above paths from OWS located on the main control desk. The flow stream path is then selected by positioning different flap gates/ movable discharge pulley at desired positions by means of keyboard available at the central control desk. Once the system is in the operation, the gates/ movable discharge pulley can not be moved from their positions and path. Flap gates which do not come in the stream in which coal flow is taking place, can be operated at any time. However, for the flap gates in Limestone bunker area conveyors, it shall be possible to change flap gate position while the conveyor is in operation and feeding coal using interlock bypass facility, provided that sequential permissive are available.

The Control system will be designed for "Auto" & "Manual" operation of the conveyors in the selected path. Auto/Manual Selection shall be done from keyboard.

Auto Mode : In the “Auto” mode, the conveyors and related equipment will start sequentially when the “System Start” is activated. During stopping, when the “System Stop” is activated, all conveyors will also stop sequentially (in the reverse sequence) allowing time delays for clearing the belts.

Manual Mode : In Manual Mode, the operator will start the conveyor system, in the same sequence as in Auto mode from keyboard. The operator will also stop the conveyor system, by pressing "System stop" or individual “Stop” push buttons/command from keyboard in the reverse sequence.

During “Sequence Start” in both Auto and Manual modes, first the required number of hooters (3 phase induction motor type) will be energized simultaneously for a preset time of 1 minute or so (adjustable at site) as per the program. After the preset time, the hooters will stop and a preset time of two minutes (adjustable at site) as per program will be allowed for the movement of the personnel and for the permissive of the conveyor system operation. This condition will be indicated on the panel by glowing of lamp “Lime Handling Sequence Start”. The starting permissive will be available for a period of 5 minutes (Pre-programmed and adjustable in the field). In the event the last conveyor / equipment is not started within this preset time of 5 minutes, the start command for equipment not started will be withdrawn. The system cannot be started again unless the “Sequence Start” push button is again pressed and the hooters sound again, as described before. Those conveyors and equipment, which have already started, will continue to run.

The status indication in the graphic display against all conveyors and equipment in the selected path/stream will start slow flickering. However, all status indications against all flap gates / movable discharge pulley in the selected path will glow steadily. Therefore, from the selected flow stream path of the flap gates / movable discharge pulley, the operator will come to know the conveyors and equipment to be started for the selected path/stream. After a conveyor/equipment is started, the status indications against that conveyor / equipment will change to steady glow indicating that it is running. **Separate color scheme shall be provided to all common conveyors and equipment, to distinguish handling of Lime and Coal while conveying**

Graphic display status indicators associated with a particular motor/equipment shall flicker fast in case of fault / trip.

In addition, emergency stop push button on the control desk for immediate shut down of complete plant shall be provided.

For changeover of feed from one row of Bunkers to another row of Bunkers without stopping of the LHP, provision shall be made for interlock bypass on the control desk for flap gates of all conveyors in Boiler area for a preset period. If the changeover, in above specified time, is not completed then the entire LHP shall stop.

(i) Lamp test facility will be provided for the annunciation and mimic lamps.

4.06.00 **Conveyor System**

(a) Normally the movement of the paddle feeders feeding Lime from the Limestone shed to the conveyor shall be controlled from the paddle feeder itself based on instructions from main control room.

(b) The paddle feeder carriages shall move continuously to and fro along their tracks. Suitable limit switches and anti-collision devices (both mechanical limit switch operated and infra- red type) shall be provided to enable them to change direction of movement as soon as they come within a specified distance at the end of travel in one direction.

(c) The operation and stoppage of the paddle feeders shall be signaled in the main control room of the Lime handling plant. It shall be possible to stop the paddle feeder from main control room. It shall be possible to stop the conveyor taking feed from paddle feeder from respective paddle feeder.

(d) Each conveyor shall be protected against damage to the edge of the belt due to excessive sideways movement by providing an adequate number of belt sway switches. In addition, each conveyor shall be provided with one (1) No. speed detection device (zero speed switch). The zero speed switches shall be designed to sense belt speed. In case of speed of belt goes below 85% of rated speed, it shall trip the conveyor.

(e) All the conveyors shall be protected from reverse running due to power failure by providing mechanical or electrical locking system.

(f) The starting sequence of the conveyors shall follow a direction opposite to that of flow of material i.e. :

(1.) In case of direct conveying of lime to limestone bunkers, start from lime bunker conveyor and end up with reclaim conveyors below track hopper/Wagon Tippler .

(2.) In case of stacking of lime in stock yard, start from yard conveyor and end up with reclaim conveyors below track hopper/Wagon Tippler.

(3.) In case of reclamation of lime from stock yard, start from bunker conveyors and end up with yard conveyor alongwith Travelling tripper.

(4) The starting of mobile trippers shall be interlocked with operation of the bunker bay conveyors.

(g) Any individual equipment (belt conveyor etc.) should not be allowed to start unless the equipment immediately following the same in the direction of flow of material is already in operation.

(h) Stop/tripping of any equipment from running condition shall trip all preceding equipment in the system, except crushers but shall not effect succeeding ones which shall continue to operate.

(i) Adequate number of pull-cord switches shall be provided at suitable intervals along the length of each belt conveyor, which shall enable the respective conveyor to be stopped immediately. Each pull chord switch shall be identified by a specific number on HMI in the main control room. Each belt sway switch shall also be identified by a specific number on HMI in control room.

(j) Means shall be provided to pre-warn personnel working nearby when starting any conveyor and mobile tripper.

(k) Interlocking of various conveyors shall be achieved with Flap Gate, discharge pulleys, limit switches and zero speed switches.

(l) Suitable indication for paddle wheel rpm shall be provided on the local panels. Manual facility to control the cutting rate of paddle feeder shall also be provided.

(m) Motors shall start only when the brake/rail clamp if-provided, is in “not applied’ ‘condition. This signal shall be obtained from limit switch provided for that purpose.

(n) Lime stone crusher shall be provided with speed and vibration monitoring instruments. crusher shall trip in case speed/ vibration is going beyond tolerable limits of design. Temperature sensing devices shall be installed on all bearings of each of the ring granulator to trip the ring granulator in case of temperature goes beyond limit. Audio-visual annunciation shall be provided in main control room and locally also.

(o) Once a conveyor trips, flap gate directing coal from this conveyor shall change over its position with a time delay and shall come back to the original position again. This is to prevent jamming of gate.

(p) Tripping of the respective conveyor shall be provided in case any of paddle feeders and mobile trippers starts running along with conveyor belt at speed higher than their rated speed by providing an over speed sensing device on the equipment.

(q) It shall be possible to trip bunker conveyor from mobile tripper Where ever scoop type coupling provided for HT motors, the coasting time of respective conveyor, thruster brake, actuator selection and the chute size shall be so selected such that there is no spillage of coal from any down stream conveyors during next start.

(r) Wherever the conveyor is provided with the movable discharge pulleys in place of flap gates, the starting of the conveyor will be interlocked with the position of the movable discharge pulley.

4.07.00 **Interlocking**

(a.) The following conveyors / equipment will come under interlock scheme :-

(1) All conveyors

(2) All flap gates

(3) Mobile Trippers

(4) Rack & Pinion Gates

(5) Metal detectors

(6) Magnetic Separators and suspended Magnet

(7) Crushers

(8) Paddle Feeders

(9) Belt scale

(b.) The following equipment will not come under interlock of the conveyor scheme.

(1.) All dust extraction systems & service water system.

(2.) Ventilation systems

(c.) All conveyors and equipment will have local push button stations each consisting of :

(1.) Pos - I, Pos - II & stop button for flap gate.

(2.) Emergency stop push button (Red) for other equipment

(d.) Belt scale shall be started when relevant conveyors are started

(e.) The dust extraction systems will be energized as soon as the conveyors are energized.

(f.) Lime handling plant shall be tripped in case of detection of fire.

(g.) Interlock for H.T. Motor :

H.T. motors used will continue to run on no load by disengaging the fluid coupling in case of failure of any process interlock. The H.T. motors will however be tripped in case of any motor fault like O/L, high motor winding temperature etc. In addition, in case of normal stop command, after running of the system, motors will stop.

(h.) The following are the various safety interlocks for the conveyors and other equipment. This list is indicative only and the Contractor shall develop a comprehensive interlocking scheme.

Conveyors

a) Pull - Chord switch - not operated

b) Belt sway switch - not operated

c) Under speed switch - closed at 90% speed of the conveyor within designed accelerating time.

d) Motor protection - not tripped

e) Local stop PB – reset

f) Chute Block switch - not operated.

g) Brakes for conveyor – not operated.

h) Trip circuits healthy.

i) Temp. of fluid coupling oil - not high

Paddle Feeders

a). Motor O/L - not tripped

b). Local E-Stop PB - reset

c). Stop PB in main FGD control room - reset

d). All Limit Switches – reset

e). Overspeed limit switch – not tripped

Travelling Tripper :

a) Stop PB in Local control station - reset

b) Motor O/L not tripped.

c) Over Travel Limit switches - not tripped.

Magnetic Separators / Metal Detectors / Suspended Magnets

a) O/L / fault relay - not tripped.

b) Stop PB (Local & Remote) reset.

c) Metal detector reset

d) Oil temperature - not high

Flap Gates/ R & P Gates

a) End of travel limit switches - reset.

b) Torque limit switches - reset.

c) Local stop - reset.

Crusher

a) Zero speed - not operated

b) Temp. of fluid coupling oil - not high.

c) Local stop push button reset.

d) Temperature of bearings – not high.

e) Cooling water flow switch – reset

Motor O/L – not tripped

Local E-Stop PB-reset

Stop PB in main FGD Control Room reset.

All limit switches - reset

All limit Switches – not tripped.

Apron feeder

Motor O/L – not tripped.

Local stop PB – reset

4.07.01 The lists of indications and audio-visual annunciation given in subsequent clauses are indicative only and the same shall be finalised during detail engineering.

4.07.02 Status indications in Large Video Screen

Following individual status indications shall be provided in LVS with individual ON/OFF/TRIP indications on CRT.

(a.) Conveyor 'ON'

(b.) Flap Gate Rack and Pinion.

(c.) Belt scale flow rate indication and totalizer.

(d.) Belt sway switch operated for each conveyor (individual switch indication on CRT).

(e.) Pull cord switch operated for each conveyor (Individual switches indication on CRT).

(f.) Zero speed switch operated for each conveyor

(g.) Paddle Feeder ''ON

(h.) Travelling tripper position."

(i.) Crusher ON

(j.) MD/ ILMS/ SM/ LSU ON

(k.) DE/ SW/PW/CW/Vent ON (System wise)

(l.) Unit wise MW indication, total lime flow & Bunker level.

(m.) Further Mimic lamps for HT and LT SLDs shall be provided on the control desk.

4.08.00 **Annunciation System:**

DDCMIS/Control desk shall be provided with adequate number of facia type annunciation windows operating through DDCMIS for the following audio-visual fault annunciation purposes. Wherever group annunciation is provided, alarm status of individual equipment shall be provided on OWS.

(a) 3.3 kV Breaker Trip (Group wise for each board)

(b) 415 V MCC Breaker Trip (MCC wise)

(c) Bus under voltage for each LT MCC & HT switchgear buses.

(d) Following group wise annunciation shall be provided for transformers :

(1.) Buchholz alarm

(2.) Winding/oil temperature high alarm

(3.) Oil level low alarm

(4.) Buchholz trip

(5.) Winding/oil temperature high trip

(e) A.C Control Supply failure.

(f) D.C. Control Supply failure.

(g) Annunciation supply failure.

(h) Both CPU fail

(i) Stand by CPU in service

(j) H.T. motor overload alarm (individual)

(k) HT motor bearing/ winding temp. high alarm (for each) and trip (for each)

(l) HT motor trip on electrical fault (for each)

(m) LT motor overload tripped (for each).

(n) Belt sway switch operated (for each)

(o) Pull cord switch operated (for each)

(p) Zero speed switch operated. (for each)

(q) Chute plugged (for each)

(r) Paddle feeder over speed tripped (group)

(s) Tripper over speed tripped (for each)

(t) Magnetic separator fault and cleaning belt trip.

(u) (i) Metal Detector fault (for each)

(ii) Metal detected / MD not reset (for each)

(v) Belt Scale fault (for each)

(w) Sampling system faults and trips (for each)

(x) Crusher low speed & crusher bearing temperature – high.

(y) Water level low in tanks (for each)

(z) Oil temperature of fluid coupling high

(aa) Dust Extraction/service water system faults and trips (system wise)

(bb) 20% spare window

For identification of the fault for a particular conveyor or equipment, status indication against that conveyor / equipment in the mimic will start fast flickering and the annunciation window will be blinking against that particular fault. In addition, a buzzer (alarm) will start sounding. After acknowledgement of the fault, the buzzer will stop, but the fast flickering on the mimic and the steady glow on the annunciation window will continue until the fault is cleared and the Reset push button is pressed. When the fault is cleared and the Reset push button is pressed, the status indication of that conveyor / equipment on the mimic will start slow blinking if it is on selected path otherwise it will go off and the steady glow in the annunciation window will go off. However, pressing of the Reset push button before clearance of the fault, will have no effect on the lamps.

At the time of a fault, the faulty conveyor / equipment, as well as the preceding conveyors / equipment in the interlock sequence, will stop except H.T. motors for which only scoop coupling will be disengaged and motor will continue to run for process fault. In case of motor fault, H.T. motor will trip but the succeeding conveyors / equipment will continue to run. The status indication against the preceding conveyors / equipment will start slow blinking while the faulty conveyor / equipment will be fast blinking.

Start command shall not be initiated unless reset button in pressed after clearance of fault.

The sequence of operation of the annunciation system shall be as follows :-

CONDITION			STATUS
Normal :	Ann. Window	:	Off.
	Status indication	:	Steady glow
	Buzzer :		Off.
Fault :	Ann. Window	:	Blinking.
	Status indication	:	Fast blinking
	Buzzer :		Sounding.
Press Accept. PB.	Ann. Window	:	Steady glow.
	Status indication	:	Fast blinking
	Buzzer	:	Off.
Press Reset PB (When	Ann. Window	:	Off.
fault is cleared):	Status indication	:	**i)** Steady blinking (if on selected path) **ii)** Off (if not on selected path)
	Buzzer.	:	Off.

4.09.00 **Dust Extraction System**

Complete interlock, protection, annunciation for Dust Extraction System to be provided by the contractor and the same shall be approved by Employer during detail engineering.

4.10.00 **Metal detectors**

(a) It shall be possible to start the conveyors only after energizing the metal detector and 'Metal detector reset' condition. Once the metal is detected, the corresponding conveyor shall trip.

It shall be possible to restart the conveyors, after local resetting of metal detector and putting back the marker bag in position. Metal detector ON/OFF push buttons shall be provided in main control room also.

(b) In case of tripping of conveyor system, metal-detector shall get de-energized after a time lag.

(c) Following individual indications shall be provided on local control panel.

(1) Metal detector 'ON'

(2) Metal detected

(3) Metal detector 'reset'.

(4) Metal detector faulty.

4.11.00 **Sump Pumps**

(a) Sump Pumps shall start and stop by the level switches in the sump automatically. Further manual override start / stop push button shall be provided locally on ground level.

(b) Any of the pumps can be selected as auto-standby.

(c) If the sump level continues to be high even after the first pump is under operation second pump shall start automatically.

(d) The following indications for sump pumps shall be provided on local Control Panel.

(1.) Water level high

(2.) Motor ON/OFF/TRIP.

4.12.00 **Lime Sampling system**

(a) Lime Sampling Unit shall be controlled through PLC as per standard and proven practices of LSU equipment / LHP supplier, which will be located nearest MCC. Controls and interlocks for proper material flow shall be provided similar to conveyor system. Suitable Mimic shall be provided in the PLC.

(b) Lime Sampling Unit shall be controlled through main FGD DDCMIS. Controls and interlocks for proper material flow shall be provided similar to conveyor system. Mimic shall be provided in the Operator Work Station (OWS) at main FGD control room.

(c) Only one start/stop push button along with selector switches for various modes of operation of Lime sampling system shall be provided for automatic operation of complete lime sampling system. This control facility shall be provided at main FGD control desk as well as locally. In any case, local push button stations shall be provided for all individual equipment of lime sampling system near the equipment.

(d) All necessary automatic controls shall be provided for meeting the requirements of ASTM-D-2234 or ASTM-C-50.

(e) Following indications shall be provided on local control panel

(1.) System ON/OFF/TRIP

(2.) Primary cutter stuck up between parking positions.

(f) In case of primary cutter getting stuck between parking positions, preceding conveyor shall trip and annunciation shall appear at Main FGD Control room.

(f) There shall be protection in the primary coal sampler to trip the conveyor belt in case primary sampler falls on running conveyor due to coupling failure etc.

(g) Necessary interface signals e.g. LSU system status, cutter stuck etc shall be provided at main FGD control room.

4.13.00 **Paddle Feeders**

Paddle feeders shall be controlled from the local control panel suitably mounted on the unit. Requirement of operation as described else where in the specification shall be complied with. Following indications shall also be provided on the local control panel:

(a.) Motor ON/OFF

(b.) Motor O/L protection operated

(c.) Brakes applied (if provided)

(d.) "Digital pressure indications of Hydraulic Power pack including those of hydraulic pump discharge, return (leakage) traverse pump discharge (forward and reverse) oil line."

(e.) Coal flow rate

Main Hydraulic pressure of paddle feeder wheel drive system to be reduced to minimum through its control circuit during each tripping of main drive motor.

4.14.00 **Travelling Trippers**

(a) Mobile tripper unit shall be locally controlled from the operating platform suitably located with the unit as per instructions given from main FGD control room.

(b) End travel limit switches shall also be provided.

(c) Travel drive motor shall start only when brake and rail clamps are in disengaged condition.

(d) It shall be possible to trip the bunker Conveyors from tripper.

(e) When the last bunker is full, it shall not be possible to change over the tripper flap gate from bunker feeding position to last bunker feeding position.

(f) As soon as the bunker conveyor trips, tripper flap gate shall change over its position after a time lag.

(g) Two nos. emergency stop button one on each side shall be provided on tripper to stop the machine at any position. The control unit on tripper shall be provided with start / stop push button and indication lamp for travel / gate. The tripper brakes and rail clamps shall be energised (and released) when the tripper motors are ON and the brakes will be applied when the travel motors are OFF. Two travel limit switches shall be provided at either end of tripper carriage for limiting the travel drive between two ends of the track. The first one shall be normal limit and the second one for over travel limit. In addition to above, position indication for bunker position of tripper will be provided in Main control room. Necessary position encoders/limit switches shall be provided.

(h) Following individual indications shall be provided on local control panel

(1.) Motor ON/OFF/TRIP

(2.) Brakes applied

(3.) Rail clamps applied

(4.) Flap gate position

(i) Indication of tripper flap gate positions shall be given in the main FGD control room.

(j) Chute blockage switch shall be provided at each leg of chute and shall trip the tripper conveyor in case of blockage.

4.15.00 **Flap Gates/ R&P Gates**

All Flap Gates/ R&P Gates shall be motorised with remote controlled from the main control desk. Their position shall be indicated on the mimic of main control room.

4.16.00 **Belt Weighers**

Each belt scale shall give output to DDCMIS for display of flow rate indicator and totalizer on TFT and print out at main FGD control room. Each belt scale shall also have rate flow indicator and totaliser mounted near the unit.

4.17.00 **Magnetic separator / Suspended Magnet**

It shall be possible to start the conveyor only after energising the magnet of ILMS or SM. Further, if conveyor system trips magnetic separators shall get de-energised after a time lag and suspended magnet will remain energised and can be de-energised locally. Also if drive motor of cleated belt of ILMS trips, magnetic separator shall not get de-energised, but conveyor system shall trip and audio-visual annunciation shall appear at main FGD control room.

Following individual indications shall be provided on local control panel

(a.) Magnetic separator ON.

(b.) Incoming supply ON

(c.) 'Under current relay' operated

(d.) Cleated belt motor ON/OFF/TRIP

(e.) Oil temperature high

4.18.00 **Service water, Cooling Water and potable water pumps**

(a) These pumps shall be started from main FGD control room

(b) Pump shall trip in case of low water level in tank.

(c)Following individual inputs shall also be provided to DDCMIS system for alarms/indications :

(1.) Motor ON/OFF/TRIP

(2.) Discharge water pressure low

(3.) Water level low in tank

(4) Water level high in tank

Contractor shall provide a comprehensive interlock and protection scheme and include a block logic diagram and write up on the scheme proposed. The final scheme shall be subject to approval of Employer. Sequential interlocking as applicable shall be provided. This shall be a part of main interlock scheme /writeup for the entire Lime Handling Plant.

4.21.00 **Summary of control philosophy**

Contractor shall furnish summary of control philosophy indicating permissive, trip and interlock conditions for each drive/equipment. It shall clearly list all permissive conditions (conditions required to start the drive), all the trip/protection conditions and each auto start/open and auto stop/close condition for each drive/equipment.

The sequential start-up and shut-down steps for a group of drive/equipments shall also be described clearly.

The above summary conditions shall be comprehensive to include all process conditions and shall be elaborated in clear and unambiguous way, and shall include tag numbers of devices and equipments.

A centralized main FGD control room (DDCIMS based) shall be provided to control and monitor the operations of the Lime handling system and Gypsum handling plant.

4.22.00 **Logic Diagram**

The contractor shall furnish comprehensive logic diagram showing all interlock, protection, sequence and alarm requirements of complete system to the employer during detail engineering stage. In this logic diagram, tag number corresponding to I/O list and drive list shall be clearly indicated. The format of this logic diagram shall be informed by employer during detail engineering. The recommended logic and write-up shall match fully.

SUB-SECTION-I-M7

ZERO LIQUID DISCHARGE SYSTEM

1.00.00 **CODES AND STANDARDS**

1.01.00 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment/plant/system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

(a.) Bureau of Indian Standards (BIS)
(b.) Indian Boiler Regulations (IBR)
(c.) Regulations of the Ministry of Environment & Forest (MoEF),
(d.) State Pollution Control Board.
(e.) Explosive Rules, 1983
(f.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
(g.) Owner's Safety Policy
(h.) Any other statutory codes/standards/regulations, as may be applicable.

1.02.00 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions, of the codes and standards given below shall also apply:

(a.) British Standards (BS)
(b.) Japanese Industrial Standards (JIS)
(c.) American National Standards Institute (ANSI)
(d.) American Society of Testing and Materials (ASTM)
(e.) American Society of Mechanical Engineers (ASME)
(f.) American Petroleum Institute (API)
(g.) Standards of the Hydraulic Institute, U.S.A.
(h.) International Organization for Standardization (ISO)
(i.) Tubular Exchanger Manufacturer's Association (TEMA)
(j.) American Welding Society (AWS)
(k.) Cooling Tower Institute (CTI)
(l.) National Electrical Manufacturers Association (NEMA)
(m.) National Fire Protection Association (NFPA)
(n.) International Electro-Technical Commission (IEC)
(o.) Expansion Joint Manufacturers Association (EJMA)
(p.) Heat Exchange Institute (HEI)
(q.) IEEE standard

(r.) JEC standard

(s.) American Gear Manufacturers Association (AGMA).

(t.) American Institute of Steel Construction (AISC).

(u.) American Iron and Steel Institute (AISI).

(v.) American National Standards Institute (ANSI).

(w.) American Society for Testing and Materials (ASTM).

(x.) American Society of Mechanical Engineers (ASME).

(y.) B31.1. Power Piping Code.

(z.) American Water Works Association (AWWA).

(aa.) D1.1 Structural Welding Code.

(bb.) Anti-Friction Bearing Manufacturers' Association (AFBMA).

(cc.) Hydraulic Institute Standards (HIS).

(dd.) Institute of Electrical and Electronic Engineers (IEEE).

(ee.) Instrument Systems and Automation Society (ISA).

(ff.) Insulated Cable Engineering Association (IPCEA).

(gg.) Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

a. SP58 - Pipe Hangers and Supports - Materials Design and Manufacture.

b. SP69 - Pipe Hangers and Supports - Selection and Application.

c.SP89 – Pipe Hangers and Supports – Fabrication and Installation Practices

d. SP90 – Guidelines on Terminology for Pipe Hangers and Supports

(hh.) National Electrical Code (NEC).

(ii.) National Electrical Safety Code (NESC).

(jj.) National Institute of Safety and Health (NIOSH).

(kk.) Occupation Safety and Health Administration (OSHA).

(ll.) Pipe Fabricators Institute (PFI).

(mm.) Rubber Manufacturers Association (RMA).

(nn.) Steel Structures Painting Council (SSPC).

(oo.) Tubular Exchanger Manufacturer's Association (TEMA).

1.03.00 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations

and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

1.04.00 National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National/International standards, established and proven standards of manufacturers shall also be considered.

1.05.00 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

2.00.00 CONDITIONS OF SERVICE

A). Design pressure of all device, piping and auxiliary facilities for waste water treatment (evaporation process) is specified as below.

a) Device and tank maximum allowance : operating pressure x 1.5

b) Piping and auxiliary facilities : 150 lbs class flange, STD wall pipe

B). All equipment shall be safely accessible for monitoring, operation and maintenance from grade or platforms.

C). All equipment, ducts, tanks, valves and piping shall be designed and installed not to cause the vibration and hammering problems during the start-up, operation and shut-down.

D). Auxiliary steam if required shall be provided by owner for start-up condition only. For continuous duty, Bidder to design the various systems considering power driven equipment and the same shall be considered in power guarantee.

3.00.00 DESIGN REQUIRMENTS

3.01.00 FGD Wastewater Treatment System

A. General System Description

The wastewater stream will be made up of reject water from FGD, GGH washing etc. Pre-treatment shall be provided with two stage clarification i.e. primary clarifier (1x100%) & secondary lime soda softening clarifier (1x100%) to reduce the hardness and suspended solids. The Clarifier outlet will be fed to the mechanical vapor recompression (MVR), Brine Concentrator and Crystallizer system. The

Evaporative concentration system consisting of 1x100% or 2x50% Evaporator/Brine concentrator train(s) to be provided to accept feed from Pre-treatment. The brine concentrator blowdown shall be fed to the crystallizer(1x100%). The Crystallizer will concentrate the brine to a solid sludge suitable for solid disposal. An indicative system process flow diagram is provided in the tender.

Brine Concentrator The design of the Brine Concentrators/Crystallizers (ZLD system) will be based on the FGD blowdown design feed chemistry. To avoid scale buildup in the Brine Concentrator, calcium sulfate (seed) will be continuously circulated over the wetted surfaces in the Brine Concentrator. The wastewater enters a feed tank to deaeration and decarbonation. The wastewater is pumped through a heat exchanger that raises its temperature close to the boiling point. The vapor, created inside the tubes, passes through mist eliminators and enters the Mechanical Vapor Compressor. Compressed vapor flows to the outside of the heat transfer tubes. Wastewater passes through a deaerator counter-current to low-pressure steam, which removes non-condensable gases such as oxygen and carbon dioxide. Heat from the vapor (steam) is transferred to the cooler brine falling inside the tubes, causing some of the brine to evaporate. As the vapor (steam) gives up heat, it condenses as distillate (condensate). Hot feed combines with the concentrated brine in the sump. The concentrated brine is constantly circulated from the sump to a floodbox at the top of a bundle of heat transfer tubes. The distillate is pumped back through the heat exchanger, where it gives up heat to the incoming wastewater. Some of the brine evaporates as it flows in a falling film down the inside of the heat transfer tubes and back into the sump. A small amount of waste brine is blown down from the sump to control the brine concentration and for further treatment in the crystallizer to produce solids.

Crystallizer System

Wastewater is pumped to the crystallizer and joins the re-circulating brine. The brine slurry is pumped through a shell and tube heat exchanger (heater) to heat the brine a few degrees. Because the tubes are flooded, the brine is under pressure and will not boil. This prevents scaling in the tubes. The process vapor is directed to a knockout pot to prevent foam from being discharge to the atmosphere. The re-circulating brine enters the Crystallizer vapor body at an angle, where it swirls in a vortex. A small amount of the brine evaporates. Condensate of steam used initially shall be collected and returned for reuse. The vapor from evaporation passes

through a mist eliminator to remove entrained particles. As water is evaporated from the brine, crystals form. Most of the brine is re-circulated back to the heater. A small stream from the re-circulating loop is sent to a centrifuge or pressure filter to separate remaining water from the crystals. The solids go to disposal and the liquid is returned to the Crystallizer. A small purge may be required. Crystallizer shall be driven by the way of mechanical vapor compressor.

B. General Design Criteria

1) The FGD wastewater treatment system shall be designed to treat the FGD waste water of all units of Plant for 24 hours continuous operation per day and seven (7) days per week except during annual cleaning period.
2) The capacity of FGD WWT plant for ZLD for Barh-I (3x660 MW) and Nabinagar JV (4x250 MW) shall not be less than 30 m^3/hr and 20 m^3/hr respectively.
3) FGD Wastewater such as GGH washing water and filtrated water which is bled to control chloride concentration in FGD system shall be routed to Pre-clarifier(s). It shall be precipitated and overflow shall be transferred to FGD wastewater Tank.
4) FGD Wastewater tank shall be aerated by the aeration devices. The Contractor shall provide the aeration devices.
5) The FGD wastewater treatment system shall be composed of the following system to meet the specified discharge water quality as defined in the specification
    i) FGD wastewater storage system
    ii) Suspended Solid removal system
    iii) Pre-treatment system(including decalcification system)
    iv) Evaporative concentration system
    v) Chemical storage & dosing system
    vi) Sludge dewatering system
6) The FGD wastewater which is stored in wastewater tank shall be transferred to Pre-treatment by wastewater pump.
7) To prevent scaling of the system and gypsum super saturation, the sludge recirculation shall be provided to required system. Wastewater from overflow tank shall be treated through the evaporative concentration process.
8) The removed impurities from the waste water will be bound in the form of solid cake, hence allowing the station to be complete ZLD.

9) Evaporated steam in evaporator shall be transferred to condenser and then stored in treated water tank. This stored water shall be reused for FGD make up water.
10) The Contractor shall provide wastewater treatment system to remove heavy metals such as mercury, selenium and T-N as well as sulfate, fluoride and chloride. The Contractor shall submit the technical documents with regard to treatment method for major pollutants in wastewater.
11) Flow meter with totalizer at the inlet and outlet of FGD wastewater treatment system shall be provided by the Contractor.
12) The Contractor shall design the FGD wastewater treatment system to minimize the sludge quantity. The sludge from clarifiers shall be transferred to thickeners and reuse gypsum storage tank. The overflow of thickeners shall be transferred to the FGD wastewater tank/pond, and the thickened sludge shall be transferred to the filter press for sludge dewatering and reuse.
13) The system design treatment rate shall be as specified.
14) The system shall be designed for influent water quality. Due to the fluctuating nature of the effluent wastewater chemistry, consideration must be given to ensure an operable system throughout a wide operating condition of flow and feed quality.
15) The Softening Reactor Tanks and Softening Clarifiers shall be designed for outdoor installation.
16) All Equipment shall be noted within proposal as indoor/outdoor equipment.
17) All wastewater treatment processes shall be designed to maintain treatability for design flow using only duty equipment. Operation of standby equipment shall not be acceptable for system functionality under normal working conditions.
18) Equipment shall be furnished as pre-assembled skids whenever possible.
19) Supplier must provide flow ranges and maximum design pressures at Equipment inlets and outlets.
20) The Contractor shall provide the safety shower and eye washer at the chemical feed equipment area.
21) All the design procedures, systems, and components proposed shall have already been adequately developed and have demonstrated good reliability under similar or more arduous conditions elsewhere.

C. FGD Wastewater Storage System

1) Wastewater from Pre-Clarifier shall be transferred to FGD wastewater tank/pond. FGD wastewater tanks(2x50%) shall designed to store FGD wastewater from all units of FGD system operated continuously for 24 hours and GGH washing water which is produced temporarily.

2) FGD waste water tank will be constructed of the concrete coated/lined with vinyl esteric resin mortar.

3) The aeration devices shall be provided and installed in FGD wastewater tank by the Contractor. The aeration devices shall be constructed of suitable corrosion resistant material. The material selection of the aeration devices shall be approved by owner.

D. Pre-treatment System

1) pH adjustment, reaction and coagulation tank

a) pH adjustment, reaction and coagulation tank shall be square or rectangular type and installed on the concrete foundation. Tanks shall be equipped partition for smooth mixing of chemicals. Tanks shall be lined with min. 4.8 mm of rubber or equivalent material.

b) The agitator for pH adjustment, reaction and coagulation tank shall be mounted on the top of those tanks and consists of shaft, propeller or paddles, lubricated bearings, constant speed and gear reducer. Inverter type of agitator shall be provided for reaction and coagulation tank in order to control rpm.

c) The capacity of pH adjustment and reaction tank shall have a minimum 10 minute retention time in order to react with chemical. Coagulation tank shall have a minimum 20 minute retention time.

d) All tanks and agitators shall meet the requirement as per specification.

2) Pre-clarifier/Thickeners

a) Clarifiers/thickeners shall be reinforced concrete coated/lined with vinyl esteric resin mortar.

b) Clarifiers and internals designed and supplied by Contractor shall include the following as a minimum:-

i) Reaction cone.

ii) Stilling chamber.

iii) Launders.

iv) Tank anchor channel.

v) Drive mechanisms for sludge scraper rake and mixer.

vi) Sludge collecting arms.

vii) Access stairs.

viii) Walkway and drive platform.

ix) High/Low torque shutoff controls.

x) Overflow pipe.

c) FGD Softening Clarifier Sludge Pumps: Sludge pumps shall be located adjacent to the clarifiers, Sludge pumps shall transfer sludge from Clarifier to Sludge Storage sump/tank.

d) Interconnecting platforms, including stairs between softening reactors and softening clarifiers shall be provided.

e) The two-rake arm will move the settled solids to a central discharge point. The blade shall be bolted to the bottom chord of truss structure of rake arm. The rake and rake support parts submerged below the liquid level shall be carbon steel with rubber lining for protection against abrasion and corrosion.

f) The bleeding of clarifier sludge collector shall be consisting of manual and automatically system in accordance with time and flow rate. In addition, the facility shall be consisting of equipment for auto flushing and internal cleaning of settled sludge and sludge feed piping to prevent clogging.

g) The bottom shall have sufficient slope for solids collection. The settled sludge will form a blanket on the bottom of the clarifier/thickener and be pushed gently toward the central discharge outlet. The center scraper will clear the discharge trench and move the solid deposits toward the underflow discharge point.

h) The feed well in the clarifier/thickener center will quiet the incoming flow as it enters the sump. The feed well shall settle solids rapidly with minimum influence from turbulence.

i) The center-driving device shall have a sufficient torque to rotate the rake arm. The channel with handrail shall be installed in the top of the clarifier/thickener across the center-driving device.

j) The Contractor shall design the clarifier as followings:

- Retention time: 3 - 5 hours
- Surface loading: 15 - 20 m^3/m^2-day

- Efficient depth: 2 - 4 m
- Linear velocity of driver: 1 - 2 m/min

k) The Contractor shall design the thickener as followings:

- Retention time of solid: 1 - 2 days
- Surface loading: 16 - 30 m^3/ m^2-day
- Efficient depth: 3.0 - 3.7 m
- Solid content of thickened sludge: 4% or more

E. Evaporative Concentration

1) The Contractor shall be responsible for detailed system design, material selection, equipment fabrication and supply. Contractor is to provide a complete description of all items to be included within proposal and shall clearly identify all items required to be supplied by contractor to complete the system within their proposal. The softened wastewater shall flow to the evaporation phase of the plant. Contractor shall provide two independent trains (2x50%) to maintain for redundancy of critical operations; however both trains shall be capable of being run simultaneously.
2) Evaporative concentration shall be designed to start/stop every day.
3) Evaporative concentration, Brine concentrator consisting of **Falling film type in first** and **Crystallizer in second**, shall be designed. The compressors shall be MVR (Mechanical Vapour Re-compressor).
4) The capacity of condenser shall be 110% to process wastewater
5) Evaporator, **sludge** centrate tank, agitator, centrifuge and pumps to meet wastewater shall consist of materials for resistance corrosion.
6) Pressure vessel in evaporative concentration shall be designed as per ASME Sec.VIII or equivalent code listed above.
7) If required, the Contractor shall provide chemical storage and injection system to maintain quality of cooling water which will be used in evaporative concentration process.
8) Evaporative concentration shall be designed to reduce and avoid a scale while it is operating, and it shall be consist of accessories to wash each part. Also, brush for washing condenser shall be provided by Contractor.
9) Evaporative concentration process shall have related equipment to drain and flush the wastewater and condensate when the process is stopped or in

emergency. Also chemical storing and injection equipment are required to remove scales in evaporative concentration process equipment.

10) Drain water and washing water from Evaporative concentration shall be transferred to FGD waste water storage by sump pump.
11) Evaporative concentration washing water shall be the treated water from treated water tank of FGD WWT system.
12) All evaporative concentration pumps shall be provided with installed stand-by pump in case of 1x100% Evaporative concentration system & with a store(warehouse) spare pump in case of 2x50% Evaporative concentration system.
13) All vessel connection in evaporative concentration shall be as per the Manufacturer's proven practice.
14) Hoists shall be provided for all vessels in evaporative concentration system as per the Manufacturer's proven practice.
15) Vessel support shall be designed same as materials for vessel. Different material cannot be welded to vessel.
16) The Contractor shall provide pressure transmitter and level transmitter with root valve for each sealed vessel. Drain pipe of vessels shall be equipped with float trap, Y strainer, bypass valve & shut-off valve and connected to drainage point.
17) The hoists for O&M in the FGD wastewater treatment system shall be provided by Contractor.
18) All support platforms and access stair required for any contractor provided piping/equipment shall be provided by contractor.

F. Centrifuge

1) Centrifuge shall be designed to minimize the sludge moisture content, and its type shall be approved by owner.
2) Centrifuge to dehydrate solids form evaporative concentration shall be consist of Centrifuge 2x50%
3) Sludge filter press shall be manually and automatically operated.
4) All accessories of centrifuge, filter press shall be provided by the Contractor.

G. Chemical Feed Equipment

1) The Contractor shall provide the all required chemical feed equipment for FGD waste water treatment system. Chemical Feed Equipment shall include the

chemical storage tank, chemical dissolving tank, chemical injection tank & pumps etc. It shall be equipped with agitator, heater, fume scrubber, if required.

2) The Contractor shall design chemical tanks as followings:
   a) Chemical storage tanks : 15 days
   b) Chemical dissolving tank : 3 days
   c) Chemical dosing/injection tank : 24 hours
3) Necessary chemical shall be provided by unloading pump, depending on the water level of the chemical tank and injection tank. Also, Contractor shall provide the piping associated with Unloading pump, injection tank and connection flange to connect the chemical transport vehicles to supply the chemicals easily and quickly.
4) If chemical shall be necessary to dissolve, the chemical tanks shall be consist of dissolving and injection tank. The chemical dissolving and injection tanks shall be provided with agitator. The chemical dissolving tank will be filled with demineralized water and chemical.
5) If polymer shall be used, the Contractor shall provide the necessary tank, pumps, piping along with auto dissolving equipment.
6) Coagulant shall use the liquefied PAC.
7) All chemical tanks shall be provided with level gauge.
8) Chemical dosing/injection system equipment shall provide and maintain constant concentration, capacity and shall meet the following.
   a) The equipment and auxiliaries shall be capable on condition of constant operation and intermittent operation of WWT system.
   b) Local control panel shall be equipped with all control circuit and device to start and stop. It shall control equipment related chemical injection at local control panel. Also, operation and monitoring of FGD waste water treatment system injection equipment should be possible at main control room.
9) Chemical storage tank shall be constructed of suitable corrosion resistance material.
   a) The caustic storage tank shall be made STS304 or equivalent, and the other chemical tanks shall be made of PE/FRP or equivalent.
   b) Acid storage/injection tank shall be provided with fume scrubber. Acid storage/injection tank shall be constructed of FRP or equivalent.

10) Caustic tank shall be provided with electric heater. Caustic piping shall be provided with electric heat tracing.
11) Each tank shall be equipped with auxiliary equipment including manhole, drainage system and overflow drainage system stairs, access way, handrails and hoists etc, for operation, monitoring and maintenance.
12) Two (2x100%) chemical feed pumps per each tank shall be provided by the Contractor. The flooded suction positive displacement, diaphragm type pumps with accumulator or equivalent shall be provided for each chemical tank. The chemical feed pumps shall be made of suitable materials for feeding chemicals.
13) Chemical injection pump shall be provided as skid mounted including motor, reducer, injection rate control device, protection devices, etc on the common base plate.
14) Material of chemical unloading and injection pump shall be constructed of suitable corrosion resistance material. The material of the chemical transport and injection pump shall be approved by owner.
15) Chemical injection pump outlet shall be equipped with equipment to prevent siphon.
16) If the chemical is hazardous material, Contractor shall provide all necessary equipment and accessories.
17) Each pump shall have the following features:
    a) Pumps shall be mounted and attached to a stainless steel, coated carbon steel or fiberglass fabricated base plates with surfaces machined flat and parallel to receive feet of mounted equipment. Rolled or bent plate base plates and pump/motor support pedestals are not acceptable. Base plates shall be designed rigid and suitable for field grouting under the entire plate
    b) Pumps and entire skid shall be capable of wash-down.
    c) The design flow rate of each chemical shall be approximately 70 percent of the maximum capacity (at the maximum specified pressure) of each metering and spare pump supplied under this Purchase Order.
    d) All pumps shall be capable of fully automatic or manual control.
    e) Provide pressure gauges at the discharge of all pumps.
    f) Pumps shall have inlet and outlet isolation ball valves, suction strainers, unions, and calibration columns.

g) Provide capability to water flush the system beginning at the pump suction strainer/skid inlet manifold.

18) Diaphragm style pumps shall have the following features:

a) Controlled volume, automatic electronic variable stroke adjustment, diaphragm metering pump.

b) 2Micrometer stroke adjustment designed to permit variance from zero to full capacity during pump operation. Pumps shall be capable of manual micro meter stroke adjustment if the electronic stroke controller fails.

c) Design target flow rate must be achieved within a range of 70-90 strokes per minute.

d) Each pump shall be designed for a minimum turndown ration of 10:1.

e) For high viscosity fluids or fluids with high vapour pressures, strokes per minute shall not exceed 70.

f) Pump shall have integral suction and discharge ball check valves and oil-lubricated drive.

g) Pump relief valve shall have one of the following options: integral to pump, relief to pump suction, return to on-skid solution tank, return to bulk storage tank, return to chemical tote.

h) A pulse dampener shall be furnished on the discharge of the pumps. If pulse dampener is not required due to design of pump and allowed by Purchaser approval, Supplier shall so indicate on Bid.

i) Materials shall be suitable for the intended service and approved by Purchaser (Sulfuric acid pumps shall be Alloy 20 wetted materials with Teflon diaphragm, Antifoam and Anti-scalant shall be 316 SS wetted materials).

19) Chemical feed strainers

a) Flanged 150-lb strainers shall be furnished in each pump suction line and shall be the same size as suction piping. If strainers are Y-type, socket weld is acceptable in place of flange.

b) Sulfuric acid pumps shall have no strainers.

c) Strainers shall be of the same materials of construction as associated pump wetted materials.

d) Strainers shall be provided with blowdown valves.

20) Calibration columns

a) Furnish one transparent, plastic graduated calibration column in the suction line for each set of pumps. Columns shall be of butyrate or other chemical resistant, rigid, transparent plastic tubing rated for intended service.

b) Columns shall have threaded bottom fitting and top shall be vented back to tank or tote.

c) Each column shall be sized so that a 2 minute pump flow at the pump design flow rate shall be performed within the graduated part of the column.

d) Columns shall be provided with isolation valves.

21) Chemical feed valves

a) Materials of construction shall be the same as piping materials of construction for transfer fluid.

b) Isolation ball valves shall be provided in suction and discharge line from each pump.

c) Check valves shall be provided in each pump discharge.

d) If required, field adjustable backpressure regulating valves shall be provided on each pump discharge.

e) Relief valves shall be provided as required. The relief valve set point shall be manually adjustable.

22) Chemical feed pump suction piping, tubing and fittings

a) Materials and pressure ratings, as required.

b) Tubing shall be fully annealed and suitable for bending.

c) All connections shall terminate in a true horizontal or vertical plane.

d) Size: ½-inch OD minimum.

e) Provide ability to flush piping through the pump.

f) Each skid shall have as a minimum one quick connect suction line. Quick connect shall be same size as the suction piping. Fittings shall be of the same materials as the suction piping.

g) Unions and isolation valves shall be provided on each pump to allow easy removal of the pump.

h) Provide dual set point pressure switch (pressure switch diaphragm for sulfuric acid shall be Viton only).

i) When specified as fed from a permanent storage tote, Supplier shall supply 6 feet of chemically compatible hose with camlock type fittings to connect tote to pump inlet manifold for each skid supplied.

H. Waste water tank

1) Unless otherwise specified, all waste water tank shall be constructed of the concrete or steel. Inner surface of the pond (side and bottom) shall be lined with vinyl esteric resin mortar minimum 6 mm thickness, tank shall be lined with minimum 4.8mm of rubber or equivalent.

2) Contractor shall install the treatment tank which can store the condensation water generated from the evaporative concentration.

3) After final treatment water condensation water of evaporative concentration shall be collected in treatment tank, to be pumped back to the FGD service storage tank.

4) Contractor shall install the access ladder and handrail for maintenance of wastewater pond/tank.

3.02.00 Process Equipment and Accessories

3.02.01 Pumps and Piping

A. General

1). The Contractor shall provide all necessary pumps required for the operation of the FGD system. Equipment supplied shall comply with currently approved applicable industry standards including those requirements of ANSI, ASME, ASTM, AFBMA, HI (Hydraulics Institute), and RMA (Rubber Manufacturers Association). Suction and discharge pressure instruments shall be supplied on all pumps.

2). The Contractor shall provide a complete, fully coordinated, pumping unit including pump, and as applicable, base plate, slide rails (with actuator), or other pump mounting provision, drive motor and mounting provision, gear reducers, couplings, sheaves/belts, seals and safety guards. The suction and discharge piping shall be equipped with erosion resistant piece, drain, vent, seal water, flush water and instrument connections.

3). Pumps shall be designed to receive and support all forces and moments associated with start-up, normal operation and temperature changes.

4). Unless otherwise specified, the Contractor shall provide the duplicate pumps (2x100%) or multiple standby pumps for the same service. Duplicate pumps for

the same service shall be designed to operate in parallel without undue noise and vibration or shaft breakage.

5). Contractor shall provide identical pumps for the same services preferably.

6). Impellers shall be individually statically balanced. In addition impellers shall be dynamically balanced, if the pump impeller is greater than 250 mm in diameter, or the speed is over 1800 rpm for any diameter. But, open impeller type pumps for slurry service are not dynamically balanced. If the Contractor wants to use pumps with speed greater than 1,800 rpm, then the Contractor's document must contain a detailed justification that will be subject to Owner’s approval.

7). Impellers shall not be either the maximum or minimum diameter for the pump casing size.

8). All pump casings shall be of such wall thickness as to be suitable for the maximum operating and hydro test pressures.

9). Pumps shall be provided with either packing, mechanical seals, or special arrangements designed to eliminate seal water consumption. Material selection for sealing components, sleeves and shafts shall be consistent with the corrosive and erosive nature of the service. Mechanical seal cover shall be duplex stainless steel or equivalent.

10). Bearings shall be designed to minimize deflection of the shaft and impeller. Bearings shall be provided with oil/dust tight seals.

11). Flange connections shall be dimensioned in accordance with ASME B16.5 except modifications as required for linings.

12). A method to quickly release the impeller from the shaft, without the use of come-along, shall be incorporated into the design.

13). The axial thrust of the pumps shall be so compensated that there will be no axial movement or float of the shaft at any flow from minimum capacity to maximum capacity under the specified conditions of operation.

14). Pumps with special construction features which facilitate service and maintenance will be given special consideration.

15). The final performance curve for all pumps shall rise steadily from the design point to pump shutoff.

16). The Contractor shall indicate the minimum flow at which each pump can operate continuously without suffering damage. The Contractor shall also indicate the continuous maximum allowable run out flow for each pump.

17). Wetted pump components such as casing internals, impeller and shaft sleeve shall be suitable for the fluid pumped, including its erosive and corrosive characteristics. The material chosen for pump shall be proven type in similar application. Reference list of previous installation for similar application shall also be furnished to the employer.

18). The large horizontal pumps with vertically split casings shall be designed to permit removal of the impellers, shafts, bearings, etc, without disassembling the suction or discharge piping other than for pump maintenance spool pieces.

19). The coupling and mechanical seal or stuffing box for packing shall be arranged so it is not necessary to remove the motor to service these items.

20). Couplings shall be spacer-type (stainless steel flexible double disk type or flexible gear type), where required, to allow dismantling of the pumps without disturbing the motors or the pump pedestals. Metal coupling guards shall be provided to cover couplings and exposed key ways.

21). The total number of different sized pumps and pump manufacturers shall be minimized.

22). When pumps of same capacities and same services are furnished, all components including spares and spare assemblies shall be completely interchangeable.

23). All Piping shall be suitable for the fluid therein, including its erosive and corrosive characteristics. The material chosen for piping shall be proven type in similar application. Reference list of previous installation for similar application shall also be furnished to the employer.

B. Wastewater Pumps

1) All components of the FGD wastewater pumps which come into contact with the wastewater shall be made of corrosive and abrasive resistant material with excellent durability for the intended service.

2) Parts subject to wear or requiring adjustment and inspection shall be accessible and capable of reasonably convenient removal.

3) The material of centrifugal pump included in Evaporative concentration system shall be complied with below requirement.

- Casing: ASTM A890 Gr. 5A or better
- Impeller: ASTM A890 Gr. 5A or better
- Shaft: SM45C or better (STS 316L and STS 304 will not be acceptable.)

C. Chemical Feed/injection Pumps

1) Chemical injection pumps shall be the metering, positive displacement diaphragm type and shall be furnished complete with drive motors, gear reducers, stroke control devices, and guards, all mounted on a common base plate.
2) The pumps for acid shall be constructed of PE/PP/FRP or equal and the pumps for caustic shall be constructed of 316 stainless steel wetted parts or equal. The other pumps shall be made of suitable materials for handling chemicals.
3) All Chemical feed rates shall be automatically controlled based on process variables and/or other appropriate measurements in the ZLD controls system.
4) For each chemical feed system identified above, the Equipment shall include, but not be limited to, the following:
   a) Metering pumps, valves, calibration columns and suction strainers.
   b) Low level shutoff controls for each tote or storage tank and associated pumps.
   c) Associated instrumentation and controls specified below and required for a complete operational system.

3.02.02 Agitators

1) Agitators shall be provided for all sumps and tanks where slurry collects and for chemical tanks, or where mixing is required by the FGD system process. A sufficient number of agitators shall be deployed at each location.
2) Design of agitators shall be proven type.
3) Agitators shall ensure that all the suspended solid particles in the slurry shall be adequately dispersed throughout the tank. Each agitator shall be complete including, but not be limited to, shaft, shaft seals, impellers, mounting provision, speed reducer and motor.
4) Materials of construction of the agitator components shall withstand normal operating and upset conditions including slurry concentration, volume and pH variation. Shaft shall be of solid construction.
5) Agitator shaft bearings shall be designed and spaced properly for minimum deflection of the shaft.
6) The operating speed shall not be within 20 percent of any of the agitator's critical speeds.
7) Agitators shall be shipped either fully assembled or in the largest shippable subassemblies. The Contractor shall design and furnish hoisting provision at

each tank for replacing completely assembled agitator and/or its largest subassembly. Agitators shall be designed to enable servicing and replacement of packing without draining the tank contents.

8) Agitators shall be oil-lubricated with provision for filling and draining.

9) Side entering agitator gearing shall be of helical bevel type design. Worm gearing shall not be used. Agitator speed shall be adjustable by means of changing gears. Changing gears shall be accomplished without disassembling the agitator.

10) Agitators may be either constructed of the appropriate metallurgy or rubber lined for the service chemistry.

11) Side entering agitators shall come complete with support legs by the steel structure on foundation.

12) Also, the strength by the agitating motion and weight shall not have effect on the absorber shell.

13) Side entering agitators shall be of the non-leakage type. Seal water, if required, shall be fed continuously, whenever the tank is in service. Hoist and monorail shall be provided for maintenance.

14) All agitators shall be driven by electric motors. Belt drive shall not be employed for speed reduction.

15) The number of different agitators shall be minimized in order to minimize spare parts requirements.

16) The degree of agitation achieved shall be that required by the process. Agitators shall be sized that, in the event of agitator failure, upon restoration of the agitator. All material which has settled as a result of the agitator failure shall be completely resuspended within 8 hrs after the agitators were inoperable for up to 24 hrs.

17) Flow patterns from the impeller shall be capable of maintaining solids in suspension with and without recirculating flow from the tank. The flow pattern shall also be capable of resuspension solids within two hours after a short (two hours) shutdown, such as a power failure.

18) The impeller and shaft shall be easily removable from inside the tanks without disturbing the speed reducers or the motor.

19) Impellers shall not be integrally welded to the shaft.

20) The agitators shall be designed and installed to minimize the vibration.

3.02.03 **Tanks**

1) The Contractor shall design and install the tanks complete with all the necessary connections and appurtenance, including manholes, hand holes and roof drain, as required for the tank service.
2) Tanks shall be provided with drain connections and associated valves to allow the tank to be easily drained to sump. Slurry tank bases shall be designed to minimize accumulation of solids and for ease of cleaning. All slurry tanks including filtrate tanks shall have agitators to provide adequate agitation of the slurry. Slurry tanks shall be provided with screen at the inlet nozzles.
3) Connections for lined pipe and plastic pipe shall be flanged.
4) Tanks in contact with slurry or reacted slurry shall be used appropriate corrosion resistant metal or linings such as flake glass or rubber, as specified herein. Mill slurry tanks must be constructed of rubber lined carbon steel. Each lining/coating procedures shall be submitted and subject to owner' approval.
5) All tank storage capacities except emergency storage tank shall be based on the minimum available storage capacity. The minimum available storage capacity is defined as volume from low level to high level (minimum 150 mm below the tank overflow level). When low level, the pump operation and/or solid suspension shall be good condition.
6) The Contractor shall furnish all necessary tanks, which shall have storage and surge capacity required for operation of the FGD system throughout the entire load range and present this information.
7) All tanks shall be designed to withstand the loads imposed by filling with the liquid to the maximum extent possible as well as the forces caused by wind and seismic loads.
8) Tanks and access hatches shall be designed in accordance with API Code 650. Remote level indicators or alarm shall be provided for all tanks. Tanks shall be provided with all necessary walkways and stairs with handrail required to provide access to areas requiring periodic maintenance or inspections. The Contractor shall provide rail guards at the periphery of the tank roof, and the spiral stair with handrail for the tank height of 3 m or more.
9) The Contractor shall ensure that the agitator support structure is arranged to enable agitator removal without destruction (field cutting or touching) of any support steel.

10) For pressure vessels, the Contractor shall provide material specification, design parameters (ASME Section VIII), manufacturing drawings and inspection reports.

11) Tanks shall have at least one, side hinged, bolted, circular shell manhole.

12) The drain size of slurry tanks shall be minimum 200 mm.

3.02.04 **Lifting Devices**

1) The Contractor shall furnish hoists with trolleys and other lifting appliances with associated support, crane rails, runways and lifting eyes required for the adequate maintenance of the equipment to be removed for routine maintenance and weighing in excess of 50 kg for Tanks,Equipment at FGD wastewater treatment system.

2) Trolley-hoists shall be electric type and shall be manufacturers' standard design in so far as practicable in meeting the requirements of this specification. The Contractor shall supply monorail beams as required to provide access to all equipment to be served by the hoists.

3) The trolley-hoists in their entirety shall comply with all current applicable local and government statutes, regulations, and safety codes relative to the design, construction, and operation of hoists in the locality where the hoists will be installed.

4) As a minimum two (2) trolley-hoists of each size shall be furnished for installation and use.

(Example: Seven(7) hoists are to be furnished. The sizing criteria call for six(6) 100 kg hoists and one(1) 150 kg hoist. To meet the above requirement, the Contractor will supply five(5) 100 kg hoists and two(2) 150 kg hoists. That is to say, one(1) hoist will be oversized to meet the requirement).

5) Monorails shall be arranged to permit movement of lifted equipment from the installation area directly to a truck, without transfer of hoists or re-rigging.

6) Trolley-hoist shall be floor controlled from a pushbutton station, suspended from a fixed point on the trolley. One button shall be provided for each direction of motion of the hoist-trolley, plus stop and start buttons. Where necessary, the Contractor shall provide a torque reel for vertical movement of the pushbutton station. Trolley-hoists shall receive a finish coat of epoxy yellow paint applied in accordance with the manufacturer's instructions. A capacity plate showing

rated capacity of the hoist shall be placed on hoists in such a manner as to be easily legible. Pushbuttons shall be protected with neoprene hoods.

7) Control panel enclosures and pushbutton station shall be suitable for operation in a corrosive environment, preferably NEW 4X or high impact fiberglass construction.

8) The Contractor may find that the layout and size of equipment lends itself to the use of a bridge crane in lieu of trolley-hoists. If bridge cranes are furnished they shall meet the requirements of this Paragraph. The Contractor shall provide detailed information in the proposal on any bridge cranes for owner's acceptance.

9) A hoist shall be provided at the mist eliminator level to assist in removal and replacement of mist eliminators. The hoist shall be positioned to minimize the distance the mist eliminators will have to be hand carried.

3.02.05 **Falling film evaporator(FEE) and accessory equipment design:**

1. FFE trains shall include following as a minimum:
   a) Feed pump
   b) Feed tank
   c) Feed heat exchanger
   d) Deaerator
   e) Falling film evaporator
   f) Vapour compressor
   g) Evaporator recirculation pump
   h) Hydro cyclone and associated pump
   i) Hot distillate tank
   j) Distillate pump
2. Seeding system
3. All valves and instrumentation.

A). Falling film evaporator(FEE)

1. One (1) per evaporator train.
2. The FFE shall be constructed of:
   i). Brine wetted parts, material with a PREN of greater than 40.
   ii). Tubes, Titanium Gr. 2.
   iii). Upper tube sheet, Titanium Gr. 1 clad on 316 SST.
   iv). Shell, duplex SST.

v). The plate thickness shall be a minimum of 6.35 mm (0.25 in). Tube wall thickness shall be a minimum of 22 BWG (0.028 in).

3. The FFE shall be designed for outdoor service with the accessory equipment located indoors. All outdoor equipment including piping shall be supported on foundations.
4. All wetted materials of construction shall be selected for severe corrosion service and are to be as specified. Any changes in proposed equipment, materials selection or manufacturer/Contractor during design shall be approved by Purchaser prior to incorporation into the design.
5. The design of equipment, arrangement of components, and routing of piping shall consider operational and maintenance accessibility of components. Equipment, piping, valves, and instruments shall be arranged so that when installed, components requiring manipulation, observation, or maintenance will be readily accessible and safe to operating and maintenance personnel.
6. Contractor shall include provisions for automatic flushing of piping upon shutdown and as operationally required.
7. Chemical feeds shall be injected tangentially into tanks or using retractable injection quills into piping.
8. Contractor shall include provisions for automatic washing of mist eliminators and Vapour Compressor blades. Wash water shall be hot distillate.
9. Any vents from the evaporator shall be supplied with bird screens.
10. The FFE shall contain a vertical shell-and-tube heat exchanger (condenser) with brine cascading into an internal reservoir or sump. The Bidder's proposal shall fully describe the evaporator design features including the following components:
    a) Description of tube attachment to the tube sheet (both upper and lower tube sheet) and evaporator volume and design.
    b) Manways shall be located above tubesheet and at sump level. Minimum manway diameter is 30". Access via stairs shall be supplied to the evaporator sump manways. Access via ladder shall be supplied to the tubesheet manways.
    c) Mist eliminators may either be integral to the evaporator or located in ductwork adjacent to the evaporator. Mist eliminator design and material

including online provisions for cleaning and method of control. Access to mist eliminators shall be via stairs.

d) Location of all site ports.

B). Evaporator Feed Tank

1) The Evaporator Feed Tank volume shall residence time, at 100% level, of no less than 30 minutes.
2) Feed tank shall be constructed of fiberglass material (FRP) fabricated per the requirements of ASTM D3299 and D4097. Tank design shall incorporate a double surface veil comprised of 10 mil of nexus and 20 mil of c-glass.
3) Tank mixers shall be furnished to provide continuous agitation.
4) Support for the agitator shall be integral to the tank structure. All wetted materials for the mixer shall be suitable for the service. Access to the agitator shall be provided with platforms at top of tank. Minimum access of 3’6” shall be provided on 2 of 4 sides around the agitator for maintenance personnel.
5) All chemicals injected into the system shall be provided with retractable injection quills of suitable materials and injected into the tank below all ranges of operating liquid level.

C). Evaporator Feed Pumps

1) Contractor shall provide Evaporator Feed Pumps for FFE. Two (2) x 100% Evaporator Feed Pump shall be installed; one operating and one spare in case of 1x100% Evaporative concentration system. One (1) x 100% Evaporator Feed Pump shall be installed per FFE train with a store stand-by Evaporator Feed Pump in case of 2x50% Evaporative concentration system.
2) Feed Pump materials shall be ASTM A890 Gr. 5A or better impeller and casing.
3) Pump shall use a double mechanical seal.

D). Feed/Distillate Heat Exchangers:

1) One (1) per evaporator train.
2) The heat exchanger’s purpose is to recover sensible heat from the distillate to preheat the feed water. Heat exchanger shall be plate-and-frame type sized to include 20 percent additional plates with no modifications. Gaskets shall be clip-in type.
3) Heat exchanger shall be constructed of Titanium Gr. 1 plates with Carbon Steel end plates and support bars.

4) Contractor shall furnish the following instrumentation:

   a. Differential pressure across the cold (feed) side of each heat exchanger.

   b. RTD's with thermowells on each stream in and out of the heat exchanger

5) The heat exchanger shall be provided with a permanently installed local cleaning system with quick connect hoses for periodic cleaning of the heat exchangers. Cleaning system shall, at a minimum, include an on-skid pump, heater, 500 lt. tank and agitator.

6) The heat exchanger shall be provided with suitable high point vents and low point drains.

E). Deaerator:

1) One (1) per evaporator.

2) The deaerator shall be constructed of 2507 duplex SST material with glass reinforced polyethylene random packing.

3) The deaerator shall be provided to remove non-condensable gasses from the heated feed water. Stripping steam from the distillate tank shall be used as the carrier for removal of non-condensable gasses.

4) The deaerator shall use a disc and donut configuration and shall be provided with an inlet nozzle designed to evenly distribute feed water over the packing. The deaerator vent or vent piping shall be supplied with bird screens.

5) A pressure transmitter shall be installed above the packing for vapour pressure monitoring and feed rate control of stripping steam from the distillate tank to the deaerator.

F). Vapour Compressor:

1) One (1) per evaporator.

2) The compressor casing shall be 316 SST and the impeller duplex SST.

3) Compressor, sealing methods, lubrication, and instrumentation shall be designed to be suitable for steam applications. The compressor bearing lubrication system shall be designed to provide continuous bearing lubrication during all modes of operation. Compressor shall be air cooled. If water cooled, the system shall be designed for a closed loop system with integral cooling.

4) The compressor and ancillary system shall be provided preferably on a common baseplate to facilitate installation and alignment. Vibration transmitters and monitoring equipment are required. To the maximum extent practical the vibration monitoring equipment and lubrication systems shall be mounted on the common baseplate. Motor shall be shipped loose for site assembly.
5) A compressor enclosure shall be supplied to meet contract noise limits.
6) Additional required equipment
   i). Shaft driven lube oil pump
   ii). Electrically driven Lube oil pump.
   iii). Lube Oil cooler
   iv). Electric Lube Oil heater
7) After the manufacture, following tests for Vapour Compressors shall be demonstrated at membrane manufacturer's works in the presence of Employer's representative and contractor:
   i) Performance Test with job motor
   ii) For detailed Quality Assurance tests, QA chapter shall be referred to.
   iii) One Compressor shall be tested at shop with job motor and guaranteed power consumption shall be determined based on shop test results of tested compressor multiplied by number of working compressors.
   iv) The responsibility for conducting the test will be with the Contractor and Contractor shall make all the arrangements for carrying out tests at compressor manufacturer's works. In case such test facilities are not available at manufacturer's works, the test may be carried out at any other test facility with the approval of Employer. All cost associated with testing at contractor's works or at any other test facility shall be borne by the contractor & shall be included in the contract price. Bidder shall submit the test procedure for Employer's approval.

G). Evaporator Recirculation Pumps:

1) Evaporator recirculation pump shall be furnished for evaporator train and designed for continuous service with minimal maintenance requirements. Two (2)x100% Evaporator recirculation Pump shall be installed; one operating and one spare in case of 1x100% Evaporative concentration

system. One (1) x 100% Evaporator recirculation Pump shall be installed per FFE train with a store stand-by Evaporator recirculation Pump in case of 2x50% Evaporative concentration system.

2) The pump casing and impeller shall be ASTM 890 Gr. 5A.
3) Recirculation pump mechanical seal shall be continuously purged to cool the seal and to minimize the amount of solids at the seal faces. Seal water shall be of service quality.

H). Distillate Tank:

One (1) distillate tank which shall be provided per evaporator train sized to provide not less than 10 minutes retention at the maximum treatment rate. Any vents from the distillate tank shall be supplied with bird screens.

The tank shall be fabricated from 316L SST.

I). Distillate Pumps:

1) Two (2) x 100% Distillate Pump shall be installed; one operating and one spare in case of 1x100% Evaporative concentration system. One (1) x 100% Distillate Pump shall be installed per FFE train with a store stand-by Distillate Pump in case of 2x50% Evaporative concentration system..
2) The distillate pump casing and impeller shall be 316L SST
3) One (1) x 100% centrifugal distillate pump.
4) Distillate pump shall transfer distillate from the distillate tank to the heat exchanger for sensible heat recovery.

J). Seeding System:

1) One (1) seeding system.
2) The seeding system shall be of proven type and the contractor shall submit the detail scheme for employer's approval. Reference list of previous installations for similar application shall also be furnished to the employer.
3) Seed tank (which is also the evaporator blowdown tank) and pump shall be supplied to provide calcium sulfate feed slurry to the evaporator recirculation pump suctions of the FFE.
4) Tank shall be of 316L SST construction.
5) Tank shall be furnished with an agitator to blend dry calcium sulphate with feed water at time of seeding.
   i) Agitator shall be propeller type.

ii) Materials of construction shall be suitable for intended purpose, identified by Contractor within the Proposal and approved by Purchaser.

6) Tank volume shall be at 10m3 minimum.

7) Access via stairs shall be provided to the top of the seed tank to facilitate maintenance of tank agitator and filling of tank with dry calcium sulfate.

K). Evaporator Blowdown Pump:

1) Two (2)x100% Evaporator Blowdown Pump shall be installed; one operating and one spare in case of 1x100% Evaporative concentration system. One (1) x 100% Evaporator Blowdown Pump shall be installed per FFE train with a store stand-by Evaporator Blowdown Pump in case of 2x50% Evaporative concentration system. Blowdown pump shall be provided to transfer brine blowdown

2) Casing and impeller shall be fabricated of A890 Gr 5A

L). Hydrocyclone Pump:

1) One (1) per evaporator train.

2) The pump casing and impeller shall be ASTM A890 Gr. 5A or equal.

3) Evaporator train shall have a centrifugal hydrocyclone feed pump.

M). Hydrocyclone:

1) One (1) per evaporator train.

2) Materials shall be 6% Mo SST/Ceramic/Equivalent.

3) Evaporator shall have a hydrocyclone for automatic control of dissolved and suspended solids in the evaporator sump.

3.02.06 Crystallizer, Crystallizer Feed Tank, Crystallizer Brine Tank & Crystallizer heat exchanger equipment:

1) Crystallizer Feed Tank and Pump-

One (1) Crystallizer Feed Tank, shall be provided for storage of evaporator effluent brine. The tank will be utilized for interim storage of brine both during normal operation and for short periods when maintenance is being performed on the crystallizer/centrifuge system. Materials of construction shall be Super Duplex 2507. The tank shall be furnished complete with Alloy C-276 agitator, level and temperature controls, and other required accessories. Feed pump shall be ASTM A 890 Gr. 5A.

2) Crystallizer Heater

One (1) forced circulation (1x120%), horizontally mounted, TEMA "C" design heat exchanger shall be furnished. Tubes to be made of Ti Gr 16, Tube sheets: Ti Gr 16, cladding on 316 SS, Shell to be made of 2205 Or 316 LSS. Head to be made of C 276.

3) Crystallizer Vapor Body

One (1) body of Alloy C 276 construction or higher grade, including de-entraining device. A cone bottom to be included. All other necessary accessories, controls, etc. shall be included. Crystallizer main circulating piping Inconel 625 or better.

4) Crystallizer Recirculation Pump

One (1), 100% duty pump constructed of ASTM A890 Gr. 5A or better shall be furnished for circulating slurry through the process. Pump type may be centrifugal or axial flow. Pump shall be furnished complete with double mechanical seals and a discharge pressure gauge.

5) Surface Condenser

One (1) surface condenser to condense crystallizer distillate shall be provided. Material of construction shall be 316L SS.

6) Anti-Foam Feed Tank and Pump

Complete feed system for injection of anti-foam to appropriate points in the process shall be included. The feed system shall include feed tank, agitator, and positive displacement metering pumps. Tank shall include a low-level alarm.

7) Caustic Feed Tank and Pump

Complete feed system for injection of caustic to appropriate points in the process shall be included. The feed system shall include feed tank, agitator, and two positive displacement metering pumps. Tank shall include low level alarm.

8) Crystallizer Distillate Tank

One (1) distillate tank shall be included, to provide positive suction head to the distillate pump. The tank shall collect both crystallizer distillate and return condensate from the crystallizer heater. Tank shall be of 316L stainless steel construction or other compatible material.

9) Crystallizer Distillate Pump

One (1) 100% duty, centrifugal pumps shall be furnished to transfer distillate from the distillate tank to be combined with the Evaporator distillate. Should the crystallizer distillate be contaminated, it shall be discharged back to the Wastewater Storage Tank. The distillate pump casing and impeller shall be 316L SST or better.

10) Recirculation piping and Vapor duct

Recirculation Piping shall be provided in C 276 material, Vapor duct to be made of 2205.

11) Mechanical Vapour Compressor

One (1), 100% duty, centrifugal compressor shall be provided. Compressor shall have 2507 casing, 2507 impeller . Inlet guide vanes or an outlet damper valve shall be provided for flow control. Oil cooler, filter and vibration monitoring shall be included as required.

12) Dewatring System: Solids generated in the crystallizer process are dewatered in the dewatering system. Centrifuge or Belt Filter Press can be offered for dewatering salts. Material of construction for wetted part should be Hastelloy C or equal. Filter cloth can be vendor's standard material based on application.

13) Centrate Tank and Centrate Pump

Centrate generated from dewatering system is collected in the Centrate tank. Brine is recycled back to crystallizer process. A small amount of purge can be separated from centrate pump discharge of necessary. Material of constriction for brine wetted material shall be Hastelloy C or equal.

3.02.07 **General**

a) All equipment and material furnished by the contractor shall have an acceptable history of satisfactory reliable operation and the Contractor shall offer only proven design in successful operation in similar application at previous installations.

b) Type of equipment and material of construction for various applications in the plant shall be selected by the Contractor as per its proven practice unless specified elsewhere.

c) Contractor shall take full responsibility that all materials and components of valves, pumps, piping and other equipment and appurtenances shall be compatible with the respective fluids herein.

d) All fasteners such as nuts, bolts etc. shall be of stainless steel.

e) Equipment shall be fabricated, assembled, installed and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer as approved by the Employer.

f) All pressure vessels shall be tested and code-stamped conforming to ASME Section VIII, Boiler and Pressure Vessel Code. ASME Section IX certified welders shall perform welding of fabricated equipment per ASME procedures.

g) The design of equipment, arrangement of components, and routing of piping shall consider operational and maintenance accessibility of components. Equipment, piping, valves, and instruments shall be arranged so that when installed, components requiring manipulation, observation, or maintenance will be readily accessible and safe to operating and maintenance personnel.

h) The owner shall:

   i). Have full access to the equipment during manufacturing.

   ii). Be notified when manufacturing schedule is arranged, and be kept informed during manufacture of any major problems or rework that may affect delivery of the equipment as scheduled.

   iii). Be notified, should any work, fabrication, or material be supplied by a subcontractor or outside bidder, prior to release to the bidder. Engineer reserves the right of approval of any subcontractor and also the right to inspect work, fabrication or material being subcontracted at the subcontractor's location.

   iv). Each Bidder furnished equipment skid shall be assembled and shop tested as completely as possible (both mechanically and electrically) including stroking of valves. All rotating parts and shaft couplings shall be statically and dynamically balanced in the shop.

   v). Each pressure vessel shall be subjected to testing specified within ASME. Skid piping and other piping assemblies shall also be hydrostatically shop tested per ASME B31.1.

vi). The Bidder shall notify the owner fifteen (15) working days prior to performing the following for potential owner witness or inspection:

a) Hydrostatic testing.

b) Functional testing.

vii). Coatings & Galvanizing:

a) Unless otherwise required, the Bidder's standard finish coating systems shall be applied in the shop to ferrous metal surfaces of equipment and materials. The coating system shall provide resistance to corrosion caused by weather and industrial environments. Surfaces to be primed only shall use a zinc rich primer. Surfaces shall be cleaned, prepared and coated in accordance with the coating manufacturer's instructions. Each shop fabricated vessel and tank shall be complete.

b) Stainless steel and FRP surfaces shall not be painted.

c) All exterior coating shall be epoxy black powder, no galvanized outdoors.

d) Bidder shall fully describe the proposed coating system for all Bidder supplied equipment. Equivalent coating systems by other manufacturers must be submitted for approval to the Engineer/Owner prior to fabrication of the equipment.

SUB-SECTION-I-M8

PIPING

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 Low Pressure piping systems covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated. 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)	Ductile Iron.	140
(iii)	Rubber lined steel pipe	120
(iv)	Stainless steel pipe	100

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 15.0 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 (except stainless steel piping).

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

1.08.00 High points in piping system shall be provided with vents along with valves as per the system requirement. Low points shall be provided with drains along with drain valves as per the system requirement. 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	
Drains & vents		x	x	x		

1.14.0 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 as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. 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.

2.03.05 Material of construction for pipes carrying various fluids shall be as follows:

Sl No	Type of Fluid	Material
1.	i) Ordinary Water (Raw Water, Clarified Water, etc.) ii) Equipment cooling water including Both primary & secondary circuit (DMCW pH-corrected & ACW drain water)	IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E'Gr.B/IS-3589 Gr. 410 /IS-1239 Heavy.
2.	i) Demineralised water, ii)Alkaline solution (ECW system chemical dosing)	Stainless Steel to ASTM A312, Gr. 304 welded for sizes 65 mm NB and above. Stainless steel to ASTM A312, Gr. 304 sch.40s seamless for sizes 50mm and below
3.	i) Drinking (potable) water ii)Compressed air (Instrument & service air)	ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.

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 Gr.410. 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.E-250B/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.E-250B 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).
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	**Field routed pipes:**
2.04.01	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 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.
2.05.00	**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. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and 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.

2.06.01 **Screwed Joints**

(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 field joined by welding for protection of Galvanising Zinc layer. 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 to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

2.06.02 **Welded Joints**

(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 Joints**

(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 For pipe fittings such as elbows (long radius), reducers, tees, etc. the material shall be to ASTM-A-234 Gr. WPB/ASTM-105 up to 300 NB. For pipe fittings 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/ 16.11.Further branching in pipes for sizes 65nb and above is also acceptable (ANSI B 31.1).

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.

2.07.02 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.

2.07.03 For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.

2.07.04 Stainless steel fittings shall conform to either ASTM-A-182 Gr. 304 or ASTM-A-403 Grade WP. 304 Class-S, for sizes upto and including 50 mm NB, i.e. the fittings shall be of seamless construction. However, for stainless fittings above 50 mm NB, the same shall conform to ASTM-A-403 Gr. WP 304 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. E-250B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 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 or any international standard.

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 or grit blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. 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.

(b) 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/ Anti corrosive Protection Coal tar tape**

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.

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.

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.
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.

Total thickness of completed coating and wrapping shall not be less than 4.0 mm.

b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS 15337 or equivalent. These-tapes shall be applied hot over the cold coal tar primer in steps of 2mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total nominal thickness of the finished protective coating shall be 4.0 mm.

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 . However for pipe sizes below 100nb the pipes may be cleaned internally by compressed air blowing as an alternative to internal blast cleaning. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done by air blowing only.

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 **Specification for hangers and supports**

2.11.01 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

2.11.02 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

2.11.03 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

2.12.00 **Design/Construction/Material Particulars of Gate/ Globe /Check /Butterfly / Ball / Air release /Float valves / Moisture Traps.**

2.12.01 **GENERAL**

(a) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.

(b) 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.

(c) The valves coming in vacuum lines shall be of extended gland type and/or water sealed.

(d) 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.

(e) Valves coming under the purview of IBR shall meet IBR requirements.

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

(g) 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

2.12.02 **VALVE BODY MATERIAL**

Valve body material for various services shall be as follows:

Valve body material for water application like 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 etc. shall be cast iron for sizes 65NB and above; gun-metal for sizes 50 Nb and below.

For compressed air application, valve body material shall be cast carbon steel or 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. However for butterfly valves, Cast Iron /Ductile Iron/SG iron/carbon steel body and disc with elastomer lining are also acceptable.

Condensate: Cast Carbon Steel / Forged Carbon Steel.

2.12.03 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 steel body 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.

2.12.04 **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).

2.13.00 **Gate/Globe/Check Valves**

(a) 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).

(b) 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.

(c) All gun metal body valves shall have screwed ends.

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

(e) Gate/sluice valves shall be used for isolation of flow. 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. 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) Draining arrangement wherever required.

(f) 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. Preferably, the valves shall be of the vertical stem type. Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

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.

(g) 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.

(h) 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);

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

(j) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing. The valves shall be preferably outside screw & yoke type.

(k) 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.

(l) 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.

(m) For Cl 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.

2.13.01 **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 or Equivalent

(2) **Stainless steel valves**

Body & Bonnet	SS 304
Disc	-do-
Trim.	SS 316

(3) **Cast iron valves**

Body & bonnet	BS 1452 Gr. 14/ IS-210 Gr. FG 260
Seating surfaces and rings	13% chromium steel/ 13% Chrome overlay
Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr FG 260
Hinge pin for non-return valves	AISI 316
Stem for gate globe valves	13% chromium steel or Equivalent
Back seat	13 % chromium steel / 13% Chrome overlay

(4) **Gun Metal valves**

Body and bonnet	IS 318 Gr. 2/ Equivalent Standard
Trim.	-do-

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

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

(d) Forged carbon steel valves are also acceptable in place of Gun metal valves.

2.14.00 **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.

2.15.00 **Butterfly valves**

2.15.01 **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. E-250B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter.

(b) 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

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

(d) Valves-200Nb and above shall also be provided with gear operator arrangement as a standard practice suitable for manual operation. Manual operation of valve shall be through 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.

2.15.02 **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 / SG iron BSEN 1563, Gr EN GJS-400-15 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 SS 304

Shaft SS 316

Seat Rings EPT/BUNA-N/Neoprene

(c) **Carbon steel Butterfly Valves**

Body & Disc ASTM A 216, Gr. WCB

Shaft SS 304

Disc & Seat Rings EPT/BUNA-N/Neoprene

(d) **Elstomer lined Butterfly Valves**

Body & Disc ASTM A48, Gr. 40 / IS: 210. Gr. FG-260 / SG Iron (ductile iron) IS 1865 Gr 400-15 or BSEN 1563, Gr EN GJS-400-15 / ASTM A 216, Gr. WCB with elastomer lining.

Shaft SS 316

2.15.03 **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.

All valves that are designed and manufactured as per AWWA-C-504 / AWWA-C-516 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504/AWWA-C-516. 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/AWWA-C-516.

2.16.00 **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.

SUB-SECTION-I-M9

MDL

S. No.	NTPC_DRG_NO	Rev_drg_no_for_inouhse_drg	TO_BE_SHIFTED_TO_PACKAGE	DRG_TITLE	PROJECT_SPECIFC_INFORMATION	DRG_PURPOSE	DRG_TYPE	AREA	MILESTONE	CUSTODIAN	REVIEWERS	SUB_FROM_MP_AWARD	SUB_FROM_FGD_AWARD
1	0000-109-PVC-B-001			GA & RCC Detail of Foundation of Reagent Feed Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	290	140
2	0000-109-PVC-B-002			GA & RCC Detail of Foundation of Secondary HC Feed Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	255	105
3	0000-109-PVC-B-003			GA & RCC Detail of Foundation of Filtrate water Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	283	133
4	0000-109-PVC-B-004			GA & RCC Detailof Foundation of Waste water Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	290	140
5	0000-109-PVC-B-005			GA & RCC Detail of Foundation of Auxilliary Storage Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	290	140
6	0000-109-PVC-B-006			GA & RCC Detail of Foundation of Process Water Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	283	133
7	0000-109-PVC-B-010			GGH-Layout of Piles (If applicable) - GA OF FOUNDATION & COLUMN FOR GGH SUPPORT STRUCTURE		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	292	142
8	0000-109-PVC-B-011			GGH - Foundation/Pilecap & Pedestal - R/F DETAILS FOR GGH SUPPORT STRUCTURE		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	292	142
9	0000-109-PVC-B-014			Pipe Rack structure- GA & RCC detail of Foundation		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,	302	152
10	0000-109-PVC-B-016			GA of Foundation of Electrical equipments & control Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
11	0000-109-PVC-B-017			RCC Detail of Foundation of Electrical equipments & control Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Mech/SG,PE-Mech/SG,	322	172
12	0000-109-PVC-B-018			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-1 - DETAILS OF GRADE BEAMS		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
13	0000-109-PVC-B-018-SHT-2			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-2 - DETAILS OF LINTEN BEAMS		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
14	0000-109-PVC-B-018-SHT-3			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-3 - DETAILS OF FLOOR BEAMS & SLABS		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
15	0000-109-PVC-B-018-SHT-4			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-4 - DETAILS OF FROOF BEAMS & SLABS AT RL (+) 295.250 (TOC)		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
16	0000-109-PVC-B-018-SHT-5			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-5 - DETAILS OF GRADE SLAB AT RL (+) 285.800 (TOC)		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
17	0000-109-PVC-B-018-SHT-6			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-6 - DETAILS OF STAIR CASES & ITS BEAM UPTO ROOF		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
18	0000-109-PVC-B-018-SHT-7			GA & RCC Detail of Superstructure of Electrical equipments & control Building - SHEET-7 - DETAILS OF COLUMNS		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Electrical,PE-C&I,PE-C&I,PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172

S. No.	NTPC_DRG_NO	Rev_drg_no_for_inouhse_drg	TO_BE_SHIFTED_TO_PACKAGE	DRG_TITLE	PROJECT_SPECIFC_INFORMATION	DRG_PURPOSE	DRG_TYPE	AREA	MILESTONE	CUSTODIAN	REVIEWERS	SUB_FROM_MP_AWARD	SUB_FROM_FGD_AWARD
19	0000-109-PVC-B-019			Architectural dwg of Electrical equipments & control Building		A	D	FGD	MISCELLANEOUS	Architecture	PE-Civil,PE-Civil,PE-C&I,PE-C&I,PE-Electrical,PE-Mech/Layout,PE-Mech/SG,	292	142
20	0000-109-PVC-B-020			GA of Foundation of Gypsum Dewatering Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
21	0000-109-PVC-B-021			RCC Detail of Foundation of Gypsum Dewatering Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	322	172
22	0000-109-PVC-B-022-SHT-1			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Grade Beams		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,PE-Electrical,	322	172
23	0000-109-PVC-B-022-SHT-10			GA & RCC Detail of Superstructure of Gypsum Dewatering Building - GA & RC Details of Lintel Beams at RL 311.2 m (BOC)		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/Layout,	322	172
24	0000-109-PVC-B-022-SHT-2			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : RC Details of Columns above Ground Level		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	322	172
25	0000-109-PVC-B-022-SHT-3			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Floor Beams & Slab at RL. 292.8 m & RL. 296.65 m		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	322	172
26	0000-109-PVC-B-022-SHT-4			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Floor Beams & Slab at RL. 300.65 m		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	322	172
27	0000-109-PVC-B-022-SHT-5			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Grade Slab		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,PE-C&I,PE-Electrical,PE-Civil,	322	172
28	0000-109-PVC-B-022-SHT-6			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Roof Beams & Slab		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	322	172
29	0000-109-PVC-B-022-SHT-7			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Lintel Beam		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	322	172
30	0000-109-PVC-B-022-SHT-8			GA & RCC Detail of Superstructure of Gypsum Dewatering Building : GA & RC Details of Roof Beams & Slab at RL 308.65 m		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	322	172
31	0000-109-PVC-B-022-SHT-9			GA & RCC Detail of Superstructure of Gypsum Dewatering Building - Superstructure Stairs		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/Layout,	322	172
32	0000-109-PVC-B-023			Architectural dwg of Gypsum Dewatering Building		A	D	FGD	MISCELLANEOUS	Architecture	PE-Civil,PE-Mech/SG,PE-Mech/Layout,PE-Electrical,	285	135
33	0000-109-PVC-B-024			GA of Foundation of Recycle Pump & Oxidation Blower Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/SG,PE-Electrical,PE-Mech/Layout,	322	172
34	0000-109-PVC-B-026			GA dwg of Recycle Pump & Oxidation Blower bldg Structure		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	292	142

S. No.	NTPC_DRG_NO	Rev_drg_no_for_inouhse_drg	TO_BE_SHIFTED_TO_PACKAGE	DRG_TITLE	PROJECT_SPECIFC_INFORMATION	DRG_PURPOSE	DRG_TYPE	AREA	MILESTONE	CUSTODIAN	REVIEWERS	SUB_FROM_MP_AWARD	SUB_FROM_FGD_AWARD
35	0000-109-PVC-B-028			GA of Foundation of Ball Mill Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	322	172
36	0000-109-PVC-B-029			RCC Detail of Foundation of Ball Mill Building		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
37	0000-109-PVC-B-030-SHT-1			GA & RCC Detail of Superstructure of Ball Mill Building : GA & RC Details of Grade Beams		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,PE-Electrical,PE-C&I,	322	172
38	0000-109-PVC-B-030-SHT-10			GA & RCC Detail of Superstructure of Ball Mill Building : GA & Detail of Side Runner		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
39	0000-109-PVC-B-030-SHT-11			GA & RCC Detail of Superstructure of Ball Mill Building : GA & Detail Monorail Beam		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
40	0000-109-PVC-B-030-SHT-2			GA & RCC Detail of Superstructure of Ball Mill Building : RC Details of Columns above Ground Level		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,	322	172
41	0000-109-PVC-B-030-SHT-3			GA & RCC Detail of Superstructure of Ball Mill Building : GA & RC Details of Floor Beams & Slab at RL. 292.1 m		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,	322	172
42	0000-109-PVC-B-030-SHT-4			GA & RCC Detail of Superstructure of Ball Mill Building : GA & RC Details of Floor Beams & Slab at RL. 296.76 m		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,	322	172
43	0000-109-PVC-B-030-SHT-5			GA & RCC Detail of Superstructure of Ball Mill Building : GA & RC Details of Grade Slab		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Electrical,PE-C&I,PE-Mech/SG,PE-Civil,	322	172
44	0000-109-PVC-B-030-SHT-6			GA & RCC Detail of Superstructure of Ball Mill Building : GA & RC Details of Lintel Beams		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,PE-Electrical,PE-C&I,	322	172
45	0000-109-PVC-B-030-SHT-7			GA & RCC Detail of Superstructure of Ball Mill Building : GA & Detail of Base Plate of Steel Structure		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Civil,	322	172
46	0000-109-PVC-B-030-SHT-8			GA & RCC Detail of Superstructure of Ball Mill Building : GA & Detail of Steel Superstructure		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
47	0000-109-PVC-B-030-SHT-9			GA & RCC Detail of Superstructure of Ball Mill Building : GA & Detail of Steel Truss		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
48	0000-109-PVC-B-031			Architectural dwg of Ball Mill Building		A	D	FGD	MISCELLANEOUS	Architecture	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Civil,PE-Electrical,	278	128
49	0000-109-PVC-B-032			Foundations for Gypsum Bleed pump & its drive		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	278	128
50	0000-109-PVC-B-033			Foundations for Oxidation Blower and its drive		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	310	160
51	0000-109-PVC-B-034			GA of Foundation of Booster Fan		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	286	136
52	0000-109-PVC-B-035			RCC Detail of Foundation of Booster Fan		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	286	136

S. No.	NTPC_DRG_NO	Rev_drg_no_for_inouhse_drg	TO_BE_SHIFTED_TO_PACKAGE	DRG_TITLE	PROJECT_SPECIFC_INFORMATION	DRG_PURPOSE	DRG_TYPE	AREA	MILESTONE	CUSTODIAN	REVIEWERS	SUB_FROM_MP_AWARD	SUB_FROM_FGD_AWARD
53	0000-109-PVC-B-036			GA of Foundation of Ball Mill		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	313	163
54	0000-109-PVC-B-037			RCC Detail of Foundation of Ball Mill		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	313	163
55	0000-109-PVC-B-038			GA of Foundation of Absorber		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,PE-Civil,	242	92
56	0000-109-PVC-B-041			GA of Foundation of Transformer		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Electrical,	322	172
57	0000-109-PVC-B-042			RCC Detail of Foundation of Transformer		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Electrical,	322	172
58	0000-109-PVC-B-044			GA & RCC Detail of Foundation of Reagent Feed Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	278	128
59	0000-109-PVC-B-045			GA & RCC Detail of Foundation of Limestone Preparation Area Sump Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	278	128
60	0000-109-PVC-B-046			GA & RCC Detail of Foundation of Recycle Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	244	94
61	0000-109-PVC-B-047			GA & RCC Detail of Foundation of Absorber Area Sump Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	271	121
62	0000-109-PVC-B-053			GA & RCC Detail of Foundation of Belt Filter Wash Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	292	142
63	0000-109-PVC-B-054			GA & RCC Detail of Foundation of Dewatering Area Sump Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	278	128
64	0000-109-PVC-B-055			GA & RCC Detail of Foundation of Auxiliary Storage Tank Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	278	128
65	0000-109-PVC-B-056			GA & RCC Detail of Foundation of Make-up water Booster Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	271	121
66	0000-109-PVC-B-057			GA & RCC Detail of Foundation of Mist Eliminator Water Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	270	120
67	0000-109-PVC-B-058			GA & RCC Detail of Foundation of Process (Make-up) Water Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Electrical,	264	114
68	0000-109-PVC-B-059			Detail civil drawings for Road		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,	320	170
69	0000-109-PVC-B-060			Detail civil drawings for Pavement		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
70	0000-109-PVC-B-061			Detail civil drawings for Drains		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	322	172
71	0000-109-PVC-B-062			LAYOUT OF FOUNDATION FOR FGD EQUIPMENT		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,PE-Electrical,	322	172
72	0000-109-PVC-B-063			ABSORBER LOAD DATA		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Civil,	322	172
73	0000-109-PVC-B-064			Foundation Load Data for Auxiliary Storage Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	-,	322	172
74	0000-109-PVC-B-065			Foundation Load Data for Reagent Feed Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
75	0000-109-PVC-B-066			Foundation Load Data for Process (Makeup) Water Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
76	0000-109-PVC-B-067			Foundation Load Data for Waste Water Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
77	0000-109-PVC-B-068			Foundation Load Data for Filtrate Water Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
78	0000-109-PVC-B-069			Foundation Load Data for Secondary Hydrocyclone Feed Tank		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172

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79	0000-109-PVC-B-071			GA & RCC Detail of Booster Fan Outlet to GGH Duct Support Foundation		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
80	0000-109-PVC-B-072			GA & RCC Detail of FDN for Duct Support DS 6 & DS 7 for Stack Inlet Duct		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
81	0000-109-PVC-B-073			GA & RCC Detail of FDN for Duct Support DS 8 & DS 9 for Stack Inlet Duct		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
82	0000-109-PVC-B-074			FDN Load Data with Base Plate & FDN Bolt Detail for DS 8&9		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
83	0000-109-PVC-B-075			Foundation Load Data with base Plate & Foundation Bolt Detail For GGH Support Structure		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Civil,	322	172
84	0000-109-PVC-B-076			Foundation Load Data with base Plate & Foundation Bolt Detail For Duct Support Structure DS-1		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
85	0000-109-PVC-B-079			Foundation Load Data with base Plate & Foundation Bolt Detail For Pipe & Cable Support Structure		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Electrical,	322	172
86	0000-109-PVC-B-080			Foundation Load Data with base Plate & Foundation Bolt Detail For Recycle Pipe Support Structure		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
87	0000-109-PVC-B-082			GA & RCC Detail of FDN DS 1		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
88	0000-109-PVC-B-083			GA & RCC Detail of FDN DS 2		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,	322	172
89	0000-109-PVC-B-084			GA & RCC Detail of FDN DS 3		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout,	322	172
90	0000-109-PVC-B-088			Foundation Load Data of Pipe & Cable Tray Support Structure		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Electrical,	322	172
91	0000-109-PVC-B-089			GA & RCC Details of Pipe & Cable Support Foundations mkd. F3 to F5		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Electrical,PE-Mech/Layout,	322	172
92	0000-109-PVC-B-091			Foundation Load Data with Base Plate and Anchor Bolt detail for GGH Stair		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Civil,	322	172
93	0000-109-PVC-B-092			GA & RCC Details of GGH Stair Foundation		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Civil,PE-Mech/Layout,	322	172
94	0000-109-PVC-B-095			GA & RCC Detail of External Recycle Pipe Support Foundation		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,	322	172
95	0000-109-PVC-B-096			GA & RCC Detail of Cooling Water Pump		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,	322	172
96	0000-109-PVC-B-097			GA & RC Details of Air Receivers		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/Layout,	322	172
97	0000-109-PVC-B-098			Detail civil drawing for sewerage system		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,PE-Mech/Layout,	322	172
98	0000-109-PVC-B-101			FGD Chimney-General Arrangement		A		FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout, PE-Electrical, PE-C&I	240	90
99	0000-109-PVC-B-102			FGD Chimney- Foundation Details (Main Reinforcement)		A		FGD	MISCELLANEOUS	PE-Civil		255	105
100	0000-109-PVC-B-103			FGD Chimney- Foundation Details (Shell Dowels)		A		FGD	MISCELLANEOUS	PE-Civil		270	120
101	0000-109-PVC-B-104			FGD Chimney- Foundation Details (Duct Pedestals)		A		FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout	270	120
102	0000-109-PVC-B-105			FGD Chimney- Shell Profile and Details of Main Reinforcement		A		FGD	MISCELLANEOUS	PE-Civil		300	150
103	0000-109-PVC-B-106			FGD Chimney- Details of Construction Openings in Shell		A		FGD	MISCELLANEOUS	PE-Civil		340	190
104	0000-109-PVC-B-107			FGD Chimney- Details of Door & Miscellaneous Openings in Shell below EL (+) 10.00 M		A		FGD	MISCELLANEOUS	PE-Civil	PE-Electrical	350	200

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105	0000-109-PVC-B-108			FGD Chimney- Details of Openings in Shell for Ducts		A		FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/Layout	355	205
106	0000-109-PVC-B-109			FGD Chimney- Details of Recesses in Shell for Platform No. 1		A		FGD	MISCELLANEOUS	PE-Civil		375	225
107	0000-109-PVC-B-110			FGD Chimney- Details of Recesses in Shell for Platform No. 2		A		FGD	MISCELLANEOUS	PE-Civil		405	255
108	0000-109-PVC-B-111			FGD Chimney- Details of Recesses in Shell for Platform No. 3		A		FGD	MISCELLANEOUS	PE-Civil		415	265
109	0000-109-PVC-B-112			FGD Chimney- Details of Recesses in Shell for Platform No.4		A		FGD	MISCELLANEOUS	PE-Civil		440	290
110	0000-109-PVC-B-113			FGD Chimney- Details of Air Outlet Openings in Shell below Roof		A		FGD	MISCELLANEOUS	PE-Civil		460	310
111	0000-109-PVC-B-114			FGD Chimney- Details of Recesses in Shell for Roof Platform		A		FGD	MISCELLANEOUS	PE-Civil		460	310
112	0000-109-PVC-B-115			FGD Chimney- Details of Roof Platform		A		FGD	MISCELLANEOUS	PE-Civil		395	245
113	0000-109-PVC-B-116			FGD Chimney- Details of Platform No.4		A		FGD	MISCELLANEOUS	PE-Civil		425	275
114	0000-109-PVC-B-117			FGD Chimney- Details of Platform No. 3		A		FGD	MISCELLANEOUS	PE-Civil		445	295
115	0000-109-PVC-B-118			FGD Chimney- Details of Platform No. 2		A		FGD	MISCELLANEOUS	PE-Civil		465	315
116	0000-109-PVC-B-119			FGD Chimney- Details of Platform No. 1		A		FGD	MISCELLANEOUS	PE-Civil		475	325
117	0000-109-PVC-B-120			FGD Chimney- General Arrangement of Liner		A		FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG	385	235
118	0000-109-PVC-B-121			FGD Chimney- Details of Liner / Can Type-A		I		FGD	MISCELLANEOUS	PE-Civil		385	235
119	0000-109-PVC-B-122			FGD Chimney- Details of Liner / Can Type - F & G		I		FGD	MISCELLANEOUS	PE-Civil		435	285
120	0000-109-PVC-B-123			FGD Chimney- Details of Liner / Can Type - E & H		I		FGD	MISCELLANEOUS	PE-Civil		450	300
121	0000-109-PVC-B-124			FGD Chimney- Details of Liner / Can Type - B & C		I		FGD	MISCELLANEOUS	PE-Civil		455	305
122	0000-109-PVC-B-125			FGD Chimney- Details of Liner / Can Type - D		I		FGD	MISCELLANEOUS	PE-Civil		480	330
123	0000-109-PVC-B-126			FGD Chimney- Details of Manholes in Liners		I		FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG	480	330
124	0000-109-PVC-B-127			FGD Chimney- Fixing Details of Liner Insulation		I		FGD	MISCELLANEOUS	PE-Civil		495	345
125	0000-109-PVC-B-128			FGD Chimney- Details of Liner Support Beams and Hanger		A		FGD	MISCELLANEOUS	PE-Civil		490	340
126	0000-109-PVC-B-129			FGD Chimney- Details of Liner Restraint		A		FGD	MISCELLANEOUS	PE-Civil		500	350
127	0000-109-PVC-B-130			FGD Chimney- Details of Liner Expansion Joints		A		FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG	495	345
128	0000-109-PVC-B-131			FGD Chimney- Details of Mini-Shell		A		FGD	MISCELLANEOUS	PE-Civil		540	390
129	0000-109-PVC-B-132			FGD Chimney- Layout of Staircase		I		FGD	MISCELLANEOUS	PE-Civil		430	280
130	0000-109-PVC-B-133			FGD Chimney- Details of Staircase		I		FGD	MISCELLANEOUS	PE-Civil		430	280
131	0000-109-PVC-B-134			FGD Chimney- Details of Ladders, Hatches and other Miscellaneous Items		I		FGD	MISCELLANEOUS	PE-Civil		440	290
132	0000-109-PVC-B-135			FGD Chimney- Details of Roof Slab		A		FGD	MISCELLANEOUS	PE-Civil		480	330
133	0000-109-PVC-B-136			FGD Chimney- Details of Grade Level Slab		A		FGD	MISCELLANEOUS	PE-Civil		510	360
134	0000-109-PVC-B-137			FGD Chimney- Scheme for Aviation Obstruction Markings		A		FGD	MISCELLANEOUS	PE-Civil		525	375
135	0000-109-PVC-B-138			FGD Chimney- Layout and Details of Strakes		A		FGD	MISCELLANEOUS	PE-Civil		420	270
136	0000-109-PVC-B-139			FGD Chimney-Supporting Arrangement for Gas Analyzer Panels & Details of Sampling Ports in Liner		A		FGD	MISCELLANEOUS	PE-Civil	PE-C&I	540	390
137	0000-109-PVC-U-001			Structural Design Basis - Civil		A	A	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,PE-Mech/SG,	160	10
138	0000-109-PVC-U-002			Civil Design Basis		A	A	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	207	57

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139	0000-109-PVC-U-003			Design Calculation for Tank foundations		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	255	105
140	0000-109-PVC-U-010			Design calculation for GGH support structure foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	272	122
141	0000-109-PVC-U-012			Design calculation for Duct support foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	292	142
142	0000-109-PVC-U-014			Design calculation for Pipe Rack structure foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	302	152
143	0000-109-PVC-U-016			Design Calculation for Electrical equipments & control Building foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	302	152
144	0000-109-PVC-U-018			Design Calculation for Electrical equipments & control Building Superstructure		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	302	152
145	0000-109-PVC-U-020			Design Calculation for Gypsum Dewatering Building foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	322	172
146	0000-109-PVC-U-021			Calculation Report of Dewatering Building Superstructure		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	550	400
147	0000-109-PVC-U-024			Design Calculation for Recycle Pump & Oxidation Blower bldg foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	292	142
148	0000-109-PVC-U-028			Design Calculation for Ball Mill Building foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	322	172
149	0000-109-PVC-U-030			Calculation Report of Ball Mill Building Superstructure		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	550	400
150	0000-109-PVC-U-034			Design Calculation for Booster Fan foundation		A	D	FGD	MISCELLANEOUS	PE-Civil	-,	286	136
151	0000-109-PVC-U-036			Design Calculation for Ball Mill foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	313	163
152	0000-109-PVC-U-038			Design Calculation for Absorber foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	242	92
153	0000-109-PVC-U-041			Design Calculation for Transformer Foundation		A	D	FGD	MISCELLANEOUS	PE-Civil	-,	322	172
154	0000-109-PVC-U-042			Design Calculation for Reagent Feed Pump Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
155	0000-109-PVC-U-043			Design Calculation for Pumps foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
156	0000-109-PVC-U-044			Calculation Report of Waste Water Tank Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
157	0000-109-PVC-U-045			Calculation Report of Process (Make up) Water Tank Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
158	0000-109-PVC-U-046			Calculation Report of Secondary HC Feed Tank Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
159	0000-109-PVC-U-047			Calculation Report of Filtrate Water Tank Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
160	0000-109-PVC-U-048			Design Calculation of Auxiliary Storage Return Pump & Gypsum Bleed Pump		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
161	0000-109-PVC-U-049			Design Calculation of Gypsum Bleed Pump		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
162	0000-109-PVC-U-070			Calculation Report for Booster Fan Inlet Duct Support Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
163	0000-109-PVC-U-071			Calculation Report for Booster Fan Outlet to GGH Duct Support Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
164	0000-109-PVC-U-083			Calculation Report of Duct Support Foundation DS-2		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
165	0000-109-PVC-U-084			Design Calculation for Duct Support Foundation DS3		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
166	0000-109-PVC-U-085			Calculation of Foundation of Oxidation Blower		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
167	0000-109-PVC-U-086			Calculation Report of GGH Stair Foundation		I	D	FGD	MISCELLANEOUS	PE-Civil	-,	285	135
168	0000-109-PVC-U-101			FGD Chimney-Design basis report for chimney		I		FGD	MISCELLANEOUS	PE-Civil		200	50
169	0000-109-PVC-U-102			FGD Chimney-Analysis and design of raft foundation for chimn		I		FGD	MISCELLANEOUS	PE-Civil		255	105

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170	0000-109-PVC-U-103			FGD Chimney-Analysis & design of RCC shell		I		FGD	MISCELLANEOUS	PE-Civil		300	150
171	0000-109-PVC-U-104			FGD Chimney-Design of platform beams of Roof Platform		I		FGD	MISCELLANEOUS	PE-Civil		395	245
172	0000-109-PVC-U-105			FGD Chimney-Design of platform beams of Platform No. 4		I		FGD	MISCELLANEOUS	PE-Civil		425	275
173	0000-109-PVC-U-106			FGD Chimney-Design of platform beams of Platform No. 3		I		FGD	MISCELLANEOUS	PE-Civil		445	295
174	0000-109-PVC-U-107			FGD Chimney-Design of platform beams of Platform No. 2		I		FGD	MISCELLANEOUS	PE-Civil		465	315
175	0000-109-PVC-U-108			FGD Chimney-Design of platform beams of Platform No. 1		I		FGD	MISCELLANEOUS	PE-Civil		475	325
176	0000-109-PVC-U-109			FGD Chimney-Analysis and design flue liner		I		FGD	MISCELLANEOUS	PE-Civil		385	235
177	0000-109-PVC-U-110			FGD Chimney-Design of extra reinforcement around openings		I		FGD	MISCELLANEOUS	PE-Civil		350	200
178	0000-109-PVC-U-111			FGD Chimney-Design of extra reinforcement around recesses f		I		FGD	MISCELLANEOUS	PE-Civil		375	225
179	0000-109-PVC-W-001			Standard Details for Concrete Works		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	280	130
180	0000-109-PVC-W-002			Standared Notes for Concrete Works		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Civil,	280	130
181	0000-109-PVC-W-003			Soil Investigation Report		A	D	FGD	MISCELLANEOUS	PE-Civil	-,	280	130
182	0000-109-PVC-W-004			Location Plan ¿ Site Office, Stores & Access Road		A	D	FGD	MISCELLANEOUS	PE-Civil	PE-Mech/SG,PE-Mech/SG,PE-Mech/Layout,	280	130
183	0000-109-PVC-W-101			FGD Chimney - wind tunnel test procedure		A		FGD	MISCELLANEOUS	PE-Civil		330	180
184	0000-109-PVC-W-102			FGD Chimney - wind tunnel test report		A		FGD	MISCELLANEOUS	PE-Civil		420	270
185	0000-109-PVC-Y-101			FGD Chimney- GA of expansion conpensator		I		FGD	MISCELLANEOUS	PE-Civil		510	360
186	0000-109-PVC-Y-102			FGD Chimney- Datasheet for expansion conpensator		I		FGD	MISCELLANEOUS	PE-Civil		510	360
187	0000-109-PVC-Y-103			FGD Chimney- Datasheet for thermal insulation		I		FGD	MISCELLANEOUS	PE-Civil		495	345
188	0000-109-PVE-B-001			FGD Lighting Panel GA & Schematic and wiring drawing		I	B	FGD	MISCELLANEOUS	PE-Electrical	-,	336	186
189	0000-109-PVE-B-002			GA. Datasheet, Terminal Box arrangement and Curves of Slurry Recirculation pump-Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,PE-Mech/SG,	320	170
190	0000-109-PVE-B-003			GA. Datasheet, Terminal Box arrangement and Curves of Oxidation Blower-Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,PE-Mech/SG,	306	156
191	0000-109-PVE-B-004			GA. Datasheet, Terminal Box arrangement and Curves of BALL MILL Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,PE-Mech/SG,	306	156
192	0000-109-PVE-B-005			GA. Datasheet, Terminal Box arrangement and Curves of Booster fan Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,PE-Mech/SG,	285	135
193	0000-109-PVE-B-006			GA of cable tray support system		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
194	0000-109-PVE-B-007			GA,SLD and BOQ of DCFB		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	336	186
195	0000-109-PVE-B-008			Drawing for Power Distribution Panels		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
196	0000-109-PVE-B-009			Drawing for VFD Panels		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
197	0000-109-PVE-B-010			Drawing for Local Starters		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
198	0000-109-PVE-B-011			GA,SLD,Scheme and BOQ of FGD MCC		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	265	115
199	0000-109-PVE-B-012			Datasheet/Drawing for Junction Box (24way, 48way, 72way, 96way)		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,PE-Electrical,	563	413
200	0000-109-PVE-B-013			Drawing for AC Distribution Board		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	336	186
201	0000-109-PVE-B-014			Drawing Local Push Button Station.		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	507	357
202	0000-109-PVE-F-001			FGD MCC Control Room - Equipment and Cable Tray Layout		A	D	FGD	MISCELLANEOUS	PE-Electrical	PE-C&I,PE-C&I,PE-Mech/WS,	311	161
203	0000-109-PVE-F-002			Earthing scheme for FGD MCC Control Room		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
204	0000-109-PVE-F-003			Electrical Equipment & JBs Location Layout for complete FGD Area & Limestone & Gypsum Handling area		A	D	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/Layout,PE-Mech/MH,PE-Mech/SG,PE-Civil,	322	172
205	0000-109-PVE-F-004			Detail Cable Routing Plan for complete FGD Area & Limestone & Gypsum Handling area		A	D	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/Layout,PE-Mech/MH,PE-Mech/SG,PE-Civil,PE-C&I,	322	172

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206	0000-109-PVE-F-005			Illumination Layout and Road / area Lighting layout for complete FGD Area & Limestone & Gypsum Handling area		A	D	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/Layout,PE-Mech/MH,	322	172
207	0000-109-PVE-F-006			Earthing Layout for complete FGD Area & Limestone & Gypsum Handling area		A	D	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/Layout,PE-Mech/MH,PE-Civil,PE-Mech/SG,	322	172
208	0000-109-PVE-F-007			Lightning Protection Layout for complete FGD Area & Limestone & Gypsum Handling area		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
209	0000-109-PVE-G-001			Lighting Layout for FGD MCC Control Room		I	D	FGD	MISCELLANEOUS	PE-Electrical	-,	285	135
210	0000-109-PVE-G-002			Cable tray layout in FGD area		A	D	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/Layout,PE-Mech/SG,PE-Mech/SG,	311	161
211	0000-109-PVE-H-001			Cable schedule for power & control cables		I	D	FGD	MISCELLANEOUS	PE-Electrical	-,	297	147
212	0000-109-PVE-P-001			Electrical Scope diagram		A	A	FGD	MISCELLANEOUS	PE-Electrical	PE-C&I,PE-Mech/SG,	160	10
213	0000-109-PVE-R-001			Motor for Booster Fan - Sub QR documents of M/s Crompton Greaves Ltd., Bhopal		A	A	FGD	MISCELLANEOUS	PE-Electrical	-,	196	46
214	0000-109-PVE-R-002			Motor for Booster Fan - Sub QR documents of M/s Weg, Hosur		A	A	FGD	MISCELLANEOUS	PE-Electrical	-,	196	46
215	0000-109-PVE-R-003			Motor for Booster Fan - Sub QR documents of M/s Crompton Greaves Ltd., Mandideep		A	A	FGD	MISCELLANEOUS	PE-Electrical	-,	196	46
216	0000-109-PVE-V-001			FGD Lighting Fixtures & Accessories - Mounting Details & Drawing		I	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,PE-Civil,	336	186
217	0000-109-PVE-W-001			Electrical load list - FGD		I	A	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,PE-Mech/SG,	187	37
218	0000-109-PVE-W-002			Type test reports (above 50 KW LT motors)		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
219	0000-109-PVE-W-003			Type test report for Booster fan motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
220	0000-109-PVE-W-004			TTR of Slurry Recirculation pump-Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
221	0000-109-PVE-W-005			TTR of Oxidation Blower-Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
222	0000-109-PVE-W-006			TTR of BALL MILL Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	322	172
223	0000-109-PVE-W-007			FGD-Type Test Reports for Lighting Panels		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	337	187
224	0000-109-PVE-W-008			FGD-Junction Boxes Type test Reports		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,PE-Electrical,	564	414
225	0000-109-PVE-W-009			FGD-Lighting Fixtures Type Test Reports		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	337	187
226	0000-109-PVE-W-010			Type test reports for Power cable		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	337	187
227	0000-109-PVE-W-011			Type test reports for Control cable		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	337	187
228	0000-109-PVE-W-012			Type Test Procedure for HT motors		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	285	135
229	0000-109-PVE-W-013-SHT-1			Type Test Reports for FGD MCC Panels (PART 1)		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
230	0000-109-PVE-W-013-SHT-2			Type Test Reports for FGD MCC Panels (PART 2)		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
231	0000-109-PVE-W-014			Type Test Reports for Bus Duct		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
232	0000-109-PVE-W-016			Type Test Reports for Local Starters		A	D	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
233	0000-109-PVE-W-018			Type Test Procedure for HT Imported Motors.		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
234	0000-109-PVE-W-020			Type test reports (90 kW LT motors- Mist Eleiminator)		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
235	0000-109-PVE-W-021			Type test reports for Receptacles and Junction boxes		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
236	0000-109-PVE-W-022			Type test reports (55 kW LT motors-Compressor)		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
237	0000-109-PVE-W-023			Type test reports (75 kW & 55 kW LT motors-MH)		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
238	0000-109-PVE-Y-001			Datasheet, GA and curves for LT Motors (FURTHER BREAK UP NECESSARY)		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,	164	14
239	0000-109-PVE-Y-002			Datasheet for Power cable		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	337	187
240	0000-109-PVE-Y-003			Datasheet for Control cable		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	337	187

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241	0000-109-PVE-Y-004			Datasheet for Control cable Additional Sizes (24Cx1.5 sqmm control cables)		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	524	374
242	0000-109-PVE-Y-005			Data sheet & layout of Bus-duct		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	475	325
243	0000-109-PVE-Y-006			Datasheet, GA and curves for LT Motors (Part II) - Agitator Motors		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	164	14
244	0000-109-PVE-Y-007			Datasheet, GA and curves for LT Motors (Part III) ¿ GGH Main Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,	164	14
245	0000-109-PVE-Y-008			Datasheet, GA and curves for LT Motors (Part IV) ¿ Clear water Pump Motor		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,	164	14
246	0000-109-PVE-Y-009			Datasheet, GA and curves for LT Motors (Part V) ¿ GGH Aux. Motors		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,	164	14
247	0000-109-PVE-Y-010			Datasheet, GA and curves for LT Motors (Part VI) ¿ GGH Aux. Motors.		A	B	FGD	MISCELLANEOUS	PE-Electrical	PE-Mech/SG,Kuntal Bhuiyan,	164	14
248	0000-109-PVE-Y-011			Datasheet, GA and curves for LT Motors (Part VII) ¿ MH Motors		A	B	FGD	MISCELLANEOUS	PE-Electrical	Kuntal Bhuiyan,PE-Mech/MH,	164	14
249	0000-109-PVE-Y-020			Datasheet for Power cable of Additional Sizes (3.5Cx50 sqmm power cables)		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	524	374
250	0000-109-PVE-Y-050			Datasheet for Earthing & Lightning Materials		A	B	FGD	MISCELLANEOUS	PE-Electrical	-,	524	374
251	0000-109-PVI-B-001			GA, BOQ & Data sheets for PLC Panels		I	B	FGD	MISCELLANEOUS	PE-C&I	-,	322	172
252	0000-109-PVI-B-002			PLC Power supply and earthing scheme drawing		I	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,PE-Electrical,	322	172
253	0000-109-PVI-B-003			PLC Module wiring diagram		I	B	FGD	MISCELLANEOUS	PE-C&I	-,	322	172
254	0000-109-PVI-B-004			Drawing & Datasheet of Rotameter		I	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	164	14
255	0000-109-PVI-B-005			Drawing & Datasheet of LIE/LIR		I	B	FGD	MISCELLANEOUS	PE-C&I	-,	164	14
256	0000-109-PVI-B-006			Drawing & datasheet of Radar type Level Transmitter (for Silo)		I	B	FGD	MISCELLANEOUS	PE-C&I	-,	164	14
257	0000-109-PVI-B-007			GA, Datasheet and Wiring diagram of Lime Dosing Local Control Panel		I	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,PE-Electrical,	164	14
258	0000-109-PVI-B-008			GA and Wiring Oxidation Blower Local Control Panel		I	B	FGD	MISCELLANEOUS	PE-Electrical	PE-C&I,Kuntal Bhuiyan,	164	14
259	0000-109-PVI-B-009			GA and Wiring Diagram Drawing for GGH-Multimedia Cleaner PLC Panel		I	B	FGD	MISCELLANEOUS	PE-C&I	PE-Electrical,	164	14
260	0000-109-PVI-F-001			Electronic Earthing Layout Drawing for FGD Control Room		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-Electrical,	257	107
261	0000-109-PVI-G-001			Instrument list		I	A	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	194	44
262	0000-109-PVI-G-002			I/O List		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	257	107
263	0000-109-PVI-G-003			Drive List		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	257	107
264	0000-109-PVI-G-004			Alarm & Trip Set Point List		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	257	107
265	0000-109-PVI-H-001			Cable Schedule for power, control & instrument cables.		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	297	147
266	0000-109-PVI-P-001			Control system configuration diagrams and Write up		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	235	85
267	0000-109-PVI-P-002			Interfacing and connectivity diagram with the Employer system		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	264	114
268	0000-109-PVI-P-009			CONTROL SYSTEM ARCHITECTURE of FGD System		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-Mech/SG,	265	115
269	0000-109-PVI-Q-001			Installation Scheme, Instrument wiring and tubing diagrams (hook up)		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	322	172
270	0000-109-PVI-T-001			Block logic diagrams with Sequence and protection interlock schemes		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	272	122
271	0000-109-PVI-T-002			Logic Diagram for Sequence and Interlocking (AS IMPLEMENTED IN PLC)		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	272	122
272	0000-109-PVI-U-007			Document for Sizing of UPS and Battery		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	166	16
273	0000-109-PVI-U-008			Document for Sizing of charger and Battery		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	164	14
274	0000-109-PVI-V-001			PLC Graphics and Mimics		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	164	14

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275	0000-109-PVI-V-002			PLC Hardware design specification		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	164	14
276	0000-109-PVI-V-003			PLC software design specification		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	164	14
277	0000-109-PVI-W-001			ATST Procedure - FGD System		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	268	118
278	0000-109-PVI-W-003			Type Test Report of PLC System		I	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	322	172
279	0000-109-PVI-W-004			Type Test Report of Battery and Charger		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	514	364
280	0000-109-PVI-W-006			Cable list of UPS and Charger		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	315	165
281	0000-109-PVI-W-007			Type Test report for Cable		I	B	FGD	MISCELLANEOUS	PE-C&I	-,	531	381
282	0000-109-PVI-W-008			FUNCTION CONTROL DESCRIPTION FOR FLUE GAS PATH SYSTEM		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/SG,PE-Mech/SG,	285	135
283	0000-109-PVI-W-009			FUNCTION CONTROL DESCRIPTION FOR ABOSRBER / OXIDATION BLOWER SYSTEM		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-C&I,PE-Mech/SG,PE-Mech/SG,	285	135
284	0000-109-PVI-W-010			FUNCTION CONTROL DESCRIPTION FOR LIMESTONE PREPARATION		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/SG,	285	135
285	0000-109-PVI-W-011			FUNCTION CONTROL DESCRIPTION FOR PRIMARY DEWATERING		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-C&I,PE-Mech/SG,PE-Mech/SG,	285	135
286	0000-109-PVI-W-012			FUNCTION CONTROL DESCRIPTION FOR SUMP PUMPS		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-C&I,PE-Mech/SG,PE-C&I,	285	135
287	0000-109-PVI-W-013			FUNCTION CONTROL DESCRIPTION FOR GYPSUM CONVEYORS		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/MH,PE-Mech/MH,	285	135
288	0000-109-PVI-W-014			Functional Control Description of Secondary Dewatering System		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-C&I,PE-Mech/SG,PE-Mech/SG,	285	135
289	0000-109-PVI-W-015			Functional Control Description of Process & Cooling Water System		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/SG,	285	135
290	0000-109-PVI-W-016			Functional Control Description of Belt Filter		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-C&I,PE-Mech/SG,PE-Mech/SG,PE-Mech/MH,	285	135
291	0000-109-PVI-W-017			FCD for Overview Control Description		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	285	135
292	0000-109-PVI-W-018			Mandatory Spare List for Instruments		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	285	135
293	0000-109-PVI-W-019			Logic diagram of FGD interface with boiler such as Booster Fan Blade Pitch Control, FGD bypass damper control, FGD Inlet and outlet gate control (Interlock & Control)		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-Mech/SG,	285	135
294	0000-109-PVI-W-020			FCD for Limestone Handling System		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/MH,	285	135
295	0000-109-PVI-W-021			LIE/LIR & JB Grouping		I	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	285	135
296	0000-109-PVI-W-022			Instruments location drawing/layout		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	285	135
297	0000-109-PVI-W-023			Pre-ATST report-FGD system		I	D	FGD	MISCELLANEOUS	PE-C&I	-,	285	135
298	0000-109-PVI-Y-001			Data sheets for Instrumentation and control Cable.		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	531	381
299	0000-109-PVI-Y-007			Data sheets for UPS, Sizing of UPS and Battery		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	317	167
300	0000-109-PVI-Y-008			Data sheets for Battery Charger and sizing of charger and Battery		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	507	357
301	0000-109-PVI-Y-009			Data Sheet/Drawing for SO2 Analyser		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	455	305
302	0000-109-PVI-Y-010			Data Sheet/Drawing for pH Analyser		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	455	305
303	0000-109-PVI-Y-011			Datasheet/Drawing for Junction Box		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	337	187
304	0000-109-PVI-Y-012			Data Sheet of Operator Desk and Computer furniture		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	322	172
305	0000-109-PVI-Y-013			Datasheet for Optical Fiber Cable		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	337	187
306	0000-109-PVI-Y-014			Datasheet/Drawing for RTD -TT- JB		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	337	187
307	0000-109-PVI-Y-015			Datasheet of Electronic Transmitter		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	303	153
308	0000-109-PVI-Y-016			Datasheet & GA Drawing of Pressure Gauge, Chemical Seal Pressure Gauge		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
309	0000-109-PVI-Y-017			Datasheet & GA Drawing of Temperature Gauge		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
310	0000-109-PVI-Y-018			Datasheet & GA Drawing of Level Gauge with scale & Reflex type Level Gauge		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358

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311	0000-109-PVI-Y-019			Datasheet & GA Drawing of Pressure Switch & DP Switch		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
312	0000-109-PVI-Y-020			Datasheet & GA Drawing of RTD with Thermowell		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
313	0000-109-PVI-Y-021			Datasheet & GA Drawing of Pressure Transmitter & Chemical Seal Pressure Transmitter		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	508	358
314	0000-109-PVI-Y-022			Datasheet & GA Drawing of Temperature Transmitter		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
315	0000-109-PVI-Y-023			Datasheet & GA Drawing of Ultrasonic Level Transmitter		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
316	0000-109-PVI-Y-024			Datasheet & GA Drawing of DP type Level Transmitter		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	508	358
317	0000-109-PVI-Y-025			Datasheet & GA Drawing of Magnetic Flow Meter		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
318	0000-109-PVI-Y-026			Datasheet & GA Drawing of Coriolis Density Meter		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
319	0000-109-PVI-Y-027			Datasheet & GA Drawing of DP type Flow Transmitter for Water		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	508	358
320	0000-109-PVI-Y-028			Datasheet & GA Drawing of DP type Flow Transmitter for Flue Gas & Air		A	B	FGD	MISCELLANEOUS	PE-C&I	-,	508	358
321	0000-109-PVI-Y-029			Datasheet & GA Drawing of Vibration Transmitter		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
322	0000-109-PVI-Y-030			Datasheet & GA Drawing of GI Conduit		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
323	0000-109-PVI-Y-031			Drawing and Datasheet for Universal HART Communicator		A	B	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
324	0000-109-PVI-Y-032			DATA SHEET / BOM / GA / SCHEMATIC / SAMPLING DRG FOR SOX/NOX/CO2/CO ANALYZERS AND ASSOCIATED SYSTEM OF CEMS		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
325	0000-109-PVI-Y-033			DATA SHEET / BOM / GA / SCHEMATIC / SAMPLING DRG FOR DUST DENSITY/SPM ANALYSER AND ASSOCIATED SYSTEM OF CEMS		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
326	0000-109-PVI-Y-034			DATA SHEET / BOM / GA / SCHEMATIC / SAMPLING DRG FOR MERCURY ANALYSER AND ASSOCIATED SYSTEM OF CEMS		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
327	0000-109-PVI-Y-035			DATA SHEET / BOM / GA / SCHEMATIC / SAMPLING DRG FOR FLUE GAS FLOWMETER AND ASSOCIATED SYSTEM OF CEMS		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
328	0000-109-PVI-Y-036			SCHEMATIC DRAWING SHOWING INTERFACING OF CEMS ANALYSERS WITH DDCMIS AND CLOUD SERVER		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
329	0000-109-PVI-Y-037			GA OF CHIMNEY INDICAING SAMPLING PORT/ TAPPINGS FOR FLUE GAS ANALYSERS (CEMS MEASUREMENTS)		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
330	0000-109-PVI-Y-038			Commissioning procedure/manual for CEMS.		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
331	0000-109-PVI-Y-039			O&M manual for CEMS.		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
332	0000-109-PVI-Y-040			Erection drawing including erection procedure for CEMS		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
333	0000-109-PVI-Y-041			Datasheet of analyser for ZLD system		A	D	FGD	MISCELLANEOUS	PE-C&I	PE-C&I,	508	358
334	0000-109-PVM-B-001			General Arrangement drawing of Elevator		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	272	122

S. No.	NTPC_DRG_NO	Rev_drg_no_for_inouhse_drg	TO_BE_SHIFTED_TO_PACKAGE	DRG_TITLE	PROJECT_SPECIFC_INFORMATION	DRG_PURPOSE	DRG_TYPE	AREA	MILESTONE	CUSTODIAN	REVIEWERS	SUB_FROM_MP_AWARD	SUB_FROM_FGD_AWARD
335	0000-109-PVM-B-002			General Arrangement & Data Sheet of Mill Hydro Cyclone		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,	308	158
336	0000-109-PVM-B-003			General Arrangement of Mill circuit Tank		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-C&I,PE-Civil,	317	167
337	0000-109-PVM-B-004			General Arrangement of Limestone Pulverizer(Wet ball Mill)		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	259	109
338	0000-109-PVM-B-005			General Arrangement for Cake wash Water Tank		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	257	107
339	0000-109-PVM-B-006			General Arrangement for Cake wash Pump		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,PE-Electrical,	257	107
340	0000-109-PVM-B-009			General Arrangement of GGH and Its auxiliries		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,	237	87
341	0000-109-PVM-B-010			General Arrangement for Absorber		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,PE-Electrical,	181	31
342	0000-109-PVM-B-011			General Arrangement for Slurry Recirculation Pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	230	80
343	0000-109-PVM-B-012			General Arrangement for Oxidation Air Blower		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	251	101
344	0000-109-PVM-B-013			General Arrangement for Gypsum Dewatering Pump(Gypsum Bleed Pump)		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	250	100
345	0000-109-PVM-B-014			General Arrangement for Limestone slurry pumps		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	250	100
346	0000-109-PVM-B-015			General Arrangement of Limestone slurry storage tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	217	67
347	0000-109-PVM-B-016			General Arrangement of Secondary Hydro-cyclone Feed Tank		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	217	67
348	0000-109-PVM-B-017			General Arrangement of Secondary Hydro-cyclone Pumps		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	264	114
349	0000-109-PVM-B-018			General Arrangement & Data Sheet of Mill Recycle Pump		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	308	158
350	0000-109-PVM-B-020			GA of Primary Dewaterng Hydorcyclone		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,	250	100
351	0000-109-PVM-B-021			General Arrangement of Limestone Day Silos		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,PE-Mech/MH,PE-Mech/MH,	292	142
352	0000-109-PVM-B-022			General Arrangement of Vacuum Belt filters		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Mech/MH,PE-Mech/MH,PE-Electrical,	268	118

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353	0000-109-PVM-B-023			General Arrangement of Filtrate Water Tank		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	217	67
354	0000-109-PVM-B-024			General Arrangement of Filtrate Water Pumps		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	257	107
355	0000-109-PVM-B-025			General Arrangement OF Emergency Quench Water Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	224	74
356	0000-109-PVM-B-026			General Arrangement of Secondary Hydrocyclone		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,	250	100
357	0000-109-PVM-B-027			General Arrangement of Waste Water Tank		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	217	67
358	0000-109-PVM-B-028			General Arrangement of Waste Water Pumps		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	264	114
359	0000-109-PVM-B-029			General Arrangement of Process (Make up) Water Tank		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	217	67
360	0000-109-PVM-B-030			General Arrangement of Water Pump		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Civil,PE-Electrical,	243	93
361	0000-109-PVM-B-031			General Arrangement of Auxiliary Absorbent (Storage) Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	224	74
362	0000-109-PVM-B-032			General Arrangement of Auxiliary Absorbent (Storage Return) Pump		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	250	100
363	0000-109-PVM-B-033			General Arrangement of Expansion Joints		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	269	119
364	0000-109-PVM-B-034			General Arrangement of Agitator for Absorber Reaction Tank		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,PE-Electrical,	308	158
365	0000-109-PVM-B-035			General Arrangement Bag Filter for Limestone Day Silos		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	278	128
366	0000-109-PVM-B-036			Arrangement of Stairs and Platforms - Absorber		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,	236	86
367	0000-109-PVM-B-037			General Arrangement for Booster fan		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,	223	73
368	0000-109-PVM-B-038			GA & Datasheet for Pipe Expansion Joint		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	551	401
369	0000-109-PVM-B-042			GA of Instrument air receiver		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,PE-Mech/WS,	306	156
370	0000-109-PVM-B-043			GA of Service air receiver		I	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,PE-Mech/WS,	306	156
371	0000-109-PVM-B-045			General arrangement of Recycle Pump & Oxidation Blower Building		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-C&I,PE-Civil,PE-Electrical,Architecture,	265	115

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372	0000-109-PVM-B-046			General arrangement of Dewatering building		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,Architecture,PE-Mech/WS,	258	108
373	0000-109-PVM-B-047			General arrangement of Ball Mill Building		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,Architecture,PE-Mech/WS,PE-Civil,PE-C&I,	271	121
374	0000-109-PVM-B-049			General Layout of FGD Ducting		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Civil,	322	172
375	0000-109-PVM-B-050			General Layout of Pipe rack/trestle & Cable ways		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,PE-Electrical,	292	142
376	0000-109-PVM-B-056			General Arrangement & Data sheet of Waste Water Tank Agitator		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
377	0000-109-PVM-B-057			General Arrangement & Data Sheet of Mill Tank Agitator		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
378	0000-109-PVM-B-058			General Arrangement & Data Sheet of Limestone Weigh Feeder		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/MH,PE-C&I,	292	142
379	0000-109-PVM-B-059			Documents for Seal Air System of Guillotine Damper		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,	292	142
380	0000-109-PVM-B-060			GA & Data Sheet for Air Cannon		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,	292	142
381	0000-109-PVM-B-066			GA & Data Sheet for Butterfly Valves		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/MH,PE-C&I,PE-Electrical,	292	142
382	0000-109-PVM-B-067			GA & Data Sheet for GLOBE VALVES		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
383	0000-109-PVM-B-068			GA & Data Sheet for BALL VALVES		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,	292	142
384	0000-109-PVM-B-069			GA & Data Sheet for GATE VALVES		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
385	0000-109-PVM-B-070			GA & Data Sheet for CHECK VALVES		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/MH,	292	142
386	0000-109-PVM-B-071			GA & Data sheet for Control Valves (including ceramic ball control valves)		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/MH,PE-C&I,PE-Electrical,	292	142
387	0000-109-PVM-B-072			GA Drawing & Datasheet of 12T Hoist for Ball Mill Building		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	292	142
388	0000-109-PVM-B-073			GA & Datasheet of 25T Hoist		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,PE-Mech/MH,	292	142
389	0000-109-PVM-B-074			GA & Datasheet of Condensate System of Chimney		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/WS	306	156
390	0000-109-PVM-F-001			P&ID- Flue Gas Ducting and Dampers System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
391	0000-109-PVM-F-002			P&ID- Booster fan Lube oil system		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
392	0000-109-PVM-F-003			P&ID - GGH and its auxiliaries		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
393	0000-109-PVM-F-004			P&ID - Absorber		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
394	0000-109-PVM-F-005			P&ID - Recycle Pumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
395	0000-109-PVM-F-006			P&ID - Gypsum Bleed Pumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
396	0000-109-PVM-F-007			P&ID - Mist Eliminator Wash Water System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49

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397	0000-109-PVM-F-008			P&ID - Absorber area Sumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
398	0000-109-PVM-F-009			P&ID - Auxiliary Storage Tank & Pumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
399	0000-109-PVM-F-010			P&ID - Oxidation Air Blower system		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
400	0000-109-PVM-F-011			P&ID - Primary Dewatering System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
401	0000-109-PVM-F-012			P&ID - Dewatering area sump & pump		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
402	0000-109-PVM-F-013			P&ID - Secondary Dewatering System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-Mech/MH,PE-C&I,	199	49
403	0000-109-PVM-F-014			P&ID - Waste Water Discharge System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
404	0000-109-PVM-F-015			P&ID - Filtrate Water System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
405	0000-109-PVM-F-016			P&ID - Limestone Silo		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
406	0000-109-PVM-F-017			P&ID - Reagent Preparation System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
407	0000-109-PVM-F-018			P&ID - Reagent Feed Tank and Pumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
408	0000-109-PVM-F-019			P&ID - Reagent Preparation area Sump & Pump		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
409	0000-109-PVM-F-020			P&ID - Make up Water Booster Pumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
410	0000-109-PVM-F-021			P&ID - Process (Make up) Water Tank & Pumps		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
411	0000-109-PVM-F-022			P&ID - Emergency Quench system		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
412	0000-109-PVM-F-023			P&ID - Water Distribution		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
413	0000-109-PVM-F-024			P&ID - Air Distribution		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
414	0000-109-PVM-F-025			P&ID - Legends & Notes		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
415	0000-109-PVM-F-026			P&ID - Neutralisation Tank		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
416	0000-109-PVM-F-027			P&ID - Cooling Water Distribution		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
417	0000-109-PVM-F-028			P&ID - Oxidation Blower		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
418	0000-109-PVM-F-029			P&ID of Vacuum Belt filter & Primary Hydrocyclone		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
419	0000-109-PVM-F-030			P&ID for Limestone Pulverizer-Wet Ball Mill Lubrication system		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
420	0000-109-PVM-F-031			P&ID for Compressed Air System for Bag Filter Pulsing		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	199	49
421	0000-109-PVM-F-044			Plant Layout of FGD System - Sheet 1		A	-	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Civil,PE-Mech/Layout,PE-C&I,PE-Electrical,PE-Mech/SG,PE-Mech/MH,PE-Mech/MH,PE-Civil,	160	10

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422	0000-109-PVM-F-045			Plant Layout of FGD System - Sheet 2		A	-	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Civil,PE-Mech/Layout,PE-C&I,PE-Electrical,PE-Mech/SG,PE-Civil,PE-Mech/MH,PE-Mech/MH,	160	10
423	0000-109-PVM-H-001			Painting schedule of FGD System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Civil,PE-Civil,PE-Mech/MH,PE-Electrical,	222	72
424	0000-109-PVM-H-002			Valve Schedules		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,	271	121
425	0000-109-PVM-H-003			Pipe Schedule		I	D	FGD	MISCELLANEOUS	PE-MECH	PE-Mech/SG,PE-C&I,PE-Electrical,	292	142
426	0000-109-PVM-H-004			Insulation Schedule		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	272	122
427	0000-109-PVM-H-005			Expansion Joint Schedule		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	272	122
428	0000-109-PVM-L-001			Process Flow Diagram of FGD System		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,	160	10
429	0000-109-PVM-L-038			General Arrangement for Piping - FGD area (Absorber, Recycle Pump, GGH & Aux storage tank area etc)		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,	292	142
430	0000-109-PVM-L-039			General Arrangement for Piping - Lime Preparation Area (Ball Mill & Lime handling area etc)		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,	292	142
431	0000-109-PVM-L-040			General Arrangement for Piping - Dewatering area (Beltfilter and Hydrocyclone area etc)		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/Layout,PE-Civil,	290	140
432	0000-109-PVM-N-001			Performance Curve for BOOSTER FANS		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	223	73
433	0000-109-PVM-R-002			Oxidation Blower - Sub QR documents of M/s ITO, Japan		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
434	0000-109-PVM-R-004			Wet Limestone Grinding Mills (Ball Mills) - Sub QR documents of M/s Thysencrupp, Germany		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
435	0000-109-PVM-R-005			Recirculation Slurry Pump - Sub QR documents of M/s DUCHTING PUMPEN, GERMANY		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
436	0000-109-PVM-R-006			Booster Fan - Sub QR documents of M/s Solyvent Flakt AB, Sweden		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
437	0000-109-PVM-R-007			Slurry Pump - Sub QR documents of M/s Duchting Pumpen, Germany		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
438	0000-109-PVM-R-008			Wet Limestone Grinding Mills (Ball Mills) - Sub QR documents of M/s Metso, USA		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
439	0000-109-PVM-R-009			Agitators - Sub QR documents of M/s EKATO RMT GMBH. Germany		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
440	0000-109-PVM-R-010			Vaccume Belt Filters - Sub QR documents of M/s Shanghai Xuhe Environmental Technology Co. Ltd., Shanghai, China		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
441	0000-109-PVM-R-012			Vaccume Belt Filters - Sub QR documents of M/s FLSmidth, USA		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
442	0000-109-PVM-R-013			Agitators - Sub QR documents of M/s Zhejiang Greatwall Reducer Mfg Co. Ltd.		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
443	0000-109-PVM-R-014			Gas to Gas Heat Exchanger (GGH) - Sub QR documents		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
444	0000-109-PVM-R-015			Slurry Pump - Sub QR documents of M/s Weir Minerals, USA		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
445	0000-109-PVM-R-016			Slurry Pump - Sub QR documents of M/s Sam Turbo Industries Pvt. Ltd., Koimbatoor		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46

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446	0000-109-PVM-R-017			Booster Fan - Sub QR documents of M/s Suewon Poongryuk Machinery Co. Ltd, Korea		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
447	0000-109-PVM-R-018			Wet Limestone Grinding Mills (Ball Mills) - Sub QR documents of M/s Cemtec, Austria		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
448	0000-109-PVM-R-019			Wet Limestone Grinding Mills (Ball Mills) - Sub QR documents of M/s Christian Pfeiffer Maschinenfabrik¿ Austria		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
449	0000-109-PVM-R-020			Oxidation Air Blower - Sub QR documents of /s Siemens Turbo Machinery / HV Turbo		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
450	0000-109-PVM-U-001			FGD System Design Basis - PROCESS		A	-	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	160	10
451	0000-109-PVM-U-002			Flue gas system design and Duct Sizing Calculation		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	187	37
452	0000-109-PVM-U-003			ABSORBER DESIGN BASIS		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	181	31
453	0000-109-PVM-U-004			Sizing Calculation & Selection parameter for GGH		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	223	73
454	0000-109-PVM-U-005			Sizing Calculation & Selection parameter for Slurry Recirculation Pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	223	73
455	0000-109-PVM-U-006			Sizing Calculation & Selection parameter for Oxidation Air Blower		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	251	101
456	0000-109-PVM-U-007			Sizing Calculation& Selection paramete for Emergency Quench Water System		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
457	0000-109-PVM-U-008			Sizing Calculation & Selection parameter for all slurry pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	264	114
458	0000-109-PVM-U-009			Sizing Calculation & Selection parameter for all slurry tanks		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
459	0000-109-PVM-U-011			Sizing Calculation& Selection parameter for Wet ball Mill including Motor sizing calculation for Ball Mill		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	315	165
460	0000-109-PVM-U-012			Sizing Calculation & Selection parameter for Vacuum Belt filters		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	237	87
461	0000-109-PVM-U-014			Sizing Calculation & Selection parameter for all Water Pump		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	257	107
462	0000-109-PVM-U-015			Sizing Calculation of Limestone day silo		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	195	45
463	0000-109-PVM-U-016			Sizing Calculation & Selection parameter for BOOSTER FANS		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	223	73
464	0000-109-PVM-U-017			Sizing Calculation & Selection parameter for Sump pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	263	113
465	0000-109-PVM-U-018			Sizing calculation of Instrument air receiver		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	171	21
466	0000-109-PVM-U-019			Sizing calculation of Service air receiver		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	171	21
467	0000-109-PVM-U-020			FGD System Design Basis -MECHANICAL		I	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	202	52
468	0000-109-PVM-U-021			Sizing Calculation for Secondary Hydro-cyclone		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	250	100
469	0000-109-PVM-U-022			Design basis (Heat load calculation) for HVAC system		A	D	FGD	MISCELLANEOUS	PE-Mech/WS	PE-Mech/SG,PE-Mech/SG,	292	142
470	0000-109-PVM-U-024			Sizing Calculation& Selection parameter for Limestone Pulverizer(Wet ball Mill) auxiliaries		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	315	165
471	0000-109-PVM-U-027			Structural Design Basis - Mechanical (Ducts, Silos, Tanks)		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	-,	160	10
472	0000-109-PVM-U-028			DESIGN CRITERIA OF ABSORBER TOWER		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	160	10
473	0000-109-PVM-U-029			Quench Sizing Calculation & Selection Parameter		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	160	10
474	0000-109-PVM-U-030			Condensate Study for Low Height Chimney		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	230	80

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475	0000-109-PVM-W-001			Selection of Material and Application Procedure for FGD plant		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	196	46
476	0000-109-PVM-W-002			Mass Flow Balance (Design Points) data		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	160	10
477	0000-109-PVM-W-003			Mass Flow Balance (Guarantee Points) data		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	160	10
478	0000-109-PVM-W-005			Write-up on & Selection of valves for slurry application		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	186	36
479	0000-109-PVM-W-006			Requirements of Instrument air, Service air, Auxiliary steam, Equipment cooling water, etc.. (Utility List)		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/WS,Navneet Kumar,Nipun Pharlia,Apurva Srivastava,	271	121
480	0000-109-PVM-W-008			Predicted Performance of FGD System at a) Design Point & b) Guarantee point		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	340	190
481	0000-109-PVM-W-010			Performance test procedure		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	340	190
482	0000-109-PVM-W-011			Type test procedure for Gates & Dampers		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	271	121
483	0000-109-PVM-W-012			Type Test Performance Procedure for BOOSTER FANS		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	230	80
484	0000-109-PVM-W-013			Type Test Performance Report for BOOSTER FANS		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	250	100
485	0000-109-PVM-W-014			Surface preparation & application procedure for Flake glass lining		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
486	0000-109-PVM-W-015			Surface preparation & application procedure for Rubber lining		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
487	0000-109-PVM-W-016			Leak tightness performance test Report of damper/gates		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
488	0000-109-PVM-W-017			Battery Limits- FGD (to take care all interfaces points among NTPC & Vendor WITH all detail views at terminal points)		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-Electrical,PE-Mech/Layout,Navneet Kumar,	292	142
489	0000-109-PVM-W-018			DOCUMENT FOR COLOUR CODING STANDARD		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-Mech/MH,	292	142
490	0000-109-PVM-W-019			DOCUMENT FOR Type Test Report of Dampers		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
491	0000-109-PVM-W-020			Write up on Equipment Handling		I	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	292	142
492	0000-109-PVM-X-001			O & M MANUAL		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-C&I,PE-C&I,PE-Electrical,	341	191
493	0000-109-PVM-Y-001			Data Sheet for Absorber		A	A	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	214	64
494	0000-109-PVM-Y-002			Data Sheet for Booster fans		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	230	80
495	0000-109-PVM-Y-003			Data Sheet for Agitators for Limestone slurry Storage Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	271	121
496	0000-109-PVM-Y-004			Data Sheet for Agitators for Secondary Hydroclone feed tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	271	121
497	0000-109-PVM-Y-005			Data Sheet for Agitators for Auxiliary Absorbent Tank		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	271	121
498	0000-109-PVM-Y-006			Data Sheet for Elevator		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	272	122
499	0000-109-PVM-Y-007			Data Sheet for GGH and auxiliaries		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	237	87
500	0000-109-PVM-Y-008			Data Sheet for Mist Eliminator		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	264	114
501	0000-109-PVM-Y-009			Data Sheet for Spray Nozzles		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	230	80
502	0000-109-PVM-Y-011			Data Sheet for Slurry Recirculation Pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	251	101

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503	0000-109-PVM-Y-012			Data Sheet for Oxidation Air Blower		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	251	101
504	0000-109-PVM-Y-014			Data Sheet for Gypsum Dewatering Pump (Bleed Pumps)		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	250	100
505	0000-109-PVM-Y-015			Data Sheet for Limestone slurry pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	250	100
506	0000-109-PVM-Y-016			Data Sheet for Limestone slurry storage Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	217	67
507	0000-109-PVM-Y-017			Data Sheet for Wet ball mill		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	257	107
508	0000-109-PVM-Y-018			Data sheet for Insulation material		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	336	186
509	0000-109-PVM-Y-019			Data sheet for Guillotine gate including sealing system		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	271	121
510	0000-109-PVM-Y-020			Data sheet/Vendor catalogue for Flake glass lining		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	336	186
511	0000-109-PVM-Y-021			Data sheet//Vendor catalogue for Rubber lining		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	332	182
512	0000-109-PVM-Y-022			Data sheet of Agitators for Sumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,	271	121
513	0000-109-PVM-Y-023			Data sheet of Agitators for Filtrate water tank		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	271	121
514	0000-109-PVM-Y-025			Data sheet of Limestone Day SILO		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	229	79
515	0000-109-PVM-Y-026			Data sheet of HOISTS/handling system		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	320	170
516	0000-109-PVM-Y-027			SIZING CALCULATION & SELECTION PARAMETER FOR PRIMARY DEWATERING HYDROCYCLONE		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	250	100
517	0000-109-PVM-Y-028			Data Sheet for Auxiliary Storage Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	250	100
518	0000-109-PVM-Y-029			Data Sheet for Vacuum Belt filters and its auxiliries		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	278	128
519	0000-109-PVM-Y-030			Data Sheet for Filtrate Water Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	252	102
520	0000-109-PVM-Y-031			Data Sheet for Filtrate Water Pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	257	107
521	0000-109-PVM-Y-032			Data Sheet for Secondary Hydro-cyclone Feed Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	245	95
522	0000-109-PVM-Y-033			Data Sheet for Secondary Hydro-cyclone Pump		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	264	114
523	0000-109-PVM-Y-034			Data Sheet for Secondary Hydrocyclone		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	264	114
524	0000-109-PVM-Y-035			Data Sheet for Waste Water Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	252	102
525	0000-109-PVM-Y-036			Data Sheet for Waste Water Pump		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	264	114
526	0000-109-PVM-Y-037			General Arrangement & Data Sheet of Lime Dosing System		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	229	79
527	0000-109-PVM-Y-038			Data Sheet for Process Water Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	252	102
528	0000-109-PVM-Y-039			Data Sheet for Water Pump		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,	257	107
529	0000-109-PVM-Y-042			Data Sheet for Auxiliary Absorbent Pump		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	250	100
530	0000-109-PVM-Y-044			Data Sheet for Sump Pumps		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	264	114

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531	0000-109-PVM-Y-045			Data Sheet for Expansion Joints		A	B	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,	258	108
532	0000-109-PVM-Y-046			Data Sheet for HVAC system		A	B	FGD	MISCELLANEOUS	PE-Mech/WS	PE-Mech/SG,PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	337	187
533	0000-109-PVM-Y-047			Data Sheet for Emergency Quench Tank		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Electrical,PE-C&I,PE-C&I,	250	100
534	0000-109-PVM-Y-048			Data Sheet for PIPES		A	D	FGD	MISCELLANEOUS	PE-Mech/SG	PE-Mech/SG,PE-Mech/MH,	250	100
535	0000-109-QVC-G-001			Field Quality Plan for civil work		A	D	FGD	MISCELLANEOUS	QA	QA	223	73
536	0000-109-QVC-G-002			Field Quality Plan for structural work		A	D	FGD	MISCELLANEOUS	QA	QA	233	83
537	0000-109-QVC-Q-001			MQP for gratings		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
538	0000-109-QVC-Q-002			MQP for colour coated cladding sheet		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
539	0000-109-QVC-Q-003			MQP for colour coated decking sheet		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
540	0000-109-QVC-Q-056			MQP for Vibration Isolation System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
541	0000-109-QVC-Q-080			MQP for Structural Fabrication		A		FGD		QA-Civil	QA-Civil		
542	0000-109-QVC-Q-082			MQP for Chimney Elevator		A		FGD		QA-Civil	QA-Civil		
543	0000-109-QVE-G-001			Field Quality Plan for Electrical Work		A	D	FGD	MISCELLANEOUS	QA	QA	322	172
544	0000-109-QVE-G-002			Field Quality Plan for Fire Sealing System		A				QA-Elect	QA-Elect		
545	0000-109-QVE-Q-001			MQP for cable tray		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
546	0000-109-QVE-Q-002			MQP for LV bus duct		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
547	0000-109-QVE-Q-003			MQP for MCC		A	B	FGD	MISCELLANEOUS	QA	QA	266	116
548	0000-109-QVE-Q-004			MQP for PDB, JB, LPBS, MLDB, SLDB, DCDB & ACDB		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
549	0000-109-QVE-Q-006			MQP of Flexible Cable Tray Supporting System		A	D	FGD	MISCELLANEOUS	QA	QA	171	21
550	0000-109-QVE-Q-007			MQP for Power Cables		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
551	0000-109-QVE-Q-008			MQP for Control & Instrumentation Cables		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
552	0000-109-QVE-Q-009			MQP for HT Motor for Booster fan		A	B	FGD	MISCELLANEOUS	QA	QA	286	136
553	0000-109-QVE-Q-010			MQP for HT Motor for other than Booster fan (QAP FOR BALL MILL MOTOR)		A	B	FGD	MISCELLANEOUS	QA	QA	317	167
554	0000-109-QVE-Q-011			MQP for LT Motor		A	B	FGD	MISCELLANEOUS	QA	QA	322	172
555	0000-109-QVE-Q-012			MQP for Lighting Transformer		A	B	FGD	MISCELLANEOUS	QA	QA	336	186
556	0000-109-QVE-Q-013			MQP for elevators		A	B	FGD	MISCELLANEOUS	QA	QA	259	109
557	0000-109-QVE-Q-014			MQP for VFD		A	B	FGD	MISCELLANEOUS	QA	QA	322	172
558	0000-109-QVE-Q-015			MQP for Geared Motor		A	B	FGD	MISCELLANEOUS	QA	QA	322	172
559	0000-109-QVE-Q-020			MQP for HT Cables		A				QA-Elect	QA-Elect		
560	0000-109-QVE-Q-021			MQP for Battery Charger (220/110 V)		A				QA-Elect	QA-Elect		
561	0000-109-QVE-Q-022			MQP for HT Switchgear		A				QA-Elect	QA-Elect		
562	0000-109-QVE-Q-023			MQP for Elect. Actuator		A				QA-Elect	QA-Elect		
563	0000-109-QVE-Q-024			MQP for DG Set		A				QA-Elect	QA-Elect		
564	0000-109-QVE-Q-025			MQP for Oil Filled Transformer		A				QA-Elect	QA-Elect		
565	0000-109-QVE-Q-051			MQP for Suspended Magnets		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
566	0000-109-QVE-Q-052			MQP for Belt Weigher		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
567	0000-109-QVE-Q-053			MQP for Metal Detector		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
568	0000-109-QVE-Q-054			MQP for Magnetic Separator		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
569	0000-109-QVE-Q-055			MQP of HT Motor (Imported)		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
570	0000-109-QVE-Q-056			MQP of LT Motor FOR AIR COMPRESSOR (ABB MAKE)		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
571	0000-109-QVE-Q-057			MQP FOR BOOSTER FAN CABLES		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
572	0000-109-QVI-G-001			FQP for Instrumentation work		A	D	FGD	MISCELLANEOUS	QA	QA	322	172
573	0000-109-QVI-Q-001			MQP for SO2 analyzer		A	B	FGD	MISCELLANEOUS	QA	QA	292	142
574	0000-109-QVI-Q-002			MQP for pressure switch / DP switch		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
575	0000-109-QVI-Q-003			MQP for RTD with thermowell		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
576	0000-109-QVI-Q-004			MQP for Temperature Transmitter / DP Transmitter / Pressure Transmitter		A	B	FGD	MISCELLANEOUS	QA	QA	293	143
577	0000-109-QVI-Q-005			MQP for flow transmitter		A	B	FGD	MISCELLANEOUS	QA	QA	337	187

S. No.	NTPC_DRG_NO	Rev_drg_no_for_inouhse_drg	TO_BE_SHIFTED_TO_PACKAGE	DRG_TITLE	PROJECT_SPECIFC_INFORMATION	DRG_PURPOSE	DRG_TYPE	AREA	MILESTONE	CUSTODIAN	REVIEWERS	SUB_FROM_MP_AWARD	SUB_FROM_FGD_AWARD
578	0000-109-QVI-Q-006			MQP for PLC		A	B	FGD	MISCELLANEOUS	QA	QA	264	114
579	0000-109-QVI-Q-007			MQP for Flow switch		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
580	0000-109-QVI-Q-008			MQP for temperature switch		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
581	0000-109-QVI-Q-009			MQP for Vibration transmitter with sensor		A	B	FGD	MISCELLANEOUS	QA	QA	293	143
582	0000-109-QVI-Q-010			MQP for UPS		A	B	FGD	MISCELLANEOUS	QA	QA	319	169
583	0000-109-QVI-Q-011			MQP for battery charger		A	B	FGD	MISCELLANEOUS	QA	QA	508	358
584	0000-109-QVI-Q-012			MQP for Instrument Cable		A	B	FGD	MISCELLANEOUS	QA	QA	315	165
585	0000-109-QVI-Q-013			MQP for GGH Control (GGH Soot Blower)		A	B	FGD	MISCELLANEOUS	QA	QA	250	100
586	0000-109-QVI-Q-014			MQP for Ni-Cd Battery		A	B	FGD	MISCELLANEOUS	QA	QA	511	361
587	0000-109-QVI-Q-015			MQP for LIE/LIR		A	B	FGD	MISCELLANEOUS	QA	QA	511	361
588	0000-109-QVI-Q-016			MQP for Control Valve						QA-C&I	QA-C&I		
589	0000-109-QVI-Q-017			MQP for Thermocouple with thermowell						QA-C&I	QA-C&I		
590	0000-109-QVI-Q-018			MQP for Impulse Pipe & Tube						QA-C&I	QA-C&I		
591	0000-109-QVI-Q-019			MQP for Instrument valve						QA-C&I	QA-C&I		
592	0000-109-QVI-Q-020			MQP for Fiber Optics Cable						QA-C&I	QA-C&I		
593	0000-109-QVI-Q-021			MQP for Transducer						QA-C&I	QA-C&I		
594	0000-109-QVI-Q-022			MQP for control desk						QA-C&I	QA-C&I		
595	0000-109-QVI-Q-023			MQP for Flue Gas analyser panel						QA-C&I	QA-C&I		
596	0000-109-QVI-Q-024			MQP for RF type Level Switch						QA-C&I	QA-C&I		
597	0000-109-QVI-Q-025			MQP for CEMS						QA-C&I	QA-C&I		
598	0000-109-QVI-Q-026			MQP for Fire Alarm system						QA-C&I	QA-C&I		
599	0000-109-QVI-Q-027			MQP for Local control panel(Blank encloser) for fire alarm panel						QA-C&I	QA-C&I		
600	0000-109-QVI-Q-072			MQP for Actuators(without IS)		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
601	0000-109-QVI-Q-073			MQP for Actuators(with IS)		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
602	0000-109-QVI-Q-075			MQP for PDB of M/s pyrotech Electronics Udaipur		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
603	0000-109-QVM-G-001			FQP for Material Receipt & Stoarge (Storage & preservation Manual at site)		A	D	FGD	MISCELLANEOUS	QA	QA	270	120
604	0000-109-QVM-G-002			Field Quality Plan for Mechanical work Part 1 - FQP for Absorber, Tanks, Silo, Ducts, pipe lines etc including Welding Manual, Heat Treatment Manuals		A	D	FGD	MISCELLANEOUS	QA	QA	233	83
605	0000-109-QVM-G-003			Field Quality Plan for Mechanical work Part 2 - Field Quality Plan of different Mechanical Equipment for Wet FGD plant		A	D	FGD	MISCELLANEOUS	QA	QA	233	83
606	0000-109-QVM-G-004			Field Quality Plan for Mechanical work Part 3 - Field Quality Plan of DUCTS		A	D	FGD	MISCELLANEOUS	QA	QA	233	83
607	0000-109-QVM-G-005			FQP RECEIPT AND STORAGE- Limestone & Gypsum Handling Plant		A	B	FGD	MISCELLANEOUS	QA	QA		
608	0000-109-QVM-G-006			FQP FOR MECHANICAL ERECTION-Limestone & Gypsum Handling Plant		A	B	FGD	MISCELLANEOUS	QA	QA		
609	0000-109-QVM-G-077			Field Quality Plan for Elevator		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
610	0000-109-QVM-Q-002			MQP for FGD SUPPORT STRUCTURE (COLUMNS BEAMS & BRACING)		A	D	FGD	MISCELLANEOUS	QA	QA	322	172
611	0000-109-QVM-Q-004			MQP for Non Metallic Expansion Joint		A	B	FGD	MISCELLANEOUS	QA	QA	261	111
612	0000-109-QVM-Q-005			MQP for Agitator		A	B	FGD	MISCELLANEOUS	QA	QA	258	108
613	0000-109-QVM-Q-006			MQP for Oxidation Blower		A	B	FGD	MISCELLANEOUS	QA	QA	238	88
614	0000-109-QVM-Q-007			MQP for Horizontal Vacuum Belt Filter with Pump and accessories		A	B	FGD	MISCELLANEOUS	QA	QA	223	73
615	0000-109-QVM-Q-008			MQP for pipes & tubes		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
616	0000-109-QVM-Q-009			MQP for recirculation slurry pump		A	B	FGD	MISCELLANEOUS	QA	QA	224	74
617	0000-109-QVM-Q-010			MQP for slury pump		A	B	FGD	MISCELLANEOUS	QA	QA	240	90
618	0000-109-QVM-Q-011			MQP for clear water pump		A	B	FGD	MISCELLANEOUS	QA	QA	244	94
619	0000-109-QVM-Q-012			MQP for Dampers & Seal air fan with heater & Gates		A	B	FGD	MISCELLANEOUS	QA	QA	272	122

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620	0000-109-QVM-Q-013			MQP for GGH with accessories		A	B	FGD	MISCELLANEOUS	QA	QA	210	60
621	0000-109-QVM-Q-014			MQP for Lime Stone & Gypsum Handling System		A	B	FGD	MISCELLANEOUS	QA	QA	257	107
622	0000-109-QVM-Q-015			MQP for Hoist		A	B	FGD	MISCELLANEOUS	QA	QA	320	170
623	0000-109-QVM-Q-016			MQP for Air Receiver		A	D	FGD	MISCELLANEOUS	QA	QA	314	164
624	0000-109-QVM-Q-017			MQP for insulation		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
625	0000-109-QVM-Q-018			MQP for REAGENT PREPARATION SYSTEM (Ball mill with accessories)		A	B	FGD	MISCELLANEOUS	QA	QA	244	94
626	0000-109-QVM-Q-019			MQP for Booster Fan wirg accessories		A	B	FGD	MISCELLANEOUS	QA	QA	286	136
627	0000-109-QVM-Q-020			MQP for foundation bolts		A	D	FGD	MISCELLANEOUS	QA	QA	322	172
628	0000-109-QVM-Q-020A			MQP for foundation bolts M/s Quality Engineering Works, Kolkata		A	D	FGD	MISCELLANEOUS	QA	QA	322	172
629	0000-109-QVM-Q-020B			MQP for foundation bolts M/s Indiana Conveyors, Jejuri		A	D	FGD	MISCELLANEOUS	QA	QA	322	172
630	0000-109-QVM-Q-021			MQP for Instrument Air Compressor		A	B	FGD	MISCELLANEOUS	QA	QA	243	93
631	0000-109-QVM-Q-022			MQP for Air Dryer		A	B	FGD	MISCELLANEOUS	QA	QA	311	161
632	0000-109-QVM-Q-023			MQP for FGD valves		A	B	FGD	MISCELLANEOUS	QA	QA	314	164
633	0000-109-QVM-Q-024			MQP for air conditiong and ventilation system		A	B	FGD	MISCELLANEOUS	QA	QA	337	187
634	0000-109-QVM-Q-031			MQP for Absorber Tank		A				QA	QA		
635	0000-109-QVM-Q-032			MQP for Hydro Cyclone		A				QA	QA		
636	0000-109-QVM-Q-055			MQP for Crusher		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
637	0000-109-QVM-Q-057			MQP for Sampling System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
638	0000-109-QVM-Q-058			MQP for Dust Extraction System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
639	0000-109-QVM-Q-059			MQP for Dust Suppression System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
640	0000-109-QVM-Q-060			MQP for Elevator(rack and Pinion Type)		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
641	0000-109-QVM-Q-061			MQP for Sump Pump		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
642	0000-109-QVM-Q-062			MQP for Ventilation System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
643	0000-109-QVM-Q-063			MQP for Fabric Belts		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
644	0000-109-QVM-Q-064			MQP for Belt Vulcanizer		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
645	0000-109-QVM-Q-065			MQP for Idler		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
646	0000-109-QVM-Q-066			MQP for Pulley		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
647	0000-109-QVM-Q-067			MQP for Helical or Bevel Gear Boxes		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
648	0000-109-QVM-Q-068			MQP for Vibration monitoring System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
649	0000-109-QVM-Q-069			MQP for Fluid Coupling(traction type)		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
650	0000-109-QVM-Q-070			MQP for CI Gate/globe/Check Valves(Upto 600 NB PN-1.6)		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
651	0000-109-QVM-Q-071			MQP for Flap Gate Gate		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
652	0000-109-QVM-Q-073			MQP for Support Structure		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
653	0000-109-QVM-Q-074			MQP for Bucket Elevator		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
654	0000-109-QVM-Q-075			MQP for Rotary Feeder		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
655	0000-109-QVM-Q-076			MQP for Travelling Tripper		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
656	0000-109-QVM-Q-078			MQP for slury pump (Imported)		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
657	0000-109-QVM-Q-079			MQP for Slurry Pump (Sump Type) ¿ Supplier is Sam Turbo, Coimabtur, India		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
658	0000-109-QVM-Q-080			MQP for Structural Fabrication		A	-	FGD	MISCELLANEOUS	QA	QA	171	21
659	0000-109-QVM-Q-081			MQP for Hoists up to 15 MT		A	-	FGD	MISCELLANEOUS	QA	QA	171	21
660	0000-109-QVM-Q-086			MQP for Technological Structure		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
661	0000-109-QVM-Q-087			MQP for Silo		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
662	0000-109-QVM-Q-088			MQP for Pipe Expansion Joint		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
663	0000-109-QVM-Q-089			MQP for Geared Motor for Bucket Elevator		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
664	0000-109-QVM-Q-090			MQP for Valve (Ball, Gate, Globe, Check Valve)		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
665	0000-109-QVM-Q-091			MQP for Knife Gate Valve		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
666	0000-109-QVM-Q-092			MQP for Diaphragm Valve (Main Package)		A	B	FGD	MISCELLANEOUS	QA	QA	171	21

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667	0000-109-QVM-Q-093			MQP for Axial Flow Fan with motor for Ventilation System		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
668	0000-109-QVM-Q-094			MQP for Ventilation Fan		A	B	FGD	MISCELLANEOUS	QA	QA	350	200
669	0000-109-QVM-Q-095			MQP for Butterfly Valve 1200 mm dia		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
670	0000-109-QVM-Q-096			MQP for Expansion Joints A/c Booster Fan		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
671	0000-109-QVM-Q-097			MQP for Ball Valve (M/s Leader)		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
672	0000-109-QVM-Q-098			MQP of Centrifugal Fan of Dust Extraction System		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
673	0000-109-QVM-Q-099			MQP for Rubber Lined Pipe		A	B	FGD	MISCELLANEOUS	QA	QA	171	21
674	0000-109-QVM-Q-101			Apron feeder		A	B	FGD	MISCELLANEOUS	QA	QA		
675	0000-109-QVM-Q-102			Paddle feeder		A	B	FGD	MISCELLANEOUS	QA	QA		
676	0000-109-QVM-Q-103			Vibrating Screen feeder		A	B	FGD	MISCELLANEOUS	QA	QA		
677	0000-109-QVM-Q-104			Vibrating feeder		A	B	FGD	MISCELLANEOUS	QA	QA		
678	0000-109-QVM-Q-105			MQP for Fluid Coupling(Scoop Type)		A	B	FGD	MISCELLANEOUS	QA	QA		
679	0000-109-QVM-Q-106			MQP for Rack & Pinion Gate		A	B	FGD	MISCELLANEOUS	QA	QA		
680	0000-109-QVM-Q-107			Centrifugal pump		A	B	FGD	MISCELLANEOUS	QA	QA		
681	0000-109-QVM-Q-108			Strainer		A	B	FGD	MISCELLANEOUS	QA	QA		
682	0000-109-QVM-Q-120			MQP OF CONDENSING UNIT				FGD		QA Mech BOP	QA Mech BOP		
683	0000-109-QVM-Q-121			MQP OF AHU				FGD		QA Mech BOP	QA Mech BOP		
684	0000-109-QVM-Q-122			MQP OF CENDRIFUGAL FAN				FGD		QA Mech BOP	QA Mech BOP		
685	0000-109-QVM-Q-123			MQP OF PAC				FGD		QA Mech BOP	QA Mech BOP		
686	0000-109-QVM-Q-124			MQP OF UAF				FGD		QA Mech BOP	QA Mech BOP		
687	0000-109-QVM-Q-125			MQP OF HORIZONTAL CENTRIFUGAL PUMP				FGD		QA Mech BOP	QA Mech BOP		
688	0000-109-QVM-Q-126			MAP OF PIPE				FGD		QA Mech BOP	QA Mech BOP		
689	0000-109-QVM-Q-127			MQP OF VALVES (GATE, BLOBE & CHECK)				FGD		QA Mech BOP	QA Mech BOP		
690	0000-109-QVM-Q-128			MQP OF BUTTERFLY VALVE				FGD		QA Mech BOP	QA Mech BOP		
691	0000-109-QVM-Q-129			MQP OF FILTERS				FGD		QA Mech BOP	QA Mech BOP		
692	0000-109-QVM-Q-130			MQP OF THERMAL INSULATION GLASS WOOL/ ROCK WOOL				FGD		QA Mech BOP	QA Mech BOP		
693	0000-109-QVM-Q-131			MQP OF THERMAL INSULATION NITRIL RUBBER/ POLEURETHANE FOAM/ POLYISOCYNURATE FOAM				FGD		QA Mech BOP	QA Mech BOP		
694	0000-109-QVM-Q-133			MQP OF PHE				FGD		QA Mech BOP	QA Mech BOP		
695	0000-109-QVM-Q-134			MQP OF PIPE				FGD		QA Mech BOP	QA Mech BOP		
696	0000-109-QVM-Q-135			MQP OF VALVES				FGD		QA Mech BOP	QA Mech BOP		
697	0000-109-QVM-Q-136			MQP OF HORIZONTAL CENTRIFUGAL PUMP				FGD		QA Mech BOP	QA Mech BOP		
698	0000-109-QVM-W-001			QA programme		I	D	FGD	MISCELLANEOUS	QA	QA	210	60
699	0000-109-QVM-W-002			QA Organisation for implementation and QA system manual		I	D	FGD	MISCELLANEOUS	QA	QA	180	30
700	0000-109-QVM-W-005			WPS for Carbon Steel Welding at site		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
701	0000-109-QVM-W-006			WPS for SS welding at site		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
702	0000-109-QVM-W-008			WPS (E-7018 & FCAW) for WFGD Steel Structural Work		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
703	0000-109-QVM-W-009			WPS for CS to SS Welding		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
704	0000-109-QVM-W-010			WPS for Welding at Shop (CS & SS)		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
705	0000-109-QVM-W-011			QA Documentation Package for items / equipmentmanufactured and despatched to site		I	D	FGD	MISCELLANEOUS	QA	QA	341	191
706	0000-109-QVM-W-012			QA Documentation Package for field activities on equip-ment/systems at site		I	D	FGD	MISCELLANEOUS	QA	QA	341	191
707	0000-109-QVM-W-013			WPS for SAW Welding (Indiana, Jejuri)		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
708	0000-109-QVM-W-014			WPS for Shop Welding (Crusher)		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
709	0000-109-QVM-W-020			WPS for Limestone & Gypsum Handling System		A	D	FGD	MISCELLANEOUS	QA	QA	248	98
710	0000-109-QVM-W-30			WPS for AC & Ventilation System of FGD				FGD		QA Mech BOP	QA Mech BOP		