



Tender Specification
for
FGD Package

ANNEXURE-1

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTRODUCTION	1
2.00.00	CODES AND STANDARDS	1
3.00.00	SCOPE OF SUPPLY AND SERVICES	3
4.00.00	DESIGN AND CONSTRUCTION	4
5.00.00	INSTALLATION	10
6.00.00	DRAWING, DATA AND INFORMATION REQUIRED	12

ATTACHMENTS

ANNEXURE-I	SPECIFICATION OF PIPES & FITTINGS	13
ANNEXURE-II	SERVICES OF VARIOUS CATEGORIES OF VALVES	16
ANNEXURE-III	SPECIFICATION OF GATE/GLOBE/CHECK/BALL VALVES	17
ANNEXURE-IV	SPECIFICATION OF BUTTERFLY VALVE	19





VOLUME : II-D

SECTION-I

PIPING, VALVES AND SPECIALTIES

1.00.00 INTRODUCTION

This section covers technical requirements of all piping, associated valves and specialties that include but is not limited to the following systems.

1.01.00 Slurry Piping – shall consist of all Slurry piping within the Flue Gas Desulphurisation system such as Limestone slurry, Gypsum slurry, etc

1.02.00 Process Piping – shall consist of various categories of piping as required for operation of the FGD Plant.

1.03.00 Service Air System - shall consist of distribution of Service air for general housekeeping terminated at hose valves at buildings/ facilities of the FGD Plant.

1.04.00 Instrument Air System - shall consist of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers of the FGD Plant.

1.05.00 Service water system (clarified quality) from Terminal Points to Storage tank and subsequent distribution points for process use.

1.06.00 Drinking Water System - from Terminal Point to auxiliary buildings included under FGD package.

1.07.00 Fire water system - from Terminal Points to distribution points for emergency cooling.

1.08.00 Demineralised Closed Cycle Cooling Water System – from Terminal points to and from equipment coolers within FGD Plant.

1.09.00 Waste water – shall consist of waste water generated in the FGD Plant upto Terminal point.

1.10.00 Any other low pressure piping as found necessary during detail engineering stage shall also be included.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out in Volume IIA (Lead Specification), Section-V, of this specification, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below :

2.01.01 IS-1239 : Mild steel tubes, tubular and other wrought steel fittings.
[Part-I & II]





2.01.02	IS-3589	:	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter).
2.01.03	IS-554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
2.01.04	IS-1363 [Part-I & II]	:	Hexagonal head bolts, screws and nuts (size range M5 M36)
2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm).
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150).
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers.
2.01.10	IS-2712	:	Compressed asbestos fibre jointing.
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings.
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged.
2.01.13	ANSI B-16.11	:	Forged steel fittings, Socket-welding and Threaded.
2.01.14	ANSI B-16.34	:	Steel Valves - Flanged and Butt Welding Ends
2.01.15	ASME B-36-10	:	Welded & Seamless Wrought steel Pipe
2.01.16	ASME B 36-19	:	Stainless Steel Pipe
2.01.17	ANSI B-36.10	:	Steel pipes thickness.
2.01.18	ANSI B-31.1	:	Code for Pressure Piping - "Power Piping".
2.01.19	IBR	:	Indian Boiler Regulations, with latest amendment.
2.01.20	API-600	:	Steel gate valves.
2.01.21	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.22	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.23	BS-5351	:	Specification for Ball valves.
2.01.24	AWWA-C-504	:	Specification for Butterfly valves.



- 2.01.25 AWWA-C-208 : Dimension for fabricated steel water pipe fittings.
- 2.02.00 Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Owner/Consultant.
- 3.00.00 **SCOPE OF SUPPLY AND SERVICES**
- 3.01.00 The equipment and materials to be supplied under this section shall include but not be limited to the following:
- a) Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.
 - b) Matching pipes, matching pieces like reducers/expanders etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc. for all terminals of other packages as required.
 - c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.
 - d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the terminal points of entire low pressure piping system.
 - e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform with access ladders, supporting structures etc.
 - f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.
 - g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.
 - h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings as well as for terminal points.
 - i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.
- 3.02.00 Following general requirements shall however be included:



- a) Instrument Connections including instruments, root valves, sensing lines etc.
- b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments as per approved P &ID during detail engineering stage.

3.04.00 For details regarding Scope of Services and works, Lead Specification Volume-IIA of this specification shall be referred.

3.05.00 **Terminal Points**

For terminal points, refer Volume-IIA (Lead Specification), Section-IV, of this specification.

4.00.00 **DESIGN AND CONSTRUCTION**

4.01.00 **General Considerations**

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every respect and in accordance with the highest standard of workmanship. Any item of the section on which the Bidder is in doubt shall be referred to the Owner for clarification.

4.01.03 All design and fabrication shall be in accordance with Codes / standards as specified.

4.01.04 No pipe work shall be run in trenches carrying electrical cables.

4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.

4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.

4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.

4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80°C or as required by the design of the different piping system, if higher.



4.01.09 **Drain Pipe work**

- a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.
- b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.
- c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.

4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I of this section.

4.02.00 **Material Specification**

4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I of this section. In case bidder wants to offer alternative piping material, same may be accepted by the Owner/Consultant provided the offered material is superior than the material specified for the intended service.

4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

All pipes above 50 NB shall have butt-welded connections as per ANSI B 16.25 with a minimum of flanged joints necessary for maintenance. Piping of sizes 50 NB and below shall have socket welded connections as per ANSI B 16.11. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimise the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipe bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within



plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant Code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the Bidder to required bend radius. However, forged bends (Bend radius = 1.5 x pipe diameter) wherever required shall be provided at no extra cost.

4.03.04 The ends of Pipe and welded fittings shall be beveled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Owner.

4.03.05 **Cutting and Beveling**

a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.

b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**





4.05.01

General Requirements

- a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexures-II & III of this section. The valves shall be provided with electric motors/solenoids and actuators as required.
- b) Valves and specialties to be supplied under this section will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.
- c) All valves shall, unless otherwise stated, have the internal diameter same as the internal diameter of the pipes to be joined.
- d) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes
- e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.
- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.
- i) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- j) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- k) All valves shall be of proven design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Owner's approval.
- l) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are



exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.

- m) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:
 - i) Hand wheel with embossed open and shut directions.
 - ii) Local position indicator.
 - iii) Motorised operation as specified by Owner/Consultant.
- n) Gate valves, in addition shall be provided with following extra features :
 - i) Bypass valve for larger valves.
 - ii) Draining arrangement.
 - iii) Gear operators for valves 300 mm size and above for ease in operation.
 - iv) Motorised operation as specified by Owner/Consultant.
- o) All gate and globe valves shall be rising stem type.
- p) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.
- q) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.
- r) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- s) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- t) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- u) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted



with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

- v) Plastic or bakelite valve hand wheels will not be accepted.
- w) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- x) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.
- y) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- z) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.
- aa) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.
- bb) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves please refer Annexure-II & III of this section.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Owner/Consultant.



The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 **Hose pipe and Accessories**

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

- a) The water hose shall be as per IS-444 (Type-3).
- b) Length of each hose shall be 15 metres.
- c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 **Hose pipes with fittings for Compressed air System**

- a) The compressed air hose shall be as per IS-911 (Type 2).
- b) The length and type of each end shall be similar to as specified in above clause no. (b & c) above.

5.00.00 **INSTALLATION**

5.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

5.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered part of work and the Erection Bidder is required to carry out such work as per instruction of Bidder/Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

5.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the Contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.

5.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.

5.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Owner before erecting the same and also during pre- commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder





during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational flexibility shall be part of erection work.

- 5.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the Owner before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.
- 5.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Owner. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.
- 5.08.00 Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Erection Bidder shall take prior approval from Bidder/Owner. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Owner.
- 5.09.00 Wherever piping erected by the Erection Bidder is connected to piping or equipment erected by some other agencies the joint at the connecting point shall be considered under this specification.
- 5.10.00
- a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.
 - b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.
 - c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Owner. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.
 - d) Overhead piping shall have a minimum overhead clearance of 2.5 meters above walkways and working areas and 8 meters above roadways unless otherwise approved by the Owner.
 - e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective Tenders drawings or not. The pipelines shall be sloped towards the drain points.
- 5.11.00 All drips and drains for piping and equipment whether shown in the Tender drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Bidder.
- 6.00.00 **DRAWING, DATA AND INFORMATION REQUIRED**



- 6.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in Volume-IIA (Lead Specification) with the offer.
- 6.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.
- 6.01.02 A complete list of all valves with their type, quantities & ratings.
- 6.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.
- 6.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.
- 6.02.00 After Award of Contract**
- Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.
- 6.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.
- 6.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.
- 6.02.03 Wiring diagram for all limit switches of motor operated valves.
- 6.02.04 The loading data required for design of structures shall be furnished well in advance to suit Owner's project schedule.



Tender Specification
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2x500 MW Project
Tuticorin, Tamil Nadu

ANNEXURE-I

SPECIFICATION OF PIPES & FITTINGS

Sl. No.	Services	Slurry Piping	Service Water and Demineralised Cooling Water	Drinking Water (chlorinated)	Service and Instrument Air	Auxiliary Steam
1.0	Material of Pipe					
a)	Above 150 mm NB	IS-3589 with minimum pipe thickness of 6 mm and 5 mm thick rubber lining.	IS-3589 with minimum pipe thickness of 6 mm	IS-3589 with minimum pipe thickness of 6 mm, galvanized as per IS-4736	Stainless steel as per ASTM A-312 Gr. 304 as per schedule 10S, ANSI B-36.19.	Carbon Steel, ASTM A-106, Gr. B or C.
b)	80 to 150 mm NB	IS-1239 Heavy Grade with 5 mm thick rubber lining	IS-1239 Heavy Grade	IS-1239 Heavy Grade, galvanized as per IS-4736		
c)	Below 80 mm NB	FRP			Stainless Steel as per ASTM A-312 Gr. 304 as per schedule 40S ANSI B36.19	
2.0	Construction	ERW / Seamless	ERW / Seamless	ERW / Seamless	Seamless	Seamless
3.0	Joints			Pipe to pipe joint shall be with union as per IS:1239, Part-II.		
a)	65 mm NB and above	Flanged	Slip on Flange / butt weld	Screwed flange	Slip on Flange / butt weld	Slip on Flange / butt weld
b)	size 50 mm NB and below.		Socket weld	Screwed socket	Socket weld	Socket weld
4.0	Fittings					
4.1	Materials					





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ANNEXURE-I

Sl. No.	Services	Slurry Piping	Service Water and Demineralised Cooling Water	Drinking Water (chlorinated)	Service and Instrument Air	Auxiliary Steam
a)	Pipe Sizes \geq 65 mm NB	ASTM-A-234 Gr. WPB with 5 mm thick rubber lining.	ASTM-A-234 Gr. WPB	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-351-CF8 or ASTM-A-403 WP304	ASTM-A-234 Gr. WPB
b)	Pipe Sizes \leq 50 mm NB	FRP	ASTM-A-105 or as compatible with IS:1239	ASTM-A-105 or as compatible with IS:1239 and galvanized as per IS-4736	ASTM-A-182 F304	ASTM-A-105
4.2	Construction	Welded/ Seamless				
a)	Pipe Sizes \geq 65 mm NB		Welded/ Seamless	Welded/ Seamless	Welded/ Seamless	Welded/ Seamless
b)	Pipe Sizes \leq 50 mm NB		Forged	Forged	Forged	Forged
4.3	Standard					
a)	Above 150 mm NB	ANSI-B-16.9/ For fabricated fitting AWWA-C-208	ANSI-B-16.9 / For fabricated fitting AWWA-C-208	ANSI-B-16.9	MSS-SP-43	ANSI-B-16.9
b)	80 to 150 mm NB	ANSI-B-16.11 or IS:1239, Part-II	ANSI-B-16.11 or IS:1239, Part-II	ANSI-B-16.11 or IS:1239, Part-II		
c)	Below 80 mm NB	As per applicable manufacturer's standard.			ANSI-B-16.11	ANSI-B-16.11
4.4	End details					
a)	Pipe Sizes \geq 65 mm NB	Flanged	Butt welded as per ANSI-B-16.25	Screwed Flanged.	Slip - on flanges as per ANSI B16.5. Butt welded for Pipe fittings	Butt welded as per ANSI-B-16.25





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ANNEXURE-I

Sl. No.	Services	Slurry Piping	Service Water and Demineralised Cooling Water	Drinking Water (chlorinated)	Service and Instrument Air	Auxiliary Steam
					and flanged for valves and equipments.	
b)	Pipe Sizes \leq 50 mm NB		Socket welded as per ANSI-B-16.11	Screwed socketed as per ANSI-B-16.11 or IS:1239, Part-II	Socket welded as per ANSE B16.11	Socket welded as per ANSI-B-16.11
5.0	Flanges	Applicable class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised- complete with nuts, bolts and gaskets.	As per ANSI-B-16.5, 150lb pressure class complete with nuts, bolts and gaskets. Material as per class 4.01.00.	Applicable class as per ANSI-B-16.5 complete with nuts, bolts and gaskets
Pipes shall be hydrostatically tested according to the said code, for other Codes please refer Volume-IIA (Lead Specification), Section-V of this specification.						

Note:

- 1) Piping system not covered in above table shall be as per Vendor's proven practice, subject to approval by Purchaser
- 2) For waste water handling system, all piping and fittings shall be HDPE material.





ANNEXURE-II

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i)	Service Water (Clarified).	For sizes 65 mm NB to 300 mm NB.
		ii)	Drinking Water.	
B.	Stainless steel body Ball/ Check Valve	i)	Service and Instrument Air.	For all sizes.
C.	Steel Body Gate/ Globe/ Check Valves	i)	Service Water (Clarified).	For sizes less than and equal to 50 mm NB.
		ii)	Drinking Water	
		iii)	Auxiliary Steam	For all sizes
		iv)	Inhibited Demineralised Water for DMCW system	
D.	Cast Iron body butterfly valve		Service Water (Clarified).	For sizes above 300 mm NB
E.	Cast Steel Knife Gate/ Butterfly valves with rubber lining		Limestone/ Gypsum Slurry	For all sizes



SPECIFICATION OF GATE/GLOBE/CHECK/BALL VALVES

Sl. No.	Description	A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve
1.0	Valve Classification Code	CIGC	SSGC	STGC
2.0	Basic Design Code			
2.1	Gate	i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70		i) API 600 for 50mm NB and above /ANSI-B-16.34 ii) API 602 for size below 50mm NB/ANSI-B-16.34
2.2	Globe	MSS - SP - 85		BS-1873/ANSI-B-16.34
2.3	Check	IS-5312/MSS - SP -71	ANSI-B-16.34	BS-1868/ANSI B16.34
2.4	Ball		BS-5351	
3.0	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.0	Construction	Cast body and bonnet / cover.	Forged body up to 50mm NB and Cast body above that.	
5.0	Material			
5.1	Body & Bonnet/ cover	IS 210 Gr. FG 260 or ASTM A216 Class B.	i) ASTM-A-182 F304 for Ball Valves ii) A351 CF8M for cast body check valves, iii) A 182 F304 for forged body check valves.	i) ASTM-A-216 Gr. WCB for cast body valves ii) ASTM-A-105 for forged body valves.
5.2	Trim / Disc.	IS-210 Gr. FG 260 or ASTM A216 Class B.	i) ASTM-A-182 F304 for Check valves ii) 351CF 8M for Ball valves.	i) 13% Cr Steel as per ASTM-A-182 Gr. F6 heat treated and hardened (min 250 HB) for cast body ii) ASTM-A-105 Hard faced





**Tender Specification
for
FGD Package**

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

ANNEXURE-III

Sl. No.	Description	A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve
				with Stellite (min 350 HB) for forged body.
5.3	Seating surface	13% Cr steel as per IS 1570.	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM- A-182 Gr. F6
6.0	End Preparation	Socket welded for size equal to and below 50 mm NB and flanged with counter flanges for 65 mm NB and above.		
7.0	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB	As per ANSI B-16.34	API-598
		ii) IS-2906 for sizes equal to and above 350 mm NB		
	b) Globe	Hydrostatic Test as per MSS-SP- 85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868

Note: For Waste water handling system, all valves shall be duplex stainless material.





SPECIFICATION OF BUTTERFLY VALVE

- 1.0 Valve classification Code : CIBF
- 2.0 Basic Design Code : AWWA-C-504
- 3.0 Pressure : To be suitably chosen by the Bidder according to requirement, but not less than class 75A as per AWWA-C-504.
- 4.0 Construction : Cast Body and Disc
- 5.0 Material
- a) Body : 2% Ni Cast Iron as per IS-210 Gr. FG260 with 2% Ni.
- b) Valve Disc : -Do-
- c) Valve Shaft : Stainless Steel ASTM-A-479 type 304
- d) Seat ring : Clamping ring Stainless Steel ASTM-A-479 type 304
- e) Shaft Bearing : Ferrobestos LA-33
- f) Gland Packing : Impregnated Teflon
- g) Seal : Nitrile Rubber
- 6.0 End preparation : Flanged, Drilled as per ANSI B16.1. Necessary counter flange nuts, bolts, gaskets are to be provided with each valve.
- 7.0 Testing : As per AWWA-C-504. However valve disc strength for both forward reverse flow is to be carried out as per BS 5155. Certificate for proof of design test for similar type of valve is to be furnished.

Note:

- 1) For Slurry lines rubber lining/EPDM/equivalent protection to be provided.
- 2) For Waste water handling system, all valves shall be duplex stainless material.

05		Revision 05			
04	18.06.2021	Revision 04	MVR	PNR	ACR
03	09.03.2021	Revision 03	MVR	PNR	ACR
02	06.02.2021	Revision 02	MVR	PNR	ACR
01	29.12.2020	Revision 01	MVR	PNR	ACR
00	14.10.2020	Fresh Issue	MVR	PNR	ACR
REV	DATE	DESCRIPTION / NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID along with process description - Limestone Pulverizer-Wet Ball Mill & Reagent Preparation System, Feed tank& Pump

OWNER/PROJECT:



NLC TAMILNADU POWER LIMITED (NTPL)
2X500 MW COAL FIRED UNITS AT TUTICORIN
FGD SYSTEM PACKAGE

EPC CONTRACTOR:



BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT, RANIPET

COLLABORATOR & QFGDM



MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION, JAPAN

	BHEL	Sign	
PREPARED BY	MVR		STATUS : <i>FOR APPROVAL</i>
CHECKED BY	PNR		BHEL CUST NO : G515,G516
APPROVED BY	ACR		REV NO : 05

BHEL DRG./DOC NO. : 3-FW-000-01633

LINE SYMBOLS

SYMBOLS	NAME
	PIPE LINE
	CAPILLARY TUBING
	ELECTRIC SIGNAL
	SOFTWARE LINK
	PRESSURE LEAD
	DUCT

PIPING VALVE SYMBOLS

SYMBOLS	NAME
	GATE VALVE (NOR.CLOSED)
	GLOBE VALVE (NOR.CLOSED)
	BALL VALVE (NOR.CLOSED)
	BUTTERFLY VALVE (NOR.CLOSED)
	DIAPHRAGM VALVE (NOR.CLOSED)
	PINCH VALVE (NOR.CLOSED)
	NEEDLE VALVE (NOR.CLOSED)
	CHECK VALVE
	CHECK VALVE (WAFER)
	PRESSURE RELIEF VALVE

INSTRUMENT VALVE SYMBOLS

SYMBOLS	NAME
	ACTUATED BY AIR
	ACTUATED BY MOTOR
	AIR CONTROL VALVE
	SOLENOID ACTUATOR
	SELF REGULATING VALVE
	SELF REGULATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
	TO ABSORBER AREA DRAIN SUMP
	TO GYPSUM AREA DRAIN SUMP
	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
	STEAM TRAP
	AIR TRAP
	Y-STRAINER
	T-STRAINER
	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
	MANHOLE
	PITOT TUBE
	SAMPLING POT
	SAMPLING NOZZLE
	ROTOMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
	FAILURE CLOSE (THE VALVE CLOSES WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)

INSULATION SYMBOLS

SYMBOLS	DESCRIPTION
H10	THERMAL INSULATION (100°C & LOWER)
H15	THERMAL INSULATION (101°C ~ 150°C)
H20	THERMAL INSULATION (151°C ~ 200°C)
H25	THERMAL INSULATION (201°C ~ 250°C)
H30	THERMAL INSULATION (251°C ~ 300°C)
H35	THERMAL INSULATION (301°C ~ 350°C)
HF	INSULATION FOR ANTI FREEZING
ET	ELECTRIC TRACE
ST	STEAM TRACE (LOW PRESSURE STEAM)
P10	PERSONAL PROTECTION (100°C & LOWER)
P15	PERSONAL PROTECTION (101°C ~ 150°C)
P20	PERSONAL PROTECTION (151°C ~ 200°C)
P25	PERSONAL PROTECTION (201°C ~ 250°C)
P30	PERSONAL PROTECTION (251°C ~ 300°C)
P35	PERSONAL PROTECTION (350°C ~ 400°C)

DELIVERY LIMITS

SYMBOLS	NAME
	BETWEEN NTP AND CONTRACTOR
	BETWEEN SUB CONTRACTOR AND VENDOR

SYSTEM

NUMBER	NAME
1	FLUE GAS SYSTEM
2	SO ₂ ABSORPTION OXIDATION SYSTEM
3	REHEATING SYSTEM
4	GYPSUM DEWATERING HANDLING SYSTEM
5	LIMESTONE PREPARATION SYSTEM
6	BLANK
7	SUMP SYSTEM
8	UTILITY SYSTEM

FLUID NAME

FLUID SYMBOL	FLUID NAME	FLUID SYMBOL	FLUID NAME
AC	COMPRESSED AIR	WCS	DM COOLING WATER SUPPLY
AF	FLUIDIZER AIR	WCR	DM COOLING WATER RETURN
AI	INSTRUMENT AIR	WD	DRINKING WATER
AO	OXIDATION AIR	WP	PROCESS WATER
AS	SEAL AIR	WR	RAW WATER
DD	DUCT DRAIN	WC	Ca(OH) ₂ WATER
FS	FILTRATE SLURRY	WW	WASTE WATER
GS	GYPSUM SLURRY	VG	VACUUM PUMP VENT
LS	LIMESTONE SLURRY	VBG	BELT FILTER VENT GAS
		LD	LIME/LIMESTONE DEDUSTING
		LOL	LUBE OIL (LOW PRESSURE)
		LOH	LUBE OIL (HIGH PRESSURE)
		CW	CLARIFIED WATER

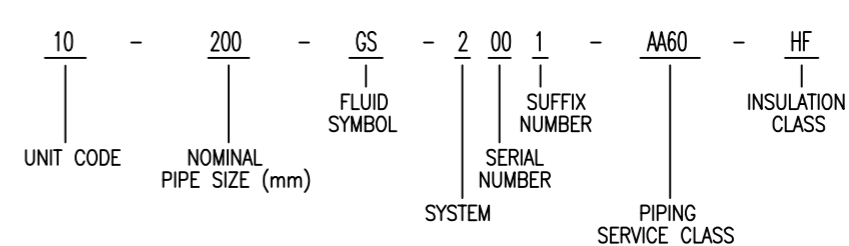
SERVICE CLASS

SERVICE CLASS	MATERIAL	FLUID SYMBOL
AA40	IIR RUBBER LINED PIPING	LS, WP, WC
AA60	IIR RUBBER LINED PIPING	GS,FS,WW,DD
BA01	Gr.304 STAINLESS STEEL PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL PIPING	LOH
BA03	Gr.316L STAINLESS STEEL PIPING	WP, AO
CA01	CARBON STEEL GENERAL PIPING	AS,AO,AC,AF,LD
CC01	CARBON STEEL PRESSURE PIPING	WP,WR,WCS,WCR, VG, AA, CW
DA60	FRP PIPING (PIPE DIA UPTO 80 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 80 NB)	LS, WP, WC
UPVC	UPVC PIPING (PIPE DIA UPTO 25 NB)	LS, WP, GS
HDPE	HDPE PIPING (PIPE DIA UPTO 100 NB)	DD, WP

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
99	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES
20	UNIT-2 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE



CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT CODE	NAME (BHEL)	DATE
DRN	J SAKTHI	05.02.21
M	VENKATA RAMAN M	05.02.21
APPD	P NAVEEN REDDY	05.02.21

P & ID - LEGENDS AND NOTES

TITLE: SH 01 of 02

BHEL DRG NO	FILE NO	REV NO
	B240 - 00001	02

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INSTRUMENT ABBREVIATION

	FIRST-LETTER		SUCCEEDING-LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TE) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
	INTERLOCK LOGIC

PNEUMATIC VALVE ACTUATOR

CODE NO.	ACTUATION
FLXXWA-D	DOUBLE SOLENOID NO LIMIT SWITCH
FLXXWA-DL	DOUBLE SOLENOID WITH LIMIT SWITCH
FLXXWA-S	SINGLE SOLENOID NO LIMIT SWITCH
FLXXWA-SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINERY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

SYMBOLS	NAME
	BAG FILTER
	SILLO
	SLIDE GATE
	TANDEM LOUVER DAMPER (MULTIVANE)
	SINGLE STAGE LOUVER DAMPER (MULTIVANE)
	LOUVER DAMPER (SINGLE VANE)
	DISTRIBUTION BOX (3WAY)
	DISTRIBUTION BOX (2WAY)
	SUMP
	HEAT EXCHANGER
	SHELL AND TUBE HEAT EXCHANGER
	AIR DRYER
	FILTER
	SPRAY NOZZLE

DRIVER SYMBOLS

SYMBOLS	NAME
	AIR MOTOR
	ELECTRIC MOTOR
	ELECTRIC MOTOR WITH VFD

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CONFIDENTIAL & PROPRIETARY INFORMATION

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT CODE	NAME (BHEL)	DATE
DRN	J SAKTHI	05.02.21
M	CHD VENKATA RAMAN M	05.02.21
APPD	P NAVEEN REDDY	05.02.21

P & ID - LEGENDS AND NOTES

TITLE:	FILE NO	REV NO
SH 02 of 02	B240 - 00002	02

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Write up on Limestone grinding system

Purpose: This write up describes the equipment associated with Limestone pulverize and wet ball mill system and defines the associated control system.

Equipment List for NTPL 2x500MW FGD package - Common system:

S. No.	Description	Item No.	Qty
1.	Wet Ball Mill	99 HTK 00 AJ 001/002	1W+1S
2.	Mill Hydro cyclone	99 HTK 00 AT 001/002	1W+1S
3.	Mill separator tank	99 HTK 01 BB 001/002	1W+1S
4.	Mill separator tank agitator	99 HTK 00 AM 001/002	1W+1S
5.	Mill circuit Pump	99 HTK 02 AP 001/002	(1W+1S) X 2

Operation Write Up:

 Limestone sent to Wet Ball Mill through Limestone Intermediate Silo Shut-off Gate, Dosing Bin and Belt Weigh Feeder. The Limestone Grinding System consists of Wet Ball Mills, Wet Ball Mill oil units, Wet Mill Receiver Tanks, Limestone Suspension Pumps, Mill Hydro cyclones and Distribution boxes.

The Belt Weigh Feeder is installed at Dosing Bin bottom which feeds limestone to the Wet Ball Mill. The limestone feed rate is weighed by the Belt Weigh Feeder. The Wet Ball Mills are the wet horizontal type. Process water is supplied to Wet Ball Mill inlet and Mill separator Tank. Slurry from the Wet Ball Mill flows by gravity to Mill separator Tank and then is pumped up to Mill Hydro cyclone to be classified.

The Mill Hydro cyclone underflow, which contains the oversized Limestone, is recirculated to Wet Ball Mill inlet directly, while the overflow is discharged to Limestone Slurry Storage Tank via Distribution Box as a product of Limestone Grinding System. The limestone slurry is pumped from the Limestone Slurry Storage Tank through a ring line and fed to the absorber tank.

Control:

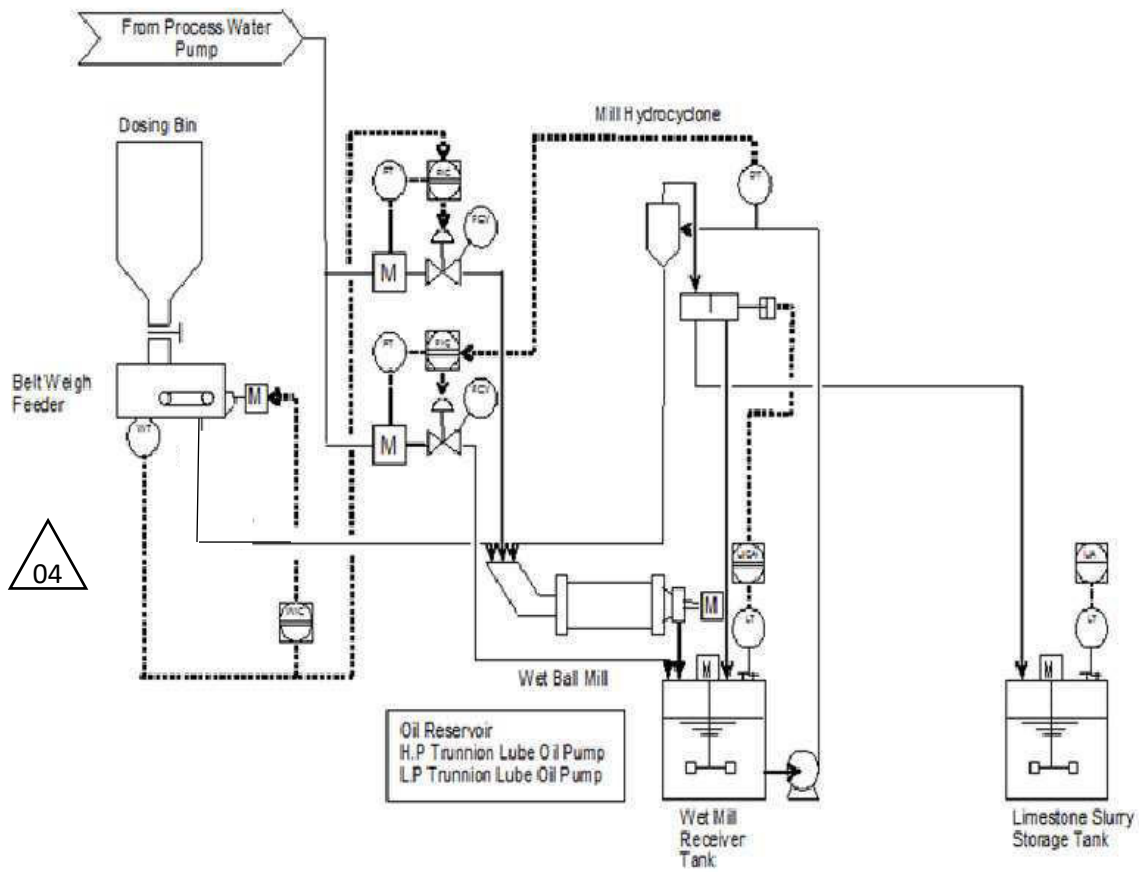
Limestone Grinding System Control

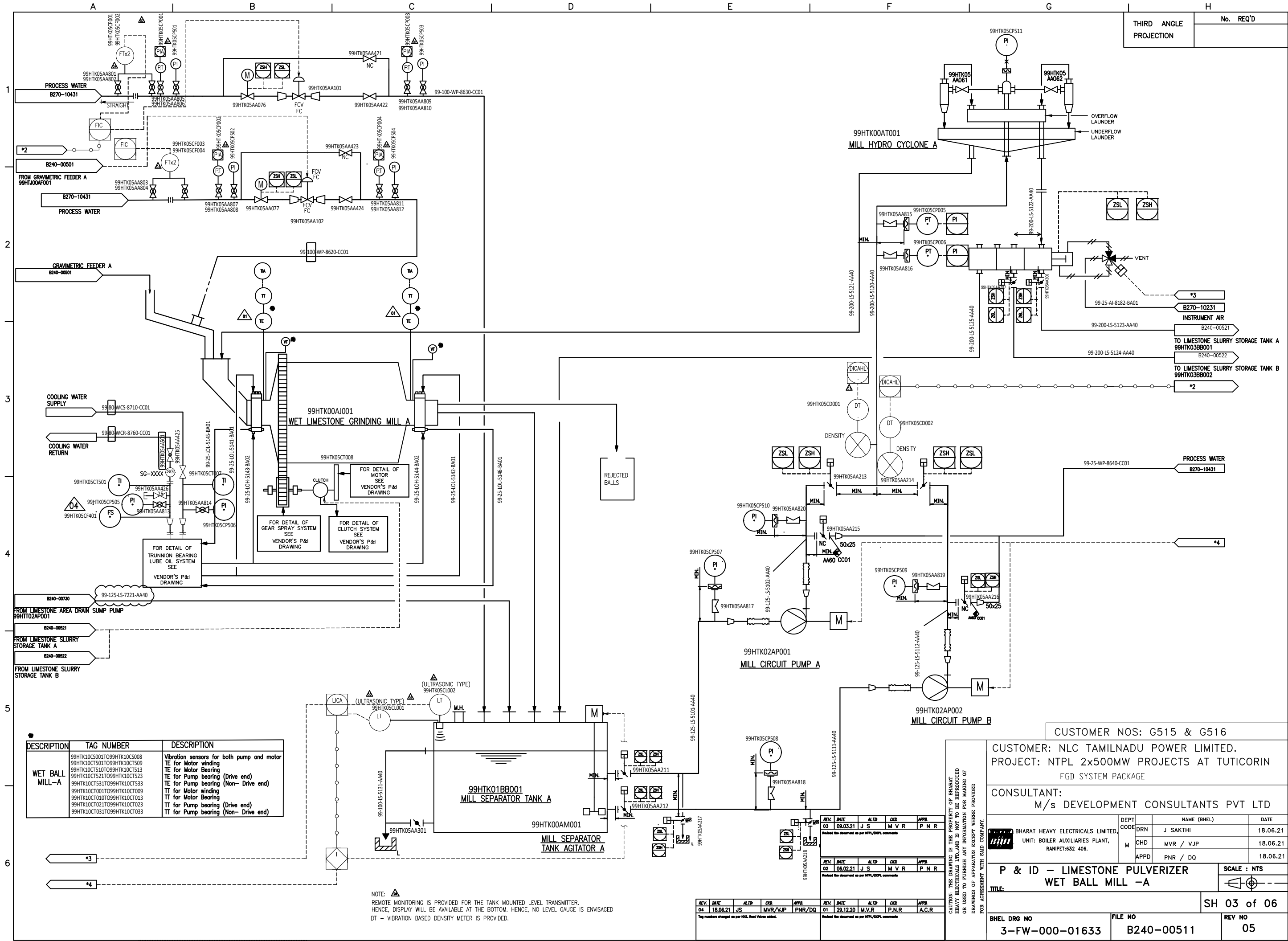


Belt weigh feeder is variable frequency drive. Hence according to the tank level/demand the limestone feed rate can be varied. The limestone which is conveyed from the Dosing Bin by using the belt weigh feeder and the process water are supplied into a limestone ball mill system. The flow rate of process water to wet limestone grinding mill is controlled by Limestone feeding amount at belt weigh feeder. The flow rate of process water to wet mill receiver tank is controlled by density signal from mill hydro cyclone feed slurry.

The slurry in wet mill separator tank is fed up to the mill hydro cyclone and separated into small particle slurry and large particle slurry. The underflow slurry (large particle size limestone) is returned to wet ball mill inlet. The overflow slurry of mill hydro cyclone (small particle size limestone) is sent to the limestone slurry storage tank. The mill separator tank level is controlled by the position of the limestone slurry distribution box. If the wet mill receiver tank level is control low, the overflow slurry of mill hydro cyclone is returned to the Mill separator Tank by recirculation position of the limestone slurry distribution box. And if Mill separator Tank level is control high, the overflow slurry of mill hydro cyclone is send to the limestone slurry storage tank discharge position of the limestone slurry distribution box.

Fig.- Limestone Grinding System Control





DESCRIPTION	TAG NUMBER	DESCRIPTION
WET BALL MILL-A	99HTK10CS001	Vibration sensors for both pump and motor
	99HTK10CT501	TE for Motor winding
	99HTK10CT510	TE for Motor Bearing
	99HTK10CT521	TE for Pump bearing (Drive end)
	99HTK10CT531	TE for Pump bearing (Non-Drive end)
	99HTK10CT001	TT for Motor Bearing
	99HTK10CT010	TT for Motor Bearing
	99HTK10CT021	TT for Pump bearing (Drive end)
	99HTK10CT031	TT for Pump bearing (Non-Drive end)

NOTE: REMOTE MONITORING IS PROVIDED FOR THE TANK MOUNTED LEVEL TRANSMITTER. HENCE, DISPLAY WILL BE AVAILABLE AT THE BOTTOM. HENCE, NO LEVEL GAUGE IS ENVISAGED
 DT - VIBRATION BASED DENSITY METER IS PROVIDED.

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
 PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
 FGD SYSTEM PACKAGE

CONSULTANT:
 M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT	NAME (BHEL)	DATE
DRN	J SAKTHI	18.06.21
CHD	MVR / VJP	18.06.21
APPD	PNR / DQ	18.06.21

**P & ID - LIMESTONE PULVERIZER
 WET BALL MILL -A**

SCALE : NTS

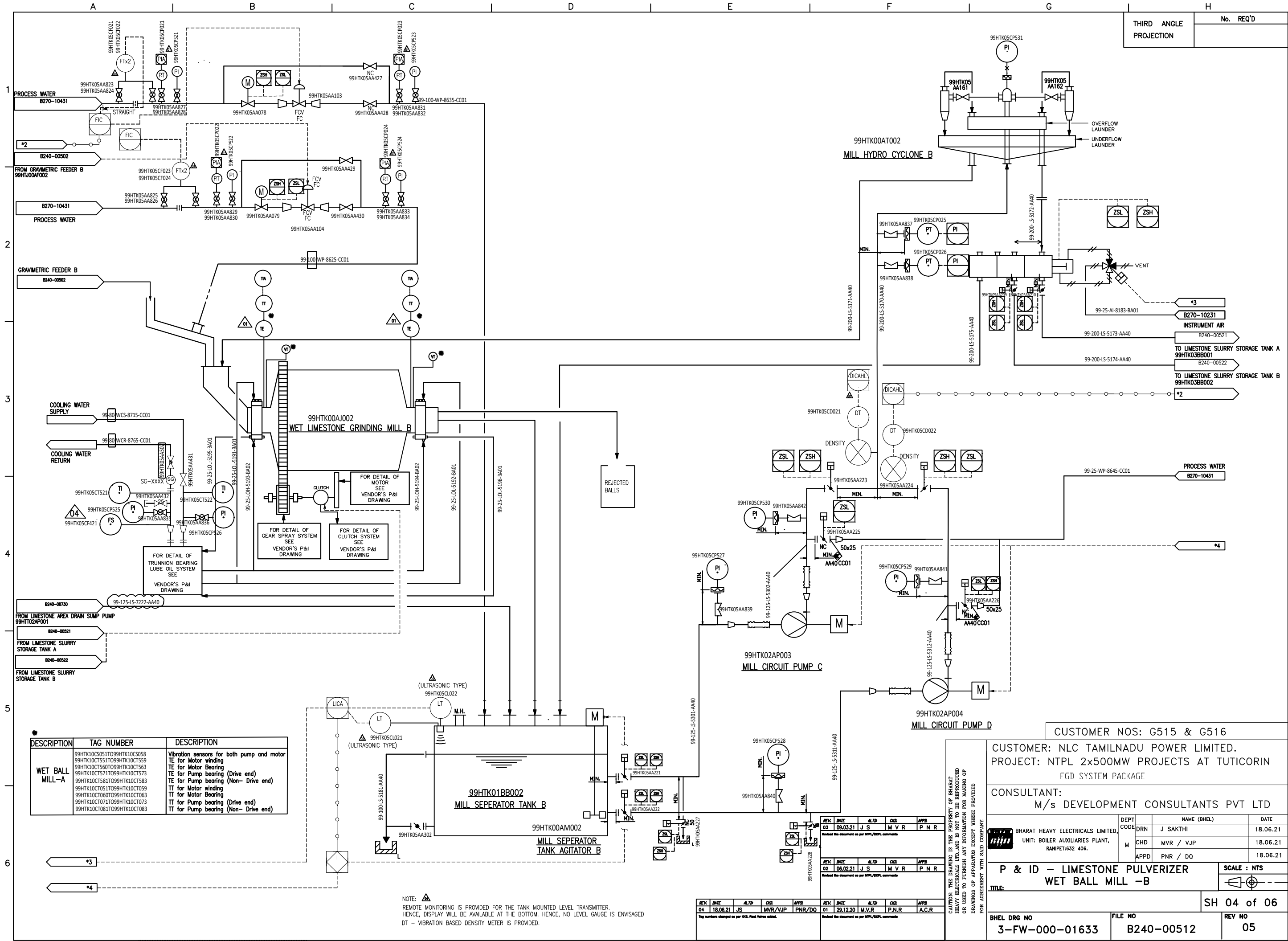
SH 03 of 06

BHEL DRG NO	FILE NO	REV NO
3-FW-000-01633	B240-00511	05

REV.	DATE	ALTD	CHK	APPD
03	09.03.21	J S	M V R	P N R
02	06.02.21	J S	M V R	P N R
04	18.06.21	J S	M V R / VJP	PNR / DQ

Tag numbers changed as per NLS, final values added.





DESCRIPTION	TAG NUMBER	DESCRIPTION
WET BALL MILL-A	99HTK10CS051T099HTK10CS058	Vibration sensors for both pump and motor
	99HTK10CT551T099HTK10CT559	TE for Motor winding
	99HTK10CT560T099HTK10CT563	TE for Motor Bearing (Drive end)
	99HTK10CT571T099HTK10CT573	TE for Pump bearing (Non- Drive end)
	99HTK10CT581T099HTK10CT583	TE for Motor winding
	99HTK10CT051T099HTK10CT059	TT for Motor Bearing
	99HTK10CT060T099HTK10CT063	TT for Motor Bearing (Drive end)
	99HTK10CT081T099HTK10CT083	TT for Pump bearing (Non- Drive end)

NOTE: (ULTRASONIC TYPE) REMOTE MONITORING IS PROVIDED FOR THE TANK MOUNTED LEVEL TRANSMITTER. HENCE, DISPLAY WILL BE AVAILABLE AT THE BOTTOM. HENCE, NO LEVEL GAUGE IS ENVISAGED DT - VIBRATION BASED DENSITY METER IS PROVIDED.

CUSTOMER NOS: G515 & G516

CUSTOMER: NLC TAMILNADU POWER LIMITED.
PROJECT: NTPL 2x500MW PROJECTS AT TUTICORIN
FGD SYSTEM PACKAGE

CONSULTANT:
M/s DEVELOPMENT CONSULTANTS PVT LTD

DEPT	NAME (SHEL)	DATE
DRN	J SAKTHI	18.06.21
CHD	MVR / VJP	18.06.21
APPD	PNR / DQ	18.06.21

P & ID - LIMESTONE PULVERIZER WET BALL MILL -B

SCALE : NTS

SH 04 of 06

BHEL DRG NO	FILE NO	REV NO
3-FW-000-01633	B240-00512	05

REV.	DATE	BY	CHKD	APPD
04	18.06.21	J.S	MVR/VJP	PNR/DQ
03	09.03.21	J.S	M.V.R	P.N.R
02	06.02.21	J.S	M.V.R	P.N.R
01	29.12.20	M.V.R	P.N.R	A.C.R



WRITEUP ON LIMESTONE SLURRY TANK & PUMPS

Purpose:

This write up describes the Limestone Slurry Feed System and defines the associated control system.

Equipment List for NTPL 2x500MW FGD package - Common system:

S.No	Description	Item No.	Qty
1.	Limestone Slurry Feed Pump A/D (including both the tanks)	99 HTK 03 AP 001/004	4 Nos
2.	Limestone Slurry Storage Tank A/B	99 HTK 02 BB 001/002	2 Nos
3.	Limestone Slurry Storage tank Agitator A/B	99 HTK 01 AM 001/002	2 Nos

Operation Write Up:

Slurry from the Wet Ball Mill flows by gravity to Wet Mill Receiver Tank and then is pumped up to the Mill Hydro cyclone to be classified.

The Mill Hydro cyclone underflow which contains the oversized Limestone is recirculated to Wet Ball Mill Inlet directly, while the overflow is discharged to Limestone Slurry Storage Tank via Distribution Box as a product of Limestone Grinding System.

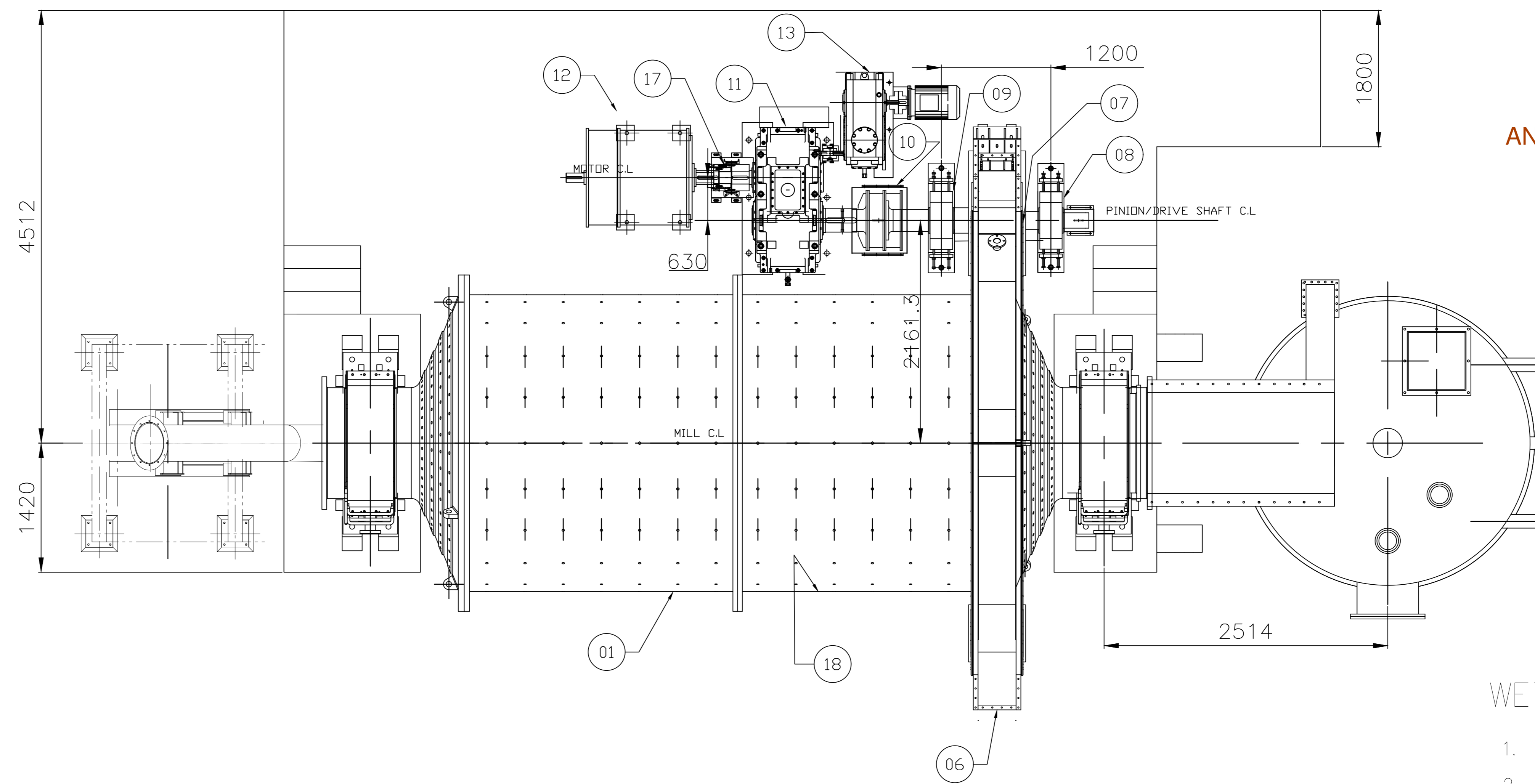
The limestone slurry is pumped from the Limestone Slurry storage tank and fed to the Absorber tank.

Control Write Up:

Limestone slurry flow rate to absorber is controlled to keep the stable desulfurization efficiency.

The limestone slurry flow rate is estimated corresponding to the boiler air flow and FGD plant inlet SO₂ concentration as a feed-forward signal, and then is adjusted by FGD outlet SO₂ concentration or the absorber tank pH as a feed-back signal.

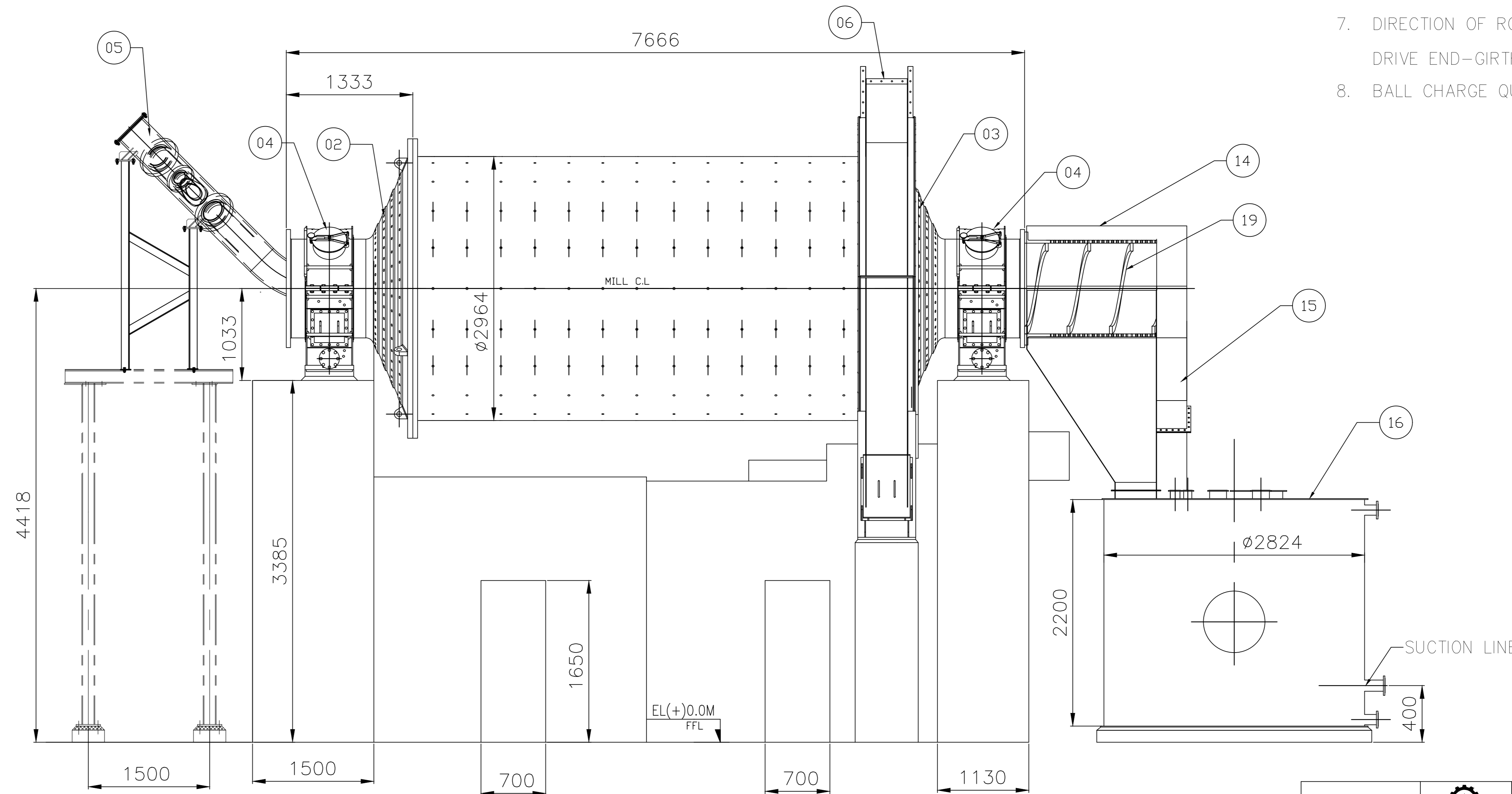
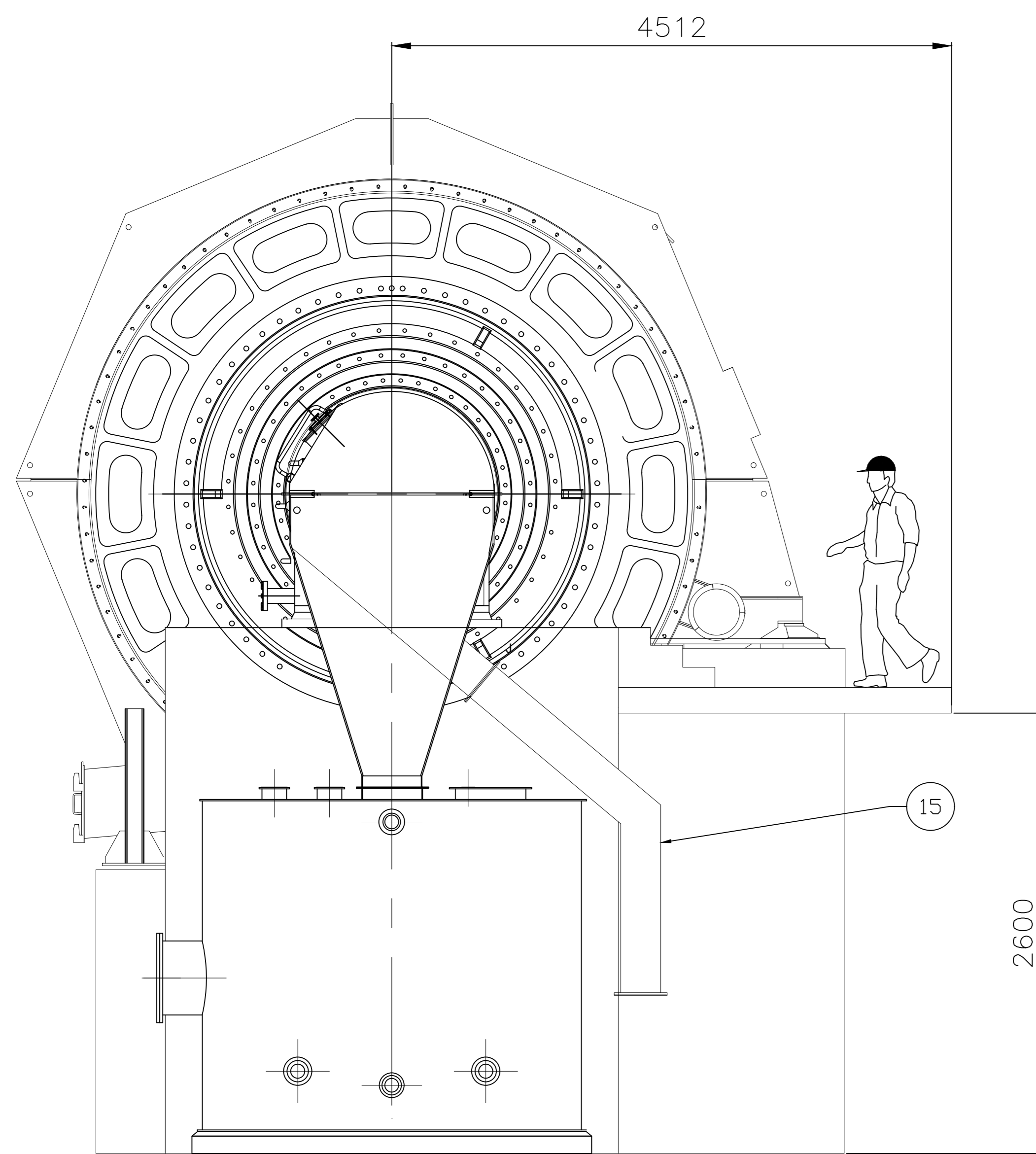
ITEM No:	DESCRIPTION	QUANTITY/MILL
01	BALL MILL SHELL ASSLY (Inner Diameter X length: ϕ 2.9m X 5m)	01
02	CHEEK WITH TRUNNION_NON DRIVE END	01
03	CHEEK WITH TRUNNION_DRIVE END	01
04	MILL SUPPORT BEARING ASSLY	02
05	INLET HOOD ASSLY	01
06	GIRTH GEAR & GIRTH GEAR HSG ASSY	01
07	DRIVE SHAFT WITH PINION	01
08	PINION BEARING HOUSING-NDE	01
09	PINION BEARING HOUSING-DE	01
10	COUPLING BETWEEN MAIN REDUCER & DRIVE ASSY	01
11	MAIN REDUCER (GEAR BOX)	01
12	MAIN MOTOR	01
13	INCHING REDUCER ASSEMBLY WITH INCHING MOTOR	01
14	DISCHARGE HOOD ASSLY	01
15	REJECT CHUTE	01
16	SLURRY TANK	01
17	COUPLING BETWEEN MAIN MOTOR & MAIN REDUCER	01
18	MILL LINERS	01 SET
19	TROMMEL SCREEN	01



ANNEXURE-4

WET BALL MILL DETAILS

- MILL CAPACITY : 15 TPH
- NO: OF MILLS : 1 (WORKING) +1 (STANDBY)
- MOTOR RATING : 540 KW
- INCHING MOTOR RATING : 15 KW
- RPM OF MAIN MOTOR : 985 RPM
- RPM OF WET BALL MILL : 18.95 RPM
- DIRECTION OF ROTATION : ANTICLOCKWISE (VIEWED FROM DRIVE END-GIRTH GEAR SIDE)
- BALL CHARGE QUANTITY : 39.5 Tons



NOTES:

- ALL DIMENSIONS ARE IN MM.
- THE MAXIMUM WEIGHT OF SINGLE COMPONENT TO BE HANDLED DURING MAINTENANCE IS MOTOR AND WEIGHT IS 7850 KGS.

BHEL-PROJECT ENGINEERING MANAGEMENT(OVL)	
THIS DRAWING MARKED (✓) IS RELEASED FOR	
<input type="checkbox"/>	COMMENTS/APPROVAL
<input type="checkbox"/>	PLANNING/INFORMATION
<input type="checkbox"/>	CONSTRUCTION
STAMP ALL PREVIOUS REVISION AS SUPERSEDED	
ISSUED BY	
NAME	--
SIGNATURE	--
DATE	16.08.2020

CUSTOMER:	एनएलसी तमिलनाडु पावर लिमिटेड NLC TAMILNADU POWER LIMITED
CONSULTANT:	M/s DEVELOPMENT CONSULTANTS PVT LTD
PACKAGE:	FLUE GAS DESULPHURIZATION SYSTEM (FGD) PACKAGE
PROJECT:	NLC TAMILNADU POWER LIMITED (NTPL) 2x500 MW COAL FIRED UNITS AT TUTICORIN
DEPT CODE:	BHARAT HEAVY ELECTRICALS LTD RC PURAM, HYDERABAD
NAME:	DRN SHARIF
SIGN:	K PAVAN
DATE:	AMAN KHORR
TITLE : GENERAL ARRANGEMENT OF WET BALL MILL	
DRAWING NO. 0-00-620-87128	
SHEET 1 OF 1	

JOB NO.	483
STATUS	CONTRACT
DRG./REF. NO. (INTERNAL)	
PRINT SCALE IN METRE	0 2 4 6 8 10 20 30 40 50

CAD FILE NAME: C:\Users\2209578\Desktop\piping\Tuticorin\0-00-620-87128-500-R000.dwg
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PROJECT	NTPL 2x500 MW PROJECT, TUTICORIN – FGD SYSTEM PACKAGE
FGD	WET LIMESTONE BASED FGD SYSTEM
PARAMETERS	SELECTION PARAMETERS FOR WET BALL MILL

2.0 LIMESTONE ANALYSIS/CHARACTERISTICS

ANNEXURE-5

The following limestone property to be used designing Limestone grinding system



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

TABLE-VII

PROPERTIES OF LIMESTONE

Limestone is proposed to be brought by Trucks to the plant. The limestone size is expected to be (-) 250 mm.

1.	CaO	%	47.5-51.0
2.	MgO	%	0.9-2.0
3.	Fe ₂ O ₃	%	0.45-1.0
4.	Al ₂ O ₃	%	1.19-2.1
5.	Si ₂ O ₃	%	2.1-4.5
6.	Mn ₂ O ₃	%	<0.12
7.	P ₂ O ₅	%	Traces
8.	Cl ₂	%	<0.015
9.	Na ₂ O	%	<0.16
10.	K ₂ O	%	<0.01
11.	TiO ₂	%	<0.02
12.	Total Sulphur	%	<0.1
13.	LOI	%	39.0-41.3

Physical Properties:

1.	Bond Index	kWh/t	13
2.	Granule size		Medium



Development Consultants Pvt. Ltd.

Page 7 of 7

Vol. II-A/Section-IX
Salient Design Data

Project: NTPL 2x500 MW PROJECT, TUTICORIN - FGD SYSTEM PACKAGE							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	21.07.2020				
Reviewer	PNR/ ACR	-sd-	21.07.2020				
Approver	RSB	-sd-	21.07.2020				



PROJECT	NTPL 2x500 MW PROJECT, TUTICORIN – FGD SYSTEM PACKAGE
FGD	WET LIMESTONE BASED FGD SYSTEM
PARAMETERS	SELECTION PARAMETERS FOR WET BALL MILL

3.0 WATER ANALYSIS

The following water to be used during the grinding process of limestone in Lime stone grinding system (LGS)



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

TABLE-II

TREATED WATER/ FGD PROCESS WATER QUALITY

Sr. Number	Item	Unit	Value
1.	<u>TDS of permeate from Desalination RO System</u>	ppm	<500
2.	Total Suspended solids	ppm	Nil
3.	Iron as Fe	ppm as Fe	<0.1
4.	Reactive Silica as SiO ₂	ppm as SiO ₂	<1.0
5.	Chloride as Cl	ppm as Cl	<200
6.	Sodium	ppm as Na	<150
7.	pH at 25 deg C	—	6.0-7.0



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Page 2 of 7

Vol. II-A/Section-IX
Salient Design Data

Project: NTPL 2x500 MW PROJECT, TUTICORIN - FGD SYSTEM PACKAGE							
Cont No: G515 & G516		Rev 00		Rev 01		Rev 02	
		Sign	Date	Sign	Date	Sign	Date
Engineer	MVR	-sd-	21.07.2020				
Reviewer	PNR/ ACR	-sd-	21.07.2020				
Approver	RSB	-sd-	21.07.2020				

ANNEXURE-6

Customer: NTPL
Project: TUSICORIN

Material Feed	15	t/h
Spec. Gravity	2700	kg/m3
Moisture	0	%

Limestone: 0-25 mm.

Grinding water		
Material Feed	8.5	t/h
Spec. Gravity	1000	kg/m3
Flow	8.5	m3/hr.

Dilution water		
Material Feed	26.5	t/h
Spec. Gravity	1000	kg/m3
Flow	26.5	m3/hr.

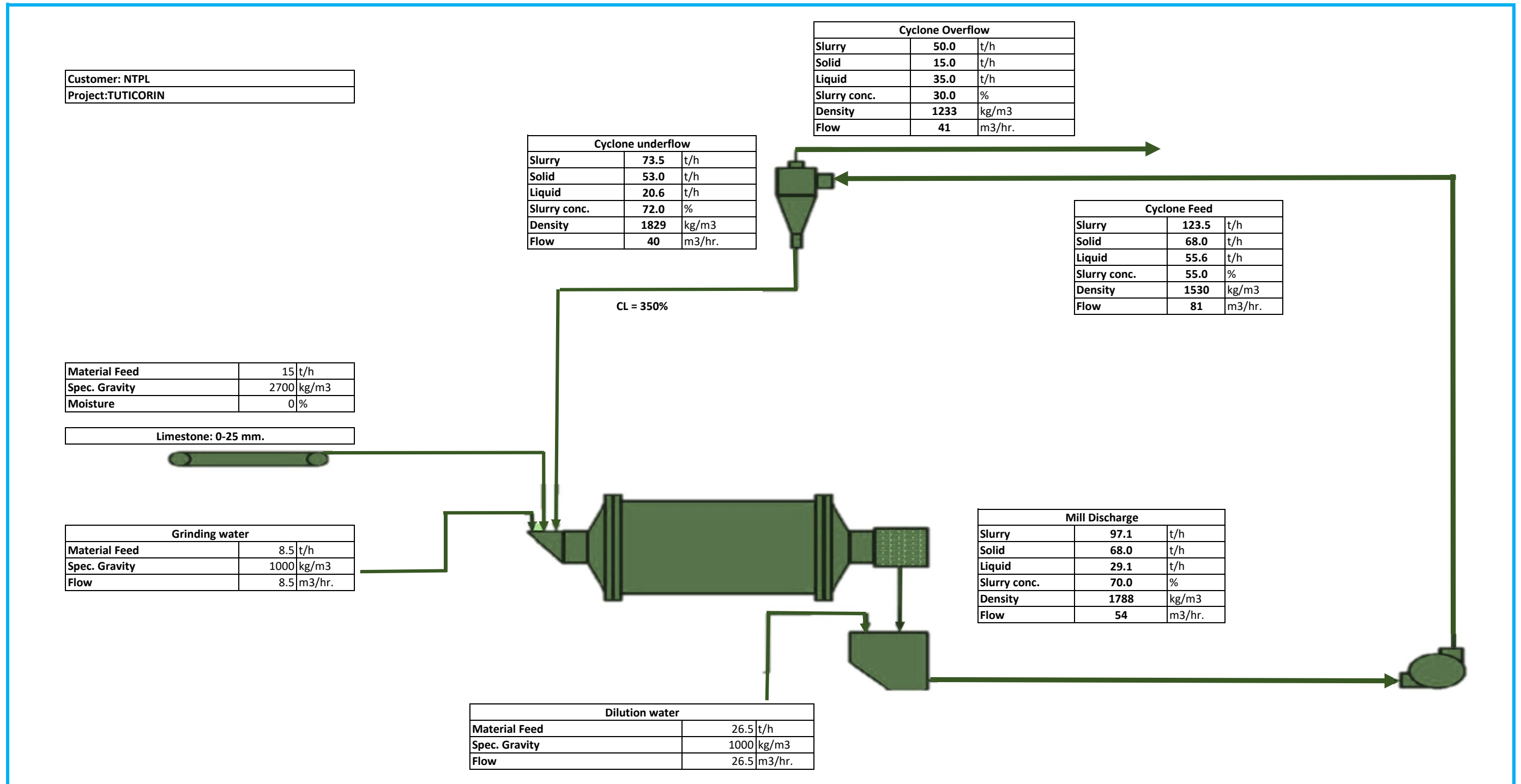
Cyclone underflow		
Slurry	73.5	t/h
Solid	53.0	t/h
Liquid	20.6	t/h
Slurry conc.	72.0	%
Density	1829	kg/m3
Flow	40	m3/hr.

Cyclone Overflow		
Slurry	50.0	t/h
Solid	15.0	t/h
Liquid	35.0	t/h
Slurry conc.	30.0	%
Density	1233	kg/m3
Flow	41	m3/hr.

Cyclone Feed		
Slurry	123.5	t/h
Solid	68.0	t/h
Liquid	55.6	t/h
Slurry conc.	55.0	%
Density	1530	kg/m3
Flow	81	m3/hr.

Mill Discharge		
Slurry	97.1	t/h
Solid	68.0	t/h
Liquid	29.1	t/h
Slurry conc.	70.0	%
Density	1788	kg/m3
Flow	54	m3/hr.

CL = 350%





CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTENT OF SPECIFICATION	1
2.00.00	FGD PLANT CONTROL PHILOSOPHY	1
3.00.00	GENERAL PERFORMANCE REQUIREMENT	2
4.00.00	PROVEN PRODUCT	3
5.00.00	WARRANTY	3
6.00.00	DESIGN CRITERIA	3
7.00.00	CODES AND STANDARDS	10
8.00.00	GENERAL REQUIREMENTS	16
9.00.00	TYPE TEST	20
10.00.00	TRAINING	26





VOLUME: II-E

SECTION-I

GENERAL TECHNICAL REQUIREMENTS

1.00.00 INTENT OF SPECIFICATION

1.01.00 This part of the specification is intended to provide the technical guidelines for the Control & Instrumentation system with auxiliaries and accessories for Flue Gas De-sulphurization (FGD) package for 2 x 500 MW of M/s NLC Tamilnadu Power Limited (NTPL) at Tuticorin, in Tamil Nadu.

1.02.00 Bidder shall provide all material, equipment and deliverables so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipment ensuring operability, maintainability and reliability. The Instrumentation and Control System shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

1.03.00 Bidder shall also include in his proposal and shall furnish all equipment, devices and deliverables which may not be specifically stated in the specification but are needed for completeness of the equipment / systems furnished by the Bidder and for meeting the intent and requirements of the specification.

1.04.00 Wherever quantity is indicated, the same refers to only one set per generating unit to be furnished by the Bidder, unless specifically indicated otherwise.

1.05.00 It is not the intent to completely specify all details of design and construction features herein. Nevertheless, the instruments / equipment and their installation shall conform to high standards of engineering design and workmanship in all respects.

1.06.00 In the event of conflict between requirements of any two clauses of this specification / documents or requirements of different codes / standards specified, the more stringent requirements as per the interpretation of the Owner / Consultant shall apply.

2.00.00 FGD PLANT CONTROL PHILOSOPHY

2.01.00 FGD control system shall operate under all operating conditions from a dedicated PLC based Control system. The control system shall be unit wise. HMI Stations shall be located in FGD common Control Room.

One Remote Input/ Output Unit of the PLC shall be considered for each unit





for achieving data acquisition from the Station DCS in the CCR.

- 2.02.00 Hardwired interfacing shall be provided with Station DCS for time critical, interlock, control & protection signals. Further PLC based control system for FGD shall be connected to Station DCS through redundant soft communication link (OPC over Ethernet based TCP/IP) for the information exchange through Station wide LAN.
- 2.03.00 The FGD PLC shall be time synchronized with the GPS Master Clock System of the existing Main Plant.
- 2.04.00 Relay based local control panels may be required for a few sub-systems having interfaces with FGD PLC for limited control & monitoring of parameters. Local control panels will be provided at strategic points (including material unloading, all major equipment & sub-system) to allow for local operation of the plant.
- 2.05.00 Control & monitoring of electrical distribution system, namely PCC, bus coupler, incomer etc. for FGD system shall also be controlled from the PLC based control system for FGD as well as from respective switchgear unit.
- 2.06.00 Refer Drawing no. 17A14-DWG-I-001 (Control System Configuration Diagram for FGD Plant) for overall control system architecture for FGD plant.
- 2.07.00 The Local Control Room near chimney for FGD Plant System shall be partitioned to different rooms to house the following equipment in general.
- a) Control Desk for Operator Stations, Operator cum Engineering Stations, Printers and associated furniture in the Operation Area
 - b) System cabinets & Marshalling cabinets in the Electronic Cubicle Room adjacent to Operation Area
 - c) Uninterrupted Power Supply System (UPS) in UPS Room
 - d) Battery Room
- 3.00.00 **GENERAL PERFORMANCE REQUIREMENT**
- 3.01.00 All instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in different sections of the specification.
- 3.02.00 Control & Instrumentation system shall be proven design and from the latest state of the art technology. Any predictable or planned deterioration and / or obsolescence of equipment shall be clearly brought out in the bid.
- 3.03.00 All instruments / equipment shall be capable of performing satisfactorily in continuous commercial operation conforming to all relevant codes and regulatory requirement under the specified environmental conditions and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion or other such operating troubles.





- 3.04.00 Instrumentation & Control system shall not impose any limitation or constraint on the operation of the main equipment. It shall be possible to utilize any in-built over capacity in design of any equipment with complete controllability and observability.
- 3.05.00 Mean Time Between Failure (MTBF) of the instruments shall be considerably higher than the equipment they shall cater to in order to avoid shutdown on account of instrumentation failure.
- 4.00.00 **PROVEN PRODUCT**
- 4.01.00 All equipment, systems and accessories furnished under this specification shall be from the latest proven product range of a reputed experienced manufacturer whose successful performance has been established by a considerable record of satisfactory operation in similar plants. Bidder shall furnish satisfactory evidence regarding successful operation and high reliability of the proposed equipment / systems in similar applications for meeting this requirement as specified elsewhere.
- 5.00.00 **WARRANTY**
- Refer Vol IIA of specification.
- 6.00.00 **DESIGN CRITERIA**
- This section lays down the general design criteria to be adapted in designing the instrumentation and control system of the FGD plant.
- 6.01.00 **General**
- 6.01.01 Instrumentation, control and automation shall be designed manufactured and installed taking into consideration the philosophy to satisfy the following requirements:
- a) State-of-the-art proven technology.
 - b) Maximum safety for plant personnel & equipment.
 - c) Reliable and efficient operation under all operating condition.
 - d) High system availability by introduction of adequate redundancies at various levels and low down time.
 - e) Diagnostics capability to pinpoint failure areas.
 - f) Use of public domain software and hardware for easy up gradation.
 - g) System flexibility and modular expansion capability. Modular System design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for hardware expansion through the



addition of controller modules, I/O cards, peripherals etc., while the existing system is fully operational.

6.01.02 Instrumentation, control and automation devices and accessories shall be designed with the following considerations:

- a) Stable in spite of temperature fluctuations.
- b) Able to withstand high humidity.
- c) Weather proof.
- d) Dust proof.
- e) Corrosion resistant.
- f) Erosion resistant.
- g) Able to withstand high vibration.
- h) Easily accessible for operation & maintenance.

6.01.03 Latest version of hardware and software available at the time of system designing shall be provided. In case of future up-gradation of software, Bidder shall remain committed to upgrade the supplied system with the new version within the warranty period, without any additional cost.

6.01.04 Bidder shall ensure that supplied controls & instruments should be supported by the supplier such that spare parts are guaranteed to be available for purchase for a period of 15 (fifteen) years. Similarly the service shall also be guaranteed for a period of 15 (fifteen) years.

6.01.05 For the sake of completeness of the system for each application and in order to ensure desired performance & safety measures, any hardware or software item as required, shall be in the scope of Bidder irrespective of their explicit or implicit inclusion in the accompanying document. Bidder shall be responsible for proper functioning of the system as a whole or any part thereof and shall render guarantee for all addition/deletion.

6.01.06 Control systems shall have their independent redundant Electronic Earth pits for system grounding. These earth pits shall be separate from the Electrical earth pits and located away from the HT equipment. FGD control system (PLC based) shall have independent redundant Electronic & Electrical Earth pits.

6.02.00 **Standardization and Uniformity of Hardware**

To ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management of various I&C instruments / equipment, the Bidder shall make reasonable efforts that all instruments / devices are of the same make, series and family of hardware. For example, all 4-20mA





electronic transmitters / transducers, control hardware, control valves, actuators and other instruments / local devices etc. being furnished by the Bidder for entire FGD Systems shall be of the same make and series for similar applications, except for the instrument integral to equipment such as Compressor etc. which may be manufacturer specific.

6.03.00 **Reliability & Availability**

6.03.01 All components and systems offered shall be of established reliability. The minimum target reliability of each component / module shall be established by taking into consideration its Mean time between failure (MTBF) and Mean time to repair (MTTR), such that the availability of the complete system is assured for 99.7%.

6.03.02 In order to establish the target reliability, Bidder shall perform necessary availability tests for major systems. Burn-in / Elevated Temperature test reports, not older than 5 (five) years shall be furnished for Owner / Consultant review. Surge protection for solid state systems, selection of proper materials, manufacturing processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured to meet the reliability and life expectancy goals.

6.03.03 Redundancy and continuous self-checking features shall be incorporated in system design with automatic transfer to healthy redundant circuits to enhance the reliability of the complete system.

6.03.04 To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criteria of 99.7%. For the protection system, independent sensing device shall be provided to ensure adequate safety of plant equipment.

6.04.00 **Operability & Maintainability**

6.04.01 The system shall be designed such that any 'single-failure' should not lead to loss of availability of the plant, modification in operating routine or degradation of performance. This shall be achieved by judicious introduction of redundancy at all critical levels like providing redundant power supply, hot-standby multi loop controllers, redundant IO modules (for all critical application), redundant IO network and data highways, redundant communication modules, duplicating console functions and servers and redundant field instruments. The plant operator remains totally transparent to 'single-failures'.

6.04.02 Control system shall be designed in a fail safe mode so that loss of signal, loss of excitation, loss of motive power or failure of any component shall not cause a hazardous condition for the plant & personnel and at the same time prevent occurrence of false trips. All modulating control valves shall be in stay put condition during any of the above failures.

6.04.03 Control consoles shall be designed for operation of the FGD system with





minimum operational manpower deployment. Bidder shall ensure proper operability and also take into account protections to minimize accidental mal-operations.

6.04.04 On-line testing, self-checking & diagnostic facility of control system shall be provided with indication for easy identification of the faulty module, while the unit is in operation. The system shall continuously check health of its modules including its redundant part and shall permit carrying out of the on-line dynamic test and self-diagnostic checks while maintaining safe condition without endangering the safety of equipment and without having any influence on the process being controlled.

6.04.05 Intercommunications in between sub-racks and system termination cabinets and in between sub racks and other panels shall be made by prefabricated connectors and cables with mechanical latch.

6.05.00 **Security and Failure Philosophy**

6.05.01 **General**

Control & instrumentation system shall meet the following requirements:

- a) No single failure shall cause the complete failure of the control.
- b) No single fault shall cause the protection system to spuriously operate or cause the protection system to become inoperative or / cause a trip or derate the unit.
- c) Due to control system failure if a final control element or plant item does not respond then that item or control element shall go into a fail-safe condition or in stay put condition as per the process requirement.
- d) Measure shall be taken on the action of IO due to loss and restoration of power. For example dual outputs such as separate start and stop outputs for motor starters / breakers etc. shall be provided.
- e) Fault on a cable does not cause loss of more than a minimum tolerable functionality of the system.

To meet the above requirement, control system shall incorporate redundancy with continuous self checking so that any internal fault can be detected prior to resulting any disturbance in the process. Protection and safety systems shall incorporate both channel redundancy and measurement redundancy with self checking and adequate test facilities.

Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations are fully met.

6.05.02 **Measurement & Channel Redundancy**

To meet the failure and self-checking criteria for the control system, measurement redundancy shall be provided for all the critical parameters.





Throughout the control system the security and validity of signals are to be ensured adhering to the following design principles.

- a) Where a plant measurement is to be duplicated or triplicated such signals shall be separately fed to the different input modules.
- b) Signals after the security and validity checking by means of voting, averaging, median, difference monitoring or similar technique shall be transmitted to the control functions of sequencing, modulating and protection.
- c) Where double measurements are used, provision shall be made for the selection of either measurement as the duty signal and continuous monitoring of difference between the signals.
- d) For binary and analog inputs, which are required for protection of more than one equipment as well as protection signals for HT drives, triple sensing devices / signals shall be provided.
- e) For binary and analog inputs required for other modulating control, protection and interlock conditions purpose of their equipment and other critical monitoring applications etc. minimum dual instruments/sensors shall be provided.
- f) Dual instruments / sensors shall be provided for instruments required for auto-starting of pumps or pump tripping due to discharge pressure very low.
- g) Measurement system, CLCS and OLCS shall all be configured with redundancy at processor modules, communication modules, data bus and power supply modules. All servers shall be dual redundant.
- h) Redundancy in input / output modules
 - i) Wherever redundant sensors are employed each sensor shall be wired to a separate input module so that even if one input module fails, the parameter shall be available from the other input module.
 - ii) Redundancy in input / output module shall be provided for all HT (11KV & 3.3 KV) drives, critical LT drives and critical modulating control drives so that any single failure of the input / output module shall not lead to the failure / disturbance of process. Critical LT drives/ modulating control drives shall be finalized by the Owner / Consultant at the time of Detail engineering.

i) Data Highway Redundancy

There shall be Redundancy in the system for high reliability of communication. The redundant buses shall work continuously. All communication modules, bus couplers, bus interfaces etc. shall also be hot redundant.

Communication between the operator station and the PLC control processors shall be by means of hot redundant data highways. Redundancy failure shall also be indicated in operating station.

All soft links amongst various PLC / proprietary control systems / Station DCS shall be redundant.





- j) Redundancy for Power supply unit
All power supply feeders from UPS (in parallel mode having 50% load sharing) shall be redundant with auto changeover in each ACDB / DCDB panel. Any kind of bulk power supplies if used shall be redundant.
- k) Redundancy in Operator Console
Operators' Consoles shall have fall back feature so that in case of failure of any console, its functions can be taken up in an adjacent console.

6.05.03 Each C&I cables shall have at least 20% or one no., whichever is maximum, spare wire capacity above the used cores for future maintenance.

6.06.00 **Instrument Accuracy, Standard Scales and Ranges**

6.06.01 **Instrument Accuracy**

- a) Accuracy of linear instruments shall meet the specified accuracy over its span.
- b) Flow meter shall meet the specified accuracy criteria when operating between 25 and 100 percent of full-scale flow value. The accuracy guarantee shall include the effect of errors in the differential head measuring device, square root converter and signal generator.
- c) Level measurement shall be linear with respect to the measured level based on a specific gravity of 1.00.
- d) Wherever the measured parameter like flow is influenced by process pressure & temperature, required correction against pressure and temperature shall be introduced for such measurement.
- e) Temperature compensation shall produce corrections over a flow range from 10 percent to 100 percent of maximum flow subject to a plus or minus tolerance of one-half of one percent of the maximum flow.

6.06.02 **Instrument Scale Displays**

- a) All displays shall be in engineering units. Instrument scales displayed on screen shall have graduations with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.
- b) Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure, respectively.



- c) Scales and charts of all instruments shall have linear graduations

6.06.03 **Instrument Ranges**

Unless otherwise impractical, Instrument range shall be selected in such a way so that the normal reading lies within 50% to 70% of full scale for linear parameters and within 70% to 90% of full scale for flow measurements. Deviation indicators shall have the null position at mid-scale. The normal operating parameter shall be identified with a clear green mark.

6.07.00 **Environmental Conditions**

- 6.07.01 Control & Instrumentation system shall be suitable for continuous operation in the environmental condition as per the project metrological data provided elsewhere in the specification and shall meet the minimum design requirement of 50°C and 95% RH.

Equipment which cannot meet the stipulated environmental condition shall be installed in air conditioned environment..

- 6.07.02 Particulate contamination from fly ash and coal dust and gaseous contaminants such as SO₂ and other flue gas constituents in the plant can have deleterious effect on printed circuit board, connectors and components. This hazard shall be taken into design considerations.

- 6.07.03 Instruments, devices and equipment for location in outdoors/ indoor/ air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment and also during periods of air conditioning failure without any loss of function, or departure from the specification.

SL. NO.	LOCATION	ENCLOSURE TYPE
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-54
2.	Indoor type ventilated enclosure in non-hazardous area	IP -42
3.	Enclosure in Air conditioned area	IP-32 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-65 with anticorrosion coating.
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location



6.08.00 **Name plate**

6.08.01 Each instrument / item of plant shall have nameplate, permanently attached to it in a prominent position, made of non-hygroscopic & non-corrosive material (generally stainless steel) upon which is to be engraved as per the existing philosophy.

6.08.02 Stainless steel tag plate shall be wired to the instrument. Inscription on equipment (labels) shall be in English.

6.08.03 Caution / Danger & Hazardous name plates shall be in English, Tamil & Hindi.

7.00.00 **CODES AND STANDARDS**

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

- a) American National Standards Institute (ANSI)
- b) American Petroleum Institute (API)
- c) American Society of Mechanical Engineers (ASME)
- d) American Society of Testing and Materials (ASTM)
- e) American Water Works Association (AWWA)
- f) American Welding Society (AWS)
- g) British Standards (BS)
- h) Deutsches Institut fur Normung (DIN), Germany
- i) Heat Exchange Institute (HEI), USA
- j) Hydraulic Institute Standards (HIS), USA
- k) International Electro-technical Commission (IEC)
- l) Institute of Electrical and Electronics Engineers (IEEE)
- m) International Organisation for Standardization (ISO)
- n) National Electric Code (NEC), USA
- o) National Electrical Manufacturers Association (NEMA), USA
- p) National Fire Protection Association (NFPA), USA
- q) Tubular Exchanger Manufacturers Association (TEMA), USA
- r) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany



Other International Standards, equivalent or superior to the above Standards can also be adopted. However, in the event of any conflict between the requirements of the International standards / codes and the requirements of the BIS standards / codes, the latter shall prevail.

7.02.00 The following latest edition of codes and standards prevailing at the time of award of contract shall generally be applicable.

1) **Temperature Measurement**

- a) Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
- b) Temperature Measurement - Thermocouples - ANSI - MC 96.1 - 1982.
- c) Temperature Measurement by electrical resistance thermometers - IS: 2806
- d) Thermometer-element-Platinum resistance - IS: 2848 / DIN 43760.

2) **Pressure Measurement**

- a) Instrument and apparatus for pressure measurement - ASME PTC 19.2 (1964).
- b) Bourdon tube pressure and vacuum gauges - IS: 3624/1996.

3) **Flow Measurement**

- a) Instruments and apparatus for flow measurement - ASME PTC 19.5 (1972) Interim supplement, Part-II.
- b) Measurements of fluid flow in closed conduit - BS 1042.

4) **Electronic Measuring Instruments and Control Hardware**

- a) Automatic null balancing electrical measuring instruments -ANSI C 39.4 (Rev. 1973), IS 9319
- b) Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 / 1974.
- c) Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1: ANSI MC 12.1 / 1975.
- d) Dynamic response testing of process control instrumentation - ANSI MC 4.1 (1975) - ISA -S26 (1968).
- e) Surge withstand capability (SWC) tests - ANSI C 37.90A (1989), IEC / EN 61000-4-4 & IEC / EN 61000-4-5.





- f) Printed circuit boards – IPC-TM-650, IEC 326-2 & IEC 326-4.
 - g) General requirements and method of tests for printed wiring boards - IS-7405 (Part-I) /1994, IEC 326-2.
 - h) Edge socket connectors - IEC 130-11.
 - i) Requirements and methods of testing of wire wrap terminations-- DIN 41611 Part-2.
 - j) Dimensions of attachment plugs and receptacles- ANSI C73-1973.(Supplement ANSI C73a – 1980)
- 5) **Instrument Switches and Contacts**
- a) Contact Rating - AC services NEMA ICS Part-2 125, A-600
 - b) Contact Rating - DC services NEMA ICS Part-2 125, N-600
- 6) **Enclosures**
- a) Enclosures for Industrial Controls and Systems–NEMA ICS-6-110.15 through 110.22
 - b) Racks, panels and associated equipment -EIA: RS-310-B-1983 (ANSI C83.9 - 1972)
- 7) **Apparatus, Enclosures and Installation Practices in Hazardous Area**
- a) Classification of hazardous area - NEMA Article 500, Volume-6, 1978.
 - b) Electrical Instruments in hazardous dust locations - ISA-RP 12.11.
 - c) Intrinsically safe apparatus - NFPA Article 493 Volume-4 1978.
 - d) Purged and pressurized enclosure for electrical equipment in hazardous location - NFPA Article 496 Volume-4, 1978.
- 8) **Annunciators**
- a) Specifications and guides for the use of general-purpose annunciators - ISA 18.1- (1979) (R2004).
 - b) Surge withstands capability tests - ANSI C37.90 -1989 / IEC /EN 61000-4-4 & IEC /EN 61000-4-5.
- 9) **Interlocks, Protections**



- a) Relays and relay system associated with electric power apparatus - IEEE Standards 3.13.
 - b) Surge withstands capability tests - ANSI C37.90 a - 1971 and IEEE Standard 472-1974.
 - c) General requirements and tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I)/1973.
- 10) **UPS System**
- a) Practice and requirements for semi-conductor power rectifiers - ANSI C34.2.
 - b) Relays and relay systems associated with electrical power apparatus IEEE Standard - 3.13.
 - c) Surge withstands capability tests - ANSI C 70.90 A/1971, IEC-255.4.
 - d) Recommended practice for sizing large lead storage batteries for generating stations and sub-stations -IEEE-485.
- 11) **Control Valves**
- a) Control valve sizing (Incompressible fluids) - ISA-S39.1 / 1972.
 - b) Control valve capacity test (Incompressible fluids) -ISA-S39.2 / 1972.
 - c) Control valve sizing (Compressible fluids) - ISA-S39.3 / 1972.
 - d) Control valve capacity test (Incompressible fluids) -ISA-S39.4 / 1972.
 - e) Control Valve seat leakage – ANSI / FCI 70.2
 - f) Face to face dimensions of Control Valves - ANSI B16.10
 - g) Control Valve Capacity Test Procedure – ISA – 575.02
- 12) **Instrument Tubing**
- i) Seamless Carbon Steel Pipe - ASTM-A-106.
 - ii) Forged carbon steel fittings - ASTM-A-105.
 - iii) Dimensions of fittings - ANSI-B16.11.



- iv) Code for pressure piping, welding, hydrostatic testing - ANSI-B 31.1.
 - v) Nomenclature for instrument tube fittings - ISA-RP 42.1 / 1982.
 - vi) Seamless Stainless Steel Tube ASTM A-213 TP 316 / ASTM A-269 TP 316
 - vii) Seamless Alloy Steel Pipe ASTM A 335 P22
 - viii) Seamless Stainless Steel Pipe ASTM A-312 TP 316
- 13) **Cables**
- a) Thermocouple extension wires / cables - ANSI MC96.1.
 - b) Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy-IPCEA S-61-402
 - c) Guide for design and installation of cable system in power generating station (insulation, jacket materials)-IEEE Standard 422.
 - d) Requirements of vertical tray flame test - IEEE 383
 - e) Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B33.
 - f) Specification for PVC insulated (heavy duty) electric cables or (Latest revision) equivalent - IS-1554 Part-1
 - g) Conductors for insulated electric cables and flexible cords or equivalent - IS-8130, 1984
 - h) PVC insulation and sheath of electric cables or equivalent - IS-5831
 - i) PVC insulated cables for working voltage upto and including 1100 volts or equivalent - IS-694 (Latest)
 - j) Mild steel wires, formed wired and tapes for armouring of cable or equivalent - IS-3975
 - k) Test on single vertical insulated wire or cable - IEC 332 (Part-1)
 - l) Swedish Chimney Flame Test - SS 424-1475
 - m) Test methods for insulations and sheaths of electric cables and cords - IEC 540



- n) Colour coding of instrumentation cables - VDE 0815
 - o) Minimum oxygen concentration to support candle-like combustion of plastics - ASTM D2863
 - p) Density of smoke from the burning of decomposition of plastics - ASTM D2843
 - q) Test on gases evolved during combustion of materials from cables - IEC 754
 - r) Determination of the amount of halogen acid gas - IEC 754 (Part-1)
 - s) Methods of test for cables - IS 10810
 - t) Drums for electric cables - IS: 10418
- 14) **Electronic Cards, Subassemblies and Components**
- a) **Unpackaged**
 - i) Vibration : IEC-68.2.6
 - ii) Shock : IEC-68.2.27
 - iii) Drop & Topple : IEC-68.2.31
 - b) **Packaged**

Vibration, Drop & Static Compression - NSTA.
 - c) **Electromagnetic Compatibility / Immunity**
 - i) Electrical Fast Transient immunity : IEC / EN 61000-4-4
 - ii) Surge Immunity : IEC /EN 61000-4-5
 - iii) Radiated Electromagnetic Field : EN 61000-4-3
 - iv) Electrostatic Discharge immunity : EN 61000-4-2
 - v) Electromagnetic Emissions : VDE 0871, Class-B
- 15) **Cable Trays, Conduits**
- a) Guide for the design and installation of cable system in power generating station (cable trays, support systems, conduits)- IEEE Standard 422, NEMA VE-1, NEC-1981. Test Standards NEMA VE-1-1979.
 - b) Galvanizing of carbon steel cable trays - ASTM A-386.



- 8.00.00 **GENERAL REQUIREMENTS**
- 8.01.00 Integrated Programmable Logic Controller (PLC) based closed loop control, open loop control and sequential control and bulk data acquisition system for FGD System in hierarchical levels has been envisaged for the plant.
- 8.02.00 Suggestive Control System Architecture for the FGD control system is schematically shown in Drawing No. 17A14-DWG-I-001. Bidder shall develop detail drawing based on this technical specification.
- 8.03.00 All field process transmitters shall be smart (HART based) type.
- 8.04.00 Final control device for regulating duty control shall have pneumatic actuator with HART based smart pneumatic positioners. Actuators for isolating and inching duty valves shall be, in general, electrical motor operated. Solenoid operated pneumatic actuator will be used for on-off duty control valves All the position limit switches employed in the pneumatic on-off valves shall be non-contact type.
- 8.05.00 Process switch (Pressure / Level switch) function shall generally be derived from analog process transmitters.
- 8.06.00 Process transmitter and valve positioner shall communicate with the PLC in the form of analog signal 4-20 mA DC along with superimposed digital signal through HART protocol. Separate handheld smart configurator shall be furnished for local and manual configuration / adjustment of all HART instrument / devices.
- 8.07.00 Power supply for Transmitters, contact interrogation, relay and solenoid shall be generally 24V DC. Power supplies for interrogation, relay and solenoid shall be provided from Bulk power supply modules separate from control system rack power supply. In all cases redundancy in power supplies & modules shall be considered.
- 8.08.00 Temperature measurement shall have upscale / down scale protection features to protect from process upset in case of sensor failure. Both the elements of duplex temperature sensors shall be brought to junction boxes.
- 8.09.00 Temperature transmitters shall be provided for all control applications. Transmitter shall be two wire type and current output of 4-20 mA DC with superimposed digital signal in HART protocol. For temperature monitoring functions, temperature elements (TC / RTD) shall be connected to their respective input module of PLC through instrumentation signal / Triad cable in case of RTD type element, extension / compensating cable for K type TC.
- 8.10.00 All alarm and trip signal shall be configured in NC mode of configuration so that any breakage in the wire can be identified with alarm.
- 8.11.00 Bidder shall be fully responsible for safe and efficient operation of the control





loops and interlock / protection logic even under all plant disturbances, disabilities, emergencies and component failures.

- 8.12.00 Critical maintenance purpose manual isolation valves of equipment, suction valves of critical pumps shall have open & close end position status indication at PLC.
- 8.13.00 All regulating duty control valves shall have mechanical position indicator and contact less position transmitter (4-20mA DC output) for monitoring the position from local and control room respectively. Air lock relays shall be provided with all regulating duty pneumatic drives to achieve stay put / fail safe condition on air failure. Hand wheel shall be provided for local operation. Pneumatic tubing for the control valve hook up including integral tubing of valve shall be of stainless steel material.
- 8.14.00 Motor winding temperature of HT motors and bearing temperature of HT motors & driven equipment shall be measured in all cases. In general bearing & winding temperature shall be measured with Duplex Resistance temperature detector (RTD).
- 8.15.00 Bearing temperatures of any equipment driven by H.T. motors shall be provided with direct mounted dial Temperature gauge at each bearing of driven equipment and motor.
- 8.16.00 All temperature-measuring elements (RTD / TC) shall be of duplex ungrounded type and both the elements shall be terminated at junction box. Extension / Compensating cable for TC and Triad cable for RTD shall be used for interfacing with PLC. Temperature elements shall be supplied with thermowell.
- 8.17.00 Flow Elements with Flow Transmitters & Flowmeter (Electro-magnetic type, Coriolis mass flow) for flow measurement of process medium like water, air, flue gas, slurry etc. shall be provided by Bidder based on application and as approved by Owner. Wherever DP type transmitter is used for flow measurement, square root extraction is to be performed in the PLC based system.
- 8.18.00 Pressure gauges, pressure switches and pressure / differential pressure transmitters shall be provided with diaphragm seal in case of dirty, corrosive & viscous fluid application. Diaphragm material shall be suitable for process fluid. Similarly the wetted part material for level transmitter / switches / gauges / analyzers in corrosive application shall have suitable grade material compatible with the corrosive fluid in contact. In all other cases material grade of the wetted part shall in no case be lower than stainless steel unless the process fluid calls for some other material.
- 8.19.00 Ergonomically & aesthetically designed furniture viz. control desks & chairs shall be provided at the local control room for various workstations. Similarly, furniture shall be provided for equipment like programming stations, PCs and various peripherals. Control desk and Video wall shall be from reputed





manufacturer/s. Local control room interior shall be designed with latest state of the art design prevailing in the modern power plant.

8.20.00 KKS identification system shall be adopted for the tagging. Bidder shall follow the KKS Tag numbering philosophy while preparing all instrumentation & control related documents.

8.21.00 The SI / MKS system of units shall be used for design, drawings, diagrams, instruments etc.

8.22.00 **Vibration Monitoring System**

Microprocessors based standalone online Vibration Monitoring System (VMS) shall be provided for rotating machine condition monitoring & diagnostic. On-line Vibration Monitoring System shall be provided for all HT drives (160 KW & above).

Each HT drive (160 KW & above) shall be provided with vibration sensors on the DE and NDE bearings of motors and fans / pumps. On each bearing there shall be two vibration sensors, one in X direction and other in Y direction along with key phasor for on line vibration monitoring and analysis.

Each vibration monitoring panel shall have local LCD display mounted on the panel.

8.23.00 **Process Connection & Instrument Hook Up (as applicable)**

Instruments	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
Level Instruments		
Internal Displacer	4" – Flanged	4" - Flanged
External Displacer	2" – Flanged	2" - Flanged
Level gauge	¾" –Flanged	¾" - Flanged
DP Type	½" (min.)-welded 1" – welded for vessel like HP heaters, LP heaters, De-aerator etc. application	½"- NPT
External cage Level switch	1"- welded	1"- welded
Flow Instruments		



Instruments	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
DP Type	1/2" - welded in general 1" - welded for high pressure / temperature main steam, feed water, PRDS etc. application	1/2" - NPT
Pressure Instruments		
Conventional	1/2" (min.)-welded 1"- welded for high pressure/ temperature. application	1/2" - NPT
Diaphragm type-HFO application	3"- Flanged	3"- Flanged
Temperature Instruments		
Thermowell	Generally - M 33 X 2 (M) 1 1/2" Flanged- For air/FG path application	1/2" NPT
Analyzer		
Liquid analyzer	1/2" - 1" - welded	1/2"

8.24.00

Electrical Power Supply Systems

240V AC Redundant Package UPS system with 60 minutes back-up to cater various C&I system loads in FGD control room including PLC, HMIs, field instruments / analyzers, Relay based Local Control Panel etc. and PLC / Proprietary control and monitoring system for package systems (if any), Vibration Monitoring System shall be provided by the bidder.

UPS Power supply (max. 1 kVA) required for the FGD C&I loads, located in main plant CCR, shall be made available to the bidder at purchaser ACDB terminals as single redundant feeder. Cabling from the purchaser ACDB to FGD load points/ ACDB is under the scope of the bidder.

DC power distribution for PLC and loop-powered field instruments shall be derived from the UPS supply and the required DC distribution boards will be located within PLC cabinets. Any other DC power supply required for the plant will also be suitably derived and distributed. (UPS specification shall be covered





in Electrical Volume)

8.25.00 **Instrumentation & Control Cabling**

8.25.01 Instrumentation cables shall be copper, overall screened for binary signals and individual & overall screened for analog signals. All cables shall be FRLS type (inner & outer sheath) and armoured. Inter panel cables inside Control Rooms may be unarmoured. All the unarmoured cables shall run through conduits.

8.25.02 Fiber Optic cables in the field shall be laid through HDPE conduits for buried section and through dedicated encased perforated GI trays for over-ground section.

8.25.03 Bidder to follow the the following philosophy

- 1) DI & DO signal cannot be routed through the same cable.
- 2) Single pair or single triad cable is not acceptable. Minimum of 2 pairs or 2 triad cable shall be used.
- 3) Each multi-pair or multi-triad cable shall have 20% or minimum 1 pair / 1 triad cable whichever is maximum as spare.

8.25.04 Cable size & type shall be as below for different type of signals and control system shall be followed in general.

- 1) Cables for analog signals will be instrumentation paired cable of 0.5 sq. mm copper conductor size, with individual pair shielding & overall shielding.
- 2) Cables for binary signals will be instrumentation paired cable of 0.5 sq. mm copper conductor size with overall shielding only.
- 3) Conductor cross section for triad signal cables will not have individual conductor cross section below 1.5 sq. mm.
- 4) For interposing relay drive connection individual conductor cross section will not be below 1.5 sq. mm.
- 5) Cables for power supply to each solenoid valves will be control cable of 3C x 2.5 sq. mm copper conductor size for all voltage level.

9.00.00 **TYPE TEST**

9.01.00 **General Requirements**

- a) The Bidder shall furnish the type test reports of all type tests as per relevant standards and codes as well as other specific tests indicated in this specification. List of major tests are furnished below for solid state equipment. For the balance systems & instruments, which are not indicated here, type tests may be conducted as per manufactures





standard or if required by relevant standard.

- b) The Bidder / sub-vendor / manufacturer is required to conduct certain type tests specifically for this project as specified in respective sections and to be witnessed by Owner / Consultant or their authorized representative, even if the same had been conducted earlier. In case Owner / Consultant decides to waive any of the Type tests for any item based on tests conducted by Bidder in the last five years, Test certificates for same shall be provided for review / acceptance and the final decision rests with Owner / Consultant.
- c) Submission of type test results and certificate shall be acceptable provided:
 - i) The same has been carried out by the Bidder / sub-vendor on exactly the same model / rating of equipment.
 - ii) There has been no change in the components of offered equipment from tested equipment.
 - iii) The test has been carried out as per the latest standards along with amendments.
- d) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the Bidder within the quoted price and no extra cost shall be payable by the Owner on this account.
- e) The schedule of conduction of type tests / submission of reports indicating the test standard shall be submitted and finalized during pre-award discussion for Owner / Consultant's review & approval.
- f) For the type tests to be conducted, Bidder shall submit detailed test procedure for approval by Owner / Consultant. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, interval of recording, precautions to be taken etc. for the tests to be carried out.

9.02.00 **Special requirements for Solid State Equipments & Systems**

The type tests reports, as a minimum, over and above the requirements of above clause which are to be submitted for each of the major C&I system shall be as indicated below:

9.02.01 **Electromagnetic Immunity as per EN 61000-6-22**

- a) Equipment furnished by Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electromagnetic interferences especially encountered in power plant



environment. Equipment, which is vulnerable to such interference, shall be suitably immunized to eliminate possible problems.

- b) Required shielding, input balancing, ripple amplitude and grounding for field signals and for the control systems to achieve an installation with minimum noise coupling from all sources.
- c) Any additional equipment, deliverables required for effectively eliminating the noise problems shall be identified and included.
- d) Electromagnetic emission as per EN 61000-6-43

9.02.02 Surge-Protection For Solid State Equipment

All solid state systems / equipment shall be immuned and able to withstand the electrical noise and surges as encountered in actual service conditions inherent in a power plant. All the solid state systems/ equipments shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90a-1989. Hence, all front end cards which receive external signals like analog input & output modules, binary input & output modules etc. including power supply, data highway, data links shall be provided with protections that meet the surge withstand capability as defined in ANSI 37.90a. Complete details of the features incorporated in electronics systems to meet this requirement, the relevant tests carried out, the test certificates etc. shall be submitted along with the proposal. As an alternative to above, IEC / EN 61000-4-4 & IEC / EN 61000-4-5 for Electrical fast transient / burst and Surge immunity may also be adopted for SWC test.

9.02.03 Type Test Requirement for C&I Systems

Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
1.	Transducers	As per Standard	IEC-688, IS-12784	NO	YES	
2.	Thermocouples	Degree of Protection Test	IS-2147	NO	NO	
3.	RTD	As per Standard	IEC-751	NO	NO	
4.	C.J.C. Box	Degree of Protection Test Ambient Temp. effect	IS-2147 Approved Procedure	NO NO	YES YES	
5.	Electronic Transmitter	As per Standard	BS-6447 / IEC-770	NO	YES	



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
6.	E/P Converter	As per Standard	Mfr. Standard	NO	YES	
7.	Dust Emission Monitor	Degree of Protection Test	IS-2147	NO	YES	
8.	Instrumentation Cables Twisted & Shielded			YES	YES	
	a) Conductor	<ul style="list-style-type: none"> • Resistance Test • Diameter Test • Tin Coating Test (drain wire) 	<ul style="list-style-type: none"> VDE-0815 IS-10810 			
	b) Insulation	<ul style="list-style-type: none"> • Loss of mass • Aging in air ovens • Tensile Strength and Elongation • Heat Shock • Hot Deformation • Shrinkage • Bleeding & Blooming 	<ul style="list-style-type: none"> VDE-0472 0472 ** VDE 0472 ** VDE 0472 ** VDE 0472 VDE 0472 IS-5831 			** As per VDE 0207 for Teflon insulated cables
	c) Inner Sheath	<ul style="list-style-type: none"> • Loss of mass • Heat Shock • Cold Bend / Cold Impact Test • Hot Deformation • Shrinkage 	<ul style="list-style-type: none"> VDE-0472 VDE 0472 ** IS-5831 VDE 0472 VDE 0472 			





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
	d) Outer Sheath	<ul style="list-style-type: none"> • Loss of mass • Aging in air ovens • Tensile Strength and Elongation Test before and after ageing • Heat Shock • Hot Deformation • Shrinkage • Bleeding & Blooming • Colour Fastness to Water • Cold Bend / Cold Impact Test • Oxygen Index Test • Smoke Density Test • Acid Gas Generation Test 	VDE-0472 VDE 0472 ** VDE 0472 ** VDE 0472 ** VDE 0472 VDE 0472 IS-5831 IS-5831 IS-5831			
	e) Fillers	<ul style="list-style-type: none"> • Oxygen Index Test • Smoke Density Test • Acid Gas Generation Test 	ASTMD-2863 ASTMD-2843 IEC-754-I			
	f) AL-MYLAR Shield	<ul style="list-style-type: none"> • Continuity Test • Shield Thickness • Overlap Test 				
		<ul style="list-style-type: none"> • Noise 	IEEE			





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
	g) Overall Cable	<ul style="list-style-type: none"> Interference • Flammability • Noise Interference • Dimensional Checks • Cross talk • Mutual Capacitance • HV Test • Drain Wire Continuity 	Transactions IEEE 383 IS 10810 VDE 0472 VDE 0472			
9.	Pressure Gauge	<ul style="list-style-type: none"> • Degree of Protection Test • Temperature Interference Test 	IS-2147 IS-3624	NO NO	NO NO	
10	Temperature Gauge	Degree of Protection Test	IS-2147	NO	NO	
11	Pressure & Differential Pressure Switch	<ul style="list-style-type: none"> • Degree of Protection Test • As per Standard 	IS-2147 BS 6134	NO NO	NO NO	
12	Level Switch	Degree of Protection Test	IS-2147	NO	NO	
13	Conductivity Level Switch	Degree of Protection Test	IS-2147	NO	YES	
14	Control Valves	CV Test	ISA 75.02	YES	NO	
15	Flow Nozzles & Orifice Plate	Calibration	ASME PTC, BS-1042	YES	NO	
16	PLCs	All tests as per IEC-1131	IEC-1131			
17	LIE / LIR / Junction Box	Degree of Protection Test	IS-2147	YES	YES	
18	Flue Gas O ₂	Degree of	IS-2147	NO	YES	





Sl. No.	Item	Test Requirement	Standard	Test to be specifically conducted	Approval required on Test Certificate	Remarks
	Analyzer	Protection Test				
19	Flue Gas SO ₂ Analyzer	Degree of Protection Test	IS-2147	NO	YES	

10.00.00 **TRAINING**

10.01.00 Bidder's experienced personnel / engineers shall provide training courses on offered PLC, VMS or any other special instrument, to Owner's engineers in the following areas:

- a) Operator training
- b) Hardware maintenance training
- c) Software training
- d) Any other specialized training as required for system operation and maintenance

10.02.00 The maintenance training shall include lectures and hands on experience on a similar type of equipment / system at manufacturer's works and / or training simulator. The details of hardware and software training shall be finalized during detailed engineering and shall be subject to Owner's acceptance.



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME : II-E

SECTION-II

SCOPE OF WORK, TERMINAL POINTS & EXCLUSIONS



Development Consultants Pvt. Ltd.

**Vol. II-E/Section-II
Scope of Work, Terminal Points
& Exclusions**



CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	INTRODUCTION	1
2.00.00	SCOPE OF SUPPLY	1
3.00.00	SCOPE OF SERVICES	5
4.00.00	TERMINAL POINTS	7
5.00.00	EXCLUSIONS	7
6.00.00	DRAWINGS AND DOCUMENTS	7





VOLUME : II-E

SECTION-II

**SCOPE OF WORK, TERMINAL POINTS & EXCLUSIONS
INSTRUMENTATION AND CONTROL**

1.00.00 **INTRODUCTION**

1.01.00 Bidder shall provide all material, equipment & services specified or otherwise required within the scope boundary to fulfill the intent of specification and to integrate into a fully functional Instrumentation and Control system ensuring operability, maintainability and reliability described in this specification.

1.02.00 Wherever quantity is indicated, the same refers to only one set per generating unit to be furnished by the Bidder, unless specifically indicated otherwise.

2.00.00 **SCOPE OF SUPPLY**

The brief scope of supply has been described in the following clauses of this section. Any other equipment / system required for ensuring the safe, reliable and trouble free operation of the FGD plants under the present scope of work shall be provided by Bidder.

The scope of supply shall include but shall not be limited to the following:

2.01.00 **FGD CONTROL SYSTEM**

2.01.01 Programmable logic controller (PLC) based control system with hot redundant controller, redundant power supplies, I/O cards and redundant communication modules for FGD plant of each unit and common systems. The control room shall be common for both the units. The scope of supply shall include but not limited to following: (Control system shall be unit wise; however the workstations shall be common to both units)

- a) Three (3) sets of Redundant, Hot Standby PLC systems [one (1) set for Unit # 1, 1 set for Unit # 2 and one (1) set for common system like water and other raw material handling system].
- b) Two (2) nos. Engineering cum Operator Workstations, two (2) nos. Operator Workstations & one (1) no. colour A3 and one (1) no. black & white A4 sized LJP.
- c) One (1) no. Historian.
- d) One (1) no. Engineering laptop with master software.
- e) Two (2) nos 70" or higher LED display with PC.





- f) One (1) no. remote Operator Workstation at Central Control Room.
- g) One (1) Remote Input/ Output (RIO) Unit for each unit to be located in CCR for obtaining data of existing compressors and other existing systems required for FGD system control.
- h) All Eight (6 workstations plus 2 LED display) PC shall be capable of individual operation and have separate software license.

2.01.02 Local control panels shall be provided as per process requirement at strategic points (including material unloading, all major equipment & sub-system) to allow for local operation of the plant.

2.01.03 Relay based Control Systems in limestone unloading and feeding plant area for control of conveyors, vibrating feeders, crushers etc. shall be provided with interface to FGD PLC.

Relay based Control System(s) shall be provided with control desk and shall be complete with colored mimic, microprocessor based window type alarm Annunciator, Push Buttons, Indicators, Indicating Lamps & Ammeters.

2.02.00 **INTERFACE WITH STATION DCS**

2.02.01 Hardwired interfacing shall be provided with the existing Station DCS for time critical, interlock, control & protection signals. The quantity of Hardwired signals will be finalized during detailed engineering. The required cables, sub-trays etc, required for this hardwire interface is in the bidder's scope of supply.

2.02.02 FGD PLC shall also be connected to Station DCS through redundant communication link for the information exchange through Station wide LAN. FGD Bidder's scope shall include all cables and accessories required for connecting Bidder's FGD PLC up to Station DCS. One set of suitable interfaces and links for this connectivity shall be provided (Redundant OPC over Ethernet based TCP/IP) at both FGD PLC end & Station DCS end. Cubicles for mounting networking components and power supply distribution equipment shall be provided by Bidder on as required basis. The exact requirement shall be as finalized during detailed engineering.

2.02.03 Bidder shall provide all necessary interface hardware/software required for satisfactory operation of equipment covered under this specification. This shall include input / output modules, relays, isolators and other necessary hardware/ software for interfacing with station DCS and other C&I systems which are not in bidder's scope.

2.03.00 **VIBRATION MONITORING SYSTEM**

Vibration Monitoring System for HT motors & driven equipment for FGD plant





complete with all sensors, mounting pads, JB's, hardware, software, cable and accessories shall be provided by the Bidder.

2.04.00 MEASURING INSTRUMENTS

- (a) All primary instruments like process transmitters with HART Protocol, Temperature Elements (Thermocouple & RTD), Electro-Magnetic flowmeters, Ultrasonic / Radar type level transmitters, Pressure Transmitter, Differential Pressure Transmitter local indicators & gauges, thermowell, process switches, sensors, converters, totalizer, flow elements etc. required for control, operation and monitoring of the system / equipment being supplied by the Bidder in this package, shall be provided on as required basis meeting redundancy, availability & reliability requirements of the specification.
- (b) Sulphur-di-oxide (SO₂) at FGD inlet and outlet to control the treatment process.
- (c) Additionally, oxygen analyzer shall be provided to measure oxygen at the downstream of FGD system.
- (d) pH analyzer for solid lime or limestone (reagent) Feed control.
- (e) Density meters for Gypsum Solids / Density control
- (f) Belt protection / safety switches including pull cord switches, zero speed switches, belt sway switches, chute jam monitoring switches, Pull Chord & Belt Sway Monitoring System, Belt Weigher System etc.
- (g) Complete CEMS system at Chimney
- (h) All the instruments which are required but not specified, to implement the control philosophy as specified in corresponding Mechanical sections or as finalized during detailed engineering shall also be provided by the Bidder.
- (i) All instruments shall be supplied with valid calibration and test certificate provided by OEM.

2.05.00 INSTRUMENTATION & CONTROL CABLE & ACCESSORIES

2.05.01 All Instrumentation signal / triad cables twisted & shielded, PVC insulated & sheathed with FRLS properties, including thermocouple extension / compensating cables and prefabricated cables (with plug-in connectors, power supply distribution cables, optical fiber cables with accessories like LIU, patch cord / pigtail, FO converter, terminators and any other special cables for C&I systems under FGD area shall be supplied, terminated and





laid by the Bidder on as required basis.

- 2.05.02 Broadly, the philosophy for cabling scope shall be as follows:
- All cabling & interconnection required in-between Bidder's supplied instruments / cabinets / panels / enclosures / equipment / MCC / SWGR etc. shall be provided by the Bidder. All cables, accessories and associated works are under the scope of Bidder.
 - When one end terminal is in the scope of Bidder and other end belongs to Owner's instruments / systems / cabinets / equipment etc., corresponding cable shall also be supplied and laid by the Bidder.
- 2.05.03 Pneumatic and motor operated Control valves / on-off valves and dampers along with actuators, smart positioners, limit & torque switches, hand-wheels, volume boosters, solenoid valves, position transmitters & accessories.
- 2.06.00 **POWER SUPPLY SYSTEM**
- 2.06.01 Isolation, conversion and distribution of UPS, DC and non-UPS (Utility) power supply to all instruments, system panels, consoles etc shall be in Bidder's scope.
- 2.06.02 UPS Power supply (max. 1 kVA) required for the FGD C&I loads, located in main plant CCR, shall be made available to the bidder at purchasers ACDB terminals as single redundant feeder. Cabling from the purchaser ACDB to FGD load points/ ACDB is under the scope of the bidder.
- 2.06.03 Bidder shall provide power supply distribution panels / cabinets / boxes for sub-distribution of UPS / Utility feeders on as required basis. The power supply distribution box shall include change over circuitry, static switches, fuse units / MCBs, terminal blocks etc. suitable for application.
- 2.07.00 **FURNITURE**
- Ergonomically designed control desks and furniture complete with all accessories and operator's chair in FGD local control room.
- a) Control Desk for Operator Workstations and LVS PC & Keyboard
 - b) Computer Table for Operator cum Engineering Workstation and Historian.
 - c) Printer Table (2 nos.)
 - d) Locker Set (1 no.)
 - e) Chair for all the work stations (OWS, EWS & Historian)

[Control Desk required for mounting FGD Remote Workstation located in the





Central Control Room shall be provided by owner.]

2.08.00 **ERECTION HARDWARE**

- 2.08.01 Process connection and piping materials comprising of stub, root valves, impulse pipes of different grades & stainless steel tubes, isolation & drain valves, valve manifolds, gauge valves, condensate pot, fittings, stands, brackets etc. as required for satisfactory installation of all field instruments like process transmitters, local switches, gauges etc.
- 2.08.02 Pneumatic hookup materials like stainless steel grade pneumatic tubes, fittings and isolating valves as required.
- 2.08.03 Erection hardware including junction boxes, canopies, structural steel etc. and consumables as required.
- 2.08.04 Conduit & accessories inclusive of all flexible & rigid conduits, perforated cable trays with top cover for main raceway and branches, pull boxes, inspection covers, bends, elbows, mounting brackets, clamps, nuts and bolts, glands, lugs, ferrules, connectors, markers, tray supports, tie wraps etc.
- 2.08.05 Rating Plates, Tag / Nameplates and Labels for all I&C items.
- 2.08.06 Complete Electronic & Electrical Earthing including Earth Pit for Bidder supplied I&C equipment / items shall be provided.
- 2.08.07 Consumables like printer cartridge, printer paper etc.
- 2.08.08 All other items as described in different sections of this specifications and any other C&I items required for safe & efficient operation of the plant.

3.00.00 **SCOPE OF SERVICES**

3.01.00 **ENGINEERING AND OTHER SERVICES**

- a) Bidder shall refer Lead Specification and Conditions of Contract for scope of services, in general.
- b) Participation of Bidder's personnel and experts as well as experts from their collaborator in discussion with Owner / Consultant and other equipment Vendors during various stages of contract implementation as required by Owner to achieve desired C&I system configuration and performance.

3.02.00 Bidder shall include all other necessary services as required like obtaining licenses, statutory clearances for pollution etc. in his scope.

3.03.00 **SCOPE OF ERECTION**





In general all items supplied by Bidder shall be erected by Bidder. Sound engineering practice of international standard shall be adopted throughout. Erection services shall be verified by the Owner site engineer / consultant on the basis of the approved Field Quality Plan (FQP) .Scope of works shall not be limited to the following:

- a) Installation of equipment, system, control room panels, desks, cabinets, junction boxes, instruments, gadgets and other accessories supplied as per this specification.
- b) Cable interconnection amongst different panels/cubicle/field instruments etc. including with third party systems.
- c) Installation of field mounted instruments and devices including primary elements along with impulse pipe laying and wiring etc. Installation of thermowells at the stubs provided at the tapping points.
- d) Installation of all transmitter racks & enclosure, cubicles, brackets, laying of impulse pipes and cable termination etc.
- e) Hook up of pneumatic tubes and interconnection between air supply point and all accessories of final control element as required.
- f) Laying of all cables including erection of sub-trays, G.I. conduits along with accessories, termination and ferruling at both ends of all cables laid.
- g) Termination & testing / checking of cable.
- h) Supply of the erection hardware, consumables, tools and tackle, test instruments and deployment of experienced personnel needed for completing the erection.
- i) Painting of site mounted structures and impulse lines after completion of erection.
- j) The JB / Instrument, numbers / KKS codes are to be written, with white paint on red background
- k) Providing a tentative programme of manufacture, erection, testing and commissioning.
- l) Erection activities shall comply with stipulated project schedule.
- m) Unloading, Storage of materials at site, transportation to site.
- n) Flanges in all process area (within their battery limit) both process & counter flanges shall be provided by the bidder.
- o) Excavation works for electronic earth pits, Installation of electronic grounding pits, Installation of risers, protection brickwork upto three (3) feet above ground, covering with MS chequer plates, painting of cover plate, laying & termination of grounding wires and grounding of panels, cabinets. Earth resistance shall be measured in presence of Owner's Engineer and shall be displayed next to the earthpit with date.

3.04.00

SCOPE OF TESTING, CALIBRATION & COMMISSIONING





Scope of works shall not be limited to the following:

- a) Testing / calibration / configuring / software development, loading, commissioning of instruments and systems as per the guidelines laid down in the specification.
- b) Setting up of site instrument laboratory equipped with testing equipment for running and maintenance of the plant and instruments needed to carry out the testing, calibration and commissioning
- c) Site modifications shall be documented and issued to Owner as design change notification and shall be signed by Owner. Subsequently, all such approved and agreed changes shall be incorporated in relevant design documents to elevate all documents to "As Built" status.

3.05.00 **COMMERCIAL OPERATION, PERFORMANCE LIABILITIES, GUARANTEES**

Major services to be rendered by Bidder on this account shall not be limited to the following:

- a) Trial operation, performing performance guarantee test, control system performance and system availability test, interfacing and co-ordination with other agencies, as indicated in relevant clauses of the specification.
- b) Satisfactory operation of the entire control and instrumentation system at varying loads .During this period, maintenance and supervision shall be in the scope of Bidder. Any defect or deficiency noted during this period shall be rectified by Bidder at no extra cost.
- c) Other requirements as indicated in the lead specification.

4.00.00 **TERMINAL POINTS**

- a) Station DCS Marshalling rack
- b) GPS Master & Slave Clock System.

Bidder to note that the terminal point for the Master Clock system shall be at Master Clock system (GPS Panel) located in main plant CCR. All the requirements for establishing connectivity with Master clock system are under the scope of the FGD bidder.

5.00.00 **EXCLUSIONS**

- a) Station DCS
- b) GPS Master & Slave Clock System

6.00.00 **DRAWINGS AND DOCUMENTS**

Bidder shall furnish system description, operational write-up, bill of materials,





drawings, data, information, technical catalogues, test certificates and other details to establish the proven-ness, capability and performance of the equipments and systems offered.

6.01.00 **DOCUMENT TO BE SUBMITTED WITH THE BID SHALL NOT BE LIMITED TO THE FOLLOWING:**

- a) FGD control system overview architecture with write up
- b) Bill of Materials of items indicating Make / Model
- c) Proposed GA of control panels, desks, system cabinets etc.
- d) Brief description of Type and Routine tests proposed to be carried out at shop and at site and write-up on the in-house quality assurance practice.
- e) List of reference of similar system in service with performance record.
- f) Sub-vendor’s list.
- g) Details of training of Owner’s personnel specifying duration of each course, number and category of personnel proposed to be trained in each course, location etc.
- h) Details of post-commissioning services
- i) Data / information as per “Bid Proposal Sheets (Technical Part)”.
- j) Deviation list, if any.
- k) All other schemes, data, drawing, document required to establish product quality and completeness of supply.

6.02.00 **SUBMISSION OF DRAWINGS AND DOCUMENTS BY SUCCESSFUL BIDDER**

On award of the contract, the successful Bidder shall submit progressively, drawings and documents in multiple copies (as specified in Vol IA of Bid document) for approval of Owner / Consultant at different stages of the contract. Contractor shall obtain owner’s approval in writing and manufacture the equipment as per these approved drawings and documents. Contractor shall revise the drawings in line with owner’s comments and resubmit till approval is accorded. The drawings & documents shall not be limited to the following. After award of the contract contractor in association with owner will draw up a list of drawings, document / deliverables with corresponding submission schedule and will assign review status of either “A” (for approval) or “I” (for information) to each deliverable Also note that whether the review status is either "A" or "I", the bidder shall submit the same for approval. The review status "I" shall not deter the bidder from getting approval or revising the drawing/document in line with the owners comment.

A.	FGD PLC/ DCS		
1.	Overall configuration diagram of FGD control	:	I





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

	system showing all components / modules, peripherals and network connections		
2.	Bill of Material FGD control system, System, mandatory spare quantities for each of the sub-systems of PLC indicating make, model no. etc.	:	I
3.	Design Philosophy for FGD control system	:	I
4.	Local Control Room Layout and Floor Opening requirements	:	I
5.	General Arrangement, Internal Arrangement of cabinets, control desk, furniture etc.	:	I
6.	Single Line Diagram for power supply requirements and distribution scheme of FGD control system (both UPS & 24V DC)	:	I
7.	Grounding Scheme of FGD control system	:	I
8.	Schematic / wiring drawings for all cabinets / systems.	:	I
9.	QAP / FAT / SAT Procedures for tests to be conducted	:	A
10.	Type Test result/ report/ certificate as applicable	:	A
11.	Input/ Output List	:	I
12.	Schedule of Alarms	:	I
13.	Sequence of Event Schedule	:	I
14.	Control loop & Control logic diagrams for control system and write-up	:	I
15.	Displays, Mimics, logs, reports etc. for HMI	:	I
16.	Hardware Design specification, Technical datasheet of all items including processors, modules, network components, peripherals etc.	:	Specification : A Vendor Final Datasheet: I
17.	System Software design manual including software listing	:	I
B.	MEASURING INSTRUMENTS		





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

1.	Complete Bill of Material for all instruments including all necessary accessories etc. with mandatory spare quantities	:	I
2.	Technical datasheets for all instruments (transmitters, switches, gauges, analyzers, flow elements etc.) and other equipment like positioner, electrical transducer / meters / relays etc.	:	Specification : A Vendor Final Datasheet: I
3.	Control Valves (a) Datasheet / specification sheet of each control valve & its accessories (b) Sizing Calculation of each control valve (c) General arrangement, dimensional and edge preparation drawing (d) Complete Bill of Material of control valves & accessories with mandatory spare quantities (e) QAP and test reports as applicable (f) Piping & tubing diagram	:	Specification : A Vendor Final Datasheet / Other: I
4.	KKS codification of instruments	:	I
5.	Schedule of Instruments.	:	I
6.	Instrument Hook-up & Installation Drawing including Bill of Material and material specification of all accessories required for erection.	:	I
7.	Local Instrument Enclosures (a) Typical GA drawings (b) Outline and mounting drawings (c) Constructional details (d) Power Supply wiring (e) Grouping details	:	Specification : A Vendor Final Datasheet / Other: I
8.	QAP and test certificates of all instruments, wherever applicable.	:	A
9.	Sizing calculation of flow elements & thermowells	:	I
C	VIBRATION MONITORING SYSTEM		





1.	Complete Bill of Material, Data sheets and technical details for each items such as sensors, JB, rack, cables etc. including Make / Model no. including Mandatory Spare quantities	:	Specification : A Vendor Final Datasheet / Other: I
2.	Vibration monitoring rack mounting drawing showing dimensional details	:	I
3.	Transducer mounting pad drawing, showing mounting hole and other mounting details	:	I
4.	Vibration monitoring system cabinets general arrangement drawing and floor cutout requirements	:	I
5.	Wiring Diagrams for vibration monitoring system	:	I
6.	Power Distribution Drawing including heat load & power supply requirement	:	I
7.	QAP and test certificate as applicable	:	A
D.	INSTRUMENTATION & CONTROL CABLE		
1.	Complete Bill of Material for all types of instrumentation cable and electrical accessories	:	I
2.	Technical datasheet of cables, junction box, terminal blocks and other electrical installation material furnished by Bidder	:	Specification : A Vendor Final Datasheet / Other: I
3.	Drive Interface Philosophy	:	I
4.	Cable Schedule & Interconnection Diagrams	:	I
5.	Junction Box Schedule	:	I
6.	I&C Grounding Scheme	:	I
7.	QAP and test certificate (as applicable)	:	A
E.	CONTROL DESK & PANEL		
1.	Complete Bill of Material for all control desk, panels, desk mounted items, LVS panel and local control panels. The bill of material shall include the accessories	:	I



	associated with panel mounted items.		
2.	Design specification sheet of all panel / desk mounted items	:	Specification : A Vendor Final Datasheet : I
3.	Power supply requirements for all equipment	:	I
4.	General Arrangement & dimensional drawings and floor opening requirements	:	I
5.	Wiring Diagrams	:	I
6.	Furniture (a) Profile & dimensional drawing (b) Datasheet / catalogue	:	Specification : A Vendor Final Datasheet/ Other: I
G.	INTERFACE ENGINEERING DOCUMENTS		
1.	Interface with Master & Slave Clock System (a) Write-up on time synchronizing scheme and interface requirements with GPS Master Clock System	:	I
2.	Interfaces with Station DCS and other systems not in Bidder's scope	:	I
H	Operation & Maintenance Manual		I
I	As Built Drawings	:	I
J	Any other design data, drawings and documents prepared for this project but not specifically listed above.	:	I

For Drawing / Document to be submitted for Electrical Power Supply System, Plant Communication system relevant sections of the specification shall be referred.

6.03.00

FINAL DRAWINGS

- a) Bidder shall secure approval on the design drawings from Owner for the drawings that will be identified as approval category ("A"), in writing. Any





manufacture done prior to approval of the drawings shall be rectified in accordance with the approved drawings by Bidder at his own cost and the equipment shall be supplied within the stipulated period.

- b) Bidder shall furnish final drawings and documents in multiple hard and soft copies. Bidder shall furnish instruction manuals containing various components, sub-assemblies, method of installation, check-ups and tests to be carried out during erection and commissioning of the equipment. The manual shall also include instruction for step checking, trouble shooting and fault rectification for different components and sub-assemblies.
- c) Bidder shall incorporate all modifications in the drawings carried out at site during trial run, start-up performance and guarantee tests till hand over of the units to Owner and submit these final as-built drawings both in hard and soft copy.
- d) Final documents shall be submitted in proper bounded form. All catalogs and literature (including sub-suppliers' catalogs), datasheets, Instrument list, input output list, function control diagram, loop diagrams, configuration diagram, etc. shall be bounded together in indexed volumes. All O&M manuals shall be in handy size and neatly bound for carrying it to the work place.



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

SECTION – III
TECHNICAL SPECIFICATION
INSTRUMENTATION AND CONTROL SYSTEM



CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	FIELD INSTRUMENTS	1
2.00.00	CONTROL PANEL / DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES	42
3.00.00	CONTROL VALVES, ACTUATORS & ACCESSORIES	44
4.00.00	CONTROL DESK / PANEL / RACK / ENCLOSURE	48
5.00.00	FGD CONTROL SYSTEM & CEMS	60
6.00.00	ON LINE VIBRATION MONITORING SYSTEM (VMS)	83
7.00.00	POWER SUPPLY SYSTEM	85
8.00.00	INSTRUMENTATION & CONTROL CABLE	86
9.00.00	ERECTION HARDWARE	101
10.00.00	SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT	110





VOLUME : II-E

SECTION-III

INSTRUMENTATION AND CONTROL SYSTEM

1.00.00 FIELD INSTRUMENTS

This section provides general guidelines for field instruments, systems and equipment to be supplied under this specification, **as applicable for the Bidder's Scope of Work** for completeness of C&I system. All measuring instruments / equipment and systems / sub-systems offered by Bidder shall be from reputed experienced manufacturer of specified type and range of equipment, whose guaranteed and trouble free operation has been established. All instruments / equipment shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance and comply with the acceptable international standards. All instruments / equipment and accessories shall be supplied as per technical specifications, ranges, make as approved by Owner / Consultant.

All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. and vibration transmitters as required shall be provided. In general, transmitters shall be provided for remote monitoring, alarm, interlock and control. Use of process actuated switches shall be avoided as far as possible unless the same is required as per manufacturer's standard & proven practice.

All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified.

For all instruments envisaged for corrosive liquid applications, they shall be provided with wetted parts made of Monel / Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by Contractor).

All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments. Anti-corrosive paint shall be applied to the field mounted enclosures / instruments.





1.01.00 **Pressure, Differential Pressure, Flow and Level Transmitter**

01. Working Principle : Smart
02. Type : 2-Wire
03. Output signal : Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
04. Signal Processing Unit : Silicon solid-state electronic circuitry
05. Measuring element : Capsule/Diaphragm
06. Element material : AISI-316 (Stainless Steel) or better
07. Over Pressure : 150% of maximum pressure
08. Turn-down ratio : 10:1 for vacuum / very low pressure application.
30:1 for other application
09. Span and Zero : Continuous non-interacting tamper proof, remote as well as manual adjustable from instrument with zero suppression and elevation facility.
10. Enclosure : Epoxy coated Die cast aluminium. IP-65 (Explosion proof for NEC Class-1, Division 1 area) with ½" NPT (F) cable entry.
11. Output Indicator : LCD type
12. Body : Forged Carbon Steel (SS for DM Water)
13. Operating Voltage : 24 V DC \pm 10%
14. Load : 600 Ohms (min.) at 24 Volts DC
15. Performance :-
 - a) Accuracy : \pm 0.1 % of span or better
 - b) Repeatability : \pm 0.05 % of span or better
 - c) Response time : 250 msec or better



- d) Zero & Span drift : 0.015% per Deg.C at max span
0.11% per Deg.C at min span
- e) Stability : 0.1% of calibrated span for six months
for ranges upto and including 70 Kg/
sq.cm.
0.25% of calibrated span for six months
for ranges more than 70 Kg/ sq.cm (g).
16. Process connection : ½" NPT (F)
17. Sealing / Isolation : Extended diaphragm with 5 meters SS
armoured capillary for corrosive, viscous
and dirty fluid applications. Material for
separator diaphragm, depending on
application.
18. Nameplate : Tag number and Service engraved in
stainless steel tag plate
19. Accessories : a) Installation accessories such as
mounting bracket, high tensile
carbon steel U-bolts suitable for
pipe mounting.
b) ½" NPT 2-valve stainless steel
manifold, constructed from
SS316 bar stock for pressure
transmitter.
c) ½" NPT 5-valve stainless steel
manifold, constructed from
SS316 bar stock for DP
transmitter. 3 valve manifold for
DP application in flue gas and
air.
d) Companion flange with nuts,
bolts and gaskets.
e) ½" NPT cable gland

1.02.00 **Ultrasonic Level Transmitter**

01. Principle of operation : Detection of reflected ultrasonic pulse





02. Signal processing : Microprocessor Controlled Signal Processing
03. Type : Smart
04. Display : Large alpha-numeric back lit LCD/LED
05. Calibration & configuration: Accessible from front of panel
06. Diagnostic : On-line
07. Status : For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
08. Construction : Plug-on board
09. Power supply : 240 V AC 50 Hz / 24V DC
10. Signal Output : 4-20 mA DC (isolated) - 600 Ohm load with HART protocol.
11. Hysteresis : Fully adjustable preferred
12. Output contacts : 2SPDT Potential free changeover contacts @ 5A 230V AC.
13. Accuracy & Repeatability : 0.25% of span or better
14. Resolution : 0.1% of span
15. Operating temp. : Transmitter-55 o C and Sensor – 80 o C
16. MOC Sensor : SS 316 in general / PTFE, PP for corrosive application.
17. Humidity : 1% to 95% non condensing.
18. Enclosure : IP-65 powder coated die cast aluminium
19. Cable connection : ½” NPT with cable gland
20. Mounting : 2” flanged for sensor and Transmitter on panel / surface.
21. Accessories : Cable gland, prefab cable, mounting accessories.

Note : Sensors and transmitter shall be separately mounted.

1.03.00

Radar type Level Measurement





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

01. Type : Radar based on Time Domain Reflectometry / Pulse / FMCW as per application
02. Antenna : Co axial / single rod type guided wave or Horn type as required for the application
03. Communication : Two wire 4-20mA DC, HART protocol
04. Enclosure : Explosion proof /IP 65 as per application
05. Cable Entry : ½" NPT
06. Calibration : a) Self calibration with internal reference
b) Zero & Span calibration
07. Programming : Handheld programmer & Local keypad
08. Process Connection : Flanged /screwed
09. Electronic Housing : Epoxy painted Die-Cast aluminium alloy
10. Antenna / Flange assembly: 316 SS or Hestallo (as required)
11. Output Indicator : Digital Integral Display
12. Accuracy : 5 mm or 0.1% of probe length
13. Accessories : a) Programming tool kit, if required
b) Gasket

1.04.00 Pressure Gauge and Differential Pressure Gauge

01. Type : Bourdon/Bellows/Diaphragm
02. MOC Sensing & Socket : AISI-316 SS
03. Movement Material : AISI-304 SS
04. Case Material : Stainless steel. Enclosure IP-65.
05. Dial Size : Generally 150 mm (100 mm for SWAS gauges)
06. Scale : Black lettering on white background in 270 Deg. arc.





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

07. Window : Shatterproof glass
08. Range Selection : Normal process pressure – 50 ~ 70% of range (approximately).
09. Over-range Protection : 125% of maximum range by internal stop. External stop at zero.
10. Adjustment : Micrometer screw for zero adjustment.
11. Element Connection : Argon welding
12. Process Connection : 1/2" NPT (M) Bottom connection for local mounting, back connection for panel mounting.
13. Performance : Accuracy of $\pm 1.0\%$ of span or better.
14. Safety Feature : Blow out disc /diaphragm at the back
15. Accessories : a) Snubbers and Glycerin filled for pulsating fluid applications.
b) Stainless steel Diaphragm seals for corrosive, viscous and solid-bearing or slurry type process fluids.
c) Gauge saver wherever required
d) 3-Way stainless steel Gauge valve for pressure gauges. Process connection 1/2" NPT.
e) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection 1/2" NPT.
f) Union, nut & tail piece and other Installation accessories as required.
16. Applicable standard : IS-3624 / 1996
17. Electrical Contact rating : Not applicable
18. Nameplate : Tag number, service engraved in stainless steel tag plate





1.05.00

Pressure Switch and Differential Pressure Switch

01. Type : a) Piston for high pressure application
b) Bellow / Diaphragm for low pressure application
02. Sensing element material : AISI SS-316. All other wetted part SS316.
03. Case Material : Epoxy coated Die-cast aluminum alloy with neoprene gasket.
04. Setter Scale : Required.
05. Over range : 150% of maximum pressure
06. Adjustments : Internal Set Point adjustable over span
07. Process Connection : 1/2" NPT (M) bottom connected
08. Switch configuration : One DPDT (Two SPDT)
09. Switch Rating : 240V, 5A AC/220V, 0.5A DC
10. Switch Type : Snap acting, shock & vibration proof
11. Terminal Block : Suitable for full ring lugs for cable connection.
12. Cable connection : 1/2" NPT conduit connection or compression gland.
13. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area).
14. Performance : Repeat accuracy $\pm 1.0\%$
15. Nameplate : Tag number, service engraved in stainless steel tag plate
16. Accessories : a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement.
b) Retention ring and screws for surface mounting.





- c) 1/2" NPT 2 Valve SS-316 manifold constructed from bar stock for pressure switch
- d) 1/2" NPT 3-Valve SS-316 manifold constructed from bar stock for DP switch
- e) 1/2" NPT cable gland

1.06.00 **Level Switch**

1.06.01 **Type-1**

- a) Type : External cage float operated, magnetically coupled
- b) Float material : AISI 316 stainless steel
- c) External cage &
other wetted part : AISI 316 stainless steel
- d) External cage mounting : Side Side, on standpipe
- e) External cage connection : 1" Flanged
- f) Switch housing : Epoxy coated die cast aluminum alloy with neoprene gasket conforming to IP-65.
- g) Enclosure class : IP 65
- h) Type of switch : Snap acting magnetically operated
- i) Switch configuration : 1DPDT
- j) Contact rating : 5A, 240VAC / 0.25A, 220V DC
- k) Accessories : Counter flange, nuts & bolts, suitable gasket etc.

Globe type Drain Valve.

1/2"NPT cable gland
- l) Application : Clean & non acidic fluid application in over ground tanks

1.06.02 **Type-2**

- a) Type : Float operated, magnetically coupled





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

- b) Float material : Polypropylene
- c) Housing : Polypropylene
- d) Mounting : Side mounted.
- e) Process connection : 1/2" NPT (F) / Flanged
- f) Switch type : 1 DPDT
- g) Enclosure class : IP 65
- h) Contact rating : 5A, 240VAC/ 0.25A, 220V DC
- i) Cable meters (minimum) : Integral FRLS PVC stranded copper (5 meters (minimum))
- j) Application : Acid application in over ground tank

1.06.03

Type-3

- 01 Type : Capacitance type
- 02 Probe :
 - a) Rod or suspended electrode
 - b) Rope type probes may be used only where required probe length is greater than 1.5 meters.
 - c) Reference rod for non grounded tank.
- 03. Probe Mounting : 1-1/2" Flanged
- 04. Material of construction : 316 SS and to suit fluid type
- 05. Insulation : PTFE / PP / Kynar Part / Full as required
- 06. Enclosure : Powder coated Die cast aluminium with neoprene gasket conforming to IP-65.
(Explosion proof for NEC Class-1, Division 1 area).
- 07. Mounting : Probe on tap, switch unit separate on surface
- 08. Supply voltage : 240V AC $\pm 10\%$, 50Hz / 24V DC $\pm 10\%$,
- 09. Relay output : 2 SPDT
- 10. Contact rating : 5A min. at 240V AC on resistive load





11. Response time : 100 msec or better
12. Cable connection : ½” NPT with cable gland
13. Accessories : Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.
Diagnostic & status LED on front of enclosure.

1.06.04

Type-4

- a) Type : Non-contact Ultrasonic type
- b) Signal processing : Microprocessor Controlled
- c) Display : Large alpha-numeric back lit LCD / LED
- d) Calibration & configuration : Accessible from front panel
- e) Diagnostic : On-line
- f) Status : For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
- g) Construction : Plug-on board
- h) Power supply : 240 V AC 50 Hz / 24V DC (UPS supply)
- i) Hysteresis : Fully adjustable
- j) Output contacts : Potential free changeover contacts @ 5A 230V AC.
- k) Repeatability : 0.25% of span or better
- l) Operating temp. : Transmitter-55° C and Sensor- 80° C
- m) MOC Sensor : SS 316 in general. PTFE, PP for corrosive application.
- n) Humidity : 95% non-condensing.
- o) Enclosure : IP-65 powder coated die cast aluminum
- p) Cable connection : ½” NPT with cable gland
- q) Mounting : 2” flanged





- r) Accessories : Cable gland, mounting accessories.
- s) Application : Sludge pits and overhead tanks containing slurry, viscous and dirty fluid like slaked lime, lime preparation tank etc.

1.07.00 **Gauge Glass**

01. Type : Reflex or transparent. Resistant to mechanical shocks by steel armour.
02. Glass : Toughened borosilicate
03. Body material : forged Carbon steel / stainless steel as per process requirements
04. End connection : As per ASME PTC and drain /vent valve 15NB
05. Accuracy : $\pm 2\%$
06. Pressure rating : Twice the maximum working pressure
07. Scale : Linear vertical
08. Range selection : Covers 125% of max. of scale
09. Test Pressure : 1.5 times to the max. design pressure at 38°C
10. Housing : CS /304SS
11. Accessories : SS Ball check valves, gaskets, companion flange, SS drain and vent valve, nuts & bolts etc.

1.08.00 **Sight Glass**

01. Type : Flap-type
02. End connection : Screwed / Flanged
03. Material :
- a) Body : SS-304
- b) Cover Plate : SS-304
- c) Indicator : SS-316
04. Sight Glass : Toughened Borosilicate





- 05. Gasket : Neoprene
- 06. Bolts & Nuts : High tensile steel
- 07. Hydraulic Test Pressure : 1.5 times maximum working pressure
- 08. Accessories : As required

1.09.00 **Temperature Gauge**

- 01. Type : Bimetallic & all angle tiltable
- 02. Sensing Element Material: Bimetal strip helix
- 03. Stem Diameter : 1/4"
- 04. Stem Material : AISI 304
- 05. Thermometer connection to well : 1/2" NPT / SS 304
- 06. Case Material : Sturdy, corrosion resistant series 304 stainless steel case and bezel.
- 07. Dial Size : 5" in general
- 08. Scale : Anti parallax heavy gauge aluminum with white matte finish glare free. Black lettering on white background.
- 09. Pointer : Balanced, lightweight aluminum with matte black finish.
- 10. Dampener : Dampening pointer oscillation
- 11. Mounting : Surface with adjustable angle.
- 12. Over range Protection : 150% of range or more
- 13. Dial connection : Back connection with stem
- 14. Range : Normal temperature – 50 ~ 70% of range approximately.
- 15. Zero adjuster : Adjustable screw at back.
- 16. Window : Shatterproof glass.
- 17. Accuracy : ±1 % or better (Grade A / ASME B40.3)





18. Enclosure Class : IP-65
19. Accessories : a) Forged/bar stock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M).

Material of construction of Thermowell:

- SS 316: In general
- Inconel: For flue gas application
- Tungsten carbide: For lignite mill application.

Bidder shall provide Wake frequency calculation for thermowell as per ASME PTC 19.3 (latest edition).

- b) Installation accessories as required.

20. Nameplate : Tag number, service engraved in stainless steel tag plate

1.10.00 **Thermocouples**

01. Type : a) Type-K (Chromel-Alumel)
b) Duplex
c) Ungrounded
02. Wire gauge : 16 AWG for Type-K
03. Standard : ANSI-MC 96.1 for thermocouple
04. Protecting Tube :-
- a) O.D. : 8 mm
 - b) Material : 316-SS Seamless
 - c) Filling : Magnesium Oxide (Purity above 99.4%)



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

05. Characteristics : Linear with respect to temperature within $\pm 1/2\%$ of top range value
06. Accuracy : As per IEC 751 / ANSI MC 96.1 (special class)
07. Head :
- a) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
- b) Material : Epoxy coated Die cast aluminum or better
- c) Terminal blocks : Nickel plated Brass - screw type/ silver plated
- d) Instrument connection to well : $1/2$ " NPT
- e) Cable connection : $1/2$ " NPT gland and grommet.
- f) Others : Terminal head cover with SS chain and suitable gasket
08. Accessories : a) Adjustable nipple-union-nipple [$1/2$ " Sch 80 X $1/2$ " NPT (M)] with thermowell connection
- b) Compression fittings/unions
- c) Flanges etc. (for flanged connections only)
- d) Forged/bar stock thermowell as per ASME PTC 19.3 code. Process connection M 33X2 (M) in general or $1/2$ " Flanged for Flue gas/ /Air etc. application.
- e) Material of construction of Thermowell:
- SS 316: In general
 - Inconel: For flue gas application
- Bidder shall provide Wake frequency calculation for thermowell as per ASME PTC 19.3 (latest edition).





09. Nameplate : Tag number, service engraved in stainless steel tag plate

Notes:

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature, at the top of mill or due to lignite burning. Hence the terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB through SS tube of required diameter and the head shall be placed nearer to the JB.
2. Thermocouples provided for steam services like MS temp, HRH, CRH, Turbine metal temp, super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.

1.11.00 **Resistance Temperature Detector**

01. Type : Platinum (Duplex), Ungrounded
02. Resistance : 100 ohm at 0 degC
03. Base : Wound on ceramic (anti-inductive)
04. Wiring : 3 /4 Wire
05. Protecting Tube :
 - a) O.D. : 8 mm
 - b) Material : SS-316, Seamless
 - c) Filling : Magnesium oxide (Purity above 99.4%).
06. Calibration : DIN 43760 Class A
07. Characteristics : Linear with respect to temperature within $\pm 1/2\%$ of top range value
08. Head :
 - a) Type : IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
 - b) Material : Epoxy coated Die cast aluminum or better
 - c) Terminal blocks : Nickel plated Brass-screw type / silver plated



- d) Cable connection : ½" NPT gland and grommet.
- e) Instrument connection to well : ½" NPT
- f) Others : Terminal head cover with SS chain and suitable gasket
09. Accessories : a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
- b) Compression fittings/unions
- c) Flanges etc. (for flanged connections only)
- d) Forged/bar stock thermowell as per ASME PTC 19.3 code. Process connection M33X2 (M).
- e) Material of construction of Thermowell:
SS 316: In general
10. Nameplate : Tag number, service engraved in stainless steel tag plate

Notes: The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be PT100.

1.12.00 **Field Mounted Temperature Transmitters**

01. Working Principle : Smart
02. Type : Two wire
03. Input : Thermocouple K and RTD (Pt 100)-3/4 wire
04. Isolation : 500V AC
05. Output Signal : Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
06. Signal Processing Circuitry : Microprocessor based Solid State Electronic



07. Span and Zero : Adjustable in field, Non-interacting facility for elevation and suppression of zero.
08. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09. Output Indicator : LCD type
10. Span Adjustability : Yes
11. Nameplate : Tag number to be engraved on metallic tag plate rigidly fixed to the body.
12. Body : Die Cast aluminum
13. Operating Voltage : 16-48 V dc
14. Load : 600 Ohms at 24V DC (Min.)
15. Performance
- a) Accuracy : 0.4% of span
 - b) Repeatability : $\pm 0.05\%$ of span
 - c) Cold Junction Compensation : Built-in
 - d) Calibration : As per N.I.S.T Monograph 125 for T/C and European Curve Alpha = 0.00385 for RTD
16. Accessories : a) Universal mounting bracket suitable for pipe and surface mounting.
- b) Hi-tensile Carbon Steel U-bolts.
 - c) $\frac{1}{2}$ " NPT cable gland

1.13.00 **Temperature Switch**

01. Type : Bimetallic / gas filled-in
02. Stem /Bulb Material : AISI SS-316
03. Capillary : SS Capillary & Flexible armour



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

04. Case material : Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
05. Over range Protection : 120%
06. Instrument connection : Bottom
07. Setter Scale : Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
08. Switch configuration : One DPDT (Two SPDT)
09. Switch rating : 240V, 5A AC/220V, 0.5A DC
10. Switch type : Snap acting, shock and vibration-proof.
11. Adjustability : Internal Set point adjustable over span
12. Cable connection : ½” NPT conduit connection or compression gland.
13. Compensation : a) Capillary compensation with invar wire throughout the capillary length.
b) Case compensation
14. Performance :
a) Repeatability : < 1 % of full range
15. Capillary length : 3 meters (minimum)
16. Nameplate : Tag number, service engraved in stainless steel tag plate
17. Accessories : a) Forged thermowell, Mounting accessories,
b) ½” NPT cable gland.
c) Material of construction of Thermowell:
SS 316 : In general
Standard : ASME PTC 19.3

1.14.00 Not used.





1.15.00 Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

1.15.01 Air Filter Regulator

- | | | | |
|-----|------------------|---|--|
| 01. | Filter Element | : | Sintered Bronze |
| 02. | Filter Size | : | 5 microns |
| 03. | Input Air | : | 10.0 Kg/Sq. cm (maximum) |
| 04. | Output | : | Adjustable from 0-2.5 Kg / Sq. cm and 0-7.0 Kg / Sq. cm (continuous) as applicable. |
| 05. | Effect of Supply | : | Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm |
| 06. | Bowl Material | : | Metallic. |
| 07. | Accessories | : | 2" dial size output pressure gauge |
| 08. | Feature | : | No perceptible drop of pressure on opening the drain port. |

1.15.02 Power Cylinders (Pneumatic)

- | | | | |
|-----|----------------|---|--|
| 01. | Mounting Type | : | a) Fixed position mounting (End mounting).
b) True union mounting |
| 02. | Control Signal | : | 4-20 mA DC for modulating purposes. 24V DC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive. |
| 03. | Supply Air | : | 0-7 Kg / Cm ² . |





04. Selection : Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
05. Casing : IP-55.
06. Accessories : a) Air lock relay
b) Hand wheel.
c) Air filter regulator with gauge.
d) Volume Booster.
e) Limit Switches.
f) Smart Positioner with Input and Output pressure gauges, local keypad & display.
g) Solenoid Valve
h) Integral non contact type position Transmitter (4-20 mA DC linear output).
i) Junction box with cable gland
07. Fail-safe operation : For regulating duty- stay put / Fail safe position against power & air fail.
08. Repeatability : Better than 0.5% of full travel.
09. Hysterisis : Less than $\pm 1\%$ of full travel
10. Travel time : Better than 20 sec.
11. Operating Temp. limit : 80°C (min.)

1.15.03 **Electric to Pneumatic (E/P) Converters**

01. Air Supply : 1.5 kg/cm²
02. Max. supply Pressure : 7 kg/cm²
03. Input Signal : 4-20 mA DC (as required by the design of control system).
04. Output Signal : 0.2 to 1.0 kg/cm²



05. Control Action : Air to Close, Air to Open and Fail freeze-field selectable.
06. Response Time : 5 seconds for 0 to 90% output pressure
07. Repeatability : +/- 0.1% span typical
08. Accuracy : +/- 0.25% span typical
09. Linearity : 0.5% of span or better
10. Hysteresis : 0.1% of span or better
11. Ambient Temp. effect : Less than 0.02% of span per °C between -20 °C to +60 °C
12. Supply pressure effect : Less than 1%
13. Span and zero adjustment: Screw
14. Mounting : Close to Actuator (but not on the actuator)
15. Output Capacity : To suit the actuator
16. Protection Class : IP 65
17. Allowable Drift Rate : ± 2% of set point / hour maximum

On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition.

1.15.04 **Smart positioner**

01. Type : Universal design (linear or rotary application)
02. Input Signal : 4-20mA DC, 2 wire loop with 24V DC.
03. Output Signal (position F/B) :
 - i) 4-20mA with HART Protocol
 - ii) Configurable end position switch
04. Supply Pressure :
Single acting 1.2 to 7.0 bar
Double acting 1.2 to 10.5 bar
05. Air Delivery : Single acting 10.0 SCFM at 2.1 bar supply





- Double acting 7.2 SCFM at 2.1 bar supply
06. Housing : IP 65
 07. Repeatability : +/- 0.3% of span or better
 08. Accuracy : +/- 0.1% of span or better
 09. Communication : Hart protocol
 10. Power-up with position control : < 150 ms or better
 11. Power interruption without Reset : <100ms or better
 12. Body Material : Aluminium
 13. Response Time : Less than 10 sec
 14. Features :
 - i) Noncontact position feedback sensor
 - ii) Integral Electro-Pneumatic convertor
 - iii) Self calibration with tunable response time
 - iv) Online diagnostics
 - v) Pressure gauges to be provided on positioner (I/P & O/P pressure)

1.15.05 **Solenoid Valve**

01. Operating Principle : Electromagnetic (noiseless)
02. Coil voltage rating : 24V DC (in general) other 220V DC /240V AC /110V AC as per manufacturer recommendation.
03. Ways : 3 ways in general other depending on requirement
04. Port size : 1/4" NPT all ports
05. Body : SS Bar Stock
06. Trim : AISI SS-316





- 07. Manual Operator : In built
- 08. Duty : Suitable for continuous energization
- 09. Sealing : Airtight and leak proof
- 10. Fluid Temperature : 0-150 O C (approx.)
- 11. Coil Enclosure : Stainless Steel
- 12. Insulation : Class-H
- 13. Coil Casing : IP-65 (Explosion proof for NEC Class-1, Division-1 area)
- 14. Mounting : On pipe or on panel
- 15. Cable Connection : ½" NPT cable gland
- 16. Accessories : Mounting brackets, nuts and bolts as required.
- 17. Special feature : a) LED indication
b) Double coil type.

1.15.06 **Air Lock Relay**

- 01. Type : Single acting with actuator (spring return) and double acting with double acting piston cylinder
- 02. Max. supply Pressure : 7 kg/cm²
- 03. Set Pressure : 1.4 ~ 7 kg/cm²
- 04. Ambient Temperature : -5 to 60°C
- 05. Port Size : ¼" NPT(F)

1.15.07 **Position Limit Switch**

- 01. Type : Proximity type
- 02. Temperature Range : -25 to 85°C
- 03. Protection Class : IP-65





04. Switch configuration : 2 SPDT
05. Contact rating : 5A min. at 240V AC on resistive load

1.16.00 **Flow Elements**

1.16.01 **Orifice Plate**

01. Application : Low fluid velocity flow measurement
02. Design Standard : Concentric as per ASME PTC 19.5 (part-II), ISA RP-3.2 or BS-1042, Part-I
03. Tapings : Flanged weld neck. No. as required plus one additional pair of taps
04. Diameter Ratio : Between 0.4 to 0.7
05. Plate material : Stainless steel or better
06. Thickness : 3 mm for main pipe diameter upto 250 mm, 6 mm for main pipe diameter above 250 mm and 10 mm for main pipe diameter of 500 mm and above.
07. Meter run pipe : Same as main pipe material
08. Root valve : Globe type, Body same as main pipe material, trim ss or better
09. Impulse pipe : Same material as main pipe upto root valve
10. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
11. Accessories : Flanges, gaskets, nuts & bolts, root valves jack screw, meter run pipe, Drain & vent hole as per application etc.

1.16.02 **Flow Nozzle**

01. Application : High fluid velocity flow measurement
02. Design Standard : Long radius, welded type as per ASME PTC 19.5 (Part-III) or BS – 1042
03. Number of Tapings : As required plus one additional pair of taps





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

04. Diameter Ratio : Between 0.4 and 0.7
05. Material : Stainless steel or better
06. Thickness : Suitable for the application
07. Meter run pipe : Same as pipe material
08. Tapping : D and D/2
09. Root valve : Globe type, Body same as main pipe material, trim ss or better
10. Impulse pipe : Same material as main pipe upto root valve
11. Document : Beta ratio calculation, assembly drawing and Flow vs. DP curve.
12. Accessories : Meter run pipe, nipples and root valves. (Inspection port assembly for nozzles used in plant performance purpose)

Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of commutated flow calculations.

1.17.00 FGD System related Special Instruments

1.17.01 Conductivity Analyzer

A. Sensor

01. Type of Cell : Flow through type / removable type (withdrawable with sealing valve)
02. Conductivity Range : As per instrument schedule
03. Cell Constant : 0.01 / 0.1 / 1.0 depending upon range
04. Temperature Compensation : Manual and Automatic (Integral) upto 0-100°C with PT-100 Sensor
05. Process Connection : Screwed
06. Wetted Parts : Electrodes SS 316L or better





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

- Insulators .KYNAR & VITON or better
07. Pressure Rating : 10 kg/cm²
08. Accessories : Vessel (SS 316) with ½” NPT connection.
09. Cable : Upto transmitter in flexible conduct
- B. Transmitter**
01. Type : Microprocessor based, Single stream with multi-range facility
02. Mounting : Flush Panel
03. Protection Class : IP-55 or better
04. Output : 4-20 mA DC (isolated) to a load of 600 ohms (min.)
05. Display
- i) Digital Display of process variable in Engineering Unit, Temperature, Alarm Status.
 - ii) Back lit LCD
 - iii) Character Height 12 mm
06. Zero / Span Adjustment : Front Panel Membrane type Keyboard.
07. Temperature Compensation : Manual or Automatic - selectable through keyboard
08. Diagnostic : Self diagnostic programme for electronics, measuring electrode, open wiring etc.
09. Alarm : Dual alarm set point (2 SPDT, high & low), hysteresis and time delay adjustable from membrane keyboard. Switch contact rating of 5 Amp, 240 VAC / 0.2 Amp, 220 VDC
10. Enclosure : Die cast aluminium epoxy coated
11. Cable Termination : Internal (cable entry through conduit)
12. Accuracy : ± 1.0 % of measured range





13. Response time : Less than 5 sec.
14. Stability : ± 1.0 % of full scale / month non-cumulative
15. Power Supply : 240 V AC, 50 Hz
16. Operating Temp. : 0 -50°C
17. Accessories : a) For cation conductivity analyzer Dual Ion-Exchange column, resin, etc. (minimum 12 months requirements).
b) Phenolic Nameplate, cable gland

1.17.02 pH Analyzer

A. **Sensor**

01. Type of Cell : Measuring and reference electrode combination with flow through type (polypropylene flow chambers).
02. Process Connection : Screwed
03. Type of measurement : Combination electrode
04. Temperature Compensation : Automatic (Integral) upto 0-100°C with PT-100 Sensor
05. Preamplifier : Integral or separate
06. Range : 0-14 pH
07. Measuring Electrode : Glass
08. Liquid Junction : Ceramic/Kyner or equivalent
09. Pressure Rating : 10 kg/cm²
10. Accessories : Vessel (SS 316) with ½" NPT connection
11. Cable : Upto transmitter in flexible conduct

B. **Transmitter**

01. Type : Microprocessor based, Single stream





- with adjustable range facility
02. Mounting : Flush Panel
03. Protection Class : IP – 55 or better
04. Output : 4-20 mA DC (isolated) to a load of 600 ohms (min.)
05. Display
- i) Digital Display of process variable in Engineering Unit, Temperature, Alarm Status.
 - ii) Back lit LCD
 - iii) Character Height 12 mm
06. Calibration : Two-point calibration with standard buffer solutions.
07. Temperature Compensation : Manual or Automatic - selectable through keyboard
08. Diagnostic : Self diagnostic for “Calibration required”/ “Calibration O.K.”, electrode checking etc.
09. Alarm : Dual alarm set point (2 SPDT, high & low), hysteresis and time delay adjustable from membrane keyboard. Switch contact rating of 5 Amp, 240 VAC / 0.2 Amp, 220 VDC
10. Enclosure : Die cast aluminium epoxy coated
11. Cable Termination : Internal (cable entry through conduit)
12. Accuracy : ± 0.03 pH or better
13. Repeatability : ± 0.02 pH or better
14. Response Time : Less than 2 seconds or better
15. Stability : ± 0.001 pH / week
16. Power Supply : 240 V AC, 50 Hz
17. Operating Temp. : 0 - 50°C
18. Accessories : a) Ultrasonic Electrode Cleaner for





uncleaned water.

- b) Phenolic nameplate giving tag number, service, cable gland etc.
- c) Pre-amplifier, special cable, ultrasonic cleaner, etc.
- d) Buffer tablets.

19. Preferred feature Self cleaning type sensor

1.17.03 Turbidity Analyzer

- 01. Type : Light reflection principle
- 02. Accuracy : 2 % Low range
5 % High range
- 03. Response Time : 5 Min (max) [90% of Full Scale]
- 04. Range : 0-100, 0-200 NTU programmable
- 05. No. of streams : Single
- 06. Output signal :-
 - a) Analog : 4-20 mA DC (isolated) into 600 ohms
 - b) Binary : Field adjustable High and low PF contacts.
- 07. Zero & span adjustment : Yes
- 08. Ambient temperature : 50°C
- 09. Indication : Digital
- 10. Enclosure Type/ Material : Weather & dust proof (IP 55) Die cast aluminum
- 11. Type of electronics : Microprocessor based
- 12. Calibration : Auto & manual
- 13. Error / Diagnostic : To be provided
- 14. Mounting arrangement : Panel mounted
- 15. Power supply : 240V AC, 50 Hz, 1 Phase UPS





16. Other requirement : All chemical reagents

1.17.04 **Non - Nucleonic (Vibration) Type Density Meter:-**

A Application : Liquid Density measurement

Detector

1. Orientation : As per requirement
2. Case Material : SS 316L/ Cast Aluminum alloy
3. Wetted part material : SS 316L
4. Operating Principle : Vibration Density measurement

Convertor

1. Output : 4-20 mA DC isolated
2. Electrical Connection : ½" NPT3
3. Enclosure Class : IP 65
4. Local Display : Digital 5 digit, density display with temp. compensation
5. Accuracy : +/- 1%
6. Response time : < 1 minute
7. Power Supply : 230 V AC, +/- 10%, 50 Hz. From UPS

1.17.05 **Density Indicator**

01. Type : Hydrometer
02. Wetted part material : Polypropylene or better
03. Body material : Polypropylene or better
04. Sight Glass chamber : Borosilicate
05. Accessories : Protection guard, assembly fixing nuts & bolts, needle valves, vent plug etc..





1.18.00 **Material Handling System related special instruments**

1.18.01 **Belt Protection / Safety Switches**

(a) **Zero Speed Switches**

It shall be provided for all belt drives or indirectly driven equipment and shall be two-wire, inductive, proximity type with local indication facility. Sensing distance range shall be 1 to 25 mm. The interconnecting cable length shall not be less than 3 meters. Following features shall be provided.

- | | | |
|-------------------------------|---|--|
| (a) Type | : | Microprocessor based |
| (b) Body | : | Cast Iron |
| (c) Type of enclosure | : | Die-Cast Aluminium |
| (d) Degree of protection | : | IP-65
Flame proof for NEC Class-2,
Division-1 area |
| (e) Speed Setting
Accuracy | : | Within $\pm 5\%$ of desired value |
| (f) Repeatability | : | Within $\pm 1\%$ |
| (g) Differential | : | Within $\pm 5\%$ of set value |
| (h) Contacts | : | 2 NO + 2 NC |
| (i) Contact Rating | : | Continuous 10Amp. (240V
AC) |
| (j) Preferred Features | : | (i) Red LED for "Supply
On"
(ii) Green LED for "Relay
On"
(iii) Display of present
speed
(iv) Display of speed set
(v) Alarm facility with
indication
(vi) Initial bypass time
delay |
| (k) Reset facility | : | Manual |



(l) Accessories : Canopy

(b) Belt Sway Switches

Auto reset type shall be provided (in pairs) for protecting all non-self-aligning conveyor belts and can be installed in vertical or horizontal position at no more than 30 Mtrs. Intervals. For any conveyor, however, minimum two pairs of switches shall be provided. These switches shall be placed not more than 15 M from either end of conveyor. Operating lever shall actuate micro switches with movement of 45° on either side. Contact roller support bearing shall be with high relative lubrication & low coefficient of friction. Local indicating lamp as a special feature is envisaged.

- (a) Type : Addressable type
- (b) Body : Cast Iron
- (c) Contacts : 2 NO+ 2 NC
- (d) Contact Rating : Continuous 10 Amp,
Breaking 2 Amp (240V AC)
- (e) Type of enclosure : Die-Cast Aluminium
- (f) Degree of protection : IP-65
Flame proof for NEC Class-
2, Division-1 area
- (g) Accessories : (a) Canopy
(b) The Belt sway switches shall be provided with a common bridging push button which shall be kept pressed to bypass the limit switch before restarting the conveyor.

(c) Pull Cord Switches

Pull cord switches shall be provided for manual safety stopping of conveyors. Pull cord wire rope shall pass through cradle of switch. Movement of lever (45° on either side) shall actuate the pull cord switch. It shall be provided at every 30 Mtr. Distance on both sides along the belt conveyors and shall only be manually reset locally. The operating handle shall be fitted with spring steel rings at both ends.



From either end of conveyor pull cord switches shall not be more than 15 Mtr.

Area alarm horns/ hooters shall be provided at various strategic plant locations, which shall sound first, continuously for sufficient time to alert personnel nearby to move clear, before the device or sequence can be started.

- | | | | |
|------|----------------------|---|---|
| i. | Type | : | Addressable type |
| ii. | Body | : | Cast Iron |
| iii. | Contacts | : | 2 NO+ 2 NC |
| iv. | Contact Rating | : | Continuous 10 Amp, Breaking 2 Amp (240V AC) |
| v. | Type of enclosure | : | Die-Cast Aluminium |
| vi. | Degree of protection | : | IP-65
Flame proof for NEC Class-2,
Division-1 area |
| vii. | Accessories | : | (a) Canopy over lever of pull cord switch
(b) Adequate length of PVC wire rope
(c) Linking of switches through a single cable for each section.
(d) Each pull cord switch shall be provided with red LED indication lamp for prominent visible indication of tripping. |

(d) Pull Cords & Belt Sway Indication System

Pull cord and belt sway switches of all conveyors shall be continuously monitored through "Pull cord & belt Sway Indication System". System shall display the exact location and number of safety switches operated in a pull cord and belt sway loop of a conveyor. It shall also monitor the condition of field cable connecting the switches in series & generate signal if field cable is found broken or short. The indicator panel shall display the operated switch number. Units shall be installed at respective Control System location (PLC / DCS / RIO). There shall be analog 4~20 mA DC or soft communication link with the FGD DCS / PLC System for remote monitoring of the switch status in the operator station. Systems shall have the diagnostic to detect faulty switch and damaged cable.



(e) **Chute Block Switch**

- | | | | |
|-------|-----------------------|---|---|
| i. | Type | : | RF based |
| ii. | Sensor Material | : | SS-316 |
| iii. | Mounting | : | Flanged |
| iv. | Insulation Material | : | PTFE |
| v. | Contacts | : | 2NO+2NC |
| vi. | Type of Enclosure | : | Die-Cast Aluminium |
| vii. | Degree of Protection | : | IP-65 |
| viii. | Electrical Connection | : | ¾" ET |
| ix. | Repeatability | : | 0.05% |
| x. | Local Indication | : | To be provided |
| xi. | Accessories | : | a) Neoprene gasket and Stud bolt
b) SS Tag plate, Nickel plated brass double compression type cable gland. |

1.18.02 **RF Type Level Switch**

- | | | | |
|-----|-----------------------|---|----------------|
| | Sensing Probe | : | |
| 01. | Type | : | Rigid |
| 02. | Material | : | SS-316 |
| 03. | Mounting | : | Threaded |
| 04. | Probe Head Housing | : | Cast Aluminium |
| 05. | Protection | : | IP-66 |
| | Electronic Controller | : | |
| 01. | Supply Voltage | : | 240V AC (UPS) |



**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 02. Relay Output : 2 nos. SPDT
- 03. Contact Rating : 240V AC,5A/ 220V DC, 0.25A
- 04. Housing Material : Cast Aluminium
- 05. Protection : IP-65
- 06. Local LED Indication : Power On, Alarm Level, Probe Healthy
- 07. Switching Repeatability: $\pm 0.5\%$
- 08. Accessories : Coaxial cable probe connection to controller
 $\frac{1}{2}$ "NPT Cable Gland

1.19.00 FGD Emission Monitoring System

- 1.19.01 Complete CEMS package with all analyzers in the Chimney, for the measurement of Flue gas parameters (SO_x, NO_x, CO, CO₂, SPM, Hg, Gas flow) as per CEA guidelines shall be provided by the bidder. All analyzers shall be capable of online remote calibration requirement by CPCB. (CPCB Lr.No. C-12011/33/2017-17/Tech/514 dt. 16-04-2018)
- 1.19.02 Flue gas analyzers shall be provided for Flue Gas De-sulphurization System emission monitoring. FGD emission monitoring system shall comprise of Sulphur-di-oxide (SO₂) measurement at inlet and outlet of FGD System to control the treatment process. The reagent dosage shall be derived from these two values. Additionally oxygen shall be measured to detect leakage. Other CEMS monitoring as indicated above shall be provided as per CEA guideline.
- 1.19.03 The Bidder shall indicate system wise requirement of instrument air along with his proposal.
- 1.19.04 Monitoring system shall be extractive type comprising of the transceiver, the Sampling probe, Prefabricated heated sample lines, filters, coolers, the converter unit, analyzers, data logger and all special cables.
- 1.19.05 The measurement shall be completely independent of particulate, moisture, presence of other gases and temperature variation.
- 1.19.06 All output signals of all emission monitoring analyzers shall be hardwired and connected to FGD PLC as applicable for monitoring, archiving and report generation etc.
- 1.19.07 The Sampling probe shall be of suitable material of construction depending on the FGD classification & direct insertion into the FGD inlet & outlet. No sampling conditioning system shall be employed for the measurement.





1.19.08 The Complete system shall be installed in the analyzer shelter suitably located in the field. A permanent, environmentally controlled (air-conditioned) shelter/hut shall be provided to house all non on-line mounted components in the vicinity of the sampling location.

1.19.09 **Technical Specification**

1.19.09.1 SO_x, NO_x, CO, CO₂ Analyzer

01. Type : Extractive type analyzer, Microprocessor based.
02. Gases to be measured : SO_x, NO_x, CO, CO₂, and MOISTURE
03. Principle of measurement : Non-dispersive infrared absorption (NDIR)
04. Flue gas Temperature : As per process requirement
05. Probe material : Stainless Steel 316L
06. Mounting/Application : Flanged/ On chimney
07. Measurement range : Fully selectable as per process requirement
08. Units of measurement : PPM, mg / Nm³ and %
09. Power Supply : 240V, 50 Hz, 1 Phase UPS
10. Local Display : Back lit LCD / LED
11. Measurement of averaging : 10 sec to 60 minutes (selectable)
12. Accuracy : 1.0% of measured value
13. Repeatability : 1.0% of full scale
14. zero & Span drift : 2% per month
15. Calibration : Zero and Span calibration in manual and automatic mode. Automatic calibration interval shall be fully selectable.
16. Analog output : 4-20 mA DC each channel (with superimposed HART signal) into 600 ohms / RS 485 MODBUS
17. Alarm output : (1NO + 1NC) for each measured parameter and self diagnostic failure. All contacts rated at 230V AC, 5A
18. Input normalisation : Required—online with pressure and





- temperature sensor and also provision for key pad entry of inputs
19. Enclosure : Corrosion resistant epoxy painted aluminium housing & enclosure rated to IP-65.
20. Accessories : a) Compressor/Blower unit, tubes & fittings for calibration and purging, purge fail alarm in CCR
- b) Calibration gas cylinders for SO₂, NO_x, CO₂ and CO filled in 10 Ltrs. of WC carbon cylinder with necessary SS regulators with pressure & flow gauges, solenoid valve & SS tubings and SS fittings etc. as required.
- c) Mounting flanges, gasket etc.
- d) control unit for interface with PC based data logger to be provided.

1.19.09.2 Smoke Density / Opacity Monitoring

01. Type : In-situ dry visible light (through LED)
02. Principle of measurement : Transmission & absorption (Dual beam type)
03. Sensor type : Luminescence
04. Display : Back Lit LCD
05. Measurement range : 0-999 mg/m³, 0-999 mg/Nm³, 0-100% opacity
06. Measurement averaging : Selectable 10 sec to 60 minutes
07. Accuracy : 0.2% of F.S
08. Resolution : 0.1% of F.S / 1mg/m³ whichever is better
09. Linearity : 1.0% of F.S
10. Repeatability : < 0.5% of Span
11. Response time (upto 90% of full scale) : 5 sec
12. Flue gas temperature : 90°C (When FGD in operation)





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 135 °C (When FGD not in operation)
Max 600 °C (at APH outlet)
13. Ambient temperature : 0 - 60 °C
14. Operating temperature : Transmitter & receiver- 0-90 °C, Electronic unit – 0-70 °C
15. Mounting : Transceiver on opposite side of the duct
16. Analog output : 4-20mA DC (in 500 ohm resistance) to DCS
17. Alarm output : 2 SPCO potential free rated at 230 VAC, 5A
18. Power Supply : 240V AC, 50 Hz, 1 Phase UPS
19. Automatic misalignment detection : Required
20. Automatic compensation of lens contamination : Required
21. Purge air Failure : Purge air to be provided from Blower unit and to be monitored for failure.
22. Span and Zero Check : Automatic periodic with manual override
23. Housing : Corrosion resistant painted aluminium rated at IP-65
24. Fail safe shutter : Automatic fail safe shutter against power and air failure
25. Input normalisation : Correction for temperature, pressure, oxygen and water vapour to be provided.
26. Preferred Features : “Power Supply On” LED visible from front
27. Accessories : a) Mounting pads suitable for mounting projector and receiver units on duct, flanges, etc.
b) Blower unit (Purging System) with purge fail alarm at CCR
c) Enclosure for electronic units & indicators
28. Application : At chimney





1.19.09.03 Oxygen Analyzer

01. Type : In-situ, Zirconium sensor, micro-processor-based transmitter,
02. Range : 0.1-10% / 0.25-25% by volume
03. Output : 4-20 mA DC linear
04. Probe Length / Material : 1800 mm (approximate depending on duct size) / SS 316
05. Process Temperature : As per Process Requirement.
06. Measurement Reference : Instrument Air
07. Accuracy : $\pm 1\%$ of F.S.
08. Response Time : Less than 5 (five) sec for 90% of full scale
09. Amplifier Housing : IP-65
10. Calibration : Manual or Automatic periodic-operator selectable
11. Power Supply : 240V, 50 Hz, 1 Phase UPS
12. Material for Gas Carrying Components : Stainless Steel
13. Read Out : Backlit LED/LCD
14. Protection : Automatic cell protection against reducing atmosphere
15. Alarm Facility : 1 HI and 1 LO independently adjustable over span. Contact rating 500 mA at 220 V DC (minimum).
16. Preferred Features :
 - a) HI and LO alarm LED visible from front.
 - b) Power Supply On/Failure LED visible from front
17. Accessories :
 - a) Mounting flanges, adaptor plate and protection shield (protection/abrasive shield shall be SS 316)
 - b) Gasket, nuts and bolts





- c) Cable with conduit from cell to amplifier (as required) and other special cables (if any)
- d) Automatic calibration kit (complete with all accessories and standard Gas Cylinders)
- e) Solenoid valve, Pressure regulator with Filter and Flow indicator

1.19.09.04 Mercury Analyzer

- 01. Operating Principle : Atomic absorption spectroscopy
- 02. Range : 0-100 µg/Nm³
- 03. Measuring Parameters : Spacious mercury, total mercury
- 04. Output : 4~20 mA DC
- 05. Alarm/ Annunciation : Four Relay contacts, dual alarm set points (240V AC, 5A)
- 06. Indication : LCD Display
- 07. Sampling System : Extractive
- 08. Enclosure : IP-65
- 09. Power Supply : 240V AC (UPS)
- 10. Accessories : Standalone system cabinet, interconnecting cables, mounting hardware as required.

1.19.09.05 Gas Flow Measurement (Ultrasonic Type)

- 01. Type : Transit time Ultrasonic meter,
- 02. Mounting style : Transducers on the duct/stack
- 03. Output
 - Analog : Isolated 4-20 mA DC
 - Binary : RS 485/ Ethernet communication link with MODBUS / OPC protocol.





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

04. Zero & Span adjustment : To be provided
05. Display : Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.
06. Protection class : IP-65
07. Accuracy : Less than $\pm 2\%$ of F.S.
08. Accessories : All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables, flexible conduits, junction boxes etc.

Purging arrangement for cleaning sensors to be provided. Material of all fittings shall be SS 316.





2.00.00 **CONTROL PANEL / DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES (As applicable)**

2.01.00 **Push Button**

01. Type : Shrouded square format
02. Face Dimension : 32 x 32 mm (maximum)
03. Contact Configuration : 2 NO + 2 NC
04. Contact Addition : Add-on block up to 4 each with 2 pairs of contacts
05. Contact Material : Hard Silver Alloy
06. Contact Rating : 500V / 10 A
07. Utilization Category : AC11 / DC11
08. Insulation Voltage : 2 KV for 1 minute between terminals and earth
09. Mechanical Life : 1 million operations
10. Construction : Aluminum shrouding with plastic lens
11. Colors : Red, Green, Yellow, Black, etc.
12. Connection : Screw terminals
13. Enclosure Class : IP-52
14. Legend : Engraving

2.02.00 **Illuminated Push Button**

01. Type : Square format
02. Face Dimension : 32 x 32 mm (maximum)
03. Contact Configuration : 2 NO + 2 NC (minimum)
04. Contact Addition : Add-on-Block up to 4 each with 2 pairs of contacts
05. Contact Material : Hard Silver Alloy
06. Contact Rating : 500 V/ 10A





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 07. Utilization Category : A C11 / DC11
- 08. Insulation Voltage : 2 KV for 1 minute between terminals and earth
- 09. Mechanical Life : 1 Million Operations
- 10. Lamp : LED with built-in resistors as required
- 11. Lamp Rating :-
 - a) Voltage : 240 V AC /24V DC
 - b) Watt : 0.5 Watt (approx)
- 12. Lamp and Lens
 - Replacement : From front
- 13. Construction : Transparent Plastic Lens
- 14. Color : Red, Green, Amber, Yellow etc.
- 15. Connection : Screw terminals
- 16. Enclosure Class : IP-52
- 17. Legend : Engraving
- 18. MTBF lamp : 100000 hours

2.03.00 Selector Switch

- 01. Type : 2/3/4 position stay put type with rotary lever actuator.
- 02. Face Dimension : 32 x 32 mm (maximum)
- 03. Contact Configuration : 4 pair of contacts
- 04. Contact Addition : Add-on-Block up to 4 each with 2 pairs of contact
- 05. Contact Material : Hard silver Alloy
- 06. Contact Rating : 500 V/10 A
- 07. Utilization Category : AC11 / DC11
- 08. Insulation Voltage : 2 KV for 1 minute between terminals and earth





- 09. Mechanical Life : 1 million operations
- 10. Construction : Aluminum shrouding
- 11. Connection : Screw terminals
- 12. Enclosure Class : IP-52

2.04.00 **Indicating Lamp**

- 01. Type : LED with built-in resistor
- 02. Face Dimension : 32 x 32 mm (maximum)
- 03. Voltage : 240 V AC / 24V DC
- 04. Watt : 0.5 Watt (approximate)
- 05. Lamp and Lens Replacement : From front
- 06. Construction : Transparent Plastic lens
- 07. Color : Red, Green, Amber, Yellow etc.
- 08. Connection : Screw terminals
- 09. Legend : Engraving
- 10. MTBF : 100000 hours

3.00.00 **CONTROL VALVES, ACTUATORS & ACCESSORIES**

3.01.00 **General Requirements**

3.01.01 Control Valves and accessories furnished by the Bidder shall be designed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR), ISA and other standards as specified elsewhere as well as in accordance with the applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards.

All the control valves, their actuators and accessories to be furnished under this section shall be fully suitable and compatible with the services covered under the specification.

3.02.00 **Control Valve Sizing and Construction**





- 3.02.01 Design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
- 3.02.02 Valve sizing shall be suitable for obtaining rated flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve stem travel. All the valves shall be capable of handling at least 120% of the required rated flow. Further, the valve stem travel range from minimum flow condition to rated flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA on control valves. While deciding the size of valves, Bidder shall ensure that valves port outlet velocity does not exceed 8 m/sec for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Bidder shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which shall be subject to Owner / Consultant's approval during detailed engineering stage.
- 3.02.03 Control valves of steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation / flashing service, only valve with anti-cavitation trim shall be provided.
- 3.02.04 All other control valves shall have leakage rate as per leakage Class-IV as minimum.
- 3.02.05 The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.
- 3.03.00 **Valve Construction**
- 3.03.01 All valves shall be of globe body design & straightaway pattern with single or double port unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure drops permit.
- 3.03.02 For large flow conditions with low pressure drops, butterfly valves shall be used.
- 3.03.03 Valves with high lift cage guided plugs & quick change trims shall be supplied in case of globe type valves.
- 3.03.04 Cast iron valves are not acceptable.
- 3.03.05 Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner / Consultant. Bonnet joints of the internal threaded or union type shall not be acceptable.



- 3.03.06 Plug shall be one-piece construction either cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.
- 3.03.07 All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing).
- 3.03.08 Valve characteristic shall match with the process characteristics.
- 3.03.09 Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280°C.
- 3.03.10 Flanged valves shall be rated at no less than ANSI pressure class of 300 lbs.
- 3.03.11 Gland material shall be chosen to suit the operating temperature. PTFE may be chosen for low temperature application and for high temperature application graphited asbestos glands are to be provided.
- 3.04.00 **Valve Materials**

Materials for Control Valves shall be equivalent/superior to the following:

SI. No.	Service	Body Material	Trim Material
1	Non-corrosive, non-flashing and non-cavitation service below 275°C.	Compatible with piping material	SS-316 with stellite faced guide posts and bushings.
2	Severe flashing / cavitation services.	Alloy steel as per ASTM A 217 Gr. WC9	400 series SS or equivalent to suit the specific requirement
3	Low flashing / cavitation service.	Alloy steel as per ASTM A 217 Gr. WC6	400 series SS or equivalent to suit the specific requirement
4	Condensate service below 300°C.	SS-316	SS-316

Note: Valve body rating shall meet the process pressure and temperature requirements as per ANSI B16.34.

However, Bidder may offer valves with body and trim materials better than specified materials and in such cases Bidder shall furnish the comparison of properties including cavitation resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis-à-vis the specified material for Owner / Consultant's consideration and approval.





3.05.00 End Preparation

Valve body ends shall be either butt welded/socket welded, flanged (Rubber lined for condensate service) or screwed as finalized during detailed engineering and as per Owner / Consultant's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves size 50 mm and below welded ends shall be socket welded as per ANSI B 16.11 Flanged ends wherever required shall be of ANSI pressure-temperature class equal to or greater than that of control valve body.

3.06.00 Valve Actuators

3.06.01 All control valves shall be furnished with pneumatic actuators. The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg. C continuously.

3.06.02 Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 kg/sq.cm. per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.

3.06.03 Travel time of pneumatic actuators shall not exceed 10 seconds.

3.06.04 Spring-diaphragm type valve actuators shall be used in general applications. However piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Piston actuator shall be of double acting type for the regulating duty valves with long stem travel for better regulation and quick response.

3.06.05 Actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.

3.06.06 All actuators shall be supplied mounted on the valve with all the accessories integrally mounted. The diaphragms shall be designed for 200% maximum operating pressure.

3.06.07 Nylon reinforced neoprene shall be used as diaphragm material.

3.06.08 Entire actuator assembly shall be painted with corrosion inhibiting paint.

3.06.09 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be of stainless steel construction.

3.06.10 Actuators shall be of failsafe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.





3.07.00 **Control Valve Accessory Devices**

All pneumatic actuated control valve accessories such as air locks, hand wheels / hand-jacks, Non-contact type limit switches, microprocessor based smart electronic Positioners, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements. For further details please refer clause no. 1.32.00 of this section of the specification.

3.08.00 **Tests**

All valves shall be tested in accordance with the Quality Assurance Programme (QAP). Bidder shall submit QAP for Owner's approval. The tests shall include but not be limited to the following :

- a) Non destructive test as per ANSI B 16.34.
- b) Hydrostatic shell test as per ANSI B 16.34 prior to seat leakage test.
- c) Valve closure test and seat leakage test as per ANSI B 16.34 and as per the leakage class
- d) Functional Tests: The fully assembled valves with actuator and all accessories shall be functionally tested to demonstrate from open to close position and vice versa. Valve lift shall be checked at 5 points at 0, 25, 50, 75 and 100% in both the directions with increasing and decreasing inputs. Performance of the valve with Positioner shall be as follows :
 - i) Linearity : +/- 1%
 - ii) Hysteresis : +/- 1%
 - iii) Sensitivity : +/- 0.5%
 - iv) Deadband : +/- 1%
 - v) Reproducibility : 0.3% of total stroke
 - vi) Overall accuracy : +/- 1%
- e) CV test: CV test shall be carried out as type test on each size, type and design of the valves as per ISA 75.02 standard and test report shall be submitted for Owner's approval.

4.00.00 **CONTROL DESK / PANEL / RACK / ENCLOSURE**

4.01.00 **General**





- a) All control desks, panels, system cabinets, local panels and local instrument enclosures, racks shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads, internal piping, detachable lifting hook and accessories as per IS:5039-1969 as required for completeness of the system.
- b) Convenient and logical approach to operational interfaces and to enhance aesthetics in the overall view of the panel / desk shall be considered.
- c) All panels, desks, cabinets shall be free standing type and have bottom entry for cables unless otherwise specified. The bottom of desks, panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire. Thickness of gland plate shall not be less than 3 mm.
- d) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the steel plate shall conform to the requirements of UL 50 or equivalent standard. Panels and cabinets shall be of adequate strength to support mounted components and to support a concentrated load of 100 Kilograms on their top after erection.
- e) For items susceptible to vibration, suitable rubber gaskets or padding shall be provided to prevent damage or malfunction.
- f) All electronic system cabinets shall be designed for 50°C operating under maximum ambient temperature without air conditioning system in service. Further cabinets, panels shall be so designed that temperature rise due to heat load does not exceed 10°C above ambient temperature under all operating conditions. Necessary louvers, fans, limited packing density, adequate spacing between instruments, devices etc. shall be provided to maintain temperature rise within permissible limits.
- g) Desk, panels, cabinets enclosures wiring and piping shall be arranged to enable the removal of instruments and devices without unduly disturbing them.
- h) All panels, desks, enclosures interiors shall be illuminated with rapid start fluorescent strip fixtures with door actuated switches. Door switch terminals shall be shrouded. All illuminated lights shall be provided with individual switch in parallel with door switch.
- i) Sufficient number of power receptacles with disconnect switches shall be installed within panels, desks, enclosure and racks.



- j) The local instrument enclosures / racks shall be provided locally for mounting of electronic transmitters and switches, etc.
- k) All panels, desks, cabinets shall be properly grounded. The grounding scheme shall be as approved by the Owner / Consultant.
- l) Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. Minimum 2 coats of primer and two sprays of final finish colour shall be applied to all surfaces.
- m) The colour of the panels shall be glossy white with fire resistant paint in the panel interior. External colour of the panels shall be as light grey RAL 7032 for other system cabinets, etc.
- n) Panel / cabinet shall have detachable type eyebolt on top for lifting.
- o) Panel shall be provided with three point latch and lock.
- p) Pocket shall be provided on the inner side of panel doors for keeping drawings & documents.
- q) Nameplates on the panel and terminal blocks shall be provided.
- r) All items like MCB, Terminals, instruments, lamps etc. inside the panels / cabinets shall be neatly arranged with easy access/ maintenance approach to avoid undue disturbing the wiring.
- s) Power supply feeders shall be double so that a single failure shall not affect the operation of the system. Required isolation & protection through MCB shall be provided in all cases. Alarm shall be provided against failure of a single power supply.
- t) Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. All panel mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

4.02.00 Surface Preparation and Painting

All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:





- a) Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

Two spray coats of epoxy primer shall be applied to all exterior and interior surfaces, each coat of primer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil.

- b) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.
- c) Colour shade for the control desk shall be finalized during detailed engineering.

4.03.00

Wiring

All control and instrument wiring used within the panels shall conform to NEC standards and shall be factory installed and tested at the works. All interior wiring shall be installed neatly. Features shall not be limited to the following:

- a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All interconnections between sections of panels / desks shall be furnished.
- b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross- identification.
- c) All wire termination shall be made with insulated sleeve and crimping type lugs. All external connections shall be made with one wire per terminal. Wire shall not be spliced or tapped between terminals. Wires shall not be looped around the terminal screws or studs.
- d) Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.
- e) Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt or mA shall be electrically and physically isolated from other high voltage AC and DC wiring.



- f) Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- g) Where pre-fabricated cables are used for direct connection to electronic cubicles plug-in type connectors shall be used.
- h) Shield wires of field signal cables shall be terminated on separate earthed terminals at panel end.
- i) Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings shall not cause fatigue failure of the conductor.
- j) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which shall impede the opening of covers or obstruct access to leads, terminals or devices.
- k) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 110V AC, 240V AC, 220V DC etc.
- l) Wire shall be multi-stranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.
- m) Conductor sizes used for internal wiring shall not be lower than the followings:
 - i) Power supply / receptacle : 2.5 sq. mm or higher as per load.
/ illumination wiring
 - ii) 4-20mA DC current : 0.5 Sq. mm
and low voltage signal
upto 48V DC
- n) Identification of conductors shall be done by insulation color-coding identified on drawings or by printed wiring lists.
- o) 20% spare conductor shall be provided in the field cable for future use.

4.04.00

Grounding





- a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.
- b) All panels and cabinets shall be provided with a continuous tinned copper ground bus bar of minimum 25 mm x 6 mm cross section, extending along the entire length of the panel / desk / cabinet assembly. This signal ground bus shall be bolted to the panel structure on the insulated post. All shield wires shall be connected to this bus for onward connection to the earth pit. System DC power ground shall also be connected to the earth pit in similar way.
- c) The panel /desk /enclosure /JB ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI / copper flat ground riser or by means of insulated copper ground cable of required cross section with lug for protection ground.
- d) Each circuit requiring grounding shall be individually and directly connected to the panel ground bus.
- e) Signal cable shields shall be grounded at the panel end only and shall never be left open. The ground in between panels of a shipping section shall be firmly looped.
- f) Manufacturer recommendation and scheme shall be followed for all system panel grounding.
- g) Electrical transmitters and switching devices, operating at a voltage less than 50V shall be grounded through the steel structure.

4.05.00 **Miniature Circuit Breakers (MCB)**

MCB shall be used for protection and isolation of logic circuit and power distribution circuit.

4.06.00 **Fuse Blocks**

Where fuse blocks are required by the specifications or the manufacturer's design, they shall be modular type with bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

4.07.00 **Fuses**





Where slow blow fuses are required for protection of instruments /devices they shall have ampere ratings of 1/4, 1/2, 1 or 2. Where fast acting fuses are required for protection of equipment they shall have ampere ratings of 1, 3, 6, 10, 15, 20 or 30. Indicating fuses or blocks to quickly identify a failed fuse shall be provided to the extent possible.

4.08.00

Terminal Blocks

- a) Terminals shall be chromated galvanized DIN rail mounted screw less cage clamp type. Terminals shall have screwed connection for conductor cross-section above 2.5 mm². Terminal blocks shall conform to IEC 947-7-1.
- b) The characteristics of the terminal blocks shall be as follows.
 - i) High contact force, independent of conductor cross-section and large contact surface area.
 - ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.
 - iii) Inspection and maintenance free (resistant to thermal aging and vibration)
 - iv) Low and constant voltage drop
- c) Material of the clamping yoke of screwed terminals shall be electroplated, chromated, case hardened steel with high strength clamping screw. For screw less terminals, the tension spring shall be made of high quality, non-rusting, acid-resistant steel. The current bar shall be of tin-lead plated copper or brass.
- d) Terminals shall be of non-flammable suitable thermoplastic material such as polyamide.
- e) Terminal blocks shall be mounted vertically in panels and cubicles with clearance for at least 100 mm between two sets and between wall and terminal block. Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.
- f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.
- g) At least 20 percent spare unwired terminals shall be provided for all panels /cabinets /desks /junction box etc. This shall be in addition to spare wired terminals of spare IO channels and wired spare modules.
- h) For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.



- i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
- j) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
- k) The terminals for DCS / PLC input /output connections to SWGR / MCC, actuator starter, solenoid valves etc. shall be provided with built in test and disconnect facilities to permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections. Technical detail for the same shall be finalized during detailed engineering.
- l) It shall also be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.
- m) Where more than one connection to a terminal block is required, two tier terminals shall be used.
- n) Terminal blocks shall preferably be assigned different colors depending upon voltage and current levels.

4.09.00 **Nameplates and Labels**

- a) Nameplate shall be furnished for each instrument or device mounted on the panel / desk.
- b) The material shall be laminated phenolic, 3 mm thick with white letters on black background.
- c) The nameplates for panels / consoles shall be provided both on the front and the rear.
- d) Nameplates for all devices shall be located adjacent to the respective devices.
- e) All such nameplates, instruction plates, lubrication charts etc. shall be with English inscriptions.

4.10.00 **Wiring Diagram**

Each panel & enclosure shall have drawing pockets to store the relevant drawings of the respective panels. For the junction box printed wiring schedule engraved in black on white bakelite sheet shall be suitably affixed inside the junction box.

4.11.00 **Control Desks**





- 4.11.01 All devices mounted on the panel / desks shall be flush type. Instruments / devices shall be so mounted that the removal and replacement can be accomplished individually without interruption of services to others.
- 4.11.02 Desk shall be ergonomically designed to suit the user / operators needs on a 24 x 7 basis. Aesthetic, ergonomics and lighting shall be considered while positioning of the desk, large video screen and panels in control room.
- 4.11.03 Control desk shall be free standing floor mounting type tabletop design with compartments for locating the computers and other hardware. Desk shall be of latest technology aesthetic design and constructed from aluminium extrusion with high pressure laminate 25 mm thick MDF board for work surface as per Owner / Consultant's approved colour. Aluminium structure shall be anodized or powder coated paint finish.
- 4.11.04 Desk should have concealed cable trays and wire management system, which shall be easily accessible for maintenance. The cable management should be designed to support vertical and horizontal cables with proper hardware and accessibility. Cable tray shall be designed from steel with powder coated paint finish.
- 4.11.05 Design shall include earthing bolts on left side end and right side end of the Desk.
- 4.11.06 Crating of the desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing and all panel mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.
- 4.11.07 OWS and other application terminals mounted on the control desk shall be powered from UPS feeders and each feeders shall be provided with MCB at the upstream of the permanent Power receptacles. A minimum of two set of Alarm Accept/Reset Push Button shall be provided on each Control Desk.
- 4.11.08 The desks shall be complete with vibration dampener and foot leveler.
- 4.11.09 **Technical Specification of Control Desk**
- i) The frame / structure should be minimum 2mm thick Powder Coated Extruded Aluminum profile.
 - ii) The Table Top / Work Surface shall be 36mm thick, Medium Density Fiber (MDF) board with high pressure laminate or Acrylic Plastic Solid Surface (APSS). Top surface shall be finished with anti-scratch material.
 - iii) Foot extension shall be of Cast Aluminum & painted.



- iv) Foot Leveler shall be injection molded glass filled nylon foot with steel insert.
- v) END Caps & Extruded PVC Caps shall be provided where required.
- vi) Front edge shall be extruded PVC or rounded post-formed laminate.
- vii) Concealed cable tray shall be powder coated steel.
- viii) Provision shall be made for keeping Multi-media speakers.
- ix) Design shall include Earthing bolts on left side end and right side end of the Workstation Desk / Rack.
- x) Design should include cutouts for Push buttons, Public Address System and Function Keyboard mounting on the Furniture.
- xi) Retractable keyboard tray in the control desk shall be provided.
- xii) Retractable tray with telescopic slide for CPU/PC block shall be provided.
- xiii) Front and Rear door shall be considered.

4.12.00 Not used.

4.13.00 **System Cabinets / Panels**

- 01. Material of construction : Cold rolled steel sheet
- 02. Thickness of Sheet : 2 mm thickness for load bearing and 1.6mm for non-load bearing.
- 03. Construction : Welded throughout as per (metallic parts) approved National Standards.
- 04. Panel height : 2300 mm (approx.)
- 05. Doors : Full height front & rear door, recessed, turned back edges. Double door for panel width more than 800 mm.
 - a) Thickness of Sheet : 2 mm
 - b) Hinges : Concealed stainless steel type





- c) Door latches : Three point type
- d) Door gaskets : Neoprene rubber on fixed frame to result dust proof / weather proof enclosure.
- e) Opening of the doors : Outward
- f) Louvers : With removable wire mesh to ensure dust and vermin proof.
- 06. Colour of interior : Glossy white
- 07. Colour external : Light grey RAL 7032
- 08. Painting : Epoxy powder coated or better
- 09. Gland plates : Removable 3 mm thick (bottom)
- 10. Cable entry : Bottom
- 11. Hardware :
 - a) Anti vibration pad- 15 mm
 - b) Predrilled base channel ISMC - 100 or equivalent for all sides.
 - c) Stainless steel buff- finished 2 mm thick kick plate for all sides.
 - d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws.
 - e) Rubber strips to ensure air tightness between kick plate and finished floor.
 - f) Detachable lifting hook / Eye bolt
 - g) Drawing pocket at front & rear door
 - h) Door switch, lamps, thermostat, heaters and fans
 - i) Door lock with master key

4.14.00 Furniture

Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.





4.14.01 **Workstation Furniture**

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

4.14.02 **PC Rack**

PC Racks shall be provided to mount CPUs of workstations/ PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

4.14.03 **Chairs**

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

4.15.00 **Local Instrument Enclosure** (Closed type enclosure shall be provided in all areas)

4.15.01 Transmitters, switches and devices located in the field shall be grouped together and shall be installed in the Enclosure in case of outdoor area such as Boiler area etc. and in Open Type Rack in case of covered area. Racks and enclosure shall be factory prefabricated & painted and complete with internal piping, tubing, manifold valve, isolation valves, blow down valves, integral junction box, wiring, illumination etc. with outside access doors, Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging. No more than six instruments shall be grouped in a single rack /enclosure

4.15.02 The local instrument enclosures shall be constructed from 2.0 mm thick sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Gaskets shall be used in between all mating sections to achieve protection class of IP-55. Enclosure doors shall have three point lock.

4.15.03 The local instrument racks shall be free standing type constructed from suitable 3 mm thick channel frame of steel and shall be provided with a canopy at top to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel and extended beyond the ends of the rack.





- 4.15.04 Bulk heads, especially designed to provide isolation from process line vibration shall be provided. Bulkhead plates shall be removable type and thickness of not less than 6 mm shall be employed.
- 4.15.05 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters/ switches at accessible height. Adequate support for manifold, impulse pipe and cable tray shall be provided and the same shall be adjustable.
- 4.15.06 All internal wirings and / or data bus connections, if any, between the transmitters and terminal junction box shall run through flexible dust tight conduits connected to the terminal box hub. No exposed wirings within transmitter racks, both open and closed type, is admissible.
- 4.15.07 All racks shall have a common closed drain trough to connect transmitter drain points to a common header after suitable pressure breaking. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. The trough shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header. Individual Instrument blow down line shall be connected to the common blow down drain header through regulating globe type blow down valves. The common blow down drain header shall be 2" NB ASTM A106, Sch-80 Gr. C installed at a slope of 1:25.
- 4.15.08 The junction box for enclosure and racks shall conform to IP 65 protection class. Junction box shall be provided as an integral compartment at one side of the enclosure / rack with front opening type door. Junction box shall be complete with DIN rail mounted terminals, MCB, receptacles and earth bar. All wiring shall be laid in PVC cable tray. Cable gland plate shall be provided for cable entry from bottom. Earth bar shall be made of tinned copper continuous and of 25 X 6 MM size.
- 4.15.09 Each rack shall be provided with receptacle, light fixture with wire guard and lighting switch. Light fixtures shall be installed on the ceilings of rack / enclosure.
- 4.15.10 Type, size and material grade of the impulse pipes, fittings and valves are listed elsewhere in this specification
- 4.15.11 Bidder shall furnish the drawing and documents showing detail arrangement of racks and enclosure and hook up along with instrument grouping at detailing stage for Owner / Consultant's approval.
- 5.00.00 **FGD CONTROL SYSTEM & CEMS**
- 5.01.00 **General Requirements**
- 5.01.01 FGD system automation shall be realized in a dedicated hot redundant Programmable Logic Control (PLC) based control system.



- 5.01.02 The control system (PLC based) shall be latest state-of-the art and proven.
- System complete with all hardware, software & interfaces including controllers with system / marshalling / termination cabinets, data highways, operator stations, engineering stations with visual display units and control devices, printers, historical data storage & retrieval system, sequence of event recording system, necessary application, diagnostic and engineering software (including firewall & anti-virus software for all servers / workstations), interfacing with other plant control systems, operation, monitoring and controlling etc. for safe efficient operation / monitoring and control (both auto control and protection logic controls) shall be provided.
- 5.01.03 PLC based system shall be provided with the latest & proven system design and shall be supplied & engineered from original PLC manufacturer only PLC system supplied & engineered through system house shall not be acceptable.
- 5.01.04 The system shall be independent for each unit and connectivity with Station DCS has been envisaged. All Three (3) (one for each unit and one for common system) systems shall be capable of communicating with each other through soft-link.
- 5.01.05 Requirements for FGD control system are indicated on functional basis in this specification. Bidder shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the Bidder has full responsibility for engineering and furnishing of a complete control system.
- 5.01.06 System shall be highly reliable with the availability of not less than 99.7% with adequate redundancy and fault tolerant configuration.
- 5.01.07 Proprietary microprocessor based control system (if any) shall also comply to the design criteria indicated for the PLC based system. Deviation (if any) shall be clearly intimated to Owner during finalization of Bid and shall depend on Owner's acceptability.
- 5.01.08 System Expandability
- Modular system design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, process I/O cards, drives control modules, hand / auto stations, push button stations, peripherals like Large Video Screen (LED display), Operator Workstation (OWS), printers etc. while the existing system is fully operational. The system shall have the capability to add any new control loops groups / subgroups, in control system while the existing system is fully operational.



5.01.09 On Line Maintenance

It shall be possible to remove / replace online various modules (like I/O module, interface module etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack. The on-line removal/insertion of controller, I/O modules etc. shall in no way jeopardize safety of plant and personnel.

5.01.10 Fault Diagnostics

The PLC shall include on-line self-surveillance, monitoring and diagnostic facility so that a failure / malfunction can be diagnosed automatically down to the level of individual module giving the details of the fault on the programmer station monitor and printers. The faults to be reported shall include:

- (a) Module level faults of control system
- (b) Failure of HMIPIS bus / unit LAN, system bus, local / remote communication bus
- (c) Power supply faults (over voltage, under voltage, loss of input) for each feeder of power supply system / marshalling relay and HMIPIS cabinets.
- (d) Software faults

5.01.11 Response Time

Response time of the control system should be adequate to maintain control over the process under all regime of operation. Response time shall include the delay and dead time both internal and external to PLC. Response time pertaining to the process sensor shall be made optimum by selecting latest high sensitivity process instruments. Response time pertaining to PLC shall include the IO scan time, data communication time, processing time etc. As a guideline, the maximum permissible response time of PLC for various functions are shown as follows:

- a) The cycle time for CLCS, OLCS and Protective logic will be configured from 40 msec to 500 msec as per the process requirement and will be decided during detail engineering stage.
- b) DAS- 500 msec to 2 sec as per process dynamics
- c) SOE - 1 msec

Minimum 50 SOE points per unit (1 milli second resolution for all binary inputs used for SOE) shall be considered by the bidder for the FGD plant.

Faster response is required for some critical equipment and systems and for those systems, requirements for response time shall be guided by the respective equipment and systems dynamics.



5.01.12 System Spare Capacity

Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, PLC shall have spare capacity and necessary hardware / equipment / accessories to meet following requirement for future expansion at site:

- i) 10% spare channels in each of the functional groups for each type of input / output fully wired up to marshalling / termination TBs.
- ii) 20% hot spare I/O modules of each type of installed I/O module in the system, fully wired up to the marshalling/ termination TBs.
- iii) Wired-in "usable" space for 20% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in marshaling cabinets..
- iv) HMI shall be provided with capacity to handle 25% of tags

5.01.13 Following guidelines regarding the data loading of various components of PLC will determine the extent of functional distribution.

The maximum permissible loadings are as follows:

- Multi-loop Multifunction Controller – 60%.
- Input / Output - 80%
- Console – 80%
- Historical Storage - 75 %
- Data Highway / communication link – 60%
- Other computing modules – 60%



5.01.14 Wiring Scheme for Inputs / Outputs to Control system

- a) Each of the dual / triple redundant binary and analog inputs shall be wired to separate input modules. Implementation of multiple measurement schemes of these inputs shall be performed in the redundant hardware. Loss of one input module shall not affect the signal to other module and also other channels of these modules can be used by other inputs of the same functional group.
- b) No single failure in any component of the control system shall lead to unavailability of more than one of dual / triple redundant input signals to control system. Similarly, no single failure in any one component of the control system shall lead to unavailability of more than one of dual / triple redundant output signals of the control system.

5.01.15 Maximum number of inputs / outputs to be considered each type of module shall be as follows:

- | | | | |
|------|----------------------------------|---|----|
| i) | Analog Input Module | : | 16 |
| ii) | Analog Output Module | : | 16 |
| iii) | Binary Input Module | : | 32 |
| iv) | Binary Output Module | : | 32 |
| v) | Analog Input & Output (combined) | : | 16 |
| vi) | Binary Input & Output (combined) | : | 32 |

5.01.16 Remote Input output Modules and Cubicles

It is envisaged to use remote input output modules of FGD PLC and necessary racks / cubicles at the following location in the plant to minimize cabling. The exact areas where remote I/O modules are provided shall be decided during detailed engineering.

- One (1) Remote Input/ Output (RIO) Unit for each unit to be located in CCR

However, the modules used for the above application shall be designed in such a way to withstand the harsh environment expected to be encountered in respective plant areas.

All communication modules, links, cables and power supply modules shall be redundant.

5.01.17 It is proposed that the logics & control schemes for Booster fan, Booster fan IG, I/L & O/L motorized isolation valve/ gate, Booster fan lube oil system,





Absorber O/L valve, Bypass dampers etc. shall be implemented in FGD vendor supplied PLC.

However, provision shall be made for operation of these equipments from main plant DDCMIS also. The required command & feedback signals to operate and monitor these equipments from station DDCMIS shall be hardwired. The FGD bidder shall consider these IOs also in their PLC. The spare IO modules in the station DDCMIS shall be used for these Interface. The necessary hardwired cable, cabling & termination in both ends for these equipments shall be done by the FGD bidder.

5.01.18 Bidder to note that the terminal point for the OPC connectivity with main plant DDCMIS shall be the Purchasers DDCMIS located in main plant CCR. All the requirements for establishing connectivity with purchaser DDCMIS are under the scope of the FGD bidder.

5.01.19 Bidder to provide/ specify/ mention the following input/ information:

- The modification (both in hardware & software) if required in the main plant control system (in DDCMIS).
- The modification required if any, in the existing CLCS/OLCS of “draft control / furnace control”.
- The effect of ON/OFF Control of Booster Fan on the Furnace Draft as well as on its control logic etc., during the detail engineering stage.

However, the implementation of logics will be discussed and decided during detailed engineering in conjunction with the Boiler manufacturer.



5.02.00 **PLC Processors**

5.02.01 PLC unit shall be provided with redundant processors (Main processing unit, communication units and memories) one for normal operation and one as hot standby. The transfer from main processor to standby processor shall be totally bumpless and shall not cause any plant disturbance whatsoever.

5.02.02 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard. Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks being performed to the other healthy CPU within fastest possible transfer time (i.e. < 50 m sec.) without causing any output to drop during the Transfer period.

5.03.00 **Interface with Station DCS**

FGD PLC shall be interfaced with the Station DCS (OPC) for centralized monitoring and limited controls. Protocol for communication shall be finalized with the DCS vendor during detail engineering.

Bidder's scope shall include all cables and accessories including network components at both ends, required for interfacing FGD PLC with Station DCS.

5.04.00 **Operator Interface to the Control System**

- a) The operator interface of the HMI system shall consist of colour LED monitors / KBDs / mouse, LVS, colour laser printers, GUI etc. The operation shall employ powerful menu-driven and multi window supported input facilities.
- b) All OWS shall be fully interchangeable i.e. all operator functions including control, monitoring and operation of any plant area and drive shall be possible from any of the OWS / LVS at any point of time. Each OWS / LVS shall be able to access all control information related data under all operating conditions.
- c) The operators functions for control on each OWS shall as a minimum include control system operation, alarm acknowledge, call control displays, demand/printout of various displays, logs, summaries etc.
- d) The display selection process shall be optimized so that the desired display can be selected with minimum number of key strokes / steps by the operator.



- e) The control related displays on the monitor / LVS shall as a minimum include mimic displays, overview displays, area displays, individual loop / drive display, closed loop control displays, open loop control displays etc.
- f) The system shall have built-in safety features that shall allow / disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions.

5.05.00 Plant Operational Displays

5.05.01 Standard plant operational and monitoring displays shall be offered by Bidder, which permits easy man machine interactions. The data presented shall be easily understandable, comprehensive and presented in soothing colors so that prolonged exposure to the screens do not lead to eye fatigue.

5.05.02 All consoles and control room furniture supplied shall be of ergonomic design so that no strain is caused to the operators & engineers.

5.05.03 Bidder shall generate typical control screen displays for operation and control. However, there shall be provision for customizing at least 20 additional screens by the Owner in future for specific operational convenience. All the displays shall be customizable by the owner in future, if required. The following typical screens are recommended. There shall be provision for multiple windows & pop-ups. Typical pop-up windows shall tentatively be as follows (i) display of some latest alarms, (ii) window to display messages for illegal key operation, (iii) HELP window to display user defined help messages. Over and above, all screens shall display a fixed header carrying salient information about the plant like MW generation, frequency, time & date, power factor, load demand etc, and an alarm footer to represent any major alarm in the plant.

5.05.04 Switching over from page-to-page or from display-to-display shall be by means of simple procedure like track ball operation and pull-down menus.

5.05.05 Control Overview Screen

Display of status & values of all analog control loops and open loop controls in one screen in color graphic form. The display shall present all the controlled parameters in color bar graph representing the value on a 100% span scale and/or the control deviation in a center-zero scale. The color of the scale shall indicate the alarm / healthy / control status of the variables. The point address code shall associate with each bar to enable the operator to select parameter display by direct addressing.

- a) Group display screen - group of related control loops, and or measurement parameters and / or related drives displayed in one screen. The display can be in controller face plate form showing the controlled variable, A/M status of the controller; engineering value of measurement parameter on a 100 %





span bar graph form; status of binary drives etc. Typically, a group screen shall be composed of 8 parameters or loops.

- b) Individual display screen - displaying one control loop, tag number of associated elements, schematic representation of the loop, trend of the controlled variable/s, alarm history, sectional plant sub-system display related to the loop, various settings including tuning parameters, alarm / trip settings etc., representing a complete data bank for the loop. Similarly, for binary drives, the representation shall include a sectional mimic for the drive area, control ladder, status of the drive, tag number, different delay and other settings etc.; all in one screen.
- c) Plant sub-system display - mimic diagrams meant for direct operation by vectoring cursor on the screen. The display shall have a fixed part representing the P&I diagram and a dynamic part refreshing parameter values and status of drives. There will be an overall plant sub-system display from which operator shall zoom into the specific area of interest. Additionally, operator shall be able to directly address specific displays by their area identification code. The displays shall be animated to represent changes. Extensive color coding shall be utilized to represent status of drives, alarm conditions, open / close status etc., together with the color coding for various lines carrying different fluids.
- d) Flow chart / logic / ladder screens - meant for sequence logic operations to represent the progress of the sequence, time-out conditions, forced or bypass conditions, hang-ups and prompts.
- e) Operator's guidance message screen - displaying process flags and prompts to the operator to assist in selecting course of action in the events of start-up and emergencies.
- f) Trend Display - The system shall be capable to display at least eight (8) numbers of real time trends with eight (8) different colors per page with selectable time frame to implement variation in resolution. The facility to magnify trend on Y-axis by 1, 2, 5 & 10 and scrolling within the range $\pm 100\%$ shall be provided. Also the facility to magnify X-axis by 1, 2, 4 or 8 and scrolling shall be provided.
- g) Screen Partitioning - The system shall be capable to implement screen partitioning to facilitate easy comparison of trending between two or more assigned screens and also display of X-T and X-Y trends on the same page and other combinations as per the requirement of operating personnel.
- h) Multi-windows - The system shall have facility of multi-windows & pop ups to allow related information to be displayed in different windows. The types of windows shall be tentatively as follows :-
 - i) Alarm window for display of all acknowledged & unacknowledged alarms in different colours. Alarm priority shall also be distinguished by colour.
 - ii) System help window for display of messages corresponding to illegal key operations.





- iii) Help windows for user defined help messages.
- iv) Trend window display with trend recording graphs.
- v) Faceplate window to display Instrument faceplate of called tag number.
- vi) Process window for display of process data.
- vii) MIMIC, System Diagnostic, Engineering menus etc.

However quantity of the above displays shall be finalized on as required basis during detail engineering.

5.06.00 **Historical Storage and Retrieval system (HSRS) (Historian)**

Complete HSRS shall be implemented in server / information workstation. The HSRS shall collect, store and process system data online on redundant hard disk. Provision shall be made to notify the operator when disk is certain percentage full. The disk capacity shall be sufficient to store at least seven days data.

The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs / reports such as event activated logs, sequence event log, trip analysis log, start-up log etc. The data/information to be stored and frequency of storage and retrieval shall be as finalized during detailed engineering.



5.07.00 **Programmer's Station**

- i. The structuring/ configuration/ modification of control loops/ logics in control system and program development/ in programming station shall be possible from fully graphic displays using familiar & conventional functional blocks.
- ii. The programming tools shall have inbuilt safety features which shall protect the system against inadvertent and unauthorized use of these tools. Necessary hard key locks and software locks, etc. shall be provided for this.
- iii. The system shall also have facility to permit the programmer to add test information at the beginning and end of each program, wherein programmer shall list out his name, time, date, the change which has been made, name of the person who has authorized the change, etc.

5.08.00 **Sequence of Event Recording / Alarm Annunciation Functions**

5.08.01 **SOE Function**

- a) The system shall monitor minimum Fifty (50) nos. sequence of Events (SOE) inputs with a resolution of one millisecond at all times for all SOE inputs including spare inputs. That is, all SOE points entering status change shall be reported and time tagged within 1 (one) millisecond of their occurrence. The start of data collection for SOE report shall be reported to OWS within 1 sec of SOE data collection initiation. The system shall also have provision of rejection of chattering inputs.
- b) The system shall also include provision for historical storage and retrieval of SOE reports for 3 months period.
- c) The SOE reports shall also include a list of major equipment trip in chronological order and include the points which initiated SOE collection.
- d) All the SOE inputs shall also be available for interlock / protection functions.
- e) The common requirements specified for all binary inputs shall also be applicable for SOE inputs.
- f) Software licenses as applicable shall be provided for SOE functionality.

5.08.02 **Annunciation System Function**





- a) The annunciation system shall be implemented as an inbuilt function of the PLC. The field contacts shall be acquired through PLC only. The annunciation sequence logic shall be implemented as a part of the PLC controllers. The annunciation logic shall include logic for presenting single alarms on a single window, logic for slow and fast flashing, logic for audible alarms including ring back, etc.
- b) The annunciation system shall have the facility of driving independent lamp box in the event of failure of HMIPIS or system bus in case the annunciation system is affected due to the same.
- c) The annunciation sequence shall conform to the following:

Designation	Visual	Audible (1)	Audible (2)
Normal	Off	Off	Off
Alarm	Fast flashing	On	Off
Return to normal before acknowledge	Slow flashing	On	On
Acknowledged	Steady on	Off	Off
Return to normal	Slow flashing	Off	On
Reset	Off	Off	Off
Test	Full functional / sequence test		

Redundant audible devices with adjustable pitch and sound level shall be provided. Audible tone of the alarms shall be settable depending upon the priority. The audible alarms shall be generated in the OWS as well as through external devices. Alarm & Trip tone shall be different.

5.09.00 **Power Supply**

5.09.01 Power supply system shall be designed to meet the total AC and DC electric power requirements of various C&I systems including PLC. In addition 20% spare capacity for future shall be provided.

5.09.02 Separate redundant bulk power supply units for powering relays and solenoids shall be provided.

5.09.03 Electrical power supply system (UPS / Utility supply / DC) for various loads for Bidder supplied system shall be provided by Bidder.

Bidder shall refer to the UPS specification mentioned in Electrical section.

5.10.00 **Grounding**





- 5.10.01 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus. The ground bus shall be bolted / welded to the panel structure and shall efficiently ground the entire structure. All individual cabinet grounds shall be connected to separate earthing riser to be provided for C&I system signal grounding. The grounding requirements of various parts of the C&I system shall be properly co-ordinated by the Bidder with design of plant earthing system. The exact grounding scheme shall be as finalized during detailed engineering.
- 5.10.02 System cabinet's AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above grounds shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment and shall also be insulated from other electrical system ground to ensure single point grounding. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed for the grounding requirement.
- 5.10.03 Separate redundant earth pit shall be envisaged for FGD PLC electrical & electronic earthing.
- 5.11.00 **System Software Requirements**
- 5.11.01 Bidder shall provide all software required by the system for meeting the intent and functional/ parametric requirements of the specification. The system shall utilize a readily upgradeable, software platform proven for real-time operation environment at the control and monitoring level overlaid with a relational database program. The general features shall not be limited to the following:
- i) The software system shall be fully modular.
 - ii) Support of multiprogramming and multi-user operation.
 - iii) Simple and easy-to-learn editing language for editing.
 - iv) Wide range of standard and non-standard peripheral support.
 - v) Effective task scheduling and support of multiple priority structure including event based interrupt etc.
 - vi) Effective debugging.
 - vii) Provision for on-line editing and program development without interrupting on-line functions.
 - viii) Self-diagnostic routines.
 - ix) Efficient memory management and effective utilization of system time.
 - x) Quick system start-up and program loading.



5.11.02 All system related software including real time operating system, file management software, screen editor, database management software, on line diagnostics / debug software, peripheral drivers software and high level language compilers shall be furnished. Latest version of standard PC based software for database handling, word processing, spreadsheet etc. and any other standard software as required shall be provided.

5.11.03 The Bidder shall provide software locks and passwords to authorized representative of Buyer at site for all operating & application software in order to prevent unauthorized access so that only Buyer's authorized representatives is able to do modifications at site.

5.11.04 **Software License**

Bidder shall provide software license for all software being used in PLC & Operator work stations. Software license shall be provided for the project (e.g. organization or site license) and shall not be hardware or machine specific. All software licenses should not have any expiry limitations and shall be valid for continuous service life of the plant. If the software license is dependent of no. of points / users then quantity to be considered 30% above finally implemented points. If licensing is based on tags / points, each point shall represent unique / distinct function and combining of tags in any form not permitted.

If licensing of software is based on number of displays, there shall be provision for adding 25% additional displays in future. Each display shall be made separately and no clubbing of similar displays and loading tags through external scripting is allowed

5.11.05 **Software Upgrade**

Bidder shall periodically inform the designated person of the Owner about the software upgrades / new release that would be taking place after the system is commissioned & handed over so that if required, the same can procured and implemented at site.

5.12.00 **Hardware Specification**

5.12.01 Input Output Modules

a) HIGH LEVEL ANALOG INPUT MODULES

- 01. Number of inputs / module : 16 (Max)
- 02. Types of input (Linear) : 4-20 mA and 1-5 V
- 03. Accuracy : 0.1% or better
- 04. A/D Converter : Integrating, 15 bit + Sign or better





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**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 05. Temperature effect : 0.01% / Deg.C or better
- 06. CMRR : 120 db (at 50 Hz) or better
- 07. NMRR : 60 db (at 50 Hz) or better
- 08. Stability : 0.03% / year or better
- 09. Features :
 - a) Diagnostic LED
 - b) Auto calibration
 - c) Auto start up
 - d) Status LED

b) LOW LEVEL ANALOG INPUT MODULES

- 01. Number of inputs / module : 16 (Max)
- 02. Types of input : Thermocouples (K, R, etc.)
[Grounded & Ungrounded]
RTD (Pt -100 Ohm)
[Four wire, three wire]
- 03. Cold junction compensation : On module
- 04. Accuracy : 0.15% or better (Linearized)
- 05. A/D converter : Integrating, 15 bit + sign or better
- 06. Temperature effect : 0.01% / Deg.C or better
- 07. CMRR : 120 db (at 50 Hz) or better
- 08. NMRR : 60 db (at 50 Hz) or better
- 09. Stability : 0.03% year or better
- 10. Features :
 - a) Diagnostic LED
 - b) Auto calibration
 - c) Auto start up
 - d) Status LED
 - e) Auto CJC for TC input

c) BINARY INPUT MODULE (SLOW SCAN)

- 01. Number of inputs/module : 32 (Max)





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Tuticorin, Tamil Nadu**

02. Types of input : 20/48V DC
NO/NC/Ch.over contacts
03. Contact bounce filtering : Hardware filter /soft adjustable
04. Resolution : 10 milli sec. or better
05. Features : a) Diagnostic LED
b) Wire break (as required)
c) LED status for inputs, power & communication
- d) BINARY INPUT MODULE (FAST SCAN SOE)
Same as above but resolution 1 m sec.
- e) SMART TRANSMITTER INTERFACE MODULES
01. Number of inputs/module : 16
02. Types of input : From Smart Transmitters.
03. Protocol : HART or any proven compatible protocol.
04. Communication : Bidirectional
05. Accuracy : 0.1% or better
06. Function : a) Signal processing
b) EU conversion
c) Alarm, Diagnostic etc.
d) Configuration Tx. database
e) Re-ranging &Tx. calibration
07. Features : a) Diagnostic LED
b) Auto calibration
c) Auto start up
d) Status LED
- f) ANALOG OUTPUT MODULES
01. Number of points/module : 16 (Max)





Tender Specification
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2x500 MW Project
Tuticorin, Tamil Nadu

02. Types of output (Linear) : 4-20 mA DC
03. Resolution : 12 bit or better
04. Accuracy : 0.1% or better
05. Load : upto 800 Ohms
06. Features : a) Diagnostic LED
b) Auto calibration
c) Auto start up
d) Status LED

g) BINARY OUTPUT MODULES

01. No. of points/module : 32 (Max)
02. Type of output : Relay with 1 change-over contact or voltage output
03. Contact rating : 60 VA
04. Contact voltage rating : 60 Volts
05. Switching frequency : 2 Hz
06. Contact life : 1 million operations
07. Output protection : Short ckt. Proof & Individual HRC fuse (as applicable)
08. Features : a) Diagnostic LED
b) LED status for outputs, power & communication

5.12.02 **Controller**

01. Type : Microprocessor based, multi-loop and multi-function
02. Word length : 32 bits
03. Register add cycle time : 1 microsecond
04. Instruction cycle time : 75 microseconds (max.)
05. Memory : EPROM & EEPROM and RAM (battery backed up) as required.





06. Redundancy Supported : Yes
07. Switch over time : 5 milli sec. Instantaneous without any loss of data
08. Mounting : Sub-rack
09. Configuration : From LAPTOP through front plug and from Engineering Terminal through DCS / PLC data highway.
10. Features : a) Power fail hold
b) Automatic restoration on power
c) Diagnostic display
d) Status display LED

5.12.03 The Servers / Workstations / PCs / Laptop to be provided by the Bidder should be latest available in the market at the time of supply to prevent early obsolescence and shall be subject to Owner's approval. The software packages to be included with the server / OWS / PCs shall also be the latest version available at the time of supply. However for Servers and Historians / Programming station / Operating work station / PC / Laptops, the hardware shall conform to the following minimum requirements:

A. Operator's work Stations / Other's work Stations

01. Processor : 32 / 64 bit- On board Intel-Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
02. Memory : 8 GB DDR4 RAM
03. Hard drive : 1 x 1000 GB Hard Disc Drive of 7200 RPM or higher.
04. Monitor : LED based 24" or higher sized monitors with non-interfaced refresh rate min. 75 Hz. Full HD resolution 1920 x 1080, 256 colours with MRPII compliant, viewing angle 178 ° vertical & horizontal and fastest response time.
05. DVD R/W : 16x or higher
06. Keyboard : ASCII



07. Pointing Device : Optical Mouse
08. Software : Latest & proven version of Windows OS with Multimedia. Third party operating system, graphical users interface and software, if required. General MS Windows latest, MS-Office Professional, Adobe Acrobat, Anti-virus software with IPS, AutoCAD etc.
- Application engineering & HMI software to suite project specific requirement
09. Miscellaneous Requirements : System chipset: Intel Express
2 x RS-232 ports
1 x parallel port
4 nos. USB (3.0/2.0 ports (2 nos. on front side)
2 x Ethernet (10/100/1000 MB) cards (Industrial Grade)
One (1) Graphic card with minimum 2048 MB memory.
Sound Card & Internal speakers
Wireless internet & Bluetooth interface.
Redundant power supply (In-built)

B. Engineering Workstation

01. Processor : Intel Xeon 6 core 64 bit processor capable 3.6 GHz with 16 MB L3 cache memory per processor, dual independent 1333 MHz system bus (2 way SMF) or better.
02. Memory : 16 GB DD4 RAM (or latest)
03. Hard drive : 2 X 1000 GB



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04. Monitor : LED based 24" or higher sized monitors with non interfaced refresh rate min. 75 Hz. Full HD resolutions 1920 x 1080, 256 colours with MRPII compliant, viewing angle 178 ° vertical & horizontal and fastest response time
05. DVD R/W : 16x or higher
06. Keyboard : ASCII
07. Pointing Device : Optical Mouse
08. Software : Windows latest edition server version standard/ Enterprise Edition
- General MS Windows latest, MS-Office Professional, Adobe Acrobat, Anti-virus software with IPS, AutoCAD etc.
- Application engineering & HMI software to suite project specific requirement
09. Additional general purpose software (for using over network by servers / workstations/ PCs) : Comprehensive disk maintenance utility for disk clean sweep / crash guard / anti-virus etc. (like "Norton System Works Latest Edition")
10. Miscellaneous Requirements : 1 x parallel port
4 nos. USB (3.0/2.0 ports (2 nos. on front side)
4 x Ethernet (10/100/1000 MB) network ports
2 non-boards and 2 added One (1) Graphic card with minimum 2048 MB memory





2PCI Express slots (1x4 lane & 1x8 lane)

2 PCI x slots (64 bit/ 100 MHz)

2 PCI x slots (one 32 bit/ 33MHz, 5V & one 64 bit/66 MHz)

Back-up & Disaster Recovery Software.

5.12.04 Specification of Laptop PC

All the Laptop shall also be used as pluggable temporary programmer's station and operator station functionalities of the programming stations mentioned in the specifications shall be provided (including requisite license).

The Laptop shall meet following minimum requirements:

- Intel Centrino TM Mobile Technology.
- Intel Core – i7 Processor with 3.46 GHz, 4 MB L2 cache, 1066 MHz FSB or better.
- 15" WXGA LED Screen with wide angle viewing.
- 1000 GB 7200 rpm HDD with shock absorber.
- 8 GB 800 MHz DDR3 SDRAM (slot for 1no. additional RAM slot should be provided) (or DDR4 latest)
- 1024 MB Graphic Accelerator
- 1 x windows 10 or latest & proven version of Windows OS with
- Multimedia
- Slim type DVD-RW/DVD ROM combo drive.
- Internal 10/100/1000Mbps Ethernet card
- IEEE 802.11B connectivity port
- 2Nos. USB 3.0/2.0 ports & Wireless INTERNET & blue tooth interface
- External mouse connectivity and Optical mouse
- Minimum 5 hrs battery backup.
- Recovery software tools.
- Sound cards
- Internal speakers
- General MS Windows latest, MS-Office Professional, Microsoft
- Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.



- Application engineering & HMI software - to suit project specific requirement.
- Carry Bag.

5.12.05 Large Video Screen (LVS)

Large video screens, complete with projectors, screens, control units (graphical generators), Master controller & associated accessories shall be supplied as per the following specifications.

1. Size (diagonal) 70 inch or higher
2. Type LED
3. Resolution of each screen Minimum 1400 x 1050 pixels and should offer 16.7 million colors. (Bidder to ensure that the aspect ratio of OWS monitor is same as that of LVS being supplied.) The brightness uniformity should not be less than 95 % ANSI 9.
4. Configuration of LVS Single tier with Screens seamlessly combined with provision of expansion of one screen on each side.
5. Control Unit Same as operator work station without the LED monitor. Facility of projecting a particular display on a selectable area of the screen upon activation of a predefined event shall be provided.
6. Input signal interface Interfacing with Video signals, to receive & project pictures from CCTV, Owner's Live camera, VCP. This Video signal shall be connected to video wall through Master controller.

Signal types: PAL, NTSC or SECAM in S-VHS/VHS, Composite, Component, S-Video DVI, VGA, SCADA Each cube should be capable of taking two inputs.

No of Inputs:6

No. of Outputs: 6





- Remote unit/video switcher for switching between video signal & HMI signal, selecting the video signal channel (live minimum 16 camera nos./location typically) shall be provided.
7. Illumination level Minimum 170 cd/sq.mtr.
 8. Degree of viewing Minimum Horizontal +/- 33 deg and Vertical +/- 27 deg
 9. The LVS and its accessories shall be designed in such a way that the brightness in the centre of the screen and the edge of the screen is uniform and there is no perceivable difference in the quality of the picture on the centre and on the edges of the screen. If any extra hardware has to be provided for achieving the above feature, same shall be provided the bidder at no extra cost. The screens should have low inter screen gap of ≤ 0.2 mm for seamless viewing.
 10. Auto brightness & colour adjustment between each screen. White point should be 3200k- 9600 K Custom.
 11. The hardware / software of the control unit shall be such that the command execution time of any control command from the LVS shall be same or better than the execution time from the OWS as stipulated elsewhere in this specification. If during any stage of the contract, the command response times as stated in specifications are not achieved, the bidder shall upgrade the hardware/software of the control unit in order to achieve the same at no extra cost to the Owner.
 12. Master controller unit shall be provided for controlling the entire video wall in LVS. It shall be capable of projecting HMI displays over a part of screen to multiple screens. Any configuration of windows shall be possible. Facility for overlays shall be provided. Specification of Master controller unit shall be same as specified for server.
 13. Complete LVS analysis & diagnostic software shall be provided.
 14. LVS annunciation functionalities shall be provided with salient features of the conventional hardware annunciations, while presenting more flexibility.
 15. The projectors, screens, control units (graphical generators), Master controller and associated wall management software should be of same manufacture. OEM should have a manufacturing setup in India for Video Walls.



16. As no hardwired backup has been envisaged, the LVS should ensure operation of the plant in case of total failure of all operator stations. Hence Complete DCS / PLC HMI & operation software shall also be loaded on respective display controller.
17. LVS shall be designed for continuous viewing (24 hours in a day) under normal room ambient lighting without any need to darken the room. Suitable darkening of the projection screen for light absorption shall be provided for this purpose.
18. The system should be configured such that any of the operators sitting on the same network should be able to work on the Large Video Screen sitting at his own position with his local keyboard & mouse.

5.12.06

Laser Printer

01. Type : Colour laser, tabletop
02. Paper size : A3 / A4
03. Speed : 6 ppm (color) for A3/ 4 ppm (color) for A4
20 ppm (B&W) for A3 / 16 ppm (color) for A4
04. Resolution : 600 dpi
05. Duty cycle : Heavy duty
- at least 50000 pages / month for A3
- at least 30000 pages / month for A4
06. First page out time : =< 1 min for color
<45 sec for BW
07. Paper input capacity : 500 sheets
08. Additional Features : Automatic Duplex printing
09. Communication port : Ethernet Port in addition to standard parallel port
10. Accessories : a) Additional cartridge
b) Printer stand

6.00.00

ON LINE VIBRATION MONITORING SYSTEM (VMS)





- 6.01.00 **Vibration Monitoring System**
- 6.01.01 Microprocessor based vibration monitoring system shall be provided for all HT motor & their driven equipment (pumps / fans) rated 160 KW and above. System shall be proven and from latest product range of the manufacturer. The System shall be supplied for each unit. Bidder shall consider Vibration Monitoring system for the HT equipments in their scope of supply (Refer Section-II of this volume of this specification for detailed scope of supply).
- 6.01.02 Vibration sensors shall be provided on the DE and NDE bearings of motors and fans / pumps. On each bearing there shall be two vibration sensors, one in X direction and other in Y direction. For vertical pumps there shall be three bearing locations i.e. DE motor, NDE motor and pump thrust / DE bearing. Proximity type key phasor sensor/s shall be provided for the shaft speed signal for analysis of the vibration.
- 6.01.03 The vibration monitoring system shall be furnished on a system basis including vibration transducers with low noise flexible cables in flexible conduit, terminated in local terminal boxes, necessary pre-amplifier / electronics mounted in local weather proof boxes, vibration monitors, mounting racks and cabinets. The vibration monitoring system shall include all power supplies, interconnecting cabling, calibration equipment, indicators, signal conditioning & measuring devices and all other accessories required for monitoring of vibration at each point.
- 6.01.04 Bidder shall offer 2/4 channel vibration monitors for each measurement location catering for horizontal and vertical measurements. Offered vibration monitors shall be modular in construction, plug in type and suitable for 19" rack mounting.
- 6.01.05 Piezo electric transducer / Eddy current type proximity transducers shall be used. However, the finally selected sensor type shall also depend on recommendation of the equipment manufacturer & suitable for application requirement. Transducers shall be furnished in weatherproof housing suitable for field conditions.
- 6.01.06 Vibration monitoring system shall give buffered output of 4-20 mA DC for each point monitored. The signal shall be suitable for use as an input to Station DCS for indication and recording linear in proportion to vibration velocity as well as displacement. Monitor shall provide vibration indication calibrated in velocity units along with provisions of changing to displacement unit (field-programmable) for each measurement point in both horizontal & vertical planes. For each vibration monitor, two independent potential free contacts shall be made available for alarm & trip purposes.



6.01.07 The vibration monitor racks with power supplies shall be mounted in a separate self-standing cabinet to be located in FGD Local Control Room. The number of racks and power supplies shall be such that on failure of a single power supply / module, no more than four monitors shall be affected. The vibration monitoring cabinet shall be fed from redundant UPS feeders with auto changeover scheme.

Complete VMS shall be time synchronized from Master clock system.

6.01.08 The functional requirement for vibration monitoring system shall include but not be limited to the following:

- a) Vibration monitor front face status indications shall be available for indications of healthy conditions of pick up circuit, monitor circuit and power supply. Also set point indication with set point adjustment facility for setting alarm & trip levels shall be provided.
- b) The facility shall be available from front of mounting rack for functional checking of monitors with inhibition of alarm and trip contact outputs during test. Alarm inhibition shall also be provided during start-up.

6.01.09 All vibration monitoring equipment shall be functionally tested for circuit continuity and output response. All the components & interconnection cables shall be tested to ensure compliance with the specification requirements and all other applicable codes & standards.

6.01.10 Vibration analysis is not envisaged for this system, hence bidder can use loop powered vibration sensors.

7.00.00 POWER SUPPLY SYSTEM

7.01.00 240V AC Redundant Package UPS system with 60 minutes back-up to cater various C&I system loads in FGD control room including PLC, HMIs, field instruments / analyzers, Relay based Local Control Panel etc. and PLC / Proprietary control and monitoring system for package systems (if any), Vibration Monitoring System shall be provided by the bidder.

7.02.00 UPS Power supply (max. 1 kVA) required for the FGD C&I loads, located in main plant CCR, shall be made available to the bidder at purchasers ACDB terminals as single redundant feeder. Cabling from the purchaser ACDB to FGD load points/ ACDB is under the scope of the bidder.

7.03.00 24V DC power distribution for PLC and loop powered field instruments shall be derived from the UPS and the required DC distribution boards shall be located within the PLC cabinets. Any other DC power supply required for the plant shall also be suitably derived and distributed. (UPS specification shall be covered in Electrical Volume).





8.00.00 **INSTRUMENTATION & CONTROL CABLE**

8.01.00 **Cable Design Criteria**

8.01.01 Cables shall be suitable for the area through which they are routed. All cable shall be flame retardant low smoke (FRLS) type conforming to IEC 60332 standards. Hot zones shall have FS / PTFE cables.

8.01.02 Cables shall be so designed and manufactured that damage does not occur in handling, during transit, storage, installation and operation under any or all the climatic and operating conditions which they may be subjected to. Outer sheath of cables shall have rodent and termite repulsion property.

8.01.03 Cables shall be suitable for laying in conduits, ducts, trenches, trays or for direct burial in ground in both dry and wet locations.

8.01.04 Cables shall be capable of operating satisfactorily under the power supply voltage and frequency variations as specified in the specification. Current ratings and ratings factors of cables shall not be worse than the ones specified in IS: 3961.

8.01.05 Performance characteristics of cables shall be based on the following conditions of laying:

- All cables shall be laid in multilayer and touching each other.
- Cables shall be suitable for laying in duct or burying in ground upto a depth of 1.5 meters with uncontrolled back fill and chances of flooding by water.

8.01.06 Suitable distance shall be maintained in routing and laying instrumentation cables so that the interferences from electrical HT & LT cables are minimized. Cables carrying redundant instrument signals shall be separately routed. In hazardous areas cables of suitable R/L ratio shall be provided for intrinsic safety.

8.01.07 Fillers in multiple conductor cables shall be flame retardant and moisture resistant.

8.01.08 Durable marking shall be provided on the surface of the cable at intervals not exceeding 5 mtrs. Marking shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / triads / type of extension /compensating cable), Insulation material, FRLS etc.

Sequential length marking shall also be provided at every meter interval on outer sheath of cable.





- 8.01.09 All cables shall be suitable for continuous operation at 85°C except for high temperature heat resistant Teflon insulated cables, which shall be suitable for continuous operation at 205°C.
- 8.01.10 The allowable tolerance on overall diameter of cable shall be +/- 2 mm (maximum) over the declared value in data sheet.
- 8.01.11 The variation in diameter shall not be more than 1.0 mm throughout the length of the cable.
- 8.01.12 The ovality at any cross-section of cable shall be not more than 1.0 mm.
- 8.01.13 The cables shall be provided in non returnable wooden drums. The drum length shall be 1000 m + 5% up to & including 12 pair cables and 500 m + 5 % for above 12 paired cables. The drum length shall be 1000 m + 5% for optical fiber cables.
- Drum shall be anti rodent, anti termite and smooth finish. Both end of cable shall be capped by means of non hygroscopic sealing material
- 8.01.14 20% spare pairs or min 1 pair cable (whichever is more) shall be provided with all type of cables, except for pre-fabricated cables which shall be as per manufacturer's standard.

8.02.00 **Instrumentation Cable Specification**

8.02.01 **Instrumentation Multi Paired Signal Cable**

01. Conductor type : Stranded (7) annealed tinned copper (as per IS 8130)
02. Conductor size : 0.5 / 1.5 Sq.mm (as applicable)
03. Conductor Insulation : Extruded HR PVC Type-C to IS-5831
05. Operating Voltage : 300 / 500V RMS (Core to earth / core to core)
06. Twisting : Twin twisted with lay of 60 mm
07. Twisting Direction : All pairs in the same direction.
Lapped to form bunch with Mylar tape.
08. Screen
(Pair & Overall) : Aluminium Mylar tape with a thickness of 28 µm (min.) for individual pair screen and 60 µm (min.) for overall screen with 100% coverage and 25% overlapped edges.





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%.

Metallic side of the screen shall be in contact with drain wire.

* Analog signals- Individual pair & overall shield to be considered.

* Binary signals- overall shield to be considered.

09. Drain wire : Annealed tinned copper wire, stranded (7)

10. Inner Sheath : FRLS HR PVC Type-ST-2 to IS-5831

Colour- Black

11. Rip Cord : Non metallic under sheath

12. Armouring : Galvanized steel wire/strip to IS:3975& IS 1554 Part II

13. Outer Sheath : FRLS HR PVC Type-ST-2 to IS-5831

Colour- Grey

14. Filler : Non hygroscopic with FRLS property.

15. Temperature Range : 85 °C

16. Electrical Parameters :

Conductor Loop Resistance at 20°C 73.2 Ohms/Km for 0.5 sq mm. Conductor size.

24.6 Ohms/Km for 1.5 sq mm. Conductor size

Insulation at 20°C 100 MOhms/ Km

Mutual Capacitance 120 nF/km (for Individual & Overall Shield)

between conductor at 0.8 KHz (Max.) 100 nF/km (For Overall Shield)

Cross Talk 60 dB

Attenuation at 1 KHz (Max.) 1.2 dB/Km





Characteristic Impedance at 0.8 KHz 370 Ohms for 0.5 sq mm.
230 ohms for 1.5 sq mm.

17. Tests :
- a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
 - b) Acid Gas Gen.: Max.20% by weight (IEC 754 Part-I)
 - c) Temp Index : Min 250 ° C at 21Oxy. Ind. (ASTM-D-2863)
 - d) Smoke Density Rating : Max.60% (ASTM-D-2843).
 - e) Flammability Test :(IEC 332 Part-B)
 - f) Swedish Chimney Test : (SS-424-1475 F3)
 - g) Halogen Content Measurement Test : 0.2% max. (ICEA T-33-655)
 - h) Insulation Resistance Test :100 M Ohm / Km Min
 - i) High Voltage Test :
Core to core- 1.5 KV for 1 min.
Core to screen - 1.0 KV for 1 min.
Screen to armour - 1.0 KV for 1 min.
 - j) Rodent & Termite repulsion test (Presence of lead shall be confirmed)
18. Colour of core for Instrumentation Cable (As per VDE-0815)

Pair	Core	Color
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black



Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

8.02.02 Thermocouple Extension &Compensating Cable (As applicable)

- | | | | |
|-----|-------------------------|---|--|
| 01. | Conductor | : | Solid conductor |
| 02. | Conductor size | : | 16 AWG (1.31 Sq. mm) |
| 03. | Type | : | Single/ multi-pair twisted and shielded type as per ANSI MC96.1
KX (Extension) (Chromel - Alumel) |
| 04. | Conductor Insulation | : | Extruded HR PVC Type-C to IS-5831 |
| 05. | Operating Voltage | : | 225 V (peak value) |
| 06. | Twisting | : | Pair twisted with lay of 60 mm (max) |
| 07. | Twisting Direction | : | All pairs in the same direction.

Lapped to form bunch with Mylar tape. |
| 08. | Screen (Pair & Overall) | : | Aluminium Mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges.

Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%.

Metallic side of the screen shall be in contact with drain wire. |
| 09. | Drain wire | : | Annealed tinned copper wire, stranded (7) |
| 10. | Inner Sheath | : | FRLS HR PVC Type-ST-2 to IS-5831 |
| 11. | Rip Cord | : | Non metallic under sheath |
| 12. | Armouring | : | Galvanized steel wire/strip to IS:3975& IS 1554 Part II |





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

13. Outer Sheath : FRLS HR PVC Type-ST-2 to IS-5831
14. Filler : Non hygroscopic with FRLS property
15. Temperature Range : Up to 85°C
16. Electrical Parameters :
- | | |
|--|---|
| Conductor Loop Resistance at 20°C | 760 (Typ.) for Kx Type
95 (Typ.) for Sx/Rx Type
390 (Typ.) for Tx Type |
| Insulation at 20°C | 100 MOhms/ Km |
| Mutual Capacitance between conductor at 0.8 KHz (Max.) | 200 nF/km |
| Cross Talk | 60 dB |
| Attenuation at 1 KHz (Max.) | 1.2 dB/Km |
| E.M.F at 100°C | 4.095 mV for Kx Type
0.646/ 0.647 mV for Sx/Rx Type
4.279 mV for Tx Type. |
| E.M.F at 200°C | 8.137 mV for Kx Type
1.441/ 1.469 mV for Sx/Rx Type
9.228 mV for Tx Type. |
17. Tests :
- Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
 - Acid Gas Gen.: Max.20% by weight (IEC 754 Part-I)
 - Temp Index : Min 250°C at 21 Oxy. Ind. (ASTM-D-2863)
 - Smoke Density Rating : Max.60% (ASTM-D-2843).
 - Flammability Test : (IEC 332 Part-B)





- f) Swedish Chimney Test : (SS-424-1475 F3)
- g) Halogen Content Measurement Test : 0.2% max. (ICEA T-33-655)
- h) Insulation Resistance Test : 100 M Ohm / Km Min
- i) High Voltage Test :
Core to core - 1.5 KV for 1 min.
Core to screen - 1.0 KV for 1 min.
Screen to armour - 1.0 KV for 1 min.
- j) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)
- k) Thermo E.M.F (ANSI MC96.1)

18. Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1 / IEC codes

Cable type	Overall Sheath Color	Wire	Sheath Color	Conductor Material
KX type	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Chromium

19. Durable printed or embossed numbering at regular interval of 50 mm shall be provided for identification of pairs.

8.02.03 Instrumentation Multi Triad Signal Cable

- 01. Conductor type : Stranded (7) annealed tinned copper (as per IS 8130)
- 02. Conductor size : 0.5 / 1.5 Sq.mm (as indicated under Section-I)
- 03. Conductor Insulation : Extruded HR PVC Type-C to IS-5831
- 04. Operating Voltage : 300 / 500V RMS (Core to earth / core to core)
- 05. Twisting : Triad twisted with lay of 50 mm
- 06. Twisting Direction : All triads in the same direction.





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

- Lapped to form bunch with Mylar tape
07. Colour : Outer sheath colour shall be black for non-IS cable and light blue for IS cable. Individual triad colour code shall be Light Blue-Brown-Black
08. Individual triad & overall shield : Polyethylene coated aluminium foil with 100% coverage with 25% overlap (0.06)
09. Drain wire : Annealed tinned copper wire, stranded (7)
10. Inner Sheath : FRLS HR PVC Type-ST-2 to IS-5831
Colour- Black
11. Rip Cord : Non-metallic under sheath
12. Armouring : Galvanized steel wire/strip to IS:3975& IS 1554 Part II
13. Outer Sheath : FRLS HR PVC Type-ST-2 to IS-5831
14. Filler : Non hygroscopic with FRLS property.
15. Temperature Range : 85 °C
16. Electrical Parameters :
- | | |
|--|---|
| Conductor Loop Resistance at 20°C | 73.2 Ohms/Km for 0.5 sq mm. Conductor size. |
| | 24.6 Ohms/Km for 1.5 sq mm. Conductor size |
| Insulation at 20°C | 100 MOhms/ Km |
| Mutual Capacitance between conductor at 0.8 KHz (Max.) | 120 nF/km (for Individual & Overall Shield)
100 nF/km (For Overall Shield) |
| Cross Talk | 60 dB |
| Attenuation at 1 KHz (Max.) | 1.2 dB/Km |
| Characteristic Impedance at 0.8 KHz | 370 Ohms for 0.5 sq mm.
230 ohms for 1.5 sq mm. |
17. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)





- b) Acid Gas Gen.: Max.20% by weight (IEC 754 Part-I)
- c) Temp Index : Min 250 ° C at 21 Oxy. Ind. (ASTM-D-2863)
- d) Smoke Density Rating : Max.60% (ASTM-D-2843).
- e) Flammability Test : (IEC 332 Part-B)
- f) Swedish Chimney Test : (SS-424-1475 F3)
- g) Halogen Content Measurement Test : 0.2% max. (ICEA T-33-655)
- h) Insulation Resistance Test : 100 M Ohm / Km Min
- i) High Voltage Test :
Core to core - 1.5 KV for 1 min.
Core to screen - 1.0 KV for 1 min.
Screen to armour - 1.0 KV for 1 min.
- j) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

8.02.04 Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTM D 2116. These cables shall be pair, multipair, triad, multitriad and twisted & shielded.

8.03.00 **Control & Power Cable**

8.03.01 **Control Cable (Core, Armoured)**

- 01. Conductor type : Stranded (7) circular high conductivity annealed plain copper generally conforming to IS 8130
- 02. Conductor size : 1.5 Sq.mm or above
- 03. Conductor resistance : 12.1 Ω/Km
- 04. Conductor Insulation : HR PVC Type-C (IS-5831,1984) 0.8 mm thick





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

05. Voltage grade (U_0 / U) : 650 V / 1100 V AC RMS(Core to earth / core to core)
06. Service : For control signals with nominal voltage of 240 VAC / 220V DC
07. Inner Sheath : Extruded FRLS PVC (anti rodent, anti termite& moisture resistant properties)
HR PVC Type ST2 of IS-5831, 1984
Thickness as per IS-1554, Part-I 1976
08. Armour : Galvanized single round steel wire armouring as per IS 3975.
09. Outer Sheath : Extruded FRLS PVC (anti rodent, anti termite& moisture resistant properties)
HR PVC Type ST2 of IS-5831, 1984
Thickness as per IS-1554, Part-I 1976
10. Temperature Range : 85 °C
11. Insulation at 20°C : 100 Mega Ohms /Km [Min]
12. Codes & Standards : a) IPCEA-S-61-402
b) IEC 332-1
c) ASTM-B-33
d) IS-8130-1984
e) IS 1554 Part-1
f) IS 10810
13. Core Identification : As per IS 1554 (Part I)
14. Outer Sheath colour : Black
15. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
c) Temp Index : Min 250 °C at 21Oxy. Ind. (ASTM-D-2863)





- d) Smoke Density Rating : Max. 60% (ASTM-D-2843).
- e) Flammability Test : as per IEC 332 Part-I
- f) Swedish Chimney Test-SS-424-1475 F3
- g) Insulation Resistance 100 M Ohm / Km Min
- h) High voltage test (3 KV for 5 minutes)
- i) Rodent & Termite repulsion test (Presence of lead shall be confirmed)
- k) Routine Test
- l) Type Test

8.03.02 **Low Voltage Power Cable (Core, Armoured)**

- 01. Conductors : Stranded and compacted high conductivity annealed plain copper as per IS-8130
- 02. Conductor size : 2.5 Sq.mm or above
- 03. Conductor Insulation : Extruded HR PVC insulation conforming to type C of IS-5831 or XLPE.
- 04. Internal sheath : Extruded PVC conforming to type ST2 of IS-5831
- 05. External Sheath : Extruded FRLS PVC conforming to type ST2 of IS-5831
- 06. Service : For instrumentation & Control power supply
- 07. Voltage grade (U_0 / U) : 650V / 1100V AC RMS (Core to earth / core to core)
- 08. Maximum rated conductor temp. in normal operation : 85 °C
- 09. Armour : Galvanized single round steel wire armouring as per IS 3975.





10. Core Identification : As per IS 1554 (Part I)
11. Outer Sheath colour : Black
12. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
- b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
- c) Temp Index : Min 250 °C at 21Oxy. Ind. (ASTM-D-2863)
- d) Smoke Density Rating : Max. 60% (ASTM-D-2843).
- e) Flammability Test : as per IEC 332 Part-I
- f) Swedish Chimney Test-SS-424-1475 F3
- g) Insulation Resistance 100 M Ohm / Km Min
- h) High voltage test (3 KV for 5 minutes)
- i) Rodent & Termite repulsion test (Presence of lead shall be confirmed)
- k) Routine Test
- l) Type Test

8.04.00 **Optical Fiber Cable**

8.04.01 This specification defines the minimum general requirements for the design, manufacture, supply, inspection, installation, testing & commissioning of multimode & mono-mode optical fiber cables and accessories, such as fiber distribution (patch) panels, adapters, connectors, joint boxes, pigtails and other components, as required to complete the system. Bidder shall consider all related activities, such as cable stripping, cable entry in boxes and panels, cable fiber splicing/fusion, cable performance testing and other deliverables, to achieve a properly documented and operational cable network.

8.04.02 Fiber Optic Cables shall be installed on cable tray, duct bank, cable trench installation as necessary. For outdoor applications the cable shall be armoured with Poly Ethylene sheathing. Cable shall be routed through suitable grade HDPE permanently lubricated protection pipe as per IS 4984, IS 12235 & TEC.G/CDS-08 /01of suitable size @ 53% fill factor.





- 8.04.03 The Optical Fiber core shall be of ultra pure fused silica glass coated with UV-cured acrylate suitable to withstand temperature of about 80°C (continuous).
- 8.04.04 Fiber optic cable shall be of loose tube design. Typically, fibers shall be housed in-groups of 6 (minimum) within gel-filled buffer tubes to protect against ingress of moisture and vibration. The tubes shall be manufactured with industry standard material like Poly-Butelene Terathylate (PBT). They shall be colored for easy identification. Buffer tubes shall be approachable with industry standard tools and practices. The buffer tubes shall be stranded around the Central Strength Member utilizing Reverse Oscillating Lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure. Cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end.
- 8.04.05 The central strength member of the cable shall be Fiberglass Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti buckling strength to the cable.
- 8.04.06 In addition to central strength member, additional strengthening substance like aramid yarns shall be helically applied over the cable core to provide additional tensile strength to the cable.
- 8.04.07 The cable shall be of dual jacket & armoured. Inner sheath consists of a medium density polyethylene (MDPE) jacket extruded over the cable core. Two highly visible ripcords are placed under the jacket to aid in sheath removal. A co-polymer coated steel tape is corrugated and wrapped around the inner jacket to provide additional cable compression strength and rodent protection. The armor is covered with an outer black FRLS MDPE jacket. A ripcord is also placed underneath the armor for easy outer jacket removal.
- 8.04.08 Minimum bending radius shall be equal or more to 15 D. A continuous strength member shall be provided for the entire length of the cables. Every tube and fiber shall be colour coded to provide easy identification. The outer sheath shall be marked to show fiber type and cable classification at suitable intervals.
- 8.04.09 Minimum 100% spare cores over the actual use shall be provided.
- 8.04.10 The entire length of each cable shall be marked with the following items:
- Manufacturer's Name
 - Month and year of manufacturer
 - Coded description of the cable based on Telcordia's (Bellcore) SR-2014 Suggested Optical Cable Code (SOCC).
 - Sheath Identification Number



- e) Sequential Length Marking in meter
- f) A Telephone Handset symbol to distinguish communication from power cable as per NESC section –35 G.

8.04.11 Fiber optic cable shall provide a long life expectancy of minimum 25 years and shall meet the industrial standard of continuous operation at temperature of 55°C and humidity to 100% without degradation to optical or mechanical performance.

8.04.12 Optical fiber used in the plant shall generally conform to the following specification.

Specification for ITU G.652 Monomode Fiber		
1.	Cladding Diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
2.	Nominal Core Diameter	8.3 $\mu\text{m} \pm 1.0 \mu\text{m}$
3.	Fiber core count	6 core (minimum)
4.	Cladding non-circularity	$\leq 0.8\%$
5.	Maximum attenuation at	
	(a) 1310 nm	< 0.5 dB/km
	(b) 1550 nm	< 0.5 dB/km
6.	Index of refraction	
	(a) 1310 nm	< 1.467
	(b) 1550 nm	< 1.468
7.	Zero Dispersion	
	(a) 1300 ~ 1324 nm	< 0.093 ps/Km/nm
8.	Proof Test	$\geq 1\%$
9.	Fiber Curl (ROC)	$\geq 4.0 \text{ m}$
10.	Macro-bend Test on Fiber	$\leq 0.1 \text{ dB}$

Specification for ITU G.651 multi mode Fiber		
1.	Cladding Diameter	125 $\mu\text{m} \pm 2.0 \mu\text{m}$
2.	Nominal Core Diameter	50 $\mu\text{m} \pm 3.0 \mu\text{m}$
3.	Fiber core count	6 core (minimum)
4.	Cladding non-circularity	$\leq 3.0\%$
5.	Maximum attenuation at	
	(a) 850 nm	< 3.5 dB/km
	(b) 1300 nm	< 1.0 dB/km



Specification for ITU G.651 multi mode Fiber		
6.	Group index of refraction	
	(a) 850 nm	< 1.483
	(b) 1300 nm	< 1.479
7.	Proof Test	≥1%
8.	Fiber Curl (ROC)	≥ 4.0 m
9.	Macro-bend Test on Fiber	≤ 0.1 dB

8.04.13

Cable Assembly

(a) Optical Fiber Environmental Splice Enclosure

Optical fiber environmental splice joint enclosures shall be re-enterrable and rack / wall mountable. The interior splice case shall be equipped to mechanically accommodate single-mode optical fibers connected by the fusion method. Splice case shall be equipped to organize the splice trays and the required service loops of buffered incoming optical fibers and outgoing 'pigtaills' in such a way that allows each completed splice and associated optical fiber to be maintained in an unstrained configuration. Splice enclosure shall be dust and weather proof.

(b) Fiber Optic Distribution Patch Panel

Fiber optic distribution panels shall be provided as required. Fiber optic distribution panels shall be of a standard wall mounted sheet metal enclosure type. Fiber optic distribution panels shall be equipped to secure optical fiber patch cables and pigtaills to prevent damage during all operation and maintenance functions. In general splice enclosure are envisaged. However, if no optical fiber splice enclosures are implemented, than the fiber optic distribution panels shall be equipped with splice trays for storage and protection of fusion splice connections of single-mode fiber optic cable and pigtaills. Each fiber optic distribution panel shall be fully equipped with 'SC' type bulkhead connector sleeves or equivalent. Unused sleeve ports shall be equipped with reusable caps to prevent the intrusion of dust.

(c) Pigtail and Patch Cord

All pigtaills shall be factory SC-connectorized, and satisfy specified performance for optical links. All unused pigtaills (including spares) shall be terminated with the connector to a bulkhead connector sleeve, protected by a reusable cap on the opposite sleeve port, to prevent the intrusion of foreign material or dust. All necessary connectorized pigtaills shall be provided in the lengths required.



9.00.00 **ERECTION HARDWARE**

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

9.01.00 **Electrical Accessories**

9.01.01 Electrical conduit and associated materials shall conform to the requirements of the articles which follow:

a) **Rigid Steel Conduit**

- i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.
- ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.
- iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with ANSI C 80.1 and UL6. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.
- iv) All conduit fittings shall conform to the requirements of ANSI C 80.4 and UL-514 where these standards apply.

b) **Flexible Conduit**

- i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.
- ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.

c) **Special Fittings**

- i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.





- ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.
- iii) Conduit supports shall be furnished and installed in accordance with the specifications.

9.01.02 **Junction Box**

- 01. Type of Enclosure : Dust tight & weatherproof conforming to IP 65
- 02. Material : 3 mm sheet steel/ fiberglass reinforced polyester (UV stabilized)
- 03. Type of Cover : Solid unhinged with retention chain/ screwed at all four corners
- 04. Paint : RAL 7032 – Siemens Grey
- 05. Mounting : Surface/ 2” pipe stanchion
(At a dry compartment at one side of the enclosure/ rack with front opening type door)
- 06. Cable Entry : 3 mm (min) Bottom / side Gland plate
- 07. Gasket : Neoprene
- 08. Grounding : Brass earth lug with green screw head
External-two (2) nos., Internal – one (1) no.
- 09. No. of Drain holes : Two at bottom capped
- 10. Identification : Label for JB & tags for cable
- 11. Accessories :
 - a) Rail mounted cage clamp type screw less terminals (suitable for conductor size up to 2.5 sq. mm of suitable voltage grade) with markers and 20% spare terminals.
 - b) Cable gland (Brass) & raceways

9.01.03 **Cable Gland**

- 01. Type : Double compression





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 02. Entry Thread : NPT
- 03. Material : Brass
- 04. Finish : Cadmium Plated.
- 05. Protection : IP 54 or better
- 06. Accessories : Neoprene gasket, locknuts, reducers etc.

9.01.04 Cable Tray

- 01. Material : Mild steel
- 02. Thickness : not less than 2.0 mm
- 03. Finish : Hot dip galvanized
- 04. Perforation : As per MFR standard.
- 05. Cover : Suitable for tray

9.02.00 Process Hook Up Accessories & Specification (as applicable)

Material and rating of the hook up items shall generally suit the piping and fluid condition. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for Owner / Consultant's approval. For the design guide line Bidder shall refer to Section-I of this Volume.

9.02.01 Specification for Process Hook Up Materials

Sr. No	System	Piping class	Impulse Pipe Material	Schedule	Materials for Valve / Fittings	Stem Material	Rating of Fitting	Pr. Class of valve
1.	Auxiliary steam	G	ASTM-A106 Gr. B	80 (1/2 inch)	ASTM-A 105	ASTM -A182 Gr. F-6a	3000 lb	800
2.	Air / Flue Gas Outside Furnace	K	ASTM-A106 Gr. B/C	80 (3/4 inch)	ASTM-A 105	ASTM -A182 Gr. F-6a	3000 lb	800
3.	Air / Flue Gas Inside Furnace	L	ASTM-A335 Gr. P-22	80 (3/4 inch)	ASTM-A 182 Gr. F-22	ASTM -A182 Gr. F-6a	3000 lb	800





Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

Sr. No	System	Piping class	Impulse Pipe Material	Schedule	Materials for Valve / Fittings	Stem Material	Rating of Fitting	Pr. Class of valve
4.	DM Cooling Water	M	ASTM A312 TP 316	40 (1/2 inch)	ASTM A182 F316	SS or better	3000 lb	800
5.	Cooling Water	N	ASTM-A106Gr . C	80 (1/2 inch)	ASTM-A 105	SS or better	3000 lb	800

Note:

- 1) Above requirements to be complied by Bidder as applicable for the FGD system. Rating of piping/ fittings / valves etc. is subjected to be approved by Owner as per the final design pressure & temperature finalized during the detail engineering as per ANSI B31.1.
- 2) Material shall be compatible with that of the impulse pipe material and design parameter.
- 3) For DM water services, complete erection hardware material shall be SS316 only.

9.02.02

Seamless Stainless Steel Pipe

01. Reference : ASTM A-312 TP 316
02. Material Grade : TP 316
03. Type : Seamless /Plain end
04. Size : 1/2" NB
05. Schedule : 40
06. Standard Length : 5 meter

9.02.03

Stainless Steel Pipe Fittings

01. Reference : ASTM A-182 F 316 / ANSI B16.11
02. Type : Forged
03. Rating : 3000 lbs / 6000 lbs / 9000 lbs
04. Size : 1/2" NB





05. End connection : Generally socket weld
06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

9.02.04 **Seamless Stainless Steel Tube**

01. Reference : ASTM A-213 TP 316
02. Material Grade : TP 316
03. Size : ½" OD X 2.1 MM Thick
04. Type : Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
05. Properties : The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
06. Test Pressure : 400 Kg/Sq. cm (minimum)
07. Tolerance : ± 0.13 mm for outside diameter
± 15 % for wall thickness
08. Standard Length : 5 meter
09. Test : Flare, Hardness, Ball and Bubble Test

9.02.05 **Stainless Steel Tube Fittings**

01. Reference : ASTM-A-182
02. Type : Double ferrule double compression
03. Material : 316 Stainless steel forged
04. Ferrule : 316 Stainless Steel
05. Type of Fittings : Male / female connector, elbow, cross / equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.





06. Size : To suit SS tubing and NPT end connection
- 9.02.06 **C.S. Pipe**
01. Reference : ASTM-A 106 Gr. C
02. Material : Cold drawn seamless black C.S.
03. Type : Seamless / Plain ends
04. Size : ½” NB
05. Schedule : 80, 160, XXS as required
06. Standard Length : 5 meter
- 9.02.07 **C.S. Pipe Fittings**
01. Reference : ASTM-A 105 / ANSI B16.11
02. Type : Forged
03. Rating : 3000 lbs / 6000 lbs / 9000 lbs
04. Size : ½” NB
05. End connection : Generally socket weld
06. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.
- 9.02.08 **A.S. Pipe**
01. Reference : ASTM-A 335 P22 AS PER ANSI B 36.10
02. Material : Cold drawn seamless A.S.
03. Type : Seamless / Plain ends
04. Size : ½” NB
05. Schedule : XXS
06. Standard Length : 5 meter



9.02.09

A.S. Pipe Fittings

- | | | | |
|-----|------------------|---|--|
| 01. | Reference | : | ASTM-A 182 F22 AS PER ANSI B 16.11 |
| 02. | Type | : | Forged |
| 03. | Rating | : | 9000 lbs |
| 04. | Size | : | ½" NB |
| 05. | End connection | : | Generally socket weld |
| 06. | Type of Fittings | : | Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc. |

9.02.10

Carbon Steel Globe Valve

- | | | | |
|-----|-----------------|---|---|
| 01. | Reference | : | ASTM A-105 |
| 02. | Type | : | Globe |
| 03. | Construction | : | Forged Body Cadmium Plated |
| 04. | End Connection | : | ½" Socket Weld |
| 05. | Rating | : | Cl. 800 / CL. 2500 |
| 06. | Material | : | Body - Carbon steel
Stem - Hardened Steel
Plug - AISI 316 SS
Seat- Stainless steel stellited |
| 07. | Packing | : | Teflon / Grafoil as required |
| 08. | Yoke | : | ASTM A105 |
| 09. | Handwheel | : | Carbon steel |
| 10. | Design standard | : | As per ANSI B 16.34 |

9.02.11

Stainless Steel Globe Valve

- | | | | |
|-----|-----------|---|-----------------|
| 01. | Reference | : | ASTM A-182 F316 |
| 02. | Type | : | Globe |





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- | | | | |
|-----|-----------------|---|--|
| 03. | Construction | : | Forged Body |
| 04. | End Connection | : | Socket Weld |
| 05. | Proof Pressure | : | 400 Kg/cm ² |
| 06. | Material | : | Body - Stainless steel
Stem - Hardened Steel
Plug - AISI 316 SS
Seat- Stainless steel stellited |
| 07. | Packing | : | Teflon as required |
| 08. | Yoke | : | ASTM A182 F316 |
| 09. | Handwheel | : | Carbon steel |
| 10. | Design standard | : | As per ANSI B 16.34 |

9.02.12 Alloy Steel Globe Valve

- | | | | |
|-----|-----------------|---|--|
| 01. | Reference | : | ASTM A-182 F22 |
| 02. | Type | : | Globe |
| 03. | Construction | : | Forged Body |
| 04. | End Connection | : | ½" Socket Weld |
| 05. | Rating | : | CL. 2500 |
| 06. | Material | : | Body - Alloy steel
Stem - Hardened Steel
Plug - AISI 316 SS
Seat- Stainless steel stellited |
| 07. | Packing | : | Grafoil as required |
| 08. | Yoke | : | ASTM A182 F22 |
| 09. | Handwheel | : | Carbon steel |
| 10. | Design standard | : | As per ANSI B 16.34 |

9.02.13 Condensate Pot

- | | | | |
|-----|-----------|---|---------------------------|
| 01. | Reference | : | ASTM A182 F22 / ASTM A105 |
|-----|-----------|---|---------------------------|





- 02. Material : Alloy steel / carbon steel as per application
- 03. Construction : Drilled from barstock
- 04. End connection : 3 nos. 1/2" socket weld end
- 05. Accessories : Vent valves

9.02.14 **Instrument Valve Manifold**

- 01. Type :
 - a) Two valve manifold
 - b) Five valve manifold
 - c) Three valve manifold
- 02. Mounting : Remote 2" Pipe Mounting
- 03. Construction : Single block (bar stock)
- 04. Material : Forged body and bonnet AISI 316 stainless steel
- 05. Ports : 1/2 " NPT (F)
- 06. Rating : 420 Kg/Sq. cm at ambient
- 07. Operating Temperature : (-)30 to (+)170°C
- 08. Packing : PTFE Wafer
- 09. Seat & Stem : AISI 316 SS
- 10. Plug : AISI 316 SS free to turn on stem / 17-4 PH
- 11. Handle Bar : AISI 316 SS
- 12. Connection : Straight
- 13. Accessories :
 - a) Plugs for all ports
 - b) Mounting Bracket, bolts, nuts

9.02.15 **Air Header**

- | | | For Panel | For Field |
|-----|----------------------------|------------------|------------------|
| 01. | Material of Construction : | Stainless steel | Stainless steel |





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

02.	Inlet Connection	:	2" NPT (M)	1" NPT (M)
03.	Header Take-off	:	Stainless Steel	Stainless Steel
04.	Take off Connection	:	1 / 2" NPT (M)	1/ 2" NPT (M)
05.	Take-off Valves	:	Stainless Steel	Stainless Steel
06.	Tube Take-off	:	Tube adapter on valve	Tube adapter on valve
07.	Drain	:	SS drain valve at lowest point	SS drain valves at lowest point

9.02.16 Seamless Stainless Steel Tube

01.	Reference	:	ASTM A-269 TP 316
02.	Material Grade	:	TP 316
03.	Size	:	¼" OD x 0.049" wall thickness
04.	Type	:	Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
05.	Properties	:	The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
06.	Test Pressure	:	400 Kg/Sq. cm
07.	Tolerance	:	± 0.13 mm for outside diameter ± 15 % for wall thickness
08.	Standard Length	:	5 meter
09.	Test	:	Flare, Hardness, Ball and Bubble Test

10.00.00 SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT

10.01.00 Bidder shall supply a complete set of new, unused and reliable type of special tools and tackle and test equipment which are necessary or convenient for erection, commissioning, maintenance and overhaul of the plant and equipment provided under this specification.





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

- 10.02.00 The tools & tackle and Test Equipment shall be shipped in separate container, clearly marked with names of the equipment for which they are intended.
- 10.03.00 Bidder shall furnish list of tools & tackle and test equipment proposed to be supplied along with the bid, if applicable. Minimum two (2) nos. antistatic wrist band in each control panels are mandatory and shall be included in the bid.





**Tender Specification
for
FGD Package**

**NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu**

VOLUME : II-E

SECTION - IV

**ERECTION, QUALITY ASSURANCE,
TESTING AND COMMISSIONING**



Development Consultants Pvt. Ltd.

**Vol. II-E/Section-IV
Erection, Quality Assurance,
Testing and Commissioning**



CONTENTS

CLAUSE NO.	DESCRIPTION	PAGE NO.
1.00.00	ERECTION TESTING & PRE-COMMISSIONING PRACTICES - GENERAL	1
2.00.00	SPECIFIC ERECTION PRACTICES AND GUIDELINES	2
3.00.00	CONSUMABLE, TOOLS AND TACKLE, CALIBRATION AND TEST, INSTRUMENTS AND ERECTION MATERIALS.....	29
4.00.00	INSTRUMENT CALIBRATION / CHECKING AT SITE PRIOR TO ERECTION	32
5.00.00	EXAMINATIONS AFTER INSTALLATION	36
6.00.00	PROTECTION DURING MANUFACTURE, TRANSPORTATION AND STORAGE BEFORE ERECTION.....	38
7.00.00	QUALITY ASSURANCE SERVICES	39
8.00.00	INSPECTION AND TESTING	41



VOLUME : II-E

SECTION-VII

ERECTION, QUALITY ASSURANCE, TESTING AND COMMISSIONING

1.00.00 ERECTION TESTING & PRE-COMMISSIONING PRACTICES - GENERAL

1.00.01 This part of the specification is intended to provide a general guideline for the procedures to be followed for the erection, testing and commissioning of various Control & Instrumentation Systems, field instrumentation, final control elements and accessories.

1.00.02 Omission of any specific reference to any method, parts, accessories or material required for proper and efficient execution of the work shall not in any way relieve the Contractor from his responsibilities of providing such facilities and performing the successful erection, testing and commissioning.

1.01.00 Equipment, Materials & Services to be provided by Contractor

1.01.01 Contractor shall follow the stipulations of the contract enumerated elsewhere in the specification regarding Equipment, Materials & Services to be provided under this specification and shall include but not limited to the following:

- a) Shop testing and Factory Acceptance Test.
- b) Pre-calibration of instruments at site and maintaining record of the same.
- c) Pre-assembly at site, as required.
- d) Erection of items.
- e) Cleaning / flushing (as required), pre-commissioning checking to ensure correctness of erection.
- f) In-situ calibration, testing, loop checking etc. of instruments and accessories, as required and maintaining record of the same.
- g) Cleaning up of instruments, accessories and worksite during and after erection.
- h) Powering on and Commissioning of all the instruments and equipment and systems.

1.02.00 Site Acceptance Test

1.02.01 General

- a) The work under Control & Instrumentation shall include activities like placement of equipment on foundation/ support, leveling and alignment,



grouting on foundation, other miscellaneous civil work such as dressing / chipping of foundation / surfaces and also assembly and pre-assembly, minor rectification, welding, cutting, site adjustments and all other incidental activities, as applicable.

- b) Contractor shall arrange all testing, erection and commissioning tools and tackle like hydraulic jacks, precision levels including micro level, dial and other gauges, surface plates, straight edges, vacuum cleaners, blowers, pumps and other equipment / implements necessary for hydro testing, compressed air testing, calibration and all other necessary tests as may be required for timely and efficient execution of the Contract.
- c) Bidder shall furnish a detailed erection micro-plan consistent with the overall project schedule and keeping in view the various site facilities and constraints encountered during various phases of work.

2.00.00 **SPECIFIC ERECTION PRACTICES AND GUIDELINES**

The specification provides the general guidelines to be followed for the warehousing, handling, testing, erection, pre commissioning checks and commissioning of various types of instruments and accessories.

- a) The guidelines provided shall not be deemed as an effort to describe the entire work involved or to identify the steps and sequence to be adhered to in the erection of specific work items.
- b) The basic intent is to establish a sound engineering practice to be adopted throughout.
- c) Equipment manufacturers' recommendation, where available, shall prevail over the guidelines furnished in this section and in case of any contradiction between the stipulations.
- d) For special instruments viz. analyzers etc., the specification furnished are of general nature only and manufacturer's recommendation shall be strictly followed as guideline for erection and commissioning.
- e) The specification shall not be treated as comprehensive. Any activity, not specifically mentioned but felt essential or advisable from good engineering consideration shall be performed.

2.01.00 Field Instruments

Guidelines provided herein shall be adhered to while erecting an instrument or accessory in the plant beyond control room areas.

- a) Care should be taken to avoid damage to the instruments during handling and transportation. Special care shall be taken while handling breakable, spillable, fragile and delicate items.



- b) Before erection, all instruments shall be subjected to calibration and other functional checks at Contractor's site laboratory. The instruments shall be uncrated and unpacked with utmost care and as per instructions furnished on the respective packages, using appropriate tools and implements.
- c) All instruments, jigs, tools and tackle for the purpose of performing the tests shall be arranged by Contractor.
- d) All instruments shall be tagged with engraved aluminum / stainless steel tag plates and shall be secured to the instrument with metallic wire fasteners, during the test.
- e) For instruments found acceptable and conforming to the declared performance parameters of the manufacturer, the test report shall be prepared.
- f) Minor repairs and adjustments of the instruments shall be performed by Contractor. Once the defective instrument has been successfully repaired, it shall again be subjected to calibration and functional checks, as indicated above.
- g) A record of such repairs and adjustments shall be systematically maintained by Contractor.
- h) For instruments where the extent of damage is such that the same cannot be repaired at site, a failure report shall be generated by Contractor, enumerating the nature of fault/ damage. Cases where the damages are only superficial and which does not affect the appearance and performance of the instrument/s, the decision as to whether such instruments are fit for erection shall solely lie with Owner.
- i) In no case, erection work shall be taken-up in areas where heavy equipment movement is foreseen, major welding activity is under progress, heavy structural items are being erected or any other major activity is being carried out or is anticipated, which may cause damage to the erected instrument or its support.
- j) If any erected instrument or its accessories are found to be vulnerable to damage or to be fouling/interfering with progress of other activities in the area, same shall be dismantled/removed. During re-erection of such instruments, all the necessary steps as indicated in the specification for the erection of the instrument shall be carried out afresh.
- k) After erection, the instruments shall be covered with transparent polyethylene sheets to protect from unauthorized handling.
- l) Colored PVC adhesive tapes shall be put on the polyethylene cover to indicate various stages of activities. Red tape shall indicate erection under progress. Yellow tape shall indicate completeness of erection. Blue tape shall imply approval of erection and Green tape shall signify the commissioning of the instrument. Adhesive paper tapes shall be fixed on the respective tapes to inscribe the dates of completion of activities.



- m) Location of field instruments shall be consistent with tapping points on pipes and equipment.
- n) No field mounted instrument shall be installed in such a manner that it depends on rigidity of the impulse piping or the electrical connection to it for support.
- o) Handrails shall not be used for mounting or supporting instruments.
- p) The place where the instrument is to be installed must be easily accessible from nearest floor / platform level and there must have enough clear space to allow maintenance work and lay-down.
- q) The installed position must be such as not to cause any inconvenience to repair, removal, observation, inspection and maintenance of the installed equipment and other items nearby.
- r) The nearby high temperature equipment or process piping shall not give rise to any injurious effect to instruments.
- s) There will be no safety valve or effluent drain point which may cause injurious effect near the instrument. In general, no instrument shall be erected in areas prone to vibration.
- t) Instruments which are outside the building or shed and are not located within transmitter rack shall be provided with protective cover or canopy to provide effective protection against dust, rain, sun etc. The cover shall be provided immediately after mounting the instrument.
- u) All clamps, supports, stands etc. required for installation and erection of instruments and their accessories, shall be painted.
- v) No field mounted instruments shall be installed without simultaneously taking up impulse line work connected with the instrument.
- w) Proper precaution is to be taken to protect his installations, instruments, accessories, devices etc. by isolation/removal from possible damages during flashing, pressure testing of main pipe lines, air headers, vessels, equipments etc.
- x) Wherever practicable the height of the instrument from its working floor/platform shall be between 1000-1400 mm. The illumination at the locations where instruments are located shall be adequate so that the scales can be read unassisted.
- y) Sub-trays, where required, shall be erected for proper routing of the cables and tubes and no cable shall be laid unsupported.
- z) The indicating meters shall be oriented properly so that the scale can be read unassisted and unobstructed from the approach floor / platform.

2.01.01 Pressure / Differential Pressure (D.P) Transmitters / Level Transmitters



Pressure and DP transmitters shall in general be on transmitter rack/enclosure mounted or shall be mounted locally on fabricated structures. Displacer type level transmitters shall, however, be mounted directly on the vessel / stand pipe attached to the vessel.

- a) All manifolds, cocks and valves shall be pressure tested at rated hydraulic test pressure. All air line and draft / vacuum service cocks and valves shall be leak tested.
- b) Manifolds / valves / Impulse pipes shall be mounted on / connected to transmitter at Contractor's workshop / site and the assembly shall be leak tested after completion of the plumbing. The leak test shall be performed with compressed air and soap solution at pressure not exceeding the maximum overload pressure of the transmitter.
- c) All tests on the transmitters shall be performed after mounting / connecting of the manifold / valve assembly.
- d) For transmitters located in transmitter racks, the erection activities shall normally include mounting of the transmitter with its manifold/valve assembly on appropriate support structures in the rack with proper fasteners, viz. U-clamps, bolts etc., proper leveling of the transmitter, all pipe connections from process to the transmitter, piping from transmitter to drain valve / vent valve, supporting/ clamping of the valve, pipe connections from transmitter / valve to drain pot/drain header/ nearest system drain, cabling from transmitter to the rack / external junction box using flexible conduits, termination of the cable with appropriate lugs, sleeves and markers; mounting and connecting all settling chambers / damper pots / siphons etc., as applicable.
- e) For transmitters mounted on stanchions, brackets etc., such supporting structures shall be designed properly to support all transmitter accessories.
- f) For displacer type level transmitters, the blanks provided on the vessel / stand pipe shall be removed and the transmitter shall be mounted with proper gaskets, bolts and nuts. All nut and bolt heads shall be properly greased before tightening.
- g) For external cage type level transmitters, additional supports to the transmitters in the form of bracings / pedestals, if felt necessary, shall be fabricated and erected. While supporting/mounting such structures due consideration shall be given to the movement/expansion of the main equipment.
- h) For transmitters mounted on local structures, cabling shall be done up to the nearest junction box through suitable flexible / rigid conduits / cable trays.
- i) Attention shall be paid to allow free space for the removal of transmitter cover.



- j) During installation of level instruments on vessels, if the nozzles on vessels are found to be out of alignment, necessary modification or addition of spool pieces as required, for proper installation, shall be carried out.

2.01.02 Temperature Instruments / Thermowells

- a) Welded thermowells shall be welded on pipes / vessels / equipment by certified welders only and all post-weld tests shall be performed as per main pipeline specification.
- b) All thermowells shall be thoroughly cleaned with air jet and wire brush before insertion of temperature gauges / element.
- c) The dial of temperature gauges and switches shall be oriented properly so that the scale can be read / set point can be adjusted unassisted from the approach floor/ platform.
- d) Capillary type instruments shall be mounted on appropriate support structure with clamps, bolts etc.
- e) Contractor shall fabricate structures for routing, supporting and protecting the capillary tubes. Capillaries shall be clamped at intervals not more than 1 meter. Capillaries shall not run unsupported.
- f) The cable take-off from temperature switches/elements shall be with flexible conduits up to the nearest sub-tray / junction box. Where appreciable movement of the pipelines are expected, adequate loop lengths shall be kept in the flexible conduits to allow the movement of the elements / switches without any strain.
- g) In the phase between erection and cabling work all cable entry points shall be kept plugged with PVC caps.
- h) Both the elements of duplex type elements shall be terminated at the junction box.
- i) All compensating cables shall be terminated with proper polarity.
- j) All cables shall cross ferruled at both the junction box and element head end.
- k) In case of thermowells with long immersion length and temperature elements having long and rigid extension neck, as in case of air or flue path measurements, mechanical supports shall be provided to avoid excessive suspension weight on the boss.

2.01.03 Pressure Gauges / Switches, Differential Pressure Gauges / Switches

Pressure gauges / switches and differential pressure gauges / switches shall either be directly mounted on the process pipeline or shall be mounted on local brackets, gauge boards or racks depending on accessibility and maintainability. Guidelines provided in clause 2.01.01 (a), (b), (c) & (d) above shall be generally followed for pressure and differential gauges and switches as well.



2.01.04 Stand Alone Field Mounted Electronic Controllers

Installation, supporting, cabling, calibrating, and commissioning of field mounted stand-alone electronic controllers (wherever used), fabrication of necessary supporting structures, pedestals, etc. shall be deemed as a part of the erection activity.

- a) Contractor shall fabricate protective enclosure of canopy wherever deemed required.
- b) The structure fabricated for installing the controller must have provision for mounting the associated accessories.
- c) All pneumatic tubing from the related I/P converter to the final control element shall be done in accordance with the specification laid down elsewhere in this specification.

2.01.05 Level Gauges / Switches

Level Gauges and Switches shall either be directly mounted on the vessel or on standpipe.

- a) Float and switching mechanism shall be installed only after welding and installing the cage in position.
- b) Contractor shall verify the following well in advance:
 - i) Necessary access platforms, ladders are provided.
 - ii) The center line of the tap-off valves are in plumb.
- c) Necessary support structures, if required for installation of external cages/gauges shall be fabricated.
- d) The erection activity of Level Gauges / Switches shall normally include mounting of the instrument, to vessel/stand pipe with necessary pipes, nipples, drain / vent valve, connection of drain to nearest system drain, cabling up to external junction box using flexible conduit, termination of cable with proper sleeves, conductor marker/ferrules and lugs etc.
- e) Necessary sub-trays, wherever required, shall be erected for proper routing of cable.
- f) The indicating side of gauge glasses shall be so oriented that it can be read unassisted and unobstructed from the approach floor / platform.
- g) Illumination in the areas where level gauges are mounted shall be adequate for the level to be visible without the help of flash light. Areas where this requirement can not be met, gauge glasses shall be provided with internal illumination.

2.02.00 Analyzers



Analyzers shall include flue gas analyzers or other analyzers, with all accessories, associated pipings / tubings and drain / purge line work/sampling system and necessary cabling.

- a) All necessary measures and precautions to be exercised for field mounted instruments shall be adhered to for field mounted analyzers, as well.
- b) Attention shall be paid to the accessibility of probe locations and withdrawal area for the probes. If Probe locations are found inaccessible, Contractor shall arrange for the construction of necessary access platforms. Also if any restriction is noted to the smooth withdrawal of the probes due to some interfering structures / railings etc., necessary modification work shall be performed by Contractor.
- c) Protective covers / canopies shall be fabricated and installed to protect the probe head / converter cabinet / calibration kit.

2.02.01 Oxygen Analyzers

- a) Suitable adapter plates with necessary openings on the duct properly stiffened and blanked with suitable blank flanges, shall be used for mounting Zirconia probe type Oxygen analyzers.
- b) Work shall include the erection of sub- trays or conduits for the cabling between probe head to the converter cabinet and the tubings for reference air and test gas, from calibration kit to the probe.
- c) While installing the converter cabinet, care shall be taken to locate the same within the specified distance from the probe.
- d) Activities shall also include the necessary sub-header work to extend reference air supply line from the nearest instrument air header to the reference air set, piping/tubing work between reference air purge meter to the reference air set and the probe, piping/tubing work between auto calibration kit to the probe and the necessary piping / tubing between the reference gas cylinders to the probe.
- e) All earthing continuity tests, insulation tests etc. shall be done as per manufacturer's recommendation.

2.02.02 Continuous Emission monitoring System (CEMS)

Contractor's scope of work shall include complete transportation, lifting, mounting, calibrating, testing and commissioning of stack emission monitoring system. Contractor's scope of work shall also include drawing of instrument air line up to platforms and subsequent distribution at Consumer points, laying of sampling lines from probe to analyser room as applicable etc. Necessary tubing, sub-tray work, cabling up to junction box on stack platform, conduiting etc. shall also be deemed to be a part of installation activity.

- a) Contractor's scope of work shall also include to arrange :



- i) Inserts and cutouts on stack wall with studs blanked-off temporarily by plates.
 - ii) Main cable tray/ladder up to the platform level and subsequent cable routine upto CEMS room.
 - iii) Instrument air take-off point near the analyzer location, if applicable.
- b) Adapter plate should be removed before installation and then bolted to the insert available on the stack or duct wall.
 - c) The stack emission monitoring systems shall be mounted in the stack/ CEMS room as per the layout drawing together with cubicle for housing the analyzers and all accessories like gas coolers, diaphragm pumps, test gas cylinders etc.
 - d) Contractor's scope shall include; rigging, installation by bolting, necessary air piping up to the cubicle, cabling up to local junction box/ CEMS room, testing, calibrating and commissioning of the system.
 - e) The necessary precautions for probe mounting as detailed in the installation procedure of Oxygen analyzers shall be taken.
 - f) Complete cabling from probe head to analyzers at platform or at CEMS room including laying of cable subtrays, conduits as required shall be in Contractor's scope of work.
 - g) CEMS monitoring will consist of transmitter and receiver units, as applicable and electronic signal conditioning unit with necessary air purge units.

Contractor's scope of work shall include mounting of the transmitter and receiver units as per the approved layout drawings / documents.

- h) Contractor's scope of work shall also include cabling from trans-receiver units to local junction box/CEMS room, providing air purge connection and routing of air lines up to the required point with valves, air filter regulators, pneumatic lines etc.
- i) Field mounted electronic unit (if any) shall be installed on site fabricated stands/stanchions/enclosures.

2.03.00 Local Panels, Racks, Cubicles, Gauge Boards Enclosures and Structures

Local racks, panels, gauge boards, cubicles shall be installed at specified locations. Work shall also include fabrication and installation of gauge boards, stands, mounting brackets and frames, drain headers etc. with associated painting and civil work.

- a) Contractor shall erect panels / cubicles / enclosures etc. only after ensuring availability of work front.
- b) The panels shall be issued from warehouse or storage yard on the same day when the actual erection is performed.



- c) Panel, once uncrated, must be installed on the same day.
- d) Panels supplied in packed condition, will be properly slinged for lifting. When lifting unpacked panels eye-bolts shall be used. Unpacking should be done at store or installation site only.
- e) During slinging or lifting of the panel, care shall be taken not to damage the structure or any instrument/equipment mounted on the panel.
- f) Panels shall be slowly lowered on its foundations and shall not be subjected on unnecessary jerk or bounce.
- g) Prior to the installation of panels the foundation shall be inspected for presence of foreign matters and existence of possible defects or damage. Positions, shape and dimensions of the foundation shall be verified against corresponding drawing. Pockets for grouting shall normally be on the concrete base. Contractor shall arrange anchor bolts or grouting spikes and grout the same in the pocket.
- h) Accurate center lines and auxiliary lines shall be marked-off with due consideration of proper alignment and level. Base channel of panel shall be dismantled from the panel and shall be positioned and set by grouted anchor bolts. Before fixing the bolts, the panels must be properly aligned and plumbed. Only brass shims may be used for leveling of the panels. Leveling of panel should be done by the help of spirit level or similar device.
- i) Contractor shall arrange to provide suitable protective coverings for the panels since unpacking and after erection to avoid any damage due to movement of men and materials in the vicinity.
- j) Retouching work of painted surface of panels shall be carried out wherever required.
- k) During installation of panels and panel instruments the panels must be kept in perfectly clean condition.
- l) All panels shall be suitably earthed as per guidelines furnished in the specification.
- m) Only construction power shall be utilized during erection of panels. Under no circumstances power lines shall be tapped-off from the panels.

2.03.01 Junction Boxes and Pull Boxes

Contractor's scope of erection of junction boxes shall include mounting of junction boxes in appropriate locations indicated in the drawings, fabrication of necessary supports, pedestals, brackets, frameworks etc., for erection and final painting of the structures and the junction boxes.

- a) Junction boxes and pull boxes shall be provided for multi-pair / multi-core cables and compensating cables.



- b) Junction boxes shall be provided either with un-drilled removable gland plates or with knock-outs. Before installation gland plates shall be drilled/knock-outs shall be removed based on the cable schedule.
- c) The junction boxes shall be fixed to the nearest available structures as far as possible. In certain cases, special pedestals may have to be fabricated and grouted/bolted to nearest available structure.
- d) Before installation, junction boxes may have to be assembled by fixing terminal blocks, mounting rail etc. Any other connected job shall be a part of the junction box installation.
- e) Unused knock-outs in the junction boxes shall be left plugged to prevent dust and moisture entry.
- f) All necessary nuts, bolts, screws, foundation bolts etc. for mounting the junction boxes and their supporting structure shall be supplied by Contractor.
- g) Identification tags for the cables shall be provided both inside and outside the junction boxes close to the glanding point.
- h) Junction box mounting shall include the fabrication of steel supporting structures as well as other connected jobs.
- i) Contractor shall arrange to repaint junction box if the paint is damaged due to improper handling. Wherever required, Contractor shall arrange to perform retouching of paint on the junction boxes. Proper identification numbers shall be labeled on the junction boxes for ease of identification.
- j) After erection, junction boxes shall be covered with polyethylene sheets.
- k) Ideally the height of junction boxes shall be 1000-1400 mm from the approach floor level.

2.03.02 Transmitter Racks

- a) The location of transmitter racks shall normally be pre-assigned. However, depending on site conditions, some may have to be relocated at site.
- b) Guidelines provided for erection of panels shall apply for erection of transmitter racks, as well.
- c) Impulse lines shall normally terminate at a bulk head union at the top or back side of the closed type racks. In cases when bulk heads are not available, entry holes shall be drilled (not gas cut) and properly sealed after installation.
- d) Contractor shall avoid hot bending of impulse pipes inside the enclosures. All bending and forming activity should be performed outside before fixing in position.



- e) Contractor shall suitably support the drain/vent valves, manifolds etc. with the necessary clamps, bolts, washers etc.
- f) Contractor's scope of work shall also include terminating all rack mounted transmitters with electrical wires/cables in flexible conduits up to the terminal blocks with necessary cable and conduit supports, clamps, glands, sleeves, conductor markers/ferrules, lugs etc.
- g) Cabling from transmitter rack up to local junction box through flexible conduits, supporting and fixing of conduits at both ends, glanding of cables, ferruling and terminating are in Contractor's Scope of Work.

2.03.03 Stanchions, Site Structures and Mounting Frames

Contractor's scope of work shall include fabrication and installation of mounting frames, pedestals, canopies, protective enclosures and local gauge boards for mounting local instruments, analyzer and junction boxes. Contractor's scope shall also include mounting of the instruments in these local stanchions/pedestals/gauge/boards with all necessary mounting fixtures; piping, painting cabling up to local junction box and any other associated civil work like chipping, grouting etc.

- a) All steel items shall be de-scaled and degreased by suitable solvent cleaning.
- b) All structures shall be welded throughout.
- c) All faces supporting instruments shall be constructed with MS sheets of thickness not less than 3 mm.
- d) The support structure shall be designed to support all accessories related to the instruments; neatly and rigidly.
- e) While fabricating the structures, attention shall be paid to accessibility and maintainability of all equipment and accessories.
- f) All floor/platform mounted structures shall be self-supporting and free standing type. These should not depend on supports derived from nearby columns/structures/pipelines etc. for their rigidity and mounting.
- g) Adequate stiffness shall be provided on flat faces to avoid waviness of the surfaces. Necessary instrument cutouts are to be formed and all edges shall be rounded to avoid any sharp projection. Gas cutting of sheet metals are not permissible.
- h) All welds should be grounded to smoothness; corners should be rounded and weld splatters should be cleaned.
- i) After welding, the structure surfaces shall be smoothed with emery paper and painted with two coats of red oxide primer.
- j) Before installation, accurate center lines and other auxiliary lines are to be marked for proper leveling and alignment.



- k) Necessary grouting pockets are to be chipped and anchor bolts/studs shall be fixed on floor, column or wall.
- l) Necessary precaution should be taken during locating site mounted structures so as not to interfere with erection activity in the area or block passage for movement of personnel/equipment during normal operation and maintenance.
- m) Contractor shall arrange to provide suitable protective coverings for site fabricated structures to avoid damage due to movement of men and materials with vicinity.
- n) After erection, all site fabricated structures shall be painted with two coats of finishing paints of 2.0 mil/coat DFT. Sags, cracks, blisters, tear drops, fat edges of paint shall render the structures unacceptable.
- o) All instruments shall be mounted as per the recommendation of the manufacturer. Associated impulse and drain pipe work and supporting of accessories; cabling up to local junction box shall be Contractor's responsibility.
- p) Structures supporting indicating instruments shall be so oriented that the dials are visible unassisted from the nearest approach floor/platform. Ideally the height of instruments shall be 1000-1400 mm from the approach floor level.
- q) Contractor shall carry out retouching of painted surface of the structures wherever required, after installation.
- r) Contractor shall fabricate 3 mm MS/Aluminum canopies for shielding of instrument from direct exposure to sun & rain.

2.04.00 Cabling and Interconnection

Cabling and interconnection activity shall include cabling work between local switches, resistance temperature detectors, transmitters, converters, limit switches, smart positioners, torque switches, solenoid valves etc. up to local junction boxes; thermocouples up to local thermostatic junction boxes, temperature transmitters or control room panels from local junction boxes / local panels / transmitter racks / instruments to termination cabinets / panels / electronic cabinets in control room / control equipment room ; command and feedback signals from MCC / Switch Gear room to termination cabinets / panels / electronic cabinets in control room / control equipment room; inter-cabling between various cabinets in control room / control equipment room ;earthing of all panels / racks / cabinets / junction boxes etc, up to ground lug / riser with appropriate cable; special cabling between sensing devices to converter cabinets and cabling work of prefabricated and hiway cables. Cabling work shall normally imply pulling, laying, marking, splicing, glanding, dressing, ferruling, crimping and termination of cables at both ends with associated conduit and sub-tray work; followed by testing of cables.

- a) Single and multi pair/core cable shall be laid on trays or in conduits. Cable shall be neatly laid with proper dressing and adequately fixed.



- b) Cable shall enter in the enclosures through cable glands.
- c) All the cable runs shall be properly identified by easily readable printed permanent tag plate fastened to the cable with steel wires, provided at both field ends and panel ends and at a maximum of 20 meter intervals in straight length. Tags shall be provided in all bends and both sides of the barrier walls as well as at both terminal ends.
- d) In the cable spreader room, cables shall be clamped rigidly below the panel entry. If required, vertical cable tray shall be provided in case where the horizontal cable tray is more than 1 Meter below the respective Panel bottom.
- e) Cables laid near the main Steam Piping and other high temperature steam pipings shall be protected through proper insulation arrangements against damage due to continuous exposure to high temperature.
- f) Bend trays with suitable roller arrangements shall be used for cross over of cables from one section to other in perpendicular direction.
- g) Spare cable runs shall be kept coiled inside the enclosures with the ends suitably protected and cables properly identified.
- h) In case of single piece straight multipair/core cable run, no joint in the cable shall be provided in between.
- i) All Control and Instrumentation Cables shall be laid maximum upto 2 layers for horizontal cable trays and in single layer for vertical trays.
- j) Cable glands and other openings in the junction boxes shall be properly sealed by means of sealing compound to make them thoroughly dust and moisture proof.
- k) The cables laid, shall not be subjected to excessive tension so as to cause damage to the conductors.
- l) At bends where excessive spatial stress may concentrate or where danger exists of damaging the insulation, extreme care shall be taken while laying the cables, to avoid any possible damage.
- m) All cable shall be tested for continuity and insulation before and after installation as per the latest Indian Electricity Rules. Test for continuity shall be done by a circuit tester. Insulation resistance test shall be done with a 500V megger. The measured insulation resistance shall be more than 50 meg. Ohms between conductors and one conductor to ground.
- n) All cable shall run through conduits up to local junction box / nearest sub-tray.
- o) All cable shields shall be individually terminated and jumpered together at the terminal blocks. Earthing of the shields shall, however, be performed at the control panel end.



- p) All cable shall be laid only along the route specified in the cable schedule.
- q) If at any time during progress of work, trays are found inadequate to accommodate the assigned cable, Contractor shall discontinue laying of the cable until the problem is rectified.
- r) Cable conducting AC and DC signals shall be segregated. Compensating cables shall not be mixed with cables carrying milliampere signals. The signal cables and power cables shall not be in the same conduit, tray or junction box. In general, a minimum clearance of 1500 mm shall be maintained between noise generating equipment like large motors, generators, transformers etc. and signal/control cables. The minimum distances to be maintained between the instrumentation signal cables and any AC power cables running in parallel are as follows :

Maximum Circuit Voltage	Separation (mm)
240 V AC	250
415 V AC	300
3.3 KV / 11 KV	600 / 900

- s) All cable shall be carefully laid or pulled in trays so that neither cable nor the trays are damaged. Cable shall be cut sufficiently long to conform to the contour of the trays, especially for vertical inside bends. All excessive slack shall be removed from the cable so that the cables lie parallel to the sides of the trays.
- t) The cable shall be tied to the trays with G.I./ Aluminum or self-locking cable grip strip at not more than 2 meter intervals for horizontal runs and at not more than 1 meter intervals for vertical runs. All cable shall be strapped individually.
- u) Pulling of cable shall be done with manila rope or nylon rope.
- v) Only the type of lubricants recommended by cable manufacturer shall be used.
- w) Before pulling cable from the drum, the drum shall be visually inspected for protruding nails, fastenings or other objects which may damage the cable. Such articles shall be removed before pulling of the cable. Continuity and I.R. test shall also be performed.
- x) Contractor shall perform a thorough visual inspection for flows, breaks, cracks and abrasions in the cable sheath during pulling.
- y) Cable damaged in any way during installation shall be replaced.
- z) The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer.



- aa) To avoid insulation damage from excessive sidewall pressure at bends in conduit runs, the pulling tension in Kilograms shall not exceed 1.5 times the radius of bend in centimeters.
- bb) For cable without metallic shielding or armor and cable with metallic tape shielding, the cable bend radius shall be in accordance with the requirements of IPCEA standards. For cable with metallic wire shielding or metallic armor the bend radius shall not be less than 8 times the overall diameter of the cable.
- cc) All spare conductors of a multipair/core cable shall be left at their maximum lengths for possible future replacements of any other conductors in the cable. Each spare conductor shall be identified and neatly coiled separately and then taped to the conductors being used.
- dd) All exposed conductor surfaces shall be taped with all-weather vinyl plastic electrical tape.

2.04.01 Instrumentation Twisted Pair Cables

Cabling in this category shall include cabling between local switches, resistance temperature detectors, transmitters, local converter, smart positioner, limit/torque switches, solenoid valves etc. up to local junction box by means of single or multipair armoured cables up to local junction boxes and from local junction boxes to panels/ cabinets in Control Room/ Control Equipment Room etc. and interconnection between various panels/ cabinets.

- a) Contractor's scope of work shall include conduit and sub-tray work from all field instruments to junction boxes, pulling, laying, glanding, dressing, sleeving ferruling, crimping and termination at both ends.
- b) Contractor should take special care regarding wastage of cables while splicing.

2.04.02 Compensating Cables

Compensating cables shall be single or multiple pair cables for connecting thermocouple head to thermostatic or ordinary field junction box or control panel in control room or field mounted converter.

- a) In general, thermocouple will be duplex type and both the elements shall be terminated in local junction box.
- b) Contractor shall also lay multipair compensating cables from local junction boxes to control panel/ cabinets in central control room / control equipment room
- c) All compensating cables shall be drawn through Instrument cable tray.
- d) Compensating cables shall be directly connected from thermocouple head/ junction box to the Input modules of PLC/ instruments.



- e) While connections for thermocouple, due care shall be taken to connect compensating cable with proper polarity to T/C and Input modules of PLC/ instruments.
- f) Sufficient length of multipair cable will be left extra in the form of loop at either end.
- g) Multipair compensating cables shall be laid on the main rack sufficiently away from the power cables as specified in the table of this section so as to eliminate the stray current effect in the temperature measurement.

2.04.03 Prefabricated Cables

Cabling work shall include laying and terminating prefabricated cables between different panels.

- a) All necessary special glands, grommets of nylon or rubber etc. shall be supplied and erected.
- b) Prefab cables shall run through cable spreader room on trays. Vertical riser trays, to support the vertical run of cables from the main trays in cable spreader room to the panel glanding areas shall be supplied and erected.
- c) All the cable runs shall be properly identified by engraved aluminum tag plates fastened to the cable at not more than 10 meter intervals by steel wires.
- d) Cables laid shall not be subjected to excessive tension so as to cause damage to the conductors or plugs.
- e) In cases where the connecting heads/plugs may be supplied loose, Contractor, after laying the cable, shall solder cable cores and screen ends to connector pins/ plug-in crimped ends of the cable to the connector plug socket/crimp-in special connectors for coupling the cable to the plug socket/wire wrap the ends to connector pins, as the case may be. Contractor shall ensure properness of end connection before embarking upon the termination.
- f) All necessary modifications, rework, splitting etc. of the gland plates to accommodate prefab cables, their glands/ grommets shall be performed.
- g) Prefab cables shall be routed through special glands/ grommets as recommended by the manufacturer.

2.04.04 Special Cables

The category of special cables shall include the cabling work related to the data highways, flue gas and water analysis system, vibration monitoring system etc. where proprietary cables are supplied as part of instrument & for the transmission of low level voltage signals or other signals susceptible to noise interference.



- a) Special cables shall not be laid through trays carrying signals having voltage level of more than 60 volts AC/DC. As far as practicable special cables shall be laid through conduits.
- b) Minimum separation to be maintained between special cables and other cables shall be as indicated in the specification, unless specified otherwise by the supplier of the cable/ instrument.
- c) All necessary connectors, lugs, sleeves, conductor markers/ferrules etc. for termination of special cables shall be supplied by Contractor .
- d) Special cables shall not run unsupported for more than 1 meter.
- e) Special cables shall run un-spliced for each individual run. Junctions, loops, bends and long vertical falls shall be avoided to the extent possible.
- f) Tools recommended by the cable/instrument supplier shall only be used for splicing, connecting and terminating special cables.
- g) Where teeing, tapping, looping or branching are required for special or co-axial cables; only the equipment, tools and tackle recommended by the manufacturer shall be used.

2.04.05 Conduits

Flexible and rigid conduits shall be used for connecting instruments to the junction boxes or nearest trays/sub-trays. The activities shall include threading, plumbing, routing, supporting, connecting to cabinets; cleaning, sealing grounding painting and other related activities, as required.

- a) Where threads are required to be formed they shall be cut and cleaned before conduit reaming.
- b) Ends of all conduits shall be reamed to remove all burrs and rough edges.
- c) Cutting oil shall be used for threading operation and the dies shall be kept sharp.
- d) Rigid conduits shall be installed in exposed runs either parallel or perpendicular to dominating surface, with right angle turns made of symmetrical bends only.
- e) Conduit shall not be installed on the outside face of exposed columns but shall be routed on the web or on the inside of the flange of column.
- f) Metal conduits shall be joined by threaded conduit couplings.
- g) A run of conduit shall not contain more than the equivalent of four quarter bends including those immediately at the outlets or fittings of cabinets.
- h) Precautions shall be taken to prevent accumulation of water, dirt, concrete , foreign material etc. in the conduit.



- i) Bending radius of the rigid conduits shall not be less than six times the internal diameter of the conduits.
- j) Rigid conduits shall be regularly clamped at intervals of not more than 600 mm.
- k) Flexible conduits shall be installed in conduit runs across expansion joints.
- l) All screwed joints shall be properly sealed with sealing compound to make them thoroughly water proof.
- m) Loop shall be provided in the flexible conduit while joining with rigid conduit, enclosure or detector. Flexible conduit shall not be kept under tension.
- n) Flexible conduits shall essentially be used for connecting instruments or equipment subjected to vibration, expansion or thermal movement. In all such cases adequate loop lengths shall be provided to allow free movement at the connected points.
- o) Not more than 40% of conduit area shall be taken up by cables.

2.04.06 Sub-trays / Supports

Erection of sub-trays / supports shall include sub-tray sections up to the main trays. In areas where main trays are not available, ray sections shall be laid up to the master junction boxes / local panels / cable spreader areas. Contractor's scope of work shall include laying and supporting of trays, fabrication of trays wherever required, painting of trays and supports and associated minor civil work wherever required.

- a) Normally slotted G.I. trays or aluminum trays shall be used.
- b) Trays shall be used to run pneumatic tubes and electrical cables and shall be mounted on steel structures and along the pipe racks wherever convenient. Special stands/supports have to be fabricated wherever required.
- c) The erection of trays shall include fabrication, welding and installation of racks including supports from structurals and installation of various sizes of tray in position. Trays shall be screwed or bolted to the supports.
- d) The supports shall be welded to the main structures, grouted in the walls/roof or welded to the plate inserts. Welding of supports to main equipment/piping shall never be allowed. Welding or gas cutting of trays shall not be allowed.
- e) The scope of work shall also include the supply, fabrication and fixing of supports, bends, offsets, corners, tees, crossings etc. as per requirement.
- f) Civil / masonry works like grouting, providing inserts, chipping the concrete, bricks etc. for providing supports etc. shall be included.



- g) Contractor shall arrange to provide hangers, jigs, inserts and other fixtures on walls, ceilings, structures and permanent scaffolding etc., for fixing racks. Fabrication and fixing of necessary jigs, hangers, inserts and other fixtures, as required, shall be considered a part of erection of structural steel work.
- h) The trays shall be properly finished and laid to give neat appearance.
- i) Cable trays shall be fixed on angle iron supporting racks fabricated at site.
- j) All supports, clamps and other fixtures shall be painted.
- k) All trays carrying SS tubes shall, in general, be vertical type.
- l) Industry areas, Contractor shall provide covers for trays. In such cases, Contractor shall procure, fabricate and strap the covers with G.I. strips, nuts and bolts.
- m) If any erected tray or its supporting structures are found to be vulnerable to damage or to be fouling/interfering with progress of other activities in the area, the same shall be dismantled and re-erected.
- n) The selection, whether to use rigid conduit or sub-tray shall be judiciously decided.

2.04.07 Earthing

Contractor's scope of work shall include the earthing of all instruments/equipment, enclosures and other metallic parts and objects. Necessary wires, lugs, sleeves, markers/ferrules etc. shall be supplied. In addition to the general guidelines given below, Contractor shall remain responsible to follow the instrument/ equipment manufacturer's grounding recommendation.

- a) Screens of all screened cables between field instruments to local junction box shall be terminated to individual terminal blocks. The other end of the screen shall be left disconnected and taped with adhesive vinyl tape. All screen terminal blocks at JB end shall be shorted with shorting links. The screen of multipair cables to cabinets shall be connected to the screen terminal block in JB and the other end to be grounded at panel end only.
- b) Compensating cable screens shall be terminated at independent terminal blocks in control panel end only. This terminal block shall, however, be wired up to insulated screen bus bar integral to the panel.
- c) All junction boxes, stands, stanchions, local panels, cubicles etc., must be connected to the nearest riser of electrical earth mat by SWG 10 MS galvanized steel wire.
- d) All control panels, desks, consoles, cubicles, cabinets etc. must be physically earthed with the electrical ground mat inside the control room area.



- e) All electrical ground terminals of local instruments shall be individually terminated up to local junction box by one core of the signal cable and these terminal blocks shall be shorted by links. The common earth point then may be led to local earth point by SWG 10 galvanized steel wire.
- f) All local panel and central panel instruments shall be grounded to the common ground bus available inside the panel. Normally the grounding wires will be available as wired-up inside the panels. Wherever grounding wires are not available inside the panel, the same shall be provided by Contractor.
- g) For terminating grounding wires only ring-tongue type lugs shall be used.

Regarding the earthing requirement of power supplies and electronic equipment, manufacturer's recommendation shall be strictly adhered to. The earthing cables shall be carefully sized not to exceed the specified earth impedance. Separate salt pit earth and earth risers shall be created as required.

Design of Earth Pit for Electronic Grounding shall be as per the Control System Supplier's recommendation. However, a general guideline for grounding pit construction may be followed as detailed below.

Copper rod of length 3 (three) meters and diameter approx 15 (fifteen) mm shall be embedded in ground at least 3 (three) meters or more. The recommended earth pit resistance shall be less than 1 (one) Ohm. Copper strip of dimension 25 mm x 3 mm (approx.) is to be placed on electrode with necessary clamps for earth termination. The earth connecting strips may also be put into a Junction Box above ground from where an earth riser may be formed for connection. To enhance the conductivity salt, charcoal etc. may be mixed with soil. Any other earth conductivity enhancement compound may also be used for this purpose. One (1) earth pit cover shall be provided for protection and inspection purpose.

Dedicated redundant earth pit shall be provided which shall be away from the HV equipment and shall also be insulated from other electrical system ground to ensure single point grounding. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed for the grounding requirement.

2.05.00 Piping and Tubing

Instrument piping and tubing work shall include the impulse piping work between take-off valves on pipe lines or equipment/take-off nozzles (for air and flue gas connections) and the instrument; the drain pipings to the nearby drain point; instrument air sub-header and main header (wherever required) installation and testing and tubings between air header/sub-header to different instruments/consumers.

2.05.01 Impulse Piping / Tubing and Accessories

- a) This section enumerates the basic guidelines for erection of primary impulse pipings, all associated fittings on primary impulse pipings, pipings for all instrument drain and vent lines with all associated valves and fittings, impulse line support and routing with accessories, all impulse line accessories viz condensing pots, temperature equalizing columns, seal



chambers, settling columns, drain headers etc. connections between instruments and valves/manifolds and their testing.

- b) For impulse piping/tubing routing Contractor shall develop a field routing sketch.
- c) The pipes shall be cut with a hacksaw or high speed cutting emery wheel; squarely and all burrs shall be removed. Roller type tube cutters shall not be used.
- d) Cold bending of the pipes shall be performed with the use of a proper pipe bender with radius of bends greater than five times the outside diameter of the pipe / tube. Allowable deformation shall be within 4%.
- e) Impulse piping shall always be installed with a slope greater than 10% in proper direction for draining and shall never be installed in level horizontally.
- f) Piping shall run with the minimum of changes in direction consistent with good practice and neat appearance.
- g) The bends/offsets must be smooth and regular. Bending shall not exceed 90 Deg. in any case. Necessary couplings, unions, fittings etc. shall be provided on impulse lines to facilitate removal and maintenance of instruments conveniently.
- h) No pipe shall be left with strain on it.
- i) Drain lines shall terminate at approved drains only.
- j) The total length of impulse piping/tubing between tapping point and instrument shall, in general, be within 10 meters.
- k) Pipes/tubes and accessories shall be adequately supported and fixed. Distance between the supports shall not exceed 1.5 meters in any case. Process piping shall not be used for supporting instrument piping. If additional structures and scaffoldings etc. are required for proper supporting of instrument pipes or accessories the same shall be arranged.
- l) Contractor shall follow the welding specifications of the main piping for the instrument piping, as well, wherever applicable. While welding, full care shall be taken to provide sufficient grounding so as not to damage any part of the instrument by arc current.
- m) Welding of steam piping and high pressure piping shall be carried out by duly certified welders only.
- n) Pipes installed but not connected, shall have ends closed with caps or plugs to prevent the entry of foreign material. All reasonable precautions shall be taken to prevent the entry of foreign materials in pipelines before and during erection. All drain points, after installation shall be sealed with caps/plugs.
- o) All pipes shall be thoroughly cleaned to remove all foreign materials, scales, oil, grease etc., before installation. This shall invariably be done after



disconnecting the instruments. After testing of steel impulse piping, the same shall be painted.

- p) All instrument impulse pipe fittings and accessories which shall include but not limited to brackets, supports, clamps, angle irons/flats shall also be painted as per the color code above.
- q) SS pipes, tubes and fittings need not be painted. Similarly G.I. pipes and fittings need not be painted.
- r) All clamps shall be first painted properly and then fitted.
- s) All surfaces to be painted and also impulse pipe shall first be cleaned by wire brushing and then with emery cloth to remove all rust/ dust/grease etc. After proper cleaning two coats of red-oxide zinc chromate primer (conforming to IS-2074) / followed by two coats of a D.F.T. of 1 mil shall be applied.
- t) For differential pressure instruments, wherever applicable, both the seal pots/condensate pots shall be brought to the same level.
- u) The preferred path for all instrument piping shall be along concrete walls, ceilings and building steel. Instrument piping may be routed through open areas, if necessary, provided that the lines are adequately supported and protected from damage. Instrument piping and piping supports shall not be supported from electrical raceways or electrical raceway supports, or process piping.

Piping/Tubing shall not be routed :

- i] Across equipment removal areas.
 - ii] Below monorails or cranes.
 - iii] Above or below removable gratings.
 - iv] Above, below, or across cable trays.
- v) All instrument piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope described above. Long continuous straight runs of piping shall be avoided. Where required, expansion loops shall be provided to take care of thermal expansion/contraction.
 - w) For differential pressure instrument both impulse lines shall run in parallel and shall be as close as possible.
 - x) All impulse pipes shall be subjected to hydraulic test/ leakage test at site after erection.
 - y) When carrying out hydraulic test, hydraulic pressure of 1.5 times the maximum working pressure shall generally be applied but care shall be taken that the pressure more than the pressure rating of the instrument is not applied. In order to prevent the instruments from being subjected to excessive testing pressure for long durations inlet valves of instruments



shall be kept closed. In case of differential pressure instruments equalizing valve shall be kept open.

- z) Before using pipes, fittings, isolation valves and manifolds etc. for impulse line work, the same shall be thoroughly tested. Contractor shall not use any defective or untested material for impulse line work.
- aa) After hydraulic testing of impulse lines, the same shall be completely drained out and service quality air shall be blown through the pipes to dry the pipes completely.
- bb) The instrument take-off piping up to the first isolation valve shall be laid and tested.

Contractor's scope of work shall include the erection of air purging system for the impulse tubes with all necessary valves and fittings, wherever required.

2.05.02 Instrument Air Distribution Piping

Erection of instrument air distribution piping include connection from nearest main air header take-off valves to the vicinity of air consumers viz. control valves, pneumatic controllers, I.P. converters, impulse line purge connections, power cylinders, purge rotameters etc. Sub-headers shall be formed with GI pipes.

- a) Supply and installation of all intermediate pipe fittings, isolation valves etc. including supply and installation of necessary clamps and supports will be considered as in integral part of instrument air piping work.
- b) For instrument air sub-header work, carbon steel hot-dipped, inside and outside galvanized pipes shall be used. Only fittings of carbon steel galvanized threaded type shall be used for GI application.
- c) Outlets of air headers shall be provided with 1/2" isolation valves, for upto 7 consumers. Contractor shall install air sub-headers up to vicinity of the consumer and thereafter 6 mm O.D. tube shall be laid.
- d) Air supply piping shall be installed always with a slope of not less than 1/100 in suitable direction to prevent accumulation of condensed water within the pipe.
- e) All joints in the instrument air header shall be screwed on all screwed joints in air header, of size 1/2" and below, Teflon sealing tape and for other sizes, good quality sealing compound shall be used in proper quantity to ensure leak-proofness.
- f) Gas cutting and gas or arc welding on all GI pipes shall not be allowed.
- g) After completion of air supply piping and prior to connection to the instruments, the piping shall be blown with oil free and dry compressed air at 5 to 7 Kg./Sq. cm to clean out any dust of foreign matter.
- h) After applying the air pressure, all connections shall be checked for possible leaks with soap solution and all leaks shall be rectified.



- i) All instrument air tubes shall be disconnected from instruments, tube ends shall be blocked, air at pressure equal to 1.5 times the working pressure shall be applied and the tubes shall be isolated from the source of pressure. The pressure shall not fall by more than 0.1 Kg./Sq. cm in ten minutes.
- j) Air to be used for testing shall be oil free dry clean air.

2.05.03 Stainless steel Tubings and Fittings

Contractor's scope shall include stainless steel pneumatic tubing for the signal and supply air control valves, servo drives, impulse line purge connections, solenoid valves, local controllers, I/P converters etc. with all necessary fittings and air filter regulators, wherever required.

- a) The tubes shall be thoroughly cleaned and flushed with air before installation and defective tubes detected during checking, if any, shall be removed.
- b) Single tube runs shall be joined together by means of straight connector (double compression fitting) at every joint of the tube or shall be telescopically brazed & sleeved.
- c) The individual single run pneumatic signal tubing shall be run and connected from the field mounted instruments to locally mounted controllers/indicators mostly on tray work or on angles.
- d) Tube runs shall be properly dressed, neatly laid and adequately clamped / supported on angles/trays. Distance between any two supports shall not exceed one meter in any case.
- e) Tubes installed but not connected shall have ends suitably closed to prevent the entry of foreign materials.
- f) Tube runs shall be provided with suitable identification tags indicating the run number for easy correlation and identification of connections. Identification ferrules at both ends shall be provided.
- g) Fittings shall be of brass flareless, of double compression type, and in accordance with ASTM or similar standard specifications. All compression fittings shall be provided by Contractor.
- h) When tightening up the nuts of the compression type fittings, spanner of suitable size shall be used. To avoid any deformation to the compression ring, adjustable wrench shall never be used.
- i) The bending radius for single tubes shall be more than five times the outside diameter of the tubes. The tubes shall be bent with proper benders and care shall be taken not to cause an flattening of the bend.
- j) The tubes shall be properly dressed on the trays to remove bends, dents etc. Tubes shall not be directly hit by steel hammers.



- k) Aluminum clamps or self-locking straps shall be used for clamping the tubes on trays/angles and same shall be supplied by Contractor at his own cost.
- l) When connecting tubings on servo-drives / valves mounted on structures having thermal movement, sufficient expansion loops shall be formed at the ends to allow for equipment movement without developing any stress on the end fittings.
- m) All tubing shall be checked for proper connections and pressure tested by Contractor.

2.06.00 Control Valves and Accessories

Contractor's scope of work shall include erection of control valves along with all related accessories like air filter regulator, smart positioners, limit switches, mechanical indicators, solenoid valves, airlock relays, volume boosters etc. Contractor's scope of work shall also include all related interconnecting tubing work for the above accessories and terminating all electrical connections up to local junction box. Any supporting structures, pedestals etc. required to make the installation complete shall be considered part of erection activity. Contractor's scope of work also include testing and commissioning of all pneumatic control valves.

- a) After completing the installation satisfactorily in all respect, Contractor shall perform the following tests.
 - i] Linearity of stem movement shall be checked at four points (inputs 25%, 50%, 75%, 100% of spring range) while rising and while falling.
 - ii] Hysteresis shall be checked.
 - iii] Response time shall be noted.
 - iv] Operation of airlock relay shall be checked.
 - v] Operation of stay put conditions (under electrical signal failure shall be checked).
- b) After testing, the valve shall be boxed up with blind gaskets at both ends to prevent entry of foreign materials and clogging of plug and seat.

2.07.00 Flow Elements

2.07.01 Orifice Plates

For orifice plates with flange taps Contractor's scope shall include fixing of nipple and first take-off valve, fixing and supporting condensation pot (wherever applicable) and insertion of orifice plate with suitable gaskets, nuts and bolts. For orifice plates with D, D/2 tapping, pipe welded stubs shall be available.

The general guidelines for installation of orifice plates are given below.



- a) The length of the take-off nipples shall be sufficient so that the first take-off valve protrudes beyond the thermal insulation.
- b) The take-off nipples shall be screwed/welded according to the design requirement.
- c) The hand wheel of the take-off valves shall be so oriented that they can be operated conveniently from approach platform, ladder etc.
- d) For steam services, condensation pots shall be connected to the tapping point before or after first take-off valves. Utmost care shall be taken to ensure that both the condensation pots are at the same level. All necessary bracing, saddle etc. shall be fabricated and used to support the condensation pots with the main pipe.
- e) Orifice plates shall be inserted with proper orientation with respect to fluid flow in line.
- f) Orifice plate should only be inserted in position for checking the alignment. Thereafter, it will be withdrawn and preserved till pre-commissioning activities are over.
- g) Contractor shall supply suitable gaskets while fixing the orifice plates in position.
- h) The orifice bar handle, shall be so oriented that the imprints are readable unassisted from the access floor of platform.
- i) Contractor shall ensure proper orientation of drain or vent holes.

2.07.02 Flow Nozzles

Flow Nozzles shall normally be shop assembled in branch pipe and welded in position with main pipe. The flow nozzles shall generally have $D - D/2$ tappings and shall be shop assembled with take-off nipples and root valves. Contractor's scope of work shall include connecting the condensation pots (for steam services) before installation of the differential pressure instrument.

2.08.00 Control Room Control Panels / Desks, Consoles & Cubicles / Cabinets

This section provides guidelines for the erection of desks, panels, consoles, cabinets etc, in the Control Room, Control equipment room, Local Control Room and other such locations.

Clauses (c), (d), (e), (i), (j), (k), (f), (g), (h), (i), (m) for the installation of Local Panels shall apply.

- a) After Inter-sectional bolting with necessary nuts and bolts, inter-sectional wiring shall be terminated at both ends



- b) Contractor shall arrange anchor bolts or grouting spikes and grout the same in the pocket. Any civil job concerned with the proper installation of the panel shall be considered as part of the panel installation work.
- c) After installation, the main incoming fuse of each panel section shall be removed and preserved till commissioning.
- d) For panels, desks, consoles etc. supplied without instruments and accessories mounted on them, Contractor shall mount and terminate all instruments & desk accessories as per drawing. Contractor shall also dress & bunch the cables properly after termination is over.
- e) If Solid state panels / desks / consoles / cubicles are supplied without the electronic PCB's plug-in modules etc. mounted on them, Contractor's responsibility shall include inserting these in position as per drawings. This activity shall be carried out only after complete installation of the panel/cubicles.
- f) After installation the following tests shall be carried out.
 - i] Visual inspection for proper alignment and inter-sectional crevices.
 - ii] Meggering shall be done between terminal blocks and ground before terminating the panel instruments.
 - iii] Visual inspection of surface finish for scratches & blemishes.
 - iv] Tightness of nuts and bolts to be physically checked.
 - v] Dressing and bunching to internal wires after termination to panel instruments.

2.08.01 Desks and Consoles / Local Control Panels / consoles and Desks

Contractor's scope of work shall include the installation of Operator's Terminals, Engineering Terminals, system cabinets/panels and other terminals, consoles and some other peripheral devices in the Local Control room wherever applicable. Associated activities shall include laying, glanding and terminating prefabricated cables, related structural work and other completing activities viz. modification of internal wirings, mounting and termination of instruments / equipment supplied loose etc.

- a) Erection of panels and desks in Control room area shall involve precise alignment and matching of surfaces. Contractor shall perform all related activities to achieve an aesthetic completion of the job. All necessary realignment, foundation work, packing and filling shall be done to compensate for shifting, waviness, misalignment etc.
- b) When bolting the panel sections, care shall be taken not to leave excessive strain on any of the surfaces. All necessary packing and filling materials shall be provided.
- c) Instruments and accessories supplied loose for mounting on panels shall be installed only after installation of the panels.



- d) If matching prefab connectors are available in pig-tail form the properness of connection shall be checked by Contractor before plugging-in. Contractor shall be fully responsible for improper connection of the connectors.

2.08.02 LVS, LED Monitors, etc.

- a) All items must be unpacked at installation site only.
- b) Contractor shall follow the general guidelines for installation of the blind panels as spelt out in previous sections.
- c) All unarmoured prefab cables shall run through flexible / rigid conduits and all conduiting and tray laying shall be considered to be a part of Contractor's scope of work.
- d) Installation and commissioning of LVS & LED Monitors in the control room is under Contractor's scope of work. This includes supply laying and termination of all interconnecting cables to complete the installation.
- e) Interconnection with existing Plant Master Clock and its Display devices (i.e. slave clocks) at different locations are under Contractor's scope of work. This includes supply of all mounting hardware and accessories, laying and termination of all interconnecting cables and other accessories to make the installation complete.

3.00.00 **CONSUMABLE, TOOLS AND TACKLE, CALIBRATION AND TEST, INSTRUMENTS AND ERECTION MATERIALS**

The purpose of this section is to outline, in general, the minimum necessary equipment / tools & tackle and consumable that may be required for erection work. The list hereunder is only meant to be a guideline and Contractor shall be responsible to arrange for supply any other equipments/ tools & tackle or consumable that may be required for satisfactory completion of the job.

- a) Erection consumables shall include but not be limited to the following :
 - i) Polythene sheets for covering field instruments and panels.
 - ii) Grease of approved quality.
 - iii) Colored adhesive PVC tapes.
 - iv) Gaskets and washers of various size and types as required.
 - v) Paints of approved quality and shade.
 - vi) Brass shims/foils for levelling of panels
 - vii) Welding electrodes, Oxygen, Acetylene and Argon Cylinders.
 - viii) Dry seal type thread sealant.



- ix) Insulated PVC/Vinyl adhesive tapes, sleeves etc.,
- x) Cable markers and clamps (G.I. or Aluminum)
- xi) Hacksaw
- xii) Cleaning solvent, petrol, rustolene, kerosene etc.
- xiii) Gland sealing compound
- xiv) 2 mm thick Aluminum Sheets
- xv) Twisted galvanized steel wire
- xvi) Cutting oil
- xvii) Teflon tape
- xviii) Liquid soap, Jute
- xix) Solder and flux
- xx) Nuts, bolts, screws and gaskets as required
- xxi) Perforated G.I./aluminum tray (if required)

- b) Necessary tools & tackle/equipment that may be required for erection/ installation/testing shall be provided.

The items listed below are indicative in nature and any other tools & tackle/equipment that may be required shall be arranged by Contractor.

- i) Hydraulic Test Jack (0-400 Kg/Sq. mm) [2 sets at least]
- ii) Continuity Tester and 500V Megger
- iii) Engraving machine
- iv) Sheet punching machine
- v) Hand drill with bits of various sizes
- vi) Welding kit (2 sets at least).
- vii) Thread cutter (with different sizes of die)
- viii) Test pressure gauges for hydraulic testing
- ix) Wire wrapping tool and soldering iron
- x) Materials for scaffolding



- xi) Materials for rigging
 - xii) Sets of wrenches, spanners, Allen keys, screw drivers and other tools for wiring and impulse piping work.
 - xiii) Crimping tool, splicing tool
 - xiv) Pipe bending jig
 - xv) High speed cutting emery wheel
 - xvi) Sheet bending machine
 - xvii) Multimeter
 - xviii) Air compressor and spray painting gun
 - xix) Air filter regulators
 - xx) Slide caliper/screw gauge
 - xxi) Tube cutter
 - xxii) Tube bender
 - xxiii) Hacksaw
- c) Necessary tools & tackle, jig, instruments/equipments that may be required for loop checking, calibrating and commissioning of all supervisory and modulating control loops, binary system, and calibration/checking of all field instruments, etc. as detailed in this specification shall be arranged.
- d) This section grossly summarizes the different items to be supplied by Contractor for completion of activities specified. The detailed job-wise requirement shall be guided by final engineering drawings and various clauses of the technical specification :
- i) Conductor markers/Ferrules, lugs, connectors as required for cabling and terminations.
 - ii) Glands and grommets for cable entry.
 - iii) Straps, nylon rope fasteners for cable support and dressing.
 - iv) Bends, tees, unions, crosses, plugs, caps and other fittings for impulse and drain pipe work.
 - v) Compression fittings, adapters ferrules etc. for SS tubing.
 - vi) G.I. tees, unions, elbows, reducer, screwed brass needle valves.
 - vii) Perforated G.I./Aluminum subtrays (50, 100, 150 mm) for cabling and tubing work.
 - viii) 1/2 & 3/4" rigid and flexible conduit fittings

ix) Terminal blocks (1.5 Sq.mm).

Contractor shall include all structural steel items.

4.00.00 **INSTRUMENT CALIBRATION / CHECKING AT SITE PRIOR TO ERECTION**

The general guidelines for calibration and functional checking of instruments and accessories are as given below :

- a) For calibration and functional checking of different types of instruments, check lists shall be prepared. The results and observations of checks and tests shall be recorded in appropriate forms.
- b) Qualified and experienced engineers, supervisors and skilled technicians shall be deployed for calibration and functional checking of instruments.
- c) Only precision testing instruments of certified accuracy specially made for testing particular make/type of instruments shall be used for calibration and functional checking of instruments.
- d) Physical checking of the instruments shall be carried out to find out any possible damage to the instruments.
- e) Instruments requiring calibration shall be calibrated, in general, throughout the instrument range at five check points viz. 0%, 25%, 50%, 75% & 100% of span, both upscale run and downscale run. The error between theoretical and calibration figures thus obtained at each check point shall not exceed the instrument manufacturer's stated figures. If the error exceeds the limits specified by the manufacturer, the instruments shall be adjusted to achieve calibration accuracy within the specified limits.
- f) Regarding the calibration and functional checking of special instruments, the instruction of the manufacturer shall be followed.

4.01.00 Pressure / DP Gauges

4.01.01 Calibration for pressure / DP gauges shall be carried out with dead weight testers / hydraulic testers / vacuum pumps against manometers / precision manometers/sub-standard gauges of certified accuracy.

4.01.02 Test results shall be presented to indicate accuracy, hysteresis and linearity.

4.01.03 Gauges shall be subjected to over-range test as per manufacturer's recommendation. Gauges shall be recalibrated after over-range test.

4.01.04 Gauges for compressed air service shall be tested with air compressor and sub-standard gauges.

4.01.05 Low pressure/dp gauges shall be tested with compressed air test jigs and sub-standard gauges.

4.02.00 Pressure / DP Switches



- 4.02.01 Pressure / DP switches shall be tested for adjustability and repeatability of set point by means of dead weight tester / hydraulic testers / vacuum pumps against manometers/precision manometers / sub-standard gauges of certified accuracy.
- 4.02.02 Exact operating point of the switches shall be identified by means of a multimeter or any appropriate instrument.
- 4.02.03 For switches having adjustable differential, the differential shall be maintained fixed during the test.
- 4.02.04 Test results shall be presented to indicate linearity and differential.
- 4.02.05 Switches shall be subjected to over-range and contact rating test. Switches shall be recalibrated after over-range test.
- 4.02.06 Switches for compressed air service shall be tested with air compressor test jigs and sub-standard gauges. Low pressure/dp gauges shall be tested with compressed air and sub-standard gauges.
- 4.02.07 The switches shall be set at the desired set point after calibration. Where set points are not available at the time of erection, the same shall be set in site, after erection, by means of compressed air/hydraulic hand jack and sub-standard gauges through the instrument drain connection after closing the instrument root valve.
- 4.03.00 Temperature Gauges
- 4.03.01 Temperature gauges shall be calibrated in controlled temperature oven with the help of standard laboratory thermometer of certified accuracy in addition to check ambient temperature reading.
- 4.03.02 Zeroing of the gauges shall be done separately by means of ice bath.
- 4.03.03 Test results shall be presented to indicate accuracy, hysteresis and linearity.
- 4.04.00 Temperature Switch (if applicable)
- 4.04.01 Temperature switches shall be calibrated in controlled temperature oven with the help of standard laboratory thermometer of certified accuracy in addition to check ambient temperature reading.
- 4.04.02 Switches shall be set at known set point after testing for repeatability and hysteresis as mentioned above. Differential, if adjustable, shall be kept fixed.
- 4.04.03 Set point and differential shall be adjusted as per Engineering data.
- 4.04.04 Temperature switches shall be set prior to installations. However, in situ setting may be necessary during commissioning by comparison with other gauges on the line.
- 4.05.00 Temperature Elements

- 4.05.01 Temperature elements shall be tested for continuity from their terminals at element head.
- 4.05.02 Temperature elements shall be ungrounded and duplex type. Both the elements shall be checked for continuity.
- 4.05.03 I.R. shall be measured between individual elements and between element and thermowell.
- 4.05.04 In general, thermocouples and RTDs will be factory tested. However, in case of any malfunction while loop testing, an element may have to be tested for linearity and accuracy at Contractor's shop.
- 4.05.05 Thermocouple & RTD will be tested in temperature controlled bath at several temperature (depending on the type of T/C or RTD) points with digital millivoltmeter / Thermocouple or RTD calibrator. The results thus obtained must be compared with standard table as per ASME / DIN.
- 4.06.00 Electronic Pressure and Differential Pressure Transmitter
- 4.06.01 Calibration of electronic transmitters will be carried out with dead weight tester or hydraulic tester with sub-standard gauges or multifunction calibrator. The output (4-20 mA) shall be checked with standard DMM at five different points throughout the specified range including zero and span with rising and falling input. Power supply to the transmitter receiver 2-wire loop should be given from 24V DC source in the Analog Input Card and the series load should be around 500 Ohms.
- 4.06.02 Following performance data should be calculated from observed input-output data and should be presented in agreed proforma.
- a) Accuracy
 - b) Hysteresis
 - c) Dead band
 - d) Repeatability
 - e) Linearity
- 4.06.03 Transmitter shall always be calibrated in vertical position rigidly fixed to a suitable jig.
- 4.06.04 It may be necessary to recalibrate the zero while commissioning by equalizing the ports of dp transmitters or opening input port of pressure transmitters to atmosphere.
- 4.06.05 Electrical tests shall include supply voltage sensitivity, short circuit proofness and maximum loading in sample cases.
- 4.07.00 Level Switch (if applicable)



- 4.07.01 Level switch shall be functionally checked by operating the float mechanically and hydraulically and testing the make and break of the switches with ohmmeter or continuity tester.
- 4.07.02 Contractor shall also be responsible for checking the current rating of the contacts.
- 4.08.00 Current to Pneumatic Converters (if applicable)
- 4.08.01 Contractor shall shop test I/P converters with input of 4-20 mA DC from standard current source. The output (0.2 to 1 Kg/Sq. cm) shall be read against substandard gauges and input- output relation shall be presented.
- 4.08.02 Air supply to the I/P Converter should be given through air filter regulator.
- 4.09.00 Receiver Instruments (wherever applicable)
- 4.09.01 Receiver instruments, in general, shall cover all panel mounted instruments like digital panel meters etc.
- 4.09.02 Contractor's responsibility shall include calibrating all receiver instruments with specified inputs like mA, pulse etc.

Indicators

- a) Input shall be provided from constant current source/ voltage generator depending upon the specified input.
- b) Input shall be given for 0%, 25%, 50%, 75% and 100% of the span and the readings shall be taken for both rising and falling input.
- c) Indicators will generally be scaled in Engineering Units.
- d) Zero and span shall be readjusted, if necessary, after mounting in position during loop checking and commissioning.
- e) Tag No., service, range and multiplication factor shall be neatly typed / engraved and pasted to the body / casing of the instrument.
- 4.10.00 Control Valves
- 4.10.01 Valves shall be lubricated (if required), stroked and checked for hysteresis. Alignment of valve positioners shall be checked. Connection and operation of solenoid valves and air lock relays (if provided) shall also be checked.
- 4.10.02 Action of actuator shall be checked by applying spring range pressure through air filter regulator / multifunction calibrator and observing the stem travel against a scale.
- 4.10.03 Smart positioner shall be tuned to achieve proper valve response.. Necessary adjustment of zero and span shall be done by the Contractor for accurate valve positioning and feedback .



- 4.10.04 Contractor shall also check the function and adjustability limit switches.
- 4.11.00 Gas Analyzers
 - 4.11.01 Zirconium probe type oxygen analyzers shall be calibrated in situ with the aid of two-point automatic calibration kit and reference gas cylinders.
 - 4.11.02 Test procedure available in the manufacturer's catalogue shall be followed.
 - 4.11.03 Prior to calibration all air and gas lines shall be tested for leakage and air tightness and all electrical connections are to be checked for correctness.
 - 4.11.04 Reference gases shall approximately have 0.4 and 8 percent Oxygen.
 - 4.11.05 Sample and air flow regulators shall be preset to recommended settings prior to the test.
 - 4.11.06 Probes shall be purged for at least 30 seconds with instrument quality air between introduction of successive test gases.
 - 4.11.07 The action of the temperature controller shall be checked prior to the test.

5.00.00 **EXAMINATIONS AFTER INSTALLATION**

- 5.00.01 On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and inspected by Contractor for correctness and completeness of installation and acceptability for start-up, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in Contractor's quality assurance program.
- 5.00.02 Contractor's commissioning / start-up engineers shall be responsible for carrying out all the pre-commissioning tests. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the complete equipment shall be placed on Initial Operation during which period the complete equipment shall be operated integral with sub-systems and supporting equipments.
- 5.00.03 All insulated conductors furnished and installed shall be electrically tested after installation.
- 5.00.04 All circuits shall be tested complete except for connections at equipment end.
- 5.01.00 Continuity, Identification and Short Circuit Tests

All insulated conductors shall be tested for continuity and conductor identification. In addition, all insulated conductors of multi-conductor cable shall be tested for short circuit. Short circuit tests shall include all tests necessary to confirm that no conductor of a multi-conductor cable is short circuited to another conductor in that cable.
- 5.02.00 Insulation Tests



All insulated conductors shall be tested with a 500 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptance resistance values shall be 10,000,000 ohms.

5.03.00 Testing

5.03.01 Tests shall be performed as many times as necessary to assure proper quality of materials and workmanship. If any tests reveal unsatisfactory materials or workmanship, such materials or installation shall be repaired or replaced.

5.03.02 All hydrostatic and pneumatic testing shall conform to ANSI B 31.1 - Code for Pressure Piping, Paragraph 137.

5.04.00 Hydrostatic Testing

5.04.01 All instrument piping which connects to process piping shall be hydrostatically tested. The specified test pressure shall be applied to the instrument piping upon completion of erection.

5.04.02 Before the leak tests are performed all instrument piping welds and screwed connections shall be inspected and all air expelled from the piping being hydrostatically tested. Welds shall be visually inspected for defects and screwed connections shall be inspected for tightness.

5.04.03 Leak tests shall be performed using cold water to pressurize the systems. The adverse effects upon test results caused by air pockets shall be avoided by expelling all of the air from the system during filling.

Tests shall be made by one of the two following methods :

- a) Isolate the instrument piping from the instrument and the process piping by disconnecting the flexible connection from the instrument and closing the root valve(s). Fill and pressurize the instrument piping through the flexible connection.
- b) Coordinate testing of instrument piping with the testing of associated process piping. Isolate the instrument by closing the shut off valve and disconnecting the flexible connection from the instrument. Test the instrument piping by opening root valve(s) and visually inspecting the instrument piping for leaks. Special precautions shall be exercised by Contractor to avoid damage to instruments and conflict with others performing the process piping hydrostatic tests.

5.05.00 Air Testing

5.05.01 All control air headers, branches and short tubing drops and all pneumatic signal tubing shall be air tested as specified herein. Additionally, all boiler draft and all vacuum instrument piping shall be air tested as specified herein.



- 5.05.02 All control air headers and instrument supply take-offs shall be blown out with clean dry air using full receiver air pressure. Larger headers shall be blown first, using full size valves. Smaller headers and take-offs shall be blown last. All supply headers shall be blown before any instrument connected to the header system is turned on. Instrument air headers and branch lines shall be tested by the pressure decay method.
- 5.05.03 Flexible hoses and short signal tubing runs between adjacent components shall be tested at normal operating pressure by visually inspecting for leaks using a commercial leak detection fluid. Long signal tubing runs shall be tested by charging each tube with air at 2 Kg/Sq. cm through a bubbler sight glass. Tubing shall be isolated from associated instruments with all open ends plugged.
- 5.05.04 Boiler draft and all vacuum instrument piping shall be tested by the same method as long signal tubing runs above except that the boiler draft tap root valve shall be closed in each case and the instrument piping shall be charged from the flexible connection at the instrument. Close shutoff valves to any permanently installed purge meters. Special considerations shall be given to multiple instruments sharing the same process connection or signal source. The Pressures applied shall not in any case exceed the allowable pressure rating of any connected devices which cannot be isolated.

6.00.00 **PROTECTION DURING MANUFACTURE, TRANSPORTATION AND STORAGE BEFORE ERECTION**

This section provides special precautions, protection & care to be taken for delicate electronic items and supplements the general guidelines provided in the specification.

6.01.00 Protection

- a) All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or non-metallic protecting device. Ends of valves and conduit shall be sealed with suitable devices to protect them from damage. The parts which are likely to get rusted due to exposure to weather, should be properly treated and protected in a suitable manner.
- b) All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. The surfaces that are to be finish painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.
- c) Special high temperature primer shall be used on surfaces exposed to temperature higher than 95°C.

6.01.01 Protective Guards

Suitable guards shall be provided for protection of personnel and delicate instrument. All such guards shall be designed for easy installation and removal for maintenance.



- 6.02.00 Storing
- 6.02.01 Stored equipment and materials shall be adequately supported and protected to prevent damage.
- 6.02.02 Stored equipment and materials shall not be allowed to contact the ground in ware houses that do not have dry concrete or suspended floors, material and equipment shall be stored on platforms or shoring.
- 6.02.03 Strip heaters and similar heating devices shall be energized immediately upon placement of the equipment in storage.
- 6.02.04 Mechanical dehydrators provided in control panels shall be maintained in operation from the date of receipt of equipment.
- 6.03.00 Defects
- 6.03.01 All defects in erection shall be corrected. The dismantling and reassembly to remove defective parts, replace parts, or make adjustments shall be included as a part of the work.
- 6.03.02 The removal of control and instrument equipment in order to allow bench calibration, if required, and the reinstallation of said equipment after calibration shall also be included as a part of the work under these specifications.

7.00.00 **QUALITY ASSURANCE SERVICES**

This section outlines, in general terms, the inspection, testing and QA/QC procedures to be adhered to with suitable check-points for Owner's intervention for Control & Instrumentation items. The general conditions outlined elsewhere in the specification over and above. The special requirements furnished below.

7.01.00 Quality Assurance Program

7.01.01 To ensure that the equipment and services of Control & Instrumentation items under the scope of this Contract, whether manufactured or assembled within Contractor's works or at his Sub-contractor's premises or at the site or at any other place of work, are in accordance with the specification, Contractor shall adapt suitable quality assurance program to ensure proper quality and workmanship at all points. A quality assurance program of Contractor for Control & Instrumentation items shall generally cover the following :

- a) Organization structure for the management and implementation of proposed quality assurance program.
- b) Documentation control system.
- c) Qualification and experience data of his key personnel.
- d) The procedure for Purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of materials purchased etc.



- e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and field activities.
- h) Control of calibration and testing of control, measuring and testing instruments/systems.
- i) System for indication and appraisal of inspection status.
- j) System for quality audits.
- k) System for handling, storage and delivery.
- l) Item/System-wise QA/QC and inspection flow charts clearly identifying the check-points of three types
 - Where in-house checks will be performed
 - Where in-house test reports will be submitted for Owner's approval
 - Where Owner's inspection is necessary
- m) System for authorizing release of manufactured product.
- n) System for maintenance of records, and
- o) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component furnished.

7.02.00 Quality Assurance Documentation

7.02.01 Contractor shall be required to submit the following Quality Assurance Documents well ahead of dispatch of the equipment :

- a) All non-destructive calibration, testing , examination procedures and repair procedure actually used during fabrication.
- b) The inspection plan with verification, inspection plan checkpoints, verification sketches (if used) and methods used to verify that the inspection were performed satisfactorily.
- c) Factory test results for testing required as per applicable codes and standards.

7.02.02 Owner shall have access to the works of Contractor and Sub-contractor at all times for the purpose of carrying out system audits, conducting quality surveillance, witnessing of tests and inspections etc.

7.02.03 Owner or his authorized representative may periodically check the work and Contractor's method of operation to assure that quality control practices are being



followed. At the time of Owner's visit, all quality documentation pertaining to test, qualifications, inspections etc., shall, upon request, be made readily available.

- 7.02.04 All reports of tests and inspections as per Quality Control Practices and Quality Plans shall be made available to Owner on demand.
- 7.02.05 Contractor shall prepare quality plan in two sections, one for quality control at shop and the other for quality control at site.
- 7.02.06 Testing/inspection procedures as detailed herein gives a basic program to be followed and is in no way comprehensive or complete. Any other inspection stages not mentioned in these clauses but required as per Contractor's quality assurance program shall included. Any tests necessary from operation, safety and reliability point of view shall also be included.
- 7.02.07 These procedures shall include all checks/tests conducted at site for preservation, pre-assembly, alignment, positioning of equipment, foundation preparation, grouting, welding/bolting, heat treatment, non-destructive examination, hydraulic test, performance tests, etc.
- 7.03.00 Shop Test
- 7.03.01 Shop tests shall include all tests to be carried out at Contractor's works, at works of his sub-contractor and at works where material used for production of the equipment is manufactured.
- 7.03.02 Individual components, instruments and devices furnished in accordance with specification shall be shop tested by manufacturer prior to shipment. The tests and test certificates shall be in accordance with the agreed QA program.
- 7.03.03 Such tests shall include electrical, mechanical, performance and hydraulic tests in accordance with relevant standards called for in the specifications to ensure that the plant being supplied fulfills the requirement of the specifications. Equipment not covered by any approved standards shall be tested in accordance with Contractor's quality control program.
- 7.03.04 All material shall be of tested quality, supported with duly correlated test certificates and wherever called upon by the Indian Boilers Regulations or by the design code, the test pieces shall be prepared and tested as per such regulation/code.
- 7.04.00 Site Test
- 7.04.01 Site tests shall include but not be limited to calibration, pre-commissioning trials, start-up trials, trial operation and performance guarantee test.
- 7.04.02 Contractor shall provide all required test equipment and simulation devices of reputed make, of required accuracy class and recently calibrated by some appropriate authority.

8.00.00 INSPECTION AND TESTING



8.00.01 General Requirements

- a) Equipment furnished under this specification shall be subject to test by quality assurance personnel of Contractor and Owner during manufacture, erection and on completion at specific agreed hold points.
- b) Contractor shall conduct all necessary shop and site tests and maintain proper records to fully meet the following requirements.
- c) Demonstrate to Owner's satisfaction that each equipment/sub-system fully meet all functional, parametric and other requirement of this specification and Owner's approved drawings/documents under all operating regimes.
- d) All applicable requirements of latest revised edition of I.S.A. Recommended practice MC-55.1 - 1982/ANSI MC 8.1-1975 regarding hardware testing of Digital process computers shall be fully met.
- e) All applicable tests shall be performed in accordance with the latest revisions of pertinent codes of ANSI, ISA and other applicable codes and standards. For equipment not covered by these codes, Bidder shall apply his standard shop and site testing procedures subject to Owner's approval.
- f) Contractor shall prepare detailed shop and site "Draft Quality Assurance Program" to fully meet the requirements of this specification. The document shall cover the following :
 - Quality assurance and testing procedures from component inspection stage up to final acceptance test at site.
 - Formats for recording calibration/test results.
 - Formats for test reports.
 - Specifications of test equipment proposed to be used for shop and site tests.
- g) The "**Quality Assurance Program**" as approved by Owner shall be used for conducting all shop and site tests.
- h) Additionally all standard quality assurance procedures of Contractor shall also be followed to ensure proper quality of equipment and compliance with specification requirements.

8.00.02 Shop Tests

- a) Contractor shall maintain proper records duly signed by authorized quality assurance personnel regarding all stage inspections, tests on individual equipment/sub-system/systems which are conducted by Contractor as per his standard procedure as well as those conducted to meet the requirements of his specification and Owner's approved "Quality Assurance Program". These records shall be made available to Owner during Acceptance Test.
- b) Contractor shall provide a complete factory test report of the system hardware and software.



8.01.00 Functional And Pre Acceptance Test

The authorized quality assurance personnel of Contractor shall conduct all tests as per the requirements of approved quality assurance program and fully satisfy compliance with specification requirements by all equipment / sub-systems and the system as a whole before sending notification for Acceptance test to Owner. Contractor shall maintain accurate records for all pre-acceptance test which shall be properly documented and duly certified documents shall be furnished to Owner at least one month prior to Factory Acceptance Test.

8.01.01 Input-output wiring check (for system cabinets, relay cabinets etc.)

- a) Contractor shall conduct a point by point wiring continuity check to every input and output and verify that the wiring connections agree with documentation. The test shall be performed by connecting a controlled signal to each input point in sequence. One point at a time, the wiring of all outputs shall be checked.
- b) Upon completion of point wiring checkout, Contractor shall conduct a system operational test employing static signals over the range of input signal. Appropriate static signals simulating each input shall be applied, scanned, processed, printed etc. as directed by the program. Signal strength shall be varied in order to check alarm functions and output fidelity. Simulation shall include testing of all specified system functions and operation. All calculations and conversions shall be verified against pre-calculated results.
- c) Calibration of outputs shall be individually tested for the quality and range over the period of not less than ten days (i.e. 240 hours) after completion of debugging, in order to confirm system stability and accuracy and to detect faulty programming, operation and components.

8.01.02 Special Tests for Solid State Equipment

All solid state equipment shall be subjected to Burn-in and Elevated temperature test and surge protection test :

- a) Surge protection test shall be conducted on all fully equipped system panels as per IEC information 255-4 Class-II. The equipment shall be designed to successfully withstand, without damage to component and/or wiring.
- b) Burn-in & Elevated Temperature Test

All solid state equipment shall be tested for a minimum of 168 hours continuously under power and simulated load prior to shipment.
- c) Acceptance Criteria for Burn-in and Elevated Temperature Test :
 - i) Functional test to be performed before and after Burn-in + ET Test.
 - ii) At no point of time the average temperature rise inside the cabinet shall be 10°C more that the ambient temperature.



8.01.03 Test for Closed Loop Control System

- a) Closed loop control system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quality Assurance Program so as to demonstrate to Owner, that the equipment furnished by Contractor meets the intent and requirements of this specification. These tests shall include but not be limited to the tests indicated in the subsequent clauses.
- b) All control systems shall be factory tested for circuit continuity and direction of the response. The components to be tested shall include all controllers, stations, other system modules, alarm contacts and multi-conductor inter-connecting cables. The tests shall be performed with all of the system components connected to form a complete system with the exception of field instrument. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system inputs. The tests shall be a qualitative functional test of each component of the control system which simulates dynamic inputs and monitors system outputs.

8.01.04 Tests for Field Instruments and Devices

The shop test for all field instruments, control actuators and devices shall include electrical, mechanical, performance and hydraulic tests in accordance with relevant IS, IBR or any other relevant approved standard or any other tests called for by Owner approved Quality Assurance Program.

8.01.05 Notification for Acceptance Test at Shop

- a) Owner, his duly authorized representative and/or an outside inspection agency acting on behalf of Owner shall have access at all reasonable times to inspect and examine the material and workmanship of the works during its manufacture of erection and if part of the works is being manufactured or assembled on other premises or works.
- b) Contractor shall give Owner/Inspector written notice of any material being ready for testing.
- c) Owner or Inspector shall within fifteen (15) days from the date of inspections, as notified by Contractor give notice in writing to Contractor of any objection to any drawings and if any equipment and proposed workmanship which in his opinion is not in accordance with the Contract. Contractor's shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objection or shall inform in writing to Owner/Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.
- d) The completion of these tests or the issue of the certificate shall not bind Owner to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.



- e) The inspection by Owner and issue of inspection certificate thereon shall in no way limit the liabilities and responsibilities of Contractor in respect of the agreed quality assurance program forming a part of the Contract.
- f) Contractor shall furnish copies of the following as implemented documents as prior to Acceptance Tests, failing which, Owner may withhold program for Acceptance Tests :
 - i) System configuration drawings
 - ii) Copies of all as-built drawings
 - iii) Final approved copies of all drawings/documents.
 - iv) All off-line diagnostic program listings
 - v) Off-line diagnostic manuals
 - vi) Dump of individual and complete data base
 - vii) Detailed main and bulk memory maps
 - viii) Final Design Specification Volumes
 - ix) Test data to verify all calculations
 - x) All console operation manuals
 - xi) Procedures of generating graphic displays, data base, logs, structuring/tuning of controllers etc.
 - xii) Test procedures, copies of approved data sheets and relevant pages of approved QAP for field instruments & control actuators.
 - xiii) All test reports for all types of tests carried out by Contractor.

8.01.06 Acceptance Test

8.01.06.1 The Acceptance Test shall include all reasonable exercises which the combination of equipment and software can be expected to perform. The test shall include but not be limited to, the following :

- a) Demonstration of the proper function of all hardware.
- b) Demonstration of required spare system capacity and all other parametric requirements of this specification.
- c) Demonstration of all man/machine functions.
- d) Demonstration of the proper functioning of all software.
- e) Demonstration of all diagnostic features.
- f) Point by point exercising of each input and output.
- g) Thorough exercising of each device, including the processor/ CPUs, Peripherals etc.

8.01.06.2 The Acceptance Tests shall also include the following Tests :



- a) Simulation of Inputs - to verify conversion accuracies, scan rates, operator functions, corrections of calculations.
- b) Operational Tests - to verify that the system performs all required functions and meets the specification requirements with respect to "free" processor time, spare memory requirements, loop response time and other parametric requirements.
- c) Diagnostics Test - to test working and bulk memory locations, instruction complements, functioning of outputs and peripheral devices, functioning of system check modules, etc.
- d) Power-consumption test - to verify KW consumption.
- e) Power failure test - to observe the consequences of a total power failure.
- f) Functions - All system functions shall be tested to demonstrate that they are in accordance with the specification.
- g) Format - All printouts and CRT display formats shall be checked to demonstrate that they are in accordance with the specification.
- h) Calculations - All calculations shall be tested to demonstrate that they are in accordance with the specification and I/O schedule. Contractor shall prepare all test cases for calculations (three for each calculation at low, mid and upper ranges of inputs) and submit them for Owner's review in accordance with contract schedule. Test cases shall include performance calculations, flow and level calculations.
- i) Demonstration of the manual and auto switch over from main to standby Bus/Controllers.

8.01.06.3 The following minimum criteria shall be followed during all tests :

- a) System shall meet all parametric and functional requirements of contract specification.
- b) The PLC shall be able to perform all specified functions without any interruption and/or degradation.
- c) Any allowable operator inputs through keyboards shall not result in system crash or hanging.
- d) Except for bulk memory failure, the disconnection / failure of any peripheral device while system is operating shall not lead to system crash.
- e) Disconnection/Failure of any offsite DPU shall not result in loss of any control function.
- f) Pulling out or insertion of any I/O module from its slot, shall not result in any system/sub-system failure.



8.01.06.4 The results of all Acceptance Tests shall be properly documented by Contractor and submitted to Owner.

8.01.06.5 Upon successful completion of Acceptance Test, Owner will provide Bidder with a written authorization for shipment of the system equipment to the project site.

8.02.00 On Site Tests

- a) On-site test shall include all tests to be carried out by Contractor at site upon receipt of equipment. These shall include but not be limited to inspection of equipment, preliminary on-site checks and tests, pre-commissioning trials, start-up tests, trial operation, performance and guarantee test, availability test etc. as per the requirements of clause 4.00.00 and other applicable clauses of this specification.
- b) Contractor shall perform the site tests in accordance with the requirements of these specifications and Owner's approved "**Quality Assurance Program**".
- c) Contractor shall maintain all test records in Owner's approved formats. These shall be countersigned by the authorized quality assurance personnel of Contractor supervising these works.

8.02.01 Preliminary On-Site Inspection And Tests

After field installation and before equipment energization and connection of field inputs, Contractor shall inspect all equipment and shall check wiring and cable to assure correctness of connections and power equipment installation. After these checks, Contractor's representative shall power the system and perform standard diagnostic tests on all system modules and equipment to assure that the system is working. The field inputs and outputs will then be connected by Contractor.

8.02.02 Start-up

- a) On completion of erection of the equipment and before start-up, each item of the equipment shall be thoroughly cleaned and inspected for correctness and completeness of the installation and acceptability for start-up, leading to initial pre-commissioning tests at site. The list of pre-commissioning tests to be performed shall be as Owner's approved "Quality Assurance Program".
- b) On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the complete equipment shall be operated integrally with sub-systems and supporting equipment as a complete system.

8.02.03 Programmable Logic Control System (Site Testing)

Site testing of PLC system being largely system-specific, only general guidelines have been provided in this section to ascertain the end-behavior of the system offered. However, detail site test procedure shall be mutually decided between Owner and Contractor during detail engineering stage and shall be followed at site.



- a) The front end or the I/O sub-system calibration and functional check procedure shall be as per the recommendation of the system manufacturer.
- b) Cards shall be inspected visually and subjected to standard pre-commissioning checks in standard test jigs before insertion in sub-racks.
- c) Cards requiring recalibration at site shall be calibrated before insertion.
- d) Contractor's activities may include minor hardware and software modification work at site.
- e) Contractor scope of work regarding the commissioning of modulating control sub-system shall include presetting of values of loop constants in respective cards, setting of alarms, timers, visual checking, mechanical and electrical testing and functional checking of all closed loop modulating controls associated with PLC. All tests shall be carried out after isolating field inputs/outputs from the system.
- f) Tests on the control system shall broadly consist of the following :
- i) Check of Equipment
- Cable termination of the cubicles will be checked.
- Locks, door function, lamps etc. shall be visually checked.
- ii) Functional Test
- Functionally test the system according to control diagram, wiring diagram and functional diagram. In case of any non-conformity, do some minor rectifications. All loops prior to functional test shall be ensured to be in manual position.
- Function test will be performed for each individual control loop successively, related or cascaded control loops must also be tested together. All normal as well as disturbance functions of the control loop and the cubicle shall have to be tested.
- iii) Testing of closed loop modulating control functions :
- Closed loop modulating control functions shall be tested with simulated input signals. Contractor shall check at least the following function :
- Inputs and outputs shall be checked for polarity
 - MVS and 1/2 selection circuits shall be checked
 - Controller cards shall be adjusted to initial setting
 - Alarm limit shall be set to process requirement
 - A/M bumpless transfers/tracking
 - Transparent fall backs and retransfer



- Release function
 - Loading of output of signal distributors
 - Memory retention time on power failure.
- g) Contractor's responsibility shall also include testing of the following performance criterion of CLCS together with control peripherals :
- i) Keyboard operation of closed loop controls
 - ii) Mimic diagram and graphic displays
 - iii) Logs
 - iv) Current and Historical trend displays of parameter associated to CLCS
 - v) Alarm displays in VDU
 - vi) Printer activation test
 - vii) Keyboard latency, control latency
 - viii) A/M transfer from keyboard
- h) In addition, to the above functional tests, Contractor shall also check the function of the Engineer's console with respect to loop configurability, graphic & log generation, power failure rebooting, trend generation etc at software level and all hardwire interface requirement with other systems.
- i) The tests on binary and sequential control sub-system shall be similar to modulating control sub-systems. The functional tests shall be performed at drive level as well as in group level.
- j) Complete off-line simulation testing of the binary control sub-system shall be carried.
- k) Prior to simulation test, Contractor should ensure that all the interposing relays are in position.
- l) Contractor shall also check the reporting function system to the Information System over the system bus.
- m) Setting of all timers as per process requirement shall also be done by Contractor during start-up.

8.03.00 Loop Checking and Pre-Commissioning

- a) After successful completion of erection and in situ calibration of field and control room instruments and equipment and on completion of associated cabling and tubing activity, Contractor shall undertake progressive loop checking of supervisory/binary and modulating loop controls to ensure all elements in measurement, protection and control loops to function in desired fashion.



b) In the category of instrument loop checking Contractor's activities shall include broadly the following :-

- i) Loop checking for supervisory instruments.
- ii) Loop checking for modulating control sub-system
- iii) Loop checking for binary & sequential sub-system

All loop checking shall be properly recorded and shall be submitted to Owner after completion of loop checking section wise/equipment wise.

8.03.01 Supervisory Loops

- a) Supervisory loops shall imply measurement loops having monitoring functions only and shall include the bulk data acquisition system.
- b) All loops shall be checked for electrical continuity and air leakage prior to loop checking.
- c) All associated groundings shall be checked before the electrical power system is energized.
- d) Spare cores of field cables can be used for communication during commissioning.
- e) If discontinuity is noted in any field cabling, Contractor shall identify the run of cable/junction at which the discontinuity has developed.
- f) Cable identification markers shall be checked at all points of the loop.
- g) Termination of all associated cable screens shall be checked for properness.
- h) All instrument fuses and power line fuses which were removed after erection shall be reinserted.
- i) If any failure of any component of the loop occurs during loop checking and commissioning the same shall be replaced by drawing from commissioning spare and reerected.
- j) All outgoing cables from temperature elements shall be disconnected at the junction head during loop checking. Proper simulated signals shall be inputted from field through the field cables to simulate temperature.
- k) Similarly, for field transmitters, field cables shall be disconnected from transmitter terminal box and simulated 4-20 mA current signal shall be injected to the loop from field through a constant current signal generator.
- l) In case of inputs connected to bulk data acquisition system the input interface card shall be progressively adjusted to obtain proper display at the console.
- m) Simulated signals shall be inputted for at least five points at equal intervals (including span and zero) of the span, both upscale and downscale.



- n) All accessories related to the measurement loops shall be adjusted/checked as a part of loop checking and commissioning.

8.03.02 Modulating Control Loops

- a) Loop checking will be carried out with all the devices hooked up as per drawings. The intent of loop checking is to establish that all wiring and tubing are as intended and all components are in functional condition. Final tuning of control loops will however be done only during commissioning/pre-commissioning stage depending upon complexity of the loops and as per manufacturer's recommendation.
- b) Before a particular modulating control loop is selected for loop checking, Contractor shall carry out the following checks :
 - i) Final control element (control valve/damper etc.) shall be checked for proper tagging, stroke and sealing, frictionfree movement of stem and positioner setting.
 - ii) Air supply to smart positioners, actuator shall be ensured at proper values.
 - iii) Contractor shall ensure that all primary sensors are properly installed, calibrated and are functioning properly.
 - iv) All scales and charts for indicators/recorders are installed properly.
 - v) Check proper hook-up between operator interface station (A/M station) and control cabinets
 - vi) All control loops must be selected in MANUAL MODE while checking.
- c) All input process signals shall be given from the field terminals in terms of current/voltage or resistance. The input signals should be variable over the total span.

8.03.03 Binary and Sequential Loops

- a) All loops shall be checked for electrical continuity and air leakage prior to loop checking.
- b) All associated groundings shall be checked before energizing the loop component.
- c) Suitability of power at final control element (air or electrical) shall be checked.
- d) All process switches, limit switches etc. shall be mechanically activated from the field and shall be checked at the receiving end. After testing for proper operation of the switches, these will be hooked up to the receiving system as applicable.



Loops will be tested as follows :

- i) One functional loop will be energized at a time.
- ii) Binary inputs shall be simulated from the field end by actuating the initiating devices mechanically whenever possible after setting the design set values.
- iii) The logical output from the binary system shall be checked at the receiving end like MCC, SWGR, DC starter panel, lamps, annunciation, PLC etc.
- iv) All timers will be set at optimum values.

8.04.00 Commissioning

During plant / equipment / section trial run, start up, running etc. Contractor shall put the associated instruments, loops, controls etc. in service in respective sections/areas for smooth commissioning. The instruments/equipment are to be put in operation/service as per sound engineering practice & manufacturer's recommendations. Any instrument problem/trouble that may arise during commissioning and afterwards is to be attended and solved promptly by Contractor.

8.04.01 Trial Operation

- a) The plant shall then be on Trial Operation during which period all necessary adjustments shall be made by Contractor while operating, over the full load range enabling the system to be made ready for Performance and Guarantee Tests.
- b) The duration of Trial Operation of the complete equipment shall be 14 days out of which at least 72 hours shall be continuous operation on full load, or any other duration as may be agreed to, between Owner and Contractor. The trial operation shall be considered successful, provided that each item of equipment/ sub-system/software supplied and erected by Contractor and the system as a whole can operate continuously at the specified operating characteristics for the period of trial operation.
- c) For the period of trial operation, the time of operation with load shall be counted. Minor interruptions not exceeding 4 hours at a time caused during the continuous operation shall not affect the total duration of trial operation. However, if in the opinion of Owner, the interruption is longer, the Trial Operation shall be prolonged for the period equivalent to the duration of interruption.
- d) Trial Operation Report comprising of observation and recording of various parameters to be measured in respect to the above described Trial Operation shall be prepared by Contractor. This report, besides recording the details of the various observations during trial run, shall also include the dates of start and finish of the Trial Operation and shall be signed by the representatives of both the parties. The report shall record all the details of interruptions, adjustments made and any minor repairs done during Trial Operation. Based on the observations, necessary modifications/repairs to



the system shall be carried out by Contractor to the full satisfaction of Owner to enable the latter to accord permission to carry out Performance and Guarantee Tests on the System.

- e) During the preliminary on site inspection and test, start up and Trial Operation the system shall be completely tested in the presence of Owner's representative to fully satisfy Owner that each equipment/sub-system/software module individually and the system as a whole fully meets the functional, parametric and other requirements of this specification. All diagnostic and software debug tests performed at the factory shall also be performed in the field. These tests shall include a full demonstration of all operating software program operating in the real time environment. Contractor shall be responsible for documentation of all test results, records of defects observed and adjustments / modifications made during these tests. Contractor shall furnish certified copies of the site tests carried out prior to date of commencement of Performance and Guarantee Test.

8.04.02 Performance and Guarantee Test

- a) Performance and Guarantee Test shall be conducted by Owner after the following requirements are met.
 - i) Preliminary on site inspection, start up test and trial operation tests are successfully completed.
 - ii) Certified copies of the results of all site tests are furnished by Contractor.
 - iii) All deficiencies noticed during shop tests and site-tests including trial operation are satisfactorily resolved.
 - iv) System documentation check is successfully completed.
- b) Performance and Guarantee Test shall cover all tests covered under Acceptance Test using actual plant inputs and outputs. Additionally, Owner may perform any other test which in his opinion is required for satisfying himself regarding full compliance of equipment with the intent and requirements of this specification.
- c) The guaranteed performance figures of all equipment as well as functional and parametric requirements of this specification shall be provided / demonstrated during these Performance and Guarantee Tests.
- d) Should the results of these tests show any decrease from guaranteed value or non fulfillment of specification requirements, Contractor shall provide all necessary enhancements / replacements / modifications / additions in hardware, software, system configuration and other technical features as required to enable the system and parts thereof to meet the guarantees and specification requirements. In such cases the Performance and Guarantee Test shall be repeated for retest.

8.04.03 Availability Guarantee and Stability Test Run



- a) Contractor shall guarantee 99.7 percent system availability for a period of 180 days. An Availability Guarantee Test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.3 percent of 180 days, during availability test run, a new 180 days test run shall start at the time when the system becomes available again. Loss of availability shall be defined as the loss of the system's guaranteed accuracy and repeatability or of any system function; except, however, that the loss of a function for not more than five percent of the I/O points shall not be considered loss of availability. Loss of a function for not more than five percent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to function and the percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The guaranteed accuracy and repeatability and system parametric requirements specified elsewhere shall be maintained for the entire 180 days run without any manual recalibration or any other changes made to the system.
- b) Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.
- c) If availability is lost due to Owner's error, down time will not be charged to Contractor.

8.04.04 Availability Test Dates

The availability test shall commence at a date which will occur between the commissioning date and 5 months following commissioning.

Contractor will be notified of the test starting date at the time of Performance and Guarantee Test. Any subsequent changes in the starting date shall require the mutual consent of both Contractor and Owner.

8.04.05 Test Duration and Definition

- a) The availability test duration shall be 180 days of accumulated test duration time. Such duration time shall be continuous from the start of test, except as defined hereinafter.
- b) The availability shall be expressed by a percentage which shall be calculated as

$$\frac{100 \times [\text{Test Duration Time} - \text{Accumulated System Outage Time}]}{\text{Test Duration Time}}$$
- c) The accumulated system outage time shall be a total of time in which all systems and system functions are not available. A weighing factor shall be used to determine the amount of outage time assessed due to partial failures. System outage time shall be calculated as :

$$(\text{Outage time}) \times (\text{Weighing factors})$$



- d) System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.

8.04.06 Outage Time and Weighting Factors

- a) Contractor shall submit a list of weightage factors for all system elements / components required for conducting the availability test. A list shall be submitted along with the bid documents. The finalization of the same shall be subject to Owner's approval.
- b) Outage time will be assessed for the length of time in which all or any part of any of the functions are either continuously available or not available when requested by operator action. The outage time shall be weighed by each functions associated weighing factor.
- c) Weighing factors for system elements shall be defined and mutually agreed upon before award of Contract.

8.04.07 Conditions

- a) Downtime shall start at the time of notification exclusive of actual travel time required by Contractor but not in excess of 8 hours.
- b) Contractor shall state in his proposal the unit price and quantity of each spare part which will be required at site during the availability test run to maintain the guaranteed availability figure.
- c) If the spare parts which are necessary for repair are not available with Owner at his site stock, the outage time necessary for obtaining the parts by Contractor shall not be counted if the spare part is on Contractor's recommended list and within the quantities indicated for each type of spares.
- d) If Contractor had not listed the spare parts or in case the requirement exceeds the quantity indicated as per point (b) above the time required to obtain the part by Contractor shall be multiplied by a weighing factor of 0.05 and counted as accumulated outage time.
- e) Spare parts which are used by Contractor and not promptly replaced by Contractor, shall accumulate outage time at the rate of time required to obtain the spare parts multiplied by a weighing factor of 0.05 if the part is on a subsequent outage.
- f) Contractor shall be responsible for replacing any of Owner's spare parts which are used in the availability run.
- g) Failure of peripheral output devices shall be counted as outage time if failure of the device affects any or part of any function as per clause.
- h) Any degradation of function shall accrue to outage time regardless of system configuration.



- i) During a period of system outage, Owner shall use operable functions of the system provided that such use does not interfere with maintenance of the inoperable functions or hardware as determined by Contractor.
- j) Should Contractor determine that partial use of the system by Owner will interfere with Contractor's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to Owner. This shall include off-line servicing.
- k) Outage time for each function shall stop at the time Contractor returns each of the functions as listed in clause on "outage time and weighing factors" to full service and relinquishes full use of the system to Owner.

8.04.08 Criteria for Handing-over of Control & Instrumentation System

- a) Contractor shall apply in writing to Owner for handing over of the complete Control & Instrumentation System after successful demonstration of tests as specified up to "Availability Guarantee Test".
- b) Owner shall take over charge of the C&I system subject to fulfillment of the conditions enumerated hereunder :
 - i) All site check-list prepared by Owner are fruitfully attended by Contractor and certified by Owner.
 - ii) All Operation / Instruction manuals are updated to incorporate changes made up to Availability Test Run.
 - iii) All drawings / sketches are submitted as per Contract, on as-built basis.
 - iv) All Close loop controls, Binary & Sequential controls should be working on auto and all interlocks are demonstrated to be functional.
 - v) All equipments and system supplied by Bidder are in working condition.
 - vi) All short supply items, as per Contract, are refurbished by Contractor.
 - vii) The above conditions are in addition to fulfillment of any / all other contractual obligations of Contractor towards Owner. Partial handing-over of systems / equipment shall not be permissible, except if desired so by Owner in special cases.



TECHNICAL SPECIFICATION OF MOTORS

GENERAL REQUIREMENTS

- For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.
- All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.
- Contractor shall provide fully compatible electrical system, equipment, accessories and services.
- All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.
- Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.
- The responsibility of coordination with electrical agencies and obtaining all necessary clearances for contractors equipment and systems shall be under the contractor scope.

Degree of Protection

Degree of protection for various enclosures as per IEC60034-05 shall be as follows:-

- i) Indoor motors - IP 54
- ii) Outdoor motors - IP 55
- iii) Cable box-indoor area - IP 54
- iv) Cable box-Outdoor area - IP 55

CODES AND STANDARDS

- 1) Three phase induction motors : IS/IEC:60034
- 2) Single phase AC motors : IS/IEC:60034
- 3) Crane duty motors : IS:3177, IS/IEC:60034
- 4) DC motors/generators : IS/IEC:60034
- 5) Energy Efficient motors : IS 12615, IEC: 60034-30

TYPE

AC Motors:

- a) Squirrel cage induction motor suitable for direct-on-line starting.
- b) Continuous duty LT motors upto 200 KW Output rating (at 50 deg.C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30. HT motors shall have minimum design efficiency of 95 % Tolerance on efficiency value applicable as per IEC 60034.
- c) Crane duty motors shall be squirrel cage Induction motor as per the requirement.
- d) Motor operating through variable frequency drives shall be suitable for inverter duty with VPI insulation. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.
- e) Motors operating through variable frequency drives shall also meet the requirements mentioned in subsection for VFD.

RATING

- (a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.
- (b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

TEMPERATURE RISE

Air cooled motors

70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation.

Water cooled

80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation. 41 deg.C over inlet cooling water maximum temperature of 39 deg.C for thermal class 90 (Y) wet wound Boiler circulation pump motor.

OPERATIONAL REQUIREMENTS

Starting Time

For motors with starting time upto 20 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 sec more than starting time.

For motors with starting time more than 20 secs and upto 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

Torque Requirements

Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

Starting voltage requirement

- (a) Up to 85% of rated voltage for ratings below 110 KW
- (b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW
- (c) Up to 85% of rated voltage for ratings from 201 KW to 1000 KW
- (d) Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW
- (e) Up to 75 % of rated voltage for ratings above 4000KW

Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.

DESIGN AND CONSTRUCTIONAL FEATURES

Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.

All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below

- (a) Fuel oil area: Group – IIB
- (b) Hydrogen generation: Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA / IEC60034)

Winding and Insulation

- (a) Type: Non-hygroscopic, oil resistant, flame resistant
- (b) Starting duty: Two hot starts in succession, with motor initially at normal running temperature.
- (C) 240VAC, 415V AC & 220V DC motors: Thermal Class (B) or better

Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

Noise level for all the motors shall be limited to 85dB (A). Vibration shall be limited within the limits prescribed in IS/IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

Motor body shall have two earthing points on opposite sides.

The spacing between gland plate & center of bottom terminal stud shall be as per Table-I.

All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 Kv /415V systems without any injurious effect on its life.

The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.

The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance).

- (a) From 50KW & upto 110KW : 11.0
- (b) From 110 KW & upto 200 KW : 9.0
- (c) Above 200 KW & upto 1000KW : 10.0
- (d) From 1001KW & upto 4000KW : 9.0
- (e) Above 4000KW : 6 to 6.5

TYPE TEST

LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this

contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip.
5. Temperature rise test.
6. Momentary excess torque test.
7. High voltage test.
8. Test for vibration severity of motor.
9. Test for noise levels of motor (Shall be limited to 85dB (A)).
10. Test for degree of protection and
11. Over speed test.
12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

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.

The type test reports once approved for any projects shall be treated as reference.

For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

TABLE - I
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW

**Minimum distance between centre of
bottom terminal stud and gland plate in mm**

UP to 3 KW

As per manufacturer's practice.

Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	385/203 (For Single core cables only)

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW

Clearance

UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

LT MOTOR APPROVED VENDORS ARE GIVEN BELOW. HT MOTORS TO BE SOURCED FROM SHEL/ABB/SIEMENS

04	LT MOTORS	a) KEC	Bangalore/ Hubli (Up to 90KW)	Please refer remark column for Categorization	BAP/QR/ G501 & G502/LTM:012 Rev NO: 00 dt 17 05 2018	Cat I Above 50 KW and up to 200KW NTPC inspn as per appd RQP/MQP
		c) CGL	Ahmednagar			
		b) SIEMENS	Mumbai	Please refer remark column for Categorization	** Acceptance of Motor rating between 30KW to 50 KW is based on NTPC Review of Routine Test Inspection report as per IS 325 Witnessed by BHEL/BHEL AIA ie Main contractor along with COC of the manufacturer and the contractor confirming as follows: "It is hereby confirmed that the above mentioned motor was /motors were manufactured taking care of NTPC specific requirements regarding ambient temperature, voltage and frequency variation, hot starts , pull out torque, starting KVA/KW, temperature rise, distance between centre of stud and gland plate, space heater and in accordance with approved drawing /data sheets"	Cat-II **From 30KW to 50KW BHEL Inspection
		c)ABB	Faridabad up to 55KW/ Bangalore above 55KW			
		a) BBL	Mumbai		##Acceptance of Motor less than 30KW is based on COC of the manufacturer and the contractor conforming as follows: "It is here by confirmed that the above mentioned motor/motor was / were manufactured taking care of NTPC specific requirements regarding ambient temperature, voltage and frequency variation, hot starts , pull out torque, starting KVA/KW, temperature rise ,distance between centre of stud and gland plate and tested m accordance with approved drawing /data sheet".	# #Cat-III Up to 30KW
		b) NGEF	Hubli (up to15KW)			
		c) Marathon	Kolkata			
		d) Jyoti	Vadodara			
		e) LHP	Solapur			
		(For other PMD vendors except above NTPC approved vendors, pl refer Sino. 4 under important notes in page no: 11)				

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**INSTRUMENTATION CABLE, CONTROL & POWER SUPPLY CABLE,
INTERNAL WIRING AND ELECTRICAL FIELD CONSTRUCTION MATERIAL**

General requirements

- All cables including special cables, internal wiring and electrical field construction material shall conform to this specification, Employer approved detail engineering drawings & documents and the latest edition of the relevant standards & guidelines. The Bidder shall furnish all material and services required for the completeness of the work identified in his scope as per this specification.
- The Contractor shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Contractor's scope and ensuring completeness of the control system.
- Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Contractor.
- Other type of cables like fiber optic/co-axial cables for system bus, cables for connection of peripherals etc. (under Contractor's scope) are also to be furnished by the Contractor.
- Contractor shall supply all cable erection and laying hardware from the main trunk routes like branch cable trays/sub-trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.
- Wherever the quantity has been defined as on as required basis, the same are to be furnished by contractor on as required basis within his quoted lump sum price without any further cost implication to the Employer.

SPECIFICATION OF INSTRUMENTATION CABLE

Common Requirements

S. No.	Property	Requirement
1	Operating Voltage	225 V (peak value)
2.	Codes and standard	All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and their amendments read along with this specification.
3.	Continuous operation suitability	At 205 Deg C for Type-C cables & heat resistant cables, at 70 Deg C for all other type of cables.
4.	Marking :-	<p>a. <i>Progressive automatic on-line sequential marking of length in meters to be provided at every one meter on outer sheath.</i></p> <p>b. Marking to read 'FRLS' to be provided at every 5 meters on outer sheath except for Type-C cable</p> <p>c. Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided on outer sheath.</p>

S. No.	Property	Requirement
5.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
6.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
7.	Ovality at any cross-section	Not more than 1.0 mm
8.	CAGE-CLAMP suitability	To be provided
9.	Color	The outer sheath shall be of blue color.
10.	Others	Repaired cables shall not be acceptable.

Specific Requirements

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
A. CONDUCTORS				
Cross section area	0.5 sq. mm			
Conductor material	ANSI type KX	ANSI type SX	Annealed bare copper	ANSI type KX
Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red
Conductor Grade	As per ANSI MC 96.1		Electrolytic	As per ANSI MC 96.1
No & dia of strands	7x0.3 mm (nom)			
No. of Pairs	2	2	2/4/8/12/16/24 / 48	2
Max. conductor loop resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1		73.4	As per ANSI MC 96.1
Reference Standard	As per ANSI MC 96.1		VDE : 0815	As per ANSI MC 96.1

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
B. INSULATION				
Material	Extruded PVC type YI 3			Teflon (i.e. extruded FEP)
Thickness in mm (Min/Max)	0.25/0.35			0.4 / 0.50 (nominal)
Volume Resistivity (Min) in ohm-cm	1 x 10 ¹⁴ at 20 deg. C & 1x10 ¹¹ at 70 deg. C.			2.8x 10 ¹⁴ at 20 deg. C & 2x10 ¹¹ at 205 deg. C.
C. PAIRING & TWISTING				
Max. lay of pairs (mm)	50			
Single layer of binder tape on each pair provided	Each core printed with number or Numbered binder tape to be provided on each pair		Yes	Each core printed with number or Numbered binder tape to be provided on each pair
Bunch (Unit Formation) for more than 4P	N.A		To be provided	N.A
Conductor /pair identification as per VDE0815	N.A.		To be provided	N.A.
D. SHIELDING				
Type of shielding	Al-Mylar tape			
Individual pair shielding	No		To be provided for F-type cable	No
Minimum thickness of Individual pair shielding	No		0.028mm (28 micron)	No
Overall cable assembly shielding	To be provided			
Minimum thickness of Overall cable assembly shielding	0.055 mm (55 micron)			
Coverage /	100% / 20%			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Overlapping				
Drain wire provided for individual shield	N.A.		Yes (for F-type) Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper	N.A.
Drain wire provided for overall shield	Yes, Size- 0.5 sqmm, No of strands-7, Dia of strands- 0.3mm, Annealed Tin coated copper			
E. FILLERS (if applicable)				
Non-hygroscopic, flame retardant	To be provided			
F. OUTER SHEATH				
Material	Extruded PVC compound YM1 with FRLS properties		Teflon (i.e. extruded FRP)	
Minimum Thickness at any point	1.8 mm		0.4 mm	
Nominal Thickness at any point	>1.8 mm		0.5 mm	
Resistant to water, fungus, termite & rodent attack	Required			
Minimum Oxygen index as per ASTM D-2863	29 %		N.A.	
Minimum Temperature index as per ASTM D-2863	250 deg.C		N.A.	
Maximum Acid gas generation by weight as per IEC-60754-1	20%		N.A.	
Maximum Smoke Density Rating as per ASTM D-2843	60%		N.A.	
	(defined as the average area under the curve when the results of smoke density test			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
	plotted on a curve indicating light absorption vs. time as per ASTM D-2843)			
Reference standard	VDE207 Part 5, VDE-816			VDE207 Part 6 ASTM D2116
G. Electrical Parameters				
Mutual Capacitance Between Conductors At 0.8 KHz (Max.)	200 nF/km		120 nF/km for F type 100 nF/km for G-type	200 nF/km
Insulation Resistance (Min.)	100 M Ohm/Km			
Cross Talk Figure (Min.) At 0.8 KHz	60 dB		60 dB	60dB
Characteristic Impedance (Max) At 1 KHz	N.A.		320 OHM FOR F-TYPE 340 OHM FOR G-TYPE	N.A.
Attenuation Figure At 1 KHz (Max)	N.A.		1.2 db/km	N.A.
H. COMPLETE CABLE				
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.			N.A.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification			As per manufacturer's standard subject to employer's approval
I. CABLE DRUM				
Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to entire drum) or steel drum.			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Length	1000 m \pm 5% for up to & including 12 pairs 500 m \pm 5% for above 12 pairs			

Note: Heat resistant instrumentation cable shall have same specification as of G/F type instrumentation cable as specified above, except that insulation and outer sheath material shall be Teflon and cable shall be suitable for continuous operation at 205 Deg. C.

SPECIFICATION OF OPTICAL FIBER CABLES (OFC)

Optic Fiber cable shall be 4/8/12 core, Electrolytically chrome plated corrugated steel taped (ECCST), fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multi-mode fibers on as required basis so as to avoid the usage of any repeaters. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter.

The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Dielectric central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum & crush resistance 4000 N minimum. The operating temperature shall be – 20 deg. C to 70 deg.C

All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.

Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables.

Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation.

Spliced / Repaired cables are not acceptable.

Penetration of water resistance and impact resistance shall be as per IEC standard.

SPECIFICATION OF LT POWER SUPPLY CABLES

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS: 1554 - I PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.

IS: 3961 Recommended current ratings for cables

IS: 3975 Low carbon galvanized steel wires, formed wires and tapes for armouring of cables.

IS: 5831 PVC insulation and sheath of electrical cables.

IS: 7098 (Part -I) Cross linked polyethylene

insulated PVC sheathed cables for working voltages upto and including 1100V.

IS: 8130 Conductors for insulated electrical cables and flexible cords.

IS: 10418 Specification for drums for electric cables.

IS: 10810 Methods of tests for cables.

ASTM-D -2843 Standard test method for density of smoke from the burning or decomposition of plastics.

IEC-754

(Part-I) Tests on gases evolved during combustion of electric cables.

IEC-332 Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

TECHNICAL REQUIREMENTS

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.

All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be stranded.

XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg.C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

The cable cores shall be laid up with fillers between the cores wherever necessary.

It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanized steel as follows:

Calculated nominal dia. of cable under armour	Size and Type of armour
Upto 13 mm	1.4mm dia GS wire
Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
Above 40 & upto 55mm	1.4 mm thick GS formed wire /2.5mm dia GS wire
Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.

The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of G.S.wire/ formed wire.

Outer sheath shall be of PVC as per IS: 5831 & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

- (a.) Oxygen index of min. 29 (as per IS 10810 Part-58).
- (b.) Acid gas emission of max. 20% (as per IEC-754-I).
- (c.) Smoke density rating shall not be more than 60 % (as per ASTM D-2843).

Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

- 1 core - Red, Black, Yellow or Blue**
- 2 core - Red & Black**
- 3 core - Red, Yellow & Blue**
- 4 core - Red, Yellow, Blue and Black**

For reduced neutral conductors, the core shall be black

In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

- (a.) Cable size and voltage grade - To be embossed
- (b.) Word 'FRLS' at every 5 metre - To be embossed
- (c.) Sequential marking of length of the cable in metres at every one metre
-To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible. For EPR cables identification shall be printed on outer sheath.

All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum, over the declared value in the technical data sheets.

In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

Cable selection & sizing:

Cables shall be sized based on the following considerations:

- (a) Rated current of the equipment.
- (b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage.
- (c) Short circuit withstand capability
This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let-out energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.

Cable lengths shall be considered in such a way that straight through cable joints are avoided.

All Cables shall be of armoured type.

All LT power cables of sizes more than 120 sq.mm shall be XLPE insulated and sizes shall be of 1Cx150, 1Cx300, 1Cx630, 3Cx150 & 3Cx240 sq.mm. However for cable sizes up to 120 sq.mm both XLPE insulated & PVC insulated LT power cables are acceptable.

Same cable sizes to be used for same type & rating of motor i.e. if there are three pumps for one application, all three pumps motor should be provided with same cables sizes.

Type Tests

The reports for the following type tests shall be submitted for one size each of LT XLPE and LT PVC Power cables. Size shall be decided by the employer during detailed engineering:

S.No.	Type test	Remarks
	For Conductor	
1.	Resistance test	
2.	Tensile test	For circular non-compacted conductors only
3.	Wrapping test	For circular non-compacted only
	For Armour Wires/ Formed Wires	
4.	Measurement of Dimensions	
5.	Tensile Test	
6.	Elongation test	
7.	Torsion test	For round wires only
8.	Wrapping test	For aluminium wires / formed wires only.
9.	Resistance test	
10(a)	Mass of zinc coating test	For GS Formed wires/wires only
10(b)	Uniformity of zinc coating	For GS Formed wires /wires only
11.	Adhesion test	For GS Formed wires/wires only
	For PVC/XLPE insulation & PVC Sheath	
12.	Test for thickness	

- | | | |
|-----|--|------------------------------------|
| 13. | Tensile strength & elongation before ageing and after ageing tests | |
| 14. | Ageing in air oven | |
| 15. | Loss of mass test | For PVC insulation and sheath only |
| 16. | Hot deformation test | For PVC insulation and sheath only |
| 17. | Heat shock test | For PVC insulation and sheath only |
| 18. | Shrinkage test | |
| 19. | Thermal stability test | For PVC insulation and sheath only |
| 20. | Hot set test | For XLPE insulation only |
| 21. | Water absorption test | For XLPE insulation only |
| 22. | Oxygen index test | For outer sheath only |
| 23. | Smoke density test | For outer sheath only |
| 24. | Acid gas generation test | For outer sheath only |
| | For completed cables | |
| 25. | Insulation resistance test
(Volume resistivity method) | |
| 26. | High voltage test | |
| 27. | Flammability test as per IEC-332 Part-3 (Category-B) | |

Indicative list of tests/checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of LT power cables enclosed.

LT CONTROL CABLES

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS :1554 - I PVC insulated (heavy duty) electric cables for working voltages up to and including 1100V.

IS : 3961 Recommended current ratings for cables

IS : 3975 Low carbon galvanized steel wires, formed wires and tapes for armouring of cables.

IS : 5831 PVC insulation and sheath of electrical cables.

IS : 8130 Conductors for insulated electrical cables and flexible cords.

IS : 10418 Specification for drums for electric cables.

IS : 10810 Methods of tests for cables.

ASTM-D –2843 Standard test method for density of smoke from the burning or decomposition of plastics.

IEC-754 (Part-I) Tests on gases evolved during combustion of electric cables.

IEC-332 Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

TECHNICAL REQUIREMENTS

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.

All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

Conductor of control cables shall be made of stranded, plain annealed copper.

PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

For multicore armoured cables, the armouring shall be of galvanized steel as follows:

Calculated nominal dia

of cable under armour	Size and Type of armour
Up to 13 mm	1.4mm dia GS wire
Above 13 upto 25 mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
Above 40 upto 55mm	1.4 mm thick GS formed wire/2.5mm dia GS wire
Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface.

Outer sheath shall be of PVC as per IS: 5831 and grey in colour. In addition to meeting all the requirements of Indian Standards referred to, outer sheath of all the cables shall have the following FRLS properties.

- (a.) Oxygen index of min. 29. (As per IS 10810 Part-58)
- (b.) Acid gas emission of max. 20% (As per IEC-754-I)
- (c.) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM D-2843.

Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

- 1 core - Red, Black, Yellow or Blue
- 2 core - Red & Black
- 3 core - Red, Yellow & Blue
- 4 core - Red, Yellow, Blue and Black
- 5 core - Red, Yellow, Blue, Black and Grey

For cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If

the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.

In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath:

- (a.) Cable size and voltage grade - To be embossed
 - (b.) Word 'FRLS' at every 5 metre - To be embossed
 - (c.) Sequential marking of length of the cable in metres at every one metre - To be embossed / printed.
- The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible. For EPR cables identification shall be printed on outer sheath.

All cables shall meet the fire resistance requirement as per Category-B of IEC- 332 Part-3.

Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum over the declared value in the technical data sheets.

In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

Cable selection & sizing

Control cables shall be sized based on the following considerations:

- (a) The minimum conductor cross-section shall be 1.5 sq.mm.
- (b) The minimum number of spare cores in control cables shall be as follows:

No. of cores in cable	Min. No. of spare cores
2C, 3C	NIL
5C	1
7C-12C	2
14C & above	3

Cable lengths shall be considered in such a way that straight through cable joints are avoided.

All Cables shall be of armoured type.

TYPE TESTS

The reports for the following type tests shall be submitted for one size of control cables. Size shall be decided by the employer during detailed engineering

S. No.	Type Test	Remarks
	For Conductor	
1.	Resistance test	
	For Armour Wires / Formed Wires (If applicable)	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	
5.	Torsion test	For round wire only
6.	Wrapping test	For aluminium wires / formed wires only.
7.	Resistance test	
8(a).	Mass of zinc Coating test	For GS wires/formed wires only
8(b).	Uniformity of zinc coating	For GS wires/formed wires only
9.	Adhesion test	For GS wires/formed wires only
	For PVC insulation & PVC Sheath	

S. No.	Type Test	Remarks
10.	Test for thickness	
11.	Tensile strength and elongation test	before ageing and after ageing
12.	Ageing in air oven	
13.	Loss of mass test	For PVC insulation and sheath only
14.	Hot deformation test	For PVC insulation and sheath only
15.	Heat shock test	For PVC insulation and sheath only
16.	Shrinkage test	
17.	Thermal stability test	For PVC insulation and sheath only
18.	Oxygen index test	For outer sheath only
19.	Smoke density test	For outer sheath only
20.	Acid gas generation test	For outer sheath only
	For completed cables	
21.	Insulation resistance test(Volume resistivity method)	
22.	High voltage test	
23.	Flammability test as per IEC-332 Part-3 (Category-B)	

INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the given Table A.

TABLE A: CABLE TERMINATION TO BE FOLLOWED

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Valves/dampers drives (Integral Junction box)	Marshalling / Marshalling – cum Termination Cubicle / local group JB	Plug in connector	Post mount cage clamp type.	G
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction box of LIE/LIR	Plug in connector	Cage clamp (Rail mount) type.	F,G
RTD heads	Local junction box	Plug in connector	Cage clamp (Rail mount) type.	F
Thermocouple	Local junction box / CJC box (if applicable)	Plug in connector	Cage clamp (Rail mount) type.	A, B, C*
Other Field mounted Instrument	Local JB / Group JB	Plug in connector	Cage clamp (Rail mount) type.	F,G
RTD	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	F
Thermocouple	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	A, B, C*
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/ MCC/SWGR	Group JB	Cage clamp (Rail mount) type.	Cage clamp (Rail mount) type.	F,G
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/ Group JB / MCC/SWGR	Marshalling / Marshalling – cum Termination Cubicle	Cage clamp (Rail mount) type.	Cage clamp (Post mounted) type.	F,G
Marshalling cubicle/ Termination Cabinet	Electronic system cabinet	Cage clamp (Post mounted) type.	Plug-in connector / other system as per Mfr.'s Standard	Internal wiring

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Marshalling/ Termination System Cabinets	UCD mounted equipments	Cage clamp (Post mounted) type.	Plug in connector / Cage clamp type (rail mounted).	F,G (with plug-in connect or at one end)
DDCMIS/PLC cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Mfr.'s Standar d

Notes:

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs, except for pre-fabricated cables which shall be as per manufacturer's standard.
2. For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
3. * For high temperature applications only.
4. For connection between field/JB and DDCMIS marshalling cabinet Minimum 4 pair instrumentation cable shall be used.
5. All the spare cores of instrumentation cable have to be terminated in Marshalling cabinets/ DCS panel end.
6. Not used.

TERMINAL BLOCKS:

Terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg.

The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Employer's approval.

All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, transparent covers, support brackets, distance sleeves, warning label, marking, etc.

The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function.

Engraved labels shall be provided on the terminal blocks.

The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.

INTERNAL PANELS/ SYSTEM CABINETS WIRING

Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.

All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferrules at both ends. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.

All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.

All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.

All the special tools as may be required for solder less connections shall be provided by Bidder.

Wire sizes to be utilised for internal wiring.

(i) Current (4-20 mA), low voltage signals (48V);
Ammeter/Voltmeter circuit, control switches etc.
for electrical system.

0.5 Sq.mm.

(ii) Power supply and internal illumination.

2.5Sq.mm. minimum (shall be as per load requirement).

INSTRUMENTATION CABLE INSTALLATION AND ROUTING

All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Employer.

Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows:

From 11 kV/6.6 kV/3.3 kV tray system	- 914 mm
From 415V tray system	- 610 mm
From control cable tray system	- 305 mm

Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Compression cable glands (double for armoured and single for other cables) shall be provided.

The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipment's/devices shall be in accordance with IEEE-Std-422.

CABLE LAYING AND ACCESSORIES

CABLE LAYING

1 Cables shall be laid strictly in line with cable schedule.

2 Identification tags for cables.

Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.

3 Cable tray numbering and marking.

To be provided at every 10m and at each end of cable way & branch connection.

4 No jointing is permissible for Instrumentation cables. For other cables jointing for more than 250 Meters run of cable shall be permitted.

5 Buried cable protection

With concrete slabs; Route markers at every 20 Meters along the route & at every bend.

6 Segregation (physical isolation to prevent fire jumping)

All cable associated with the unit shall be segregated from cables of other Units.

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire.

7 Cable clamping

All cables laid on trays shall be neatly dressed up & suitably clamped/tied to the tray. For cables in trefoil formation, trefoil clamps shall be provided.

SECTION – 2

ANNEXURE-10

GENERAL PROJECT INFORMATION

2.0 GENERAL PROJECT INFORMATION

1	Owner / Purchaser	NLC Tamil Nadu Power Limited (NTPL) (A Joint Venture Between NLC INDIA LIMITED and Tamil Nadu Electricity Board)
2	Project Name	NTPL Tuticorin Thermal Power Project
3	Capacity and Configuration	1000 MW [2 x 500 MW]
4	Owner's Consultant	Development Consultants Private Limited
5	Geographical Location	Latitude 8 ^o 45'38.09"North Longitude 78 ^o 10'15.85"East At Tuticorin Taluk in Tuticorin district in the Southern Part of Tamil Nadu along the Bay of Munnar, India
6	Access to site	
6.1	Nearest Airport	Nearest airstrip is located at Pudukottai at a distance of 16.5 km
6.2	Nearest port	Tuticorin sea port is located adjacent to the plant.
6.3	Nearest Railway Station	The nearest railway station is Port Trust Railway Yard at a distance of 1.0 km
6.4	Nearest Town	Nearest town is Tuticorin, which is located 5.5 km away from the plant and nearest city is Pallayamkottai, away from 60 km from the plant.
6.5	Nearest Highway	National Highway No. 7A adjacent to plant
7	Meteorological data	
7.1	Site Elevation	The natural land profile of the site 1.46 m above mean sea level
7.2	Ambient Temperature DBT	
i.	Maximum DBT	36.5 °C



Tender Specification
for
FGD Package

NLC Tamil Nadu Power Ltd.
2x500 MW Project
Tuticorin, Tamil Nadu

ii.	Minimum DBT	20.8 °C
iii.	Performance DBT	27 °C
7.3	RELATIVE HUMIDITY	
i.	Maximum	82 %
ii.	Minimum	35 %
iii.	Performance	50%
7.4	Earthquake Zone	Zone II
7.5	Predominant Wind direction	East to West
7.6	Wind velocity	Civil/structural design will be done considering IS 875 part 3
7.7	Rainfall	
i.	Annual	437 mm
7.8	Availability of Raw Water	Main source of water of the plant is sea water, which shall be taken from the Bay of Munnar.

Project Name :ENQ/ NIT No: _____(Vendor to fill & submit along with offer)

LIST OF DEVIATIONS/ EXCEPTIONS (IF ANY, vendor to fill and submit along with offer)

Sl No	Clause No	Page No	Description of Deviation

Note: Enlarge the table to incorporate items

SIGNATURE OF BIDDER -----

NAME -----

DESIGNATION -----

Class I items

S. no.	Item/System Description	Category I	Category II
a).	Technological Items		
1	Limestone Crusher	Larsen & Toubro	Sandvik Asia Pvt. Ltd.
		Elecon engineering co. ltd.	Terrasourse global corp
		Thyssenkrupp Industries India Pvt. Ltd.	ECOMANN
		MCNALLY BHARAT	McNally sayaji eng ltd.
		TRF	
2	Bucket Elevator	AUMUND Engineering Private Limited	Masyc Project
		Schenck Process Solutions India Pvt Ltd	Ardee Engineering Company
		Bevcon Wayors	Mahindra Tsubaki Conveyor Systems Pvt. Ltd.
			Cobit Engineering Pvt Ltd
			SAIKRUPA CONVEYORS PVT LTD
			Nestler Protec (india) Ltd.
3	Wet Ball Mills	FLSmidth	Cemtec
		Metso Minerals	Christian Pfeiffer
		Fam	Zhejiang tuna environmental science & technology co., ltd
		METSO	JINAN HEAVY MACHINERY
		L&T	CEMET
		ThyssenKrupp	JHMC-CHINA
			PFEIFFER,
			KHD
			TKII
			CECO ENVIRONMENTAL
	TUNA		
4	Flue Gas Booster fans	BHEL	CHENGDU TLT
		TLT-Turbo India (Pvt.) Ltd	SHANGHAI FANS
		L&T HOWDEN	BOLDROORCHI
			CLARAGETT
			FAWENT
			HUBEI SANFENG TURBINE EQUIPMENT CO., LTD.
	SHANGHAI BLOWER WORKS		
5	Absorbers	BHEL	
		BGRE	
6	Oxidation Air Compressors	ITO Engineering	Euro Enterprises Ltd
		Howden	Boldrocchi India Pvt Ltd

NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
		Aerzen Machines	Jiangsu Jintongling Fluid Machinery Technology Co. Ltd
		Kay International	ELGI EQUIPMENTS LTD
		Swam Pneumatics Pvt. Ltd	INGERSOLL- RAND (INDIA) LTD.
		ATLAS COPCO (INDIA) LTD.	
7	All types of Limestone and Gypsum Slurry Pumps	DuchtingPumpen	XiangyangWuerWu
		KSB	Krebs
		Weir Minerals	Flowcon Engineer India Private Limited
		Andritz	Shijiazhuang Kingda Pump Industry Group Co. Ltd
		Metso Minerals	EXCELLENCE PUMP INDUSTRY CO., LTD
		Mitsubishi Heavy Industries Ltd	XIANGYANG WUERWU PUMP INDUSTRY CO., LTD
			GIW INDUSTRIES, INC.
			SHIJIAZHUANG SUNBO PUMP CO., LTD
			HONSTAR SLURRY PUMP CO., LTD
			MASCHINENFABRIK GMBH & CO. KG
			HUBEI SANFENG TURBINE EQUIPMENT CO., LTD.
			SHIJIAZHUANG INDUSTRIAL PUMP FACTORY CO., LTD
			LIUZHOU ACID KING PUMP MANUFACTURE CO., LTD
			SHIJIAZHUANG BODA INDUSTRIAL PUMP CO. LTD., CHINA
			ALIAxis
8	Ball charging devices	FLSmidth	Cemtec
		Metso Minerals	Christian Pfeiffer
		ThyssenKrupp	Zhejiang tuna environmental science & technology co., ltd
		Fam	JINAN HEAVY MACHINERY
		METSO	CEMET
		L&T	JHMC-CHINA
			PFEIFFER,
			KHD
			TKII
			CECO ENVIRONMENTAL
			TUNA

NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
9	All types of Hydrocyclones		Shanghai Xuhe Environmental Equipment Co. Ltd
			AKW
			Weir Minerals
			Multotech
			Flsmidth
			BEIJING HUADE CREATION ENVIRONMENTAL PROTECTION EQUIPMENT CO.,LTD
			SHANGHAI AKW SEPARATION PROCESS EQUIPMENT CO.,LTD
10	Vacuum Belt filter	FLSmidth Minerals	Shanghai Xuhe Environmental Equipment Co. Ltd,
		TenovaDelkor	Westech
		Thyssenkrupp	Zhejiang tuna environmental science & technology co., ltd
		Eimco KCP	HAIWANG, CHINA.
		ANDRITZ	TENOVA
			BHS-SONTHOFEN GMBH
			AKW APPARATE + VERFAHREN GMBH
			DIM GMBH
			ENVAG
			TUNA
			HENAN JINCHENG FILTER EQUIPMENT CO.,LTD
			QINGDAO HESHENG
			YANTAI SUNNY HEXING ENVIRONMENT PROTECTION EQUIPMENT CO., LTD.
			THE EIMCO-KCP LTD
	SHANGHAI ASahi AND ENVIRONMENTAL ENGINEERING CO., LTD		
	YANTAI SUNNY RUBBER CO., LTD		
11	All types water, waste water and filtrate pumps	Voltas Limited	SAP Turbo Industry Pvt Ltd
		Flowmore Limited	Tap Turbo Engineers Pvt Ltd
		SAM TURBO	MAXFLOW
		FLOWSERVE	KISHORE PUMPS
		MATHER & PLATT	SINTECH PRECISION PRODUCT LTD.
		WPIL	V-Flo Pumps & Systems Co. Ltd.,
		KBL	
		KSB	



NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
		SULZER	
		VARAT PUMPS	
		BEACON WEIR	
12	Waste water treatment system components	Ion Exchange Ltd.	Aqua Engineers & Consultants India Pvt Ltd.
		BGR ENERGY SYSTEMS LIMITED, CHENNAI	Aquatech Engineers Limited
			Arvind Envisol Ltd
			Clear water Ltd
13	Seal Air Fans	Swam Pneumatics Pvt. Ltd.	Patels Airflow Ltd.
		Boldrocchi India Pvt Ltd	Nadi Technologies Pvt Ltd.
			VacunairEngg. Co. Pvt. Ltd
			Draft Air India Pvt Ltd
			Laxmi Engineering Work
			Air Control & Chemical Engineering Co. Ltd
			Everest Blowers Pvt Ltd
			Kulkarni Power Tools Ltd
			INDIRA INDUSTRIES
			EFFOX FLEXTOR
			BALTEC
			HMT
			AFT
14	Mist Eliminator		Koch Chemical Technology Group India Pvt Ltd
			RPT Rea Plastik Tech Gmbh
			Zhejiang Tuna Environmental Science & Technology Co., Ltd
			SHANGHAI GEHOPE ENVIRONMENTAL PROTECTION CO., LTD
			SHENZHEN WANATONE INDUSTRY CO.,LTD
			MUNTERS AIR TREATMENT EQUIPMENT (BEIJING) CO LTD
			DEMISTER(SHANGHAI) ENVIRONMENTAL TECHNOLOGY CO.,LTD
			SHANGHAI CHERO GAS TREATMENT CO., LTD.
15	Vibration Isolation System	GERB INDIA	



NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
b).	Air Conditioning & Ventilation System		
1	Air Conditioning System	VOLTAS LIMITED	EMERSON NETWORK POWER (I) PVT.LTD., BANGALORE
		BLUE STAR LTD, COCHIN	BATLIBOI LTD.,
		ADVANCE VENTILATION PVT LTD.,	SK SYSTEMS PRIVATE LIMITED
		STERLING AND WILSON PRIVATE LIMITED	ANAGHA & ASSOCIATES
		BGR ENERGY SYSTEMS LIMITED, CHENNAI	TRAC FUJICO AIR SYSTEMS LIMITED
		CARRIER AIRCONDITIONING & REFRIGERATION LTD	APC AIR SYSTEMS PVT LTD
			DHRUVA THARE AIR CONDITIONING
			GLOBAL ENVIRO AIR SYSTEM PVT LTD.,
			GODREJ & BOYCE MFG. CO., LTD.,
			GENTECH ENGINEERING SERVICES
			PACK PLAST INDUSTRIES
			INDUSTRIAL PROJECT & PRODUCTS CO.
			ROOTS COOLING SYSTEMS PVT. LTD.
2	Ventilation System	ABB LIMITED	MESINA, MUMBAI
		BATLIBOI LTD.,	JAYPEE ENGINEERING WORKS, KOLKATA
		SK SYSTEMS PRIVATE LIMITED	SPRAYING SYSTEMS INDIA PVT., LTD.,
		A.P.C. SYSTEMS & PRODUCTS PVT.LTD	TRAC FUJICO AIR SYSTEMS LIMITED
		ROOTS COOLING SYSTEM PVT LTD	APC AIR SYSTEMS PVT LTD

NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
		ADVANCE VENTILATION PVT LTD.,	GLOBAL ENVIRO AIR SYSTEM PVT LTD.,
		GEMINISHREEWAS (ENGRS) P. LTD	GENTECH ENGINEERING SERVICES
		DUSTVEN PVT.LTD.	PACK PLAST INSDUSTRIES.
		AEROVENT	DUSTECH ENGINEERS PVT LTD.,
		BLUE STAR, MUMBAI	WOLLAQUE VENTILATION AND CONDITIONING PVT LTD.
		HYDERABAD POLLUTION CONTROLS, HYDERABAD	TAP ENGINEERING
		BGR ENERGY SYSTEMS LIMITED, CHENNAI	SPACE HEATING
		INDVENT FANS PRIVATE LTD.,	NADI
		SUBURBAN INDUSTRIAL	DUSTECH
		VOLTAS, MUMBAI	IDMC, ANAND
		STERLING & WILSON, KOLKATA	ETA ENGG, BANGALORE
		ROOTS COOLING SYSTEMS	ADVANCE VENTILATION, DELHI
			AIRLINK
			SK SYSTEMS, DELHI
			ADROIT
c).	Handling & Hoisting		
1	Elevators	ECE Industries Ltd	Mangla Hoists Private Limited
		KONE Elevator India Pvt Ltd	Alikraft Engineers Pvt Ltd
		Techno Industries	AlimakHek India Pvt. Ltd,
		Mitsubishi Electric Corporation India	International Sales Dept (Xel) Hitachi Ltd
		KONE	AlimakHek Group AB
		THYSSEN KRUPP	Cooper Elevators India Pvt. Ltd.
		JOHNSON	METRO
		OTIS	UT LIFTS
2	Double Girder EOT Cranes	Lifting Equipment and Accessories	Hercules Hoist
		FAFECO, VADODARA/MUMBAI	Consolidated Hoist
		UNIQUE	Power build
		CENTURY CRANES	Grip Engineering Pvt Ltd
		REVA INDUSTRIES	Amsel MHE Pvt Ltd
		GRIP ENGINEERS	Techno Industries

NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
		EDDY CRANES ENGG	Universal Hoist
		MUKAND, THANE	TRACTEL TRIFOR INDIA (P) LTD
		ANUPAM	ELECTROMECH
			TUOBRO FURGUSON INDIA PVT. LTD
			SAFEX
			AVON CRANES
			TISCO GROWTH
			MILLARS
			ALPHA SERVICES
			DEMAG
			BRADY & MORRIS
			ACME
3	Single Girder Underslung Crane/EOT crane	Lifting Equipment and Accessories	Hercules Hoist
		FAFECO, VADODARA/MUMBAI	Consolidated Hoist
		MUKAND, THANE	Power build
		GRIP ENGINEERS	Grip Engineering Pvt Ltd
		EDDY CRANES ENGG	Amsel MHE Pvt Ltd
		ALPHA SERVICES	Techno Industries
		DEMAG	Universal Hoist
		ANUPAM	Alpha Services
		UNIQUE	Mangla Hoists Pvt Ltd
		REVA INDUSTRIES	Universal Hoist-O-Fabrik
		TUOBRO FURGUSON INDIA PVT. LTD	TRACTEL TRIFOR INDIA (P) LTD
			CENTURY CRANES
			ELECTROMECH
			SAFEX
			AVON CRANES
			TISCO GROWTH
			MILLARS
			BRADY & MORRIS
			ACME
d).	DG Set		
1	DG Set Assemblers	Sterling Generators Pvt Ltd, Silvasa	Supernova Engineers Ltd, Rajpur
		BHEL Electrical Machines, Kasargod	Absotherm Services P Ltd., Mumbai

NTPL FGD_Mech_Sub vendor List

Class I items

S. no.	Item/System Description	Category I	Category II
		Powerica Ltd, Silvasa	Apollo Power Systems Pvt. Ltd., Bangalore
		Jakson Ltd, Kathua	CLLS, Singapore
		GMMCO Ltd (Caterpillar), Bangalore	G D Anklesaria & Co. Ratlam, MP
		Caterpillar, Hosur	MODI Mirrless Delhi / Bangalore
		Kirloskar Oil Engines Ltd, Bangalore	Kohler, Singapore
		CUMMINS - POWERICA/SUDHIR/JAKSON	Sudhir Gensets Ltd, Delhi (Cummins), New Delhi
		CATTER PILLAR – GMMCO	TIL, Ghaziabad
		KIRLOSKAR – GENLITE	Trading Engineers (International) Limited, New Delhi
			Trans Generators Pvt. Ltd., Bangalore
			Triangle Agencies& Sales Pvt Ltd, Bangalore
			Universal Generator (Greaves Ltd.), Bangalore
			Vijay Power Systems, Bangalore
			Wartsila NSD India Ltd, Bangalore
			PERKINS - STERLING WILSON
			MAHINDRA - SUNPOWER

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
a).	Technological Items		
1	Flue Gas Dampers / Gates	BHEL	BEIJING HUADE CREATION ENVIRONMENTAL PROTECTION EQUIPMENT CO.,LTD
			FOURESS ENGINEERING (INDIA) PVT. LIMITED
			BALTEC IES PTY LTD
2	Air and Flue Gas Ducting	BHEL	
		BGRE	
3	Belt Weighers	POWER BUILD, LIMITED	THERMO RAMSAY, AUSTRALIA
		SCHENCK PROCESS INDIA LIMITED	AVERY INDIA LTD., NEW DELHI
		SCHENK	INDUS CONTROL & AUTOMATION PVT.LTD., BANGALORE
			KLISTER MORSE AUTOMATION LTD
			TRANSWEIGH NSWEIGH
			RAMSAY
4	Weigh Belt feeders	SCHENK	ZHEJIANG TUNA ENVIRONMENTAL SCIENCE & TECHNOLOGY CO., LTD- China
		THYSSENKRUPP INDUSTRIES INDIA PVT LTD- Pune	CEMTEC CEMENT AND MINING TECHNOLOGY GMBH-Austria
			CEMTEC INDIA PVT LTD-Kolkata
			TRANSWEIGH
			RAMSAY
5	Dust Extraction system	F. HARLEY	A.P.C. SYSTEMS & PRODUCTS PVT .LTD.,
		REICO	BATLIBOI ENVIRONMENTAL ENGG LTD.,
		DUSTVEN PVT .LTD., BANGALORE	CK AIRTECH INDIA PVT. LTD.,
		AEROVENT	DURAG INDIA INSTRUMENTATION PVT. LTD.,
			NEVCO ENGINEERS PVT LTD.,
			BEVCON WAYORS PVT LTD
			APC AIR SYSTEMS PVT LTD

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
			GLOBAL ENVIRO AIR SYSTEM PVT LTD.,
			INDVENT FANS PRIVATE LTD.,
			CLAIR ENGINEERS PVT LTD.,
			APC SYSTEM
			WRC
6	Diesel engine	CUMMINS	MTU
		CATERPILLAR	PERKINS
		MITSHUBISHI	VOLVO PENTA
		KIRLOSKAR	KOHLER
		GREAVES	KOEL
7	Slurry Tanks	BHEL	
		BGR ENERGY SYSTEMS LIMITED, CHENNAI	
8	Misc. Tanks	BHEL	
		BGR ENERGY SYSTEMS LIMITED, CHENNAI	
9	Ball Valves	Bharat Heavy Electricals Limited	Upadhaya Valves Manufacturers Pvt Ltd
		FouressEngg. (I) Pvt. Ltd	Surmount Enterprises
		Larsen & Tubro Ltd	VarunaEngg Co
		Av Valves Ltd	Ashwathi Controls Pvt. Ltd.
		Dembla Valves Ltd.	Zed Valves Co.Pvt. Ltd.
		MICRO FINISH	GM Engineering Private Limited
		Weir BDK Valves	M/S Brosco Valves Pvt Ltd
		R&D MULTIPLES	Hi-Tec Valves
		FISHER XOMOX	Micon Valves (India) Pvt Ltd
		VENUS	Mascot Valves Pvt Ltd
		LEVCON	SAP Industries Ltd
		OSWAL INDUSTRIES	Kismet Industries
		PRECISION ENGG	Rajeev And Company
		LEADER	Vamaja Agencies
		ADVANCE	Canle Valves Private Limited
		H.SARKAR	Voltech Manufacturing Company Ltd
MICON VALVES	Audco India Limited		

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
			Flocon Systems Pvt. Ltd
			Uniflow Control Instruments Pvt Ltd
			Sigma Industries
			Propel Valves & Private Ltd.
			Delval Flow Controls Pvt Ltd
			Virgo Valves & Controls Private Limited
			Microfinish Valves Pvt Ltd
			BDK
			Inter valve Poonawalla Ltd
			Bray Controls India Private Limited
			FLOW CHEM
			HAWA VALVES
			CHEMTECH
			STEEL STRONG
10	Butterfly Valves	Tyco valves	Gm engineering
		Weir bdk valves	Aira euro automation
		Intervalvepoonawalla ltd	Sigma valves
			Aswati controls
		Kirloskar brothers limited	Crane process flow technology (i) ltd.,
		Delval flow controls pvt ltd,	Microfinish valves pvt ltd
		FOURESS	Sigma industries
		L&T	Gm engineering private limited
		IL, PALGHAT	Mascot valves pvt ltd
		R&D MULTIPLES	Bray controls india private limited
		ADVANCE VALVES	Kamala valves & engineering works
		HAWA VALVES	Sap industries ltd
		INTERVALVE	Stafford controls limited
			Canle valves private limited
			Orbinoxindia private limited
			Sewvac india
			Aliaxis utilities & industry pvt ltd
	Astral indiapvt ltd.		
	Georg fischer piping systems (switzerland) ltd		

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
			Georg fischer piping systems pvt ltd
			Aircon handling systems pvt ltd
			Dembla valves ltd.,
			PROCESS CONTROL
			PROCON
			BDK
			AUDCO
			CRANE PROCESS FLOW
			KEYSTONE
			EBRO ARMATUREN,
			AFT
			NOPA VALVES
11	Gate/Globe/ Non Return Valves	Bankim valves	Leader
		H.Sarkar co	A.v valve
		Weir BDK	Surmount enterprise
		KBL	Varunaengg co.
		Leader valves limited	Hind metal work
		Av valves ltd	Skilt fabricators pvt ltd.
		Weir bdk valves a unit of weir indiapvt ltd	Zed valves co.pvt. Ltd
		WEIR BDK VALVES, HUBLI	Gm engineering private limited
		LARSEN & TOUBRO LTD, COIMBATORE	M/s broscos valves pvt It
		KSB PUMPS LTD.,COIMBATORE	Thorat valves pvt ltd
		NITON VALVE INDUSTRIES (P) LTD, MUMBAI	Voltech manufacturing company ltd
		FOURESS ENGINEERING (INDIA) LTD, AURANGABAD	Galaxy controls private ltd
		OSWAL INDUSTRIES LIMITED,GANDHINAGR	Punjab metal works
		VELAN INC, CANADA	Joshijampala engineering pvt ltd
		TYCO VALVES	Mascot valves pvt ltd
		FOURESS	Kamala valves & engineering works
		L&T	Pee industrial valves private limited
IL, PALGHAT	Sap industries ltd		
R&D MULTIPLES	Integrated equipment(i) pvt ltd		

BD

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
		KBL	Integral process controls india private limited
		DEMBLA VALVES	Canle valves private limited
		ADVANCE VALVES	DI valve private limited
		HAWA VALVES	Lehry instrumentation & valves pvt. Ltd
		INTERVALVE	Aparudyog
		BDK	Sant valves private limited
		MICON VALVES	Atam valves private limited
			V.k.valves private limited.
			NSSL LIMITED, NAGPUR
			MEIWA CORPORATION(TOA VALVES), JAPAN
			BABCOCK VALVES, SPAIN
			WEIR VALVES & CONTROLS UK LTD, UK
			HP VALVES OLDENZAAL B.V., THE NETHERLANDS
			KOKUSAI COMMERCE CO.LTD., JAPAN
			Flowserve Edward valves
			Alloy Valve Stockist, Spain.
			KUMWOO , KOREA
			STEEL STRONG VALVES (I) P.LTD, MUMBAI
			KSB MIL CONTROLS LIMITED, THRISSUR
			PROVALVE Armaturen GmbH & Co. KG /GERMANY
			PROCESS CONTROL
			PROCON
			CHEMTECH,
			HAWA ENGINEERS,
			VENUS VALVES
			EBRO ARMATUREN,
			AFT
			NOPA VALVES
			FISHER XOMOX
			LEVCON
			VENUS
			PRECISION ENGG
			STEEL STRONG
		D.WREN INDUSTRIES.	Vetri elastomeric engineers

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
12	Rubber Expansion Joints	CORI	J.k.fenner (india) limited
		SRM EXOFLEX	Sundaram industries private limited
			Lakhotia enterprise
			R k rubber products
			Rubber products
			AB Conveyors Pvt Ltd
			IGP
			MADRAS INDUSTRIES LIMITED (MIL)
			DIENS FLEXO
13	Safety Valve	Leader Valves Limited	Kracht GMBH
			VarunaEngg Co.
			Brosco Valves Pvt Ltd
			LEADER ENGG.
			SPIRAX MARSHALL FISHER SANMAR
14	Piping	SAIL	
		JINDAL INDUSTRIES	ASIAN MILLS, AHMEDABAD
		WELSPUN	ADVANCE STEEL TUBES
		JINDAL SAW	PSL
		MAHARASHTRA SEAMLESS	SURYA ROSHINI
		ISMT	MUKAT PIPES
		TISCO	JCO PIPE
			INDUS PIPES
			DADU PIPES
			JINDAL PIPES LTD
			ASIAN TUBES LTD
			MAN INDUSTRIES
			SHRIRAM SEPL, CHENNAI
			EPP COMPOSITE, RAJOKOT
			GRAPHITE INDIA, NASIK
			EXTRACO COMPOSITES
			PACIFIC PIPES, AHMEDABAD
			AMIANITIT FIBER GLASS, GOA
			KEMROCK, BARODA
			MEGHA FIBER GLASS, HYDERABAD
	RATNAMANI		
	HEAVY METAL TUBES		
	PRAKASH STEELAGE		
	RAJENDRA MECHANICAL WORKS (REMI)		
	SANDVIK		

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
15	Agitators	EKATO RUHR UND MISCHTECHNIK GMBH	Remi Process Plant And Machinery Ltd
		REMI	Zhejiang Greatwall Mixers Co Ltd
		MUT-TSCHAMBER	ECMI Technical Services Pvt Ltd
			CEECONS PROCESS
			MECON ENGG.
			SJ INDUSTRIES
			FIBRE & FIBRE PRODUCTS
			AGRO ALLIED
			TECHWAY ENGINEERS
			POSITIVE METERING
			REDOR
	STAMO		
		ZHEJIANG GREATWALL MIXERS CO., LTD	
16	Sump Pumps	KSB	XiangyangWuerWu
		KISHORE	Metso Minerals
		VARAT	Krebs
		FLOWMORE	Flowcon Engineer India Private Limited
		KBL	Shijiazhuang Kingda Pump Industry Group Co. Ltd
		SU MOTORS	SINTECH PUMPS
		Weir Minerals	AQUA MACHINERIES
		Andritz	SAM INDUSTRIAL PUMPS
		DuchtingPumpen	
		Mitsubishi Heavy Industries Ltd	
18	Air Release Valves	Leader Valves Limited	Kracht GMBH
		R & D MULTIPLES(METAL CAST) PVT.LTD	VarunaEngg Co.
		FOURESS ENGINEERING (INDIA) LIMITED	Brosco Valves Pvt Ltd
		A.V.VALVES LTD	VENUS VALVES & ENGINEERING WORKS
19	Aluminium sheet	Bharat Aluminium Co Ltd.,	Chongqing LanrenAluminium Co Ltd
		Hindalco Industries Limited	Eival SA
		Jindal Aluminium Ltd	Tianjin Huali Thermal Insulation Building Material Co Ltd
		National Aluminium Co. Ltd.,	Indocean Engineers
20	Thermal Insulation	Lloyd Insulation	Minsulate Mfg. Co
		Rockwool Industries	Dhanbad Rockwool
		Minwool Rock fibres Ltd.	Hitech Rockwool Fibre
		Lapinus Rockwool Ltd	

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
		Punjstar (PIFCO)	
		GoenkaRockwoolLapinus Rockwool Ltd	
		Goenka Rockwool	
		Rockwool India Ltd	
		Thermocare Rockwool	
		Polyband Projects	
		ShreeramEquitech	
		Roxul Rockwool Insulation	
		21	Welding electrodes
Mailam India Limited	B.R.Kumar& Sons		
D & H India Limited,	Essen Engineers		
Honavar Electrodes Private Limited	S.D.K. Electricals		
Ador Welding Limited	Welspring Universal		
	A.F.Noman& Co		
	D & H Secheron Electrodes Pvt.		
	Fusion Engineering Product Ltd		
	Voltarc Electrodes Pvt Ltd		
	MantekElectrods Private Limited		
	Maruthi Electrodes Pvt. Ltd.,		
	Royal Arc Electrodes Limited		
	Sundeeep Electrodes Pvt Ltd.,		
	Royal Welding Wires Pvt Ltd		
	Malu Electrodes Pvt Ltd		
	MagnarcPvt Ltd		
	Vijey Electrodes And Wires Pvt Ltd		
b).	Handling and Hoisting		
1	Electric Hoists	Hercules Hoist	Power build
		Consolidated Hoist	Techno Industries
		Lifting Equipment and Accessories	Mangla Hoists Pvt Ltd
		Grip Engineering Pvt Ltd	ELECTROMECH
		INDEF (HERCULES)	Amsel MHE Pvt Ltd
		Alpha Services	BATLIBOI
		BRADY & MORRIS ENGINEERING CO. LTD.	ARMSSELL
		REVA INDUSTRIES LTD.	ALPHA SERVICES
	TRACTEL TIRFOR INDIA PVT. LTD.	UNICON	

NTPL FGD_Mech_Sub vendor List

Class II items

S. no.	Item/System Description	Category I	Category II
		Universal Hoist-O-Fabrik	ELECTRO THERAPY
		CENTURY CRANE ENGINEERS PVT. LTD.	
		EDDY CRANES PVT. LTD.	
		HITECH INDUSTRIES	
		GREAVES	
		GRIP ENGINEERS	
		AVON CRANE	
		DEMAG	
		Universal Hoist	
2	Manual Hoists	Armsel MHE Pvt. Ltd.	Transpade Engineers Pvt. Ltd.
		Tractel Tirfor India Pvt. Ltd.	Mangla hoists pvt. Ltd.
		Century crane engineers pvt. Ltd.	
		Consolidated hoists pvt. Ltd.	
		Reva Industries Ltd.	
		Eddy cranes Engineers pvt. Ltd.	
		Hercules hoist Ltd.	
		Tuobro Furguson (India) Pvt. Ltd.	
		Grip Engioneers Pvt. Ltd.	
c).	Ventilation and Air conditioning		
1	Split Air Conditioner/Pack age air conditioner.	VOLTAS Ltd.	ADVANCE VENTILATION PVT.LTDV.T.LTD.
		CARRIER	INDUSTRIAL PROJECT & PRODUCTS CO.
		BLUE STAR	ROOTS COOLING SYSTEMS PVT. LTD.
		HITACHI	STERLING AND WILSON PRIVATE LIMITED
		LG	Pack plast Industries
		SAMSUNG	S. K. Systems Pvt. Ltd.
			Tap Engineering
			STULZ
			EMERSON
			SCHNEIDER/UNIFLAI
			CLIMARENETA

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NTPL FGD_Electrical Sub-vendor List

Class I items:

Sl. No	Item Description	Cat 1	Cat 2
1.	63MVA, 220/11KV FGD Transformer	<ul style="list-style-type: none"> • ABB • BHEL • GE T&D • SIEMENS • TELK • TOSHIBA, INDIA 	<ul style="list-style-type: none"> • BIAODING, CHINA • CGL • DANISH PRIVATE LIMITED • EMCO LIMITED • ESENNAR TRANSFORMERS (P) LTD. • HYUNDAI, S.KOREA • ILJIN TRANSFORMERS • KANO HAR ELECTRICALS LTD. • KIRLOSKAR ELECTRIC CO.LTD. • KRYFS POWER COMPONENTS LTD. • MARSONS LIMITED • SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED • SEPCO, CHINA • SHANDONG , CHINA • SOUTHERN POWER EQUIPMENT COMPANY PVT. LTD. • T&R (INDIA) LTD. • TESLA TRANSFORMERS LTD., • UNIVERSAL POWER TRANSFORMERS PVT. LTD., • VOLTAMP TRANSFORMERS LTD. • XIAN, CHINA • TBEA, INDIA
2.	Auxiliary Transformers (Oil Filled)	<ul style="list-style-type: none"> • Andrew Yule • BHEL • CGL • GE • GE Prolec • KIRLOSKAR • SCHNEIDER • TOSHIBA • VOLTAMP 	<ul style="list-style-type: none"> • DANISH PRIVATE LIMITED • ESENNAR • HYOSUNG • KANO HAR ELECTRICALS LTD. • KRYFS Power Components Ltd • Raychem RPG • Shree Abirami Electricals • Telawne • Tesla Transformers Ltd., • TRANSFORMERS (P) LTD • Voltech
3.	415 V Switchgear (PCC/PMCC/ MCC)	<ul style="list-style-type: none"> • ABB • BHEL • C&S ELECTRIC • GE POWER • GE-T&D • L&T • SCHNEIDER • SIEMENS 	<ul style="list-style-type: none"> • Alstom • Areva T&D • CONTROL & SCHEMATICS • Crompton Greaves Limited • NITYA ELECTRO CONTROLS • Toshiba • VENUS • VOLTECH MANUFACTURING LIMITED



NTPL FGD_Electrical Sub-vendor List

4.	ACB	<ul style="list-style-type: none"> • ABB • ALSTOM • BHEL • C&S ELECTRIC • CGL • GE-POWER • GE-T&D • L&T • SCHNEIDER • SIEMENS 	
5.	Auxiliary Relays	<ul style="list-style-type: none"> • ABB • ALSTOM • C & S Electric • GE • JYOTHI LTD • L&T • SCHNEIDER • SIEMENS 	<ul style="list-style-type: none"> • BCH • GEC • JVS • VOLTECH
6.	Battery Charger (FC/FCBC)	<ul style="list-style-type: none"> • AMARARAJA • CALDYNE • CHHABI • CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED • DUBAS • HBL - NIFE • HBL POWER SYSTEMS LTD • MASS-TECH CONTROLS PVT.LTD • EMERSON NETWORK POWER • Vertiv Energy Private Limited 	<ul style="list-style-type: none"> • AMCO • ENERPAC • MASS-TECH • EXIDE • HOPPECKE, GERMANY • MMAX • ENGINEERS • ELTECH • SABNIFE • STATCON POWER SYSTEMS & SOLUTIONS
7.	Electrical Actuators	<ul style="list-style-type: none"> • ANTRIEB • AUMA (India) • LIMITORQUE • ROTORK CONTROLS LTD 	
8.	Electro Mechanical Relays	<ul style="list-style-type: none"> • ABB • ALSTOM • C & S Electric • EASUN REYRALLE • GE • JYOTI RE-300 • L&T • SCHNEIDER • SIEMENS 	<ul style="list-style-type: none"> • ALLEN BRADELY • GEC • JVS • OMRON • PARAMOUND
9.	H.T. Motors	<ul style="list-style-type: none"> • ABB • BHEL • CROMPTON GREAVES • KEC • MARATHON (ALSTOM) • SIEMENS • TMEIC 	<ul style="list-style-type: none"> • BBL • ELJIN • HUNDAI • HYOSUNG • IJLIN • JEUMOUNT ELECTRIC • LHP

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • WEG INDIA LTD 	<ul style="list-style-type: none"> • NANYANG EXPLOSION • SHANGAI ELECTRIC • TECO ELECTRIC & MACHINERY (P) Ltd. • JYOTHI
10.	H.T. Power Cables (XLPE)	<ul style="list-style-type: none"> • APAR INDUSTRIES LTD • CCI • CMI LTD • Finolex • GEMSCAB • GUPTA POWER • INFRASTRUCTURE LIMITED • KEC INTERNATIONAL LIMITED • KEI INDUSTRIES • POLYCAB • TORRENT CABLES • UNIVERSAL CABLES 	<ul style="list-style-type: none"> • DYNAMIC CABLES • HAVELLS INDIA LTD • LS CABLE • PARAMOUNT COMMUNICATIONS LTD • RAVIN CABLES LIMITED • SERVAL • SRIRAM CABLES PVT. LTD • STERLITE • Sterlite Power Transmission Ltd • TIRUPATI PLASTOMATICS PVT. LTD.
11.	HT Busduct (Segregated Phase)	<ul style="list-style-type: none"> • BHEL • C&S • KGS Engg • POWERGEAR • REEP • STARDRIVE 	<ul style="list-style-type: none"> • BUS BAR SYATEMS LIMITED • ELEMECH • ELPRO • ENPRO ENGG • GLOBE ELECTRICAL INDUSTRIES • POWER WAYS • VEE VEE CONTROLS
12.	HT Switchboard 11KV, 3.3KV	<ul style="list-style-type: none"> • ABB • BHEL • L&T • SCHNEIDER • SIEMENS 	<ul style="list-style-type: none"> • CGL • SYSTEM CONTROL • VOLTECH
13.	L.T. Motors (AC & DC)	<ul style="list-style-type: none"> • ABB • ALSTOM • Bharat Bijilee Ltd., • Jyoti Limited • Kirloskar Electric Co. Ltd • Laxmi Hydraulics Pvt Ltd • Marathon Electric Motors India Limited • Siemens • WEG 	<ul style="list-style-type: none"> • BHEL Electrical Machines Ltd • ELJIN MOTOR • GE POWER • Hem Industries • HYUNDAI • IJLIN • JEUMOUNT ELECTRIC • NANYANG EXPLOSION • Power House • SHANGAI ELECTRIC • TECO ELECTRIC & MACHINERY (P) Ltd. • TMEIC • CGPower & Industrial Solutions Limited • NGEF(Hubli) Ltd
14.	Lighting Transformer	<ul style="list-style-type: none"> • AMES IMPEX ELECTRICALS PVT.LTD. • BHEL 	<ul style="list-style-type: none"> • MEGAWIN • MEHRU ELECT & MECH ENGINEERS(P) LTD,



NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • ESENNAR TRANSFORMERS PVT LTD • INDCOIL TRANSFORMERS PVT LTD 	<ul style="list-style-type: none"> • POWER PACK • SOUTHERN POWER EQUIPMENT CO PVT LTD (SPEC) • SUDHIR INTRA VIDYUT • SUDHIR TRANSFORMERS LIMITED
15.	LT Busduct (Non-Segregated Phase)	<ul style="list-style-type: none"> • ALSTOM • BHEL • CONTROL & SWITCHGEAR • POWERGEAR • STARDRIVE 	<ul style="list-style-type: none"> • Balaji Electro controls • BUSBAR SYSTEMS LIMITED • Controls and schematics • ELEMECH • ELPRO • GLOBE ELECTRICALS • POWER WAYS • REEP • System Infotech • Tech up engineering • Tricolite Electrical Ind. Ltd • VEE VEE CONTROLS
16.	LT Control Cables	<ul style="list-style-type: none"> • APAR INDUSTRIES LTD. • CABLE CORPORATION OF INDIA LTD • CCI • CMI LIMITED, • CORD Cable • DELTON CABLES • Elkay Telelink • FINOLEX • GEMSCAB INDUSTRIES LTD, • GOVIND CABLE INDUSTRIES • GOYOLENE FIBRES (INDIA) PVT LTD., DAMAN • GUPTA POWER INFRASTRUCTURE LTD, • HAVELLS • HINDUSTAN VIDYUT PRODUCTS LTD. • ICL • INCAB • INDO ASIAN FUSE GEAR LIMITED, • KEC INTERNATIONAL LIMITED, • KEI INDUSTRIES • KRISHNA ELECTRICAL INDUSTRIES LTD, • LAPP INDIA (P) LTD • NICCO • PARAGON • PARAMOUNT • PLAZA CABLES • POLYCAB WIRES PVT LTD 	<ul style="list-style-type: none"> • Advance cable • ALPHA COMMUNICATION LTD • BHANSALI CABLES & CONDUCTORS PVT LTD • BROOKS CABLES,MUMBAI • CHANDRESH CABLES LIMITED • DIAMOND POWER INFRASTRUCTURE LTD • DYNAMIC CABLES • EPSILON CABLES PVT. LTD, • FINECAB WIRES & CABLES PVT. LTD • GLOSTER cables • GoyleneFibre Pvt Ltd • MANOJ CABLES LTD. • MANSFIELD CABLE CO., • NANGALWALA IMPEX (P) LTD • NATARAJ PLAST INDUSTRIES LTD., NEW DELHI, • PAGODA CABLES PVT. LTD • PARAMOUNT COMMUNICATIONS LTD. • RALLISON ELECTRICALS PVT. LTD. (Old name-Roolex Electroproducts LTd) • RAVIN CABLES • RR Kabel • SBEE CABLES LTD., • Scott Innovation wires and cables • SERVAL • SHIVAPRIYA CABLES LTD., • SHYAM CABLE INDUSTRIES DELHI • SPECIAL CABLES PVT. LTD

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • Radiant • SRIRAM CABLES PVT. LTD • Suyog Cables • SUYOG ELECTRICALS LTD., BARODA, • TCL CABLES LTD • TECHMECH ENGINEERS , BANGALORE • THERMO CABLES LIMITED • TORRENT CABLES • TOSHNIWAL CABLES, JAIPUR • UNIVERSAL CABLES 	<ul style="list-style-type: none"> • SPM POWER & TELECOM PVT LTD. • STEP Industries • SUJOG ELECTRICALS • SURAJ CABLES • TC COMMUNICATION PVT LTD. • TERACOM • TERACOM LIMITED • THERMO PADS • TIRUPATI PLASTOMATICS PVT. LTD. • TirupatiPlasomatics • TORRENT Power • VARSHA CABLES PVT LTD • VIKAS CABLE COMPANY • WINDSOR CABLES PVT. LTD.
17.	LT Power Cables (XLPE)	<ul style="list-style-type: none"> • APAR INDUSTRIES LTD. • CCI • CMI LIMITED, • CORDS CABLE INDUSTRIES LTD. • DELTON CABLES • ELKAY TELELINKS, NEW DELHI • FINOLEX • GEMSCAB INDUSTRIES LTD, • GLOSTER CABLES LTD • GOVIND CABLE INDUSTRIES • GOYOLENE FIBRES (INDIA) PVT LTD., DAMAN • GUPTA POWER INFRASTRUCTURE LTD, • HAVELL'S INDIA LTD., NEW DELHI • HINDUSTAN VIDYUT PRODUCTS LTD. • ICL • INCAB • INDO ASIAN FUSE GEAR LIMITED, • KEC INTERNATIONAL LIMITED, • KEI INDUSTRIES • KRISHNA ELECTRICAL INDUSTRIES LTD, • LAPP INDIA (P) LTD • NICCO CORPORATION LTD • PARAGON • Paramount cable • POLYCAB • Radiant • RAVIN • RAVIN CABLES LIMITED • Sbee Cables 	<ul style="list-style-type: none"> • Advance cable • ALPHA COMMUNICATION LTD • AVOCAB • BHANSALI CABLES & CONDUCTORS PVT LTD • BROOKS CABLES, MUMBAI • CHANDRESH CABLES LIMITED • CRYSTAL CABLES, KOLKATA • DIAMOND POWER INFRASTRUCTURE LTD • DYNAMIC CABLES • EPSILON CABLES PVT. LTD, • FINECAB WIRES & CABLES PVT. LTD • MANOJ CABLES LTD. • MANSFIELD CABLE CO., • NANGALWALA IMPEX (P) LTD • NATARAJ PLAST INDUSTRIES LTD., NEW DELHI, • PAGODA CABLES PVT. LTD • PARAMOUNT COMMUNICATIONS LTD. • Plaza CABLES • Rallison • RALLISON ELECTRICALS PVT. LTD. (Old name-Roolex lectroproducts LTd) • RPG • RR KABEL • SBEE CABLES LTD., • Scott Innovation wires and cables • SERVAL • SHIVAPRIYA CABLES LTD., • SPECIAL CABLES PVT. LTD • SPM POWER & TELECOM PVT LTD. • Sri Ram Cables



NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • SHYAM CABLE INDUSTRIES DELHI • TCL CABLES LTD • THERMO CABLES LIMITED • Thermocables • TORRENT CABLES • TOSHNIWAL CABLES, JAIPUR • UNIVERSAL CABLES 	<ul style="list-style-type: none"> • STEP Industries • SURAJ CABLES • SUYOG ELECTRICALS LTD., BARODA, • TC COMMUNICATION PVT LTD. • TECHMECH ENGINEERS, BANGALORE • TERACOM LIMITED • THERMO CABLE • THERMO PAD • TIRUPATI PLASTOMATICS PVT. LTD. • TORRENT POWER LIMITED • VARSHA CABLES PVT LTD • VIKAS CABLE COMPANY • WINDSOR CABLES PVT. LTD.
18.	LT Trailing Cables		<ul style="list-style-type: none"> • RALLISON • SUJOG ELECTRICALS • THERMO PADS
19.	LT Transformer (Dry Type)	<ul style="list-style-type: none"> • ABB • BHEL • CG POWER (CGL) • GE PROLEC • KIRLOSKAR • SCHNEIDER • TOSIBA T&D SYSTEM (INDIA) • VOLTAMP TRANSFORMERS 	<ul style="list-style-type: none"> • RAYCHEM RPG • SUDHIR INTRA VIDYUT • TELAWNE • VOLTECH • AMES IMPEX • KANO HAR ELECTRICALS
20.	MLDB/PDB/ACDB/ WDB/ELDB / DCDB / LCP / LPBS / DCLDB	<ul style="list-style-type: none"> • ABB • ADVANCE POWER CONTROLS LIMITED • ALSTOM, • AMBIT SWITCHGEAR PVT LTD • AUTOMATION NETWORKS & SERVICES • BALAJI ELECTRO CONTROLS PVT LTD. • BCH ELECTRIC LIMITED • BHEL • C&S ELECTRIC • CGL, • CONTROL & SCHEMATICS • CONTROL DEVICES • CONTROL ENGINEERING CO. • CONTROL INFOTECH P LTD, • CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED • CUBIC CONTROL SYSTEMS • DYNASPEDE INTEGRATED SYSTEMS PVT. LTD. 	<ul style="list-style-type: none"> • ADLEC POWER • ANAND POWER LTD • ELINS SWITCHBOARDS PVT LTD. • ELKTRISCHEN POWER GEARS (P) LTD. • EMCONS • EXCEL POWER • HORSE POWER CONTROL • HYUNDAI, • INTRELEC • JANANI ELECTRICALS • LOAD CONTROL • POPULAR SWITCHGEAR • POWER CONTROL EQUIPMENTS • POWERICA LTD. • PRASHA TECHNOLOGIES • PRITHVI TECHNOLOGIES • SEN & SINGH ENGINEERS, KOLKATA • SHREE ABIRAMI ELECTRICAL ENGINEERS • SHRENIK & COMPANY • SPACE AGE • STAR DELTA ENGINEERING

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • ELECMECH SWITCHGEAR & INSTRUMENT • ENPRO INDUSTRIAL • GE • GEC • GEMCO CONTROLS LTD • GEPC • HAVELLS, • HENSEL ELECIC INDIA PVT. LTD. • HINDUSTAN CONTROLS & EQUIPMEN PVT. LTD.,KOLKATA • HI-TECH SERVICES • INDO ASAIN • INDO KOPP • INDUSTRIAL CONTROLS & APPLIANCES PVT.LTD • INDUSTRIAL CONTROLS & DRIVES (I) PVT. LTD. • JAKSON ENGINEERS LTD • JASPER ENGINEERS PVT.LTD. • JOLLY ENGINEERING INSUSTRIES • KMG ATOZ SYSTEMS (P) LTD. • L&T, • LOTUS POWER GEAR PRIVATE LTD. • MDS, • MEDITRON, • MERLIN GERIN • MK ENGINEERS • NAPTUNE INDIA LTD. • NGEF, • NIE POWER & ENGINEERING (P) LTD. • NIKITECH ELECTRIC PVT LTD. • NITYA ELECTOCONTROLS • POPULAR SWITCHGEAR PVT LTD., MUMBAI, • POSITRONIC • POWER CONTROL • POWER & PROECTION • POWER PLUS (BANGALORE) PVT LTD. • POWERTECH SWITCHGEARS (I) PVT LTD • PYROTECH . • PYROTECH ELECTRONICS PVT. LTD. • S&S 	<ul style="list-style-type: none"> • STERLING GENERATORS • SUPERNOVA ENGINEERS LTD • VOLTECH • ADVANCE ENGG. COMPAN • Sterling Generators Pvt. Ltd. • ELEXPRO ELECTRICALS PVT/ LTD. • AVAIODS TECHNOVATORS LTD
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NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • S.B. POWER SYSTEMS • SAMCON INDUSTRIAL CONTROLS PVT LTD • SCHNEIDER • SCHNEIDER ELECTRIC INDIA PVT.LTD. • SIEMENS • STANDARD • SWITCHING CIRCUITS, KOLKATA • SYSTEM INFOTECH • TAURUS • TECH-UP ENGINEERING PVT LTD. • TELEMECANIQUE • TRICOLITE ELECTRICAL INDUSTRIES, SAHIBABAD, • UNILEC ENGINEERS LIMITED • VEE VEE CONTROLS • VENSON ELECTRIC CO. LTD • VENUS CONTROLS & SWITCHGEAR PVT.LTD. • VERSATRP • VIDYUT CONTROL • VMAX POWER CONTROLS PVT LTD • VRL AUTOMATION ENGINEERING & PROJECTS LTD 	
21.	Neutral Grounding Resistors (NGR)	<ul style="list-style-type: none"> • AMP CONTROL EQUIPMENTS PVT LTD. • LACHHMAN ELECTRONICS • NATIONAL RESISTORS • NATIONAL SWITCHGEAR • RESITECH • RSI INDIA PVT LTD • SR NARKHEDE 	
22.	Numerical Protection Relays	<ul style="list-style-type: none"> • ABB • ALSTOM • C & S • EASUN REYRALLE • GE (ALSTOM) • L&T • SCHNEIDER • SIEMENS 	<ul style="list-style-type: none"> • GEC • JYOTI RE-300 • TM • SEL
23.	Plante Battery	<ul style="list-style-type: none"> • EXIDE • HOPPECKE, GERMANY 	<ul style="list-style-type: none"> • AMARA RAJA • CUMMINS • HBL – NIFE • HBL POWER SYSTEMS LTD • PULSELITE
24.	UPS	<ul style="list-style-type: none"> • HITACHI HI-REL POWER 	<ul style="list-style-type: none"> • Consul Neowatt Power Solutions

NTPL FGD_Electrical Sub-vendor List

		<p>ELECTRONICS</p> <ul style="list-style-type: none"> • Vertiv Energy (formerly EMERSON Network Power) • KELTRON POWER ELECTRONICS 	<ul style="list-style-type: none"> • GUTOR
25.	Variable Frequency Drive (VFD)		
26.	VCB	<ul style="list-style-type: none"> • ABB • ALSTOM • BEL • BHEL • CGL • GE-T&D • L&T • SCHNEIDER • SIEMENS • BHEL 	<ul style="list-style-type: none"> • C&S • Eaton Corporation

Class II items

Sl. No	Item Description	Cat1	Cat2
1.	AC/DC Control Contactors	<ul style="list-style-type: none"> • ABB • C&S • GE POWER • L&T • SCHNEIDER • SIEMENS 	
2.	AC/DC Power Contactors	<ul style="list-style-type: none"> • ABB • C&S • GE POWER • L&T • SCHNEIDER • SIEMENS 	<ul style="list-style-type: none"> • BCH
3.	Cable Glands	<ul style="list-style-type: none"> • 3D • BRACO ELECTRICALS (INDIA) PVT. LTD. • Commet • COSMOS • DOWELLS • Jainson • SUNIL & COMPANY 	<ul style="list-style-type: none"> • HMI • SMI
4.	Cable Lugs	<ul style="list-style-type: none"> • 3D • Commet • COSMOS • DOWELLS • HEX • Jainson 	<ul style="list-style-type: none"> • A.F.Noman& Co • Excel Enterprises Chennai • Fomra Electricals • Goodwill Hardware Stores • Industrial Equipment Suppliers

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • Sunil & Co. 	<ul style="list-style-type: none"> • Kayser Electricals • M.J.Traders • Navakar Trading Co. Pvt. Ltd. • Rangoon Mill Stores • Rashmi Electric Co • S.M Trading Co. • Shanthi Electricals • Singhi Industrial Electrical • South India Astek Electricals &Controls switch Gear Co • South India Switch Gear Co. • Southern Industrial Products • Standard Electric Co.
5.	Cable Termination & Jointing Kits	<ul style="list-style-type: none"> • 3M ELECTRICALS • 3M Electro and Communication India P.Ltd • RAYCHEM – RPG 	<ul style="list-style-type: none"> • ACCESSORIES PVT. LTD. • ALPHA POWER SYSTEM • Classic Enterprises • HARI CONSOLIDATED • HARI CONSOLIDATED PVT.LTD.,NEW DELHI • POWER CABLE CORPORATION • SATYA ELECTRO MECH PVT. LTD • SS ENGINEERING • TRANS ELECTRIC • VENELEC ELECTROMECH IND. PVT. LTD • YAMUNA CABLE ACCESSORIES PVT. LTD
6.	Cable Trays	<ul style="list-style-type: none"> • Amtech • AnadUdyog • AV Engg • GLOBE • Inar Profile • India Electric Syndicate • Indiana Cable Trays • Indiana Gratings • INDIANA GRATINGS PVT • INDUSTRIAL PERFORATION • JAMNA METAL • MJ Engg • PARMAR METAL PVT. LTD. • Patny • PATNY SYSTEMS • Rabi Engg • RATAN PROJECTS 	<ul style="list-style-type: none"> • Ind mark Formtech • Premier Power • T.R.G

SL

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • RatanEngg • Rukani • RUKMANI ELECTRICAL • Sterlite • Techno Engg • Unitech Fabricators & Engineers • VATCO • Mahavir 	
7.	Control Transformers	<ul style="list-style-type: none"> • Automatic Electric • Gujrat plug in • Indcoils • KALPA • Kappa Electricals • Precise Electricals • SILCON • Pragati 	<ul style="list-style-type: none"> • Newtek Electricals • POWER PACK
8.	Current Measuring Modules	<ul style="list-style-type: none"> • ABB • ALSTOM • EASUN REYRALLE • GEC • JYOTI RE-300 • L&T • SCHNEIDER • SIEMENS • TM 	
9.	Energy Meters/Multi Function Meters	<ul style="list-style-type: none"> • AE • CONZERVE • L&T • MECO • RISHAB • Secure • SIEMENS • SCHNEIDER 	<ul style="list-style-type: none"> • ABB • ELMEASURE • IMP
10.	High Mast	<ul style="list-style-type: none"> • BAJAJ ELECTRICALS LIMITED • CANARA LIGHTING INDUSTRIES, MANGALORE • CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED • HAVELL'S INDIA LTD., NEW DELHI • PHILIPS INDIA LIMITED • VINTUS SYSTEMS • WIPRO ENTERPRISES PVT. LTD. 	<ul style="list-style-type: none"> • CHENNAI POLES • KUMARAN INDUSTRIES • METAL COATS • PONDICHERI POLES & FABRICATORS
11.	Intelligent Controllers	<ul style="list-style-type: none"> • ABB 	<ul style="list-style-type: none"> • EASUN REYROLLE

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • ALSTOM • GE • L&T • Schneider Electric • SIEMENS 	<ul style="list-style-type: none"> • GEC • JYOTI RE-300 • TM
12.	LED Lighting	<ul style="list-style-type: none"> • BAJAJ ELECTRICALS LIMITED • CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED • PHILIPS INDIA LIMITED • WIPRO ENTERPRISES PVT. LTD. • HAVELL'S INDIA LTD., NEW DELHI 	<ul style="list-style-type: none"> • CANARA LIGHTING INDUSTRIES, MANGALORE • VINTUS SYSTEMS
13.	Lighting Fixtures (Flame Proof)	<ul style="list-style-type: none"> • BAJAJ ELECTRICALS LIMITED • BaliGA • CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED • FCG • GE HAVELL'S INDIA LTD., NEW DELHI • PHILIPS INDIA LIMITED • WIPRO ENTERPRISES PVT. LTD. 	<ul style="list-style-type: none"> • HAVELL'S INDIA LTD., NEW DELHI • CANARA LIGHTING INDUSTRIES, MANGALORE • K-LITE • SURYA ROSHINI LIMITED • THORN • VINTUS SYSTEMS
14.	Lighting Fixtures (General)	<ul style="list-style-type: none"> • BAJAJ • CANARA LIGHTING INDUSTRIES, • CROMPTON • GE • PHILIPS • WIPRO 	<ul style="list-style-type: none"> • AVAIDS TECHNOVATORS PVT. LTD • ENGG. CO. LTD. • HAVELL'S INDIA LTD., • HPL Electric & Power Ltd • K-LITE • MIKA ENGINEERS • Signify Innovations India Limited • SURYA ROSHINI LIMITED • TECHNO ELECTRIC and • THORN • VINTUS SYSTEMS
15.	MCCB/MPCB/MCB	<ul style="list-style-type: none"> • ABB • ALSTOM, • BCH Electric • C & S Electric • CGL, • GE-POWER • HAVELLS, • L&T, • LEGRAND • MDS, 	<ul style="list-style-type: none"> • HYUNDAI, • NGEF



NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none"> • Schneider • SIEMENS • STANDARD 	
16.	Meters (Analog/Digital)	<ul style="list-style-type: none"> • ABB • AE • CGL • Conzerv • ENERCON • GE POWER • IMP • INDUSTRIAL METERS • L&T • MECO • NIPPON • RISHAB • SCHNEIDER • Secure • SIEMENS • SILKAANS • STANDARD 	<ul style="list-style-type: none"> • GEC • SIMCO
17.	Street Light Poles	<ul style="list-style-type: none"> • BAJAJ • BOMBAY TUBES & POLES • CHENNAI POLE • CROMPTON GREAVES CONSUMER ELECTRICALS LIMITED • PHILIPS INDIA LIMITED • WIPRO 	<ul style="list-style-type: none"> • CANARA LIGHTING INDUSTRIES • HAVELL'S INDIA LTD., • KUMARAN INDUSTRIES • METAL COATS • MIKA ENGINEERS • PONDICHERI POLES & FABRICATORS • VINTUS SYSTEMS
18.	Transducer	<ul style="list-style-type: none"> • ABB • AE • ALSTOM • ELESTER • MECO • PERFECT CONTROL • PYROTECH • RISHAB • SECURE • SIEMENS • SOUTHREN 	<ul style="list-style-type: none"> • C&S • Elesta • Guardian • HEL • Jyothi • L&T • OEN • Omran • Paramount
19.	CT/PT	<ul style="list-style-type: none"> • A.E • ABB • BHEL • CGL • Gujrat plug in • IND COIL • KALPA • KAPPA • PRAGATI 	<ul style="list-style-type: none"> • JYOTI LTD • Newtek Electricals • PRAYOG • WSI

NTPL FGD_Electrical Sub-vendor List

		<ul style="list-style-type: none">• PRECISE• SIEMENS• SILCON• TELK	
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NTPL- FGD_C&I Sub- Vendor List

Sl. No	Item	CAT-1	CAT -2
CLASS-I			
1	DDCMIS	<ul style="list-style-type: none"> • ABB • YOKOGOWA • SIEMENS • EMERSON • HONEYWELL 	<ul style="list-style-type: none"> • VALMET DNA, • INVENSYS (SCHNEIDER)
2	PLC system	<ul style="list-style-type: none"> • HONEYWELL • BGRESL(IAD) – HONEYWELL 	<ul style="list-style-type: none"> • VALMET DNA,
3	Vibration Monitoring system	<ul style="list-style-type: none"> • BENTLEY NEVADA • MEGITT • SKF • GE • SHINKAWA (FORBES MARSHALL) 	<ul style="list-style-type: none"> • VALMET DNA • IRD MECHANALYSIS LIMITED, • ROCKWELL AUTOMATION • MILWANKEE WISCONSIN • SENSONICS LIMITED • HUAWEI • MOXA • CISCO • HIRSCHMANN • RUGGEDCOM
4	Industrial grade Ethernet Switches	<ul style="list-style-type: none"> • HIRSCHMANN • MOXA • CISCO 	<ul style="list-style-type: none"> • HIRSHMANN • SIEMENS
5	Operator Station/ Work Station	<ul style="list-style-type: none"> • DELL • HP • COMPAQ • IBM- LENOVO 	
6	Printers	<ul style="list-style-type: none"> • EPSON • XEROX • CANON • HP 	<ul style="list-style-type: none"> • IBM • LEXMARK

NTPL- FGD_C&I Sub- Vendor List

7	SMART transmitters (P,L, F, DP)	<ul style="list-style-type: none"> • SIEMENS • YOKOGAWA • ABB • HONEYWELL AUTOMATION- INDIA LTD • EMERSON/ ROSEMOUNT • ENDRESS & HOUSER 	<ul style="list-style-type: none"> • M/S YOKOGAWA ELECTRIC • M/S BALDOTA CONTROL & EQUIPMENTS PVT LTD • KROHNE MARSHALL •
8	Temperature transmitters	<ul style="list-style-type: none"> • ENDRESS & HOUSER • EMERSON • ABB • YOKOGAWA • SIEMENS • HONEYWELL AUTOMATION- INDIA LTD 	<ul style="list-style-type: none"> • M/S M-SYSTEM • M/S MOORE INDUSTRIES INTL. INC
9	Thermocouples/ Thermowells/ RTDs	<ul style="list-style-type: none"> • TECHNO INSTRUMENTS • DETRIV INSTRUMENTAT ION & ELECTRONICS LTD • GIC • PYRO ELECTRIC • TEMSENS • TOSHNIWAL INDUSTRIES • BAUMER 	<ul style="list-style-type: none"> • DETRIVINSTN. & ELEC. LTD., • H.GURU INDUSTRIES • TELEVISION & ELECTRONIC SERVIC • SERTEL ELECTRONICS (P) LTD • GOA INSTRUMENTS INDUSTRIES PVT LTD • HTA INSTRUMENTATI ON PVT. LTD., • ASIAN ENGG & SERVICES • KARLO TRADERS • LEHRY INSTRUMENTATI ON & VALVES PVT

NTPL- FGD_C&I Sub- Vendor List

			<ul style="list-style-type: none"> LTD., • EXOTHERM INSTRUMENTS • GAUGES BOURDON INDIAPVT LTD • AAVAD INSTRUMENT • GAUGES BOURDON INDIAPVT LTD • THERMAL INSTRUMENT INDIAPVT LTD • WALCHANDNAGAR INDUSTRIES LIMITED • TETHERMO ELECTRIC COMPANY INDIAPVT LTD • INDUSTRIAL INSTRUMENTATION. • OKAZAKI • THERMAL INSTRUMENT INDIA PVT. LTD. • WIKA INSTRUMENTS • NESSTECH INSTRUMENTS PVT LTD • MINCO • GOA INSTRUMENT INDUSTRIES
10	Level transmitters (Displacer type)	<ul style="list-style-type: none"> • CHEMTROLS INDUSTRIES LIMITED • MAGNETROL • ENDRESS + HAUSER 	<ul style="list-style-type: none"> • DELETED

8

NTPL- FGD_C&I Sub- Vendor List

		<ul style="list-style-type: none"> INSTRUMENTS, • LEVCON INSTRUMENTS PVT LTD • ECKARDT AG • DK INSTRUMENTS • SBEM • V AUTOMAT 	
11	Level transmitters (Ultrasonic, radar type)	<ul style="list-style-type: none"> • EMERSON • E&H • VEGA • ABB • SIEMENS MILLITRONICS 	<ul style="list-style-type: none"> • ENDRESS + HAUSER (I) PVT. LTD. • ENDRESS+HAUSER GMBH+CO.KG, • WEIL AM RHEIN" • FORBES MARSHALL PVT. LTD • PEPPERL+FUCHS (I) PVT LTD • PEPPERL+FUCHS GMBH
12	Flow element	<ul style="list-style-type: none"> • INSTRUMENTATION LIMITED, • MICRO PRECISION PRODUCTS PVT LTD, • MINCO • GIC • STAR-MECH CONTROLS (I) PVT.LTD. • ENGINEERING SPECIALITIES PVT. LTD. 	<ul style="list-style-type: none"> • EMERSON PROCESS MANAGEMENT • CHEMTROLS INDUSTRIES PVT. LTD., • DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD. • ELECTRONET EQUIPMENTS PVT LTD., • FLOW STAR ENGINEERING PVT. LTD., • HYDROPNEUMATICS PVT. LTD. • INSTRUMENTATION ENGINEERS PVT LTD

NTPL- FGD_C&I Sub- Vendor List

			<ul style="list-style-type: none"> • SCIENTIFIC DEVICES (BOMBAY) PVT LTD, • T211 TANSA EQUIPMENTS PVT. LTD. • SIEMENS
13	pH analyzers	<ul style="list-style-type: none"> • THERMO ORION INC • ABB • EMERSON • HACH • POLYMETRON • YOKOGAWA 	<ul style="list-style-type: none"> • SWAN • METTLER-TOLEDO INDIA PVT. LTD. • DKK TOA • E&H • TELEDYNE
14	Sulphur Dioxide (SO2) Analyzer	<ul style="list-style-type: none"> • EMERSON PROCESS-MANAGEMENT • YOKOGAWA • SICK • CHEMTROLS INDUSTRIES LTD • SIEMENS LIMITED • ENVIRONMENT SA • ANALYSER INSTRUMENTS CO. PVT LTD. • ABB 	<ul style="list-style-type: none"> • FUJI ELECTRIC SYSTEMS CO., LTD • NEVCO ENGINEERS PVT LTD
15	Instrument Cables	<ul style="list-style-type: none"> • PARAMOUNT COMMUNICATION • THERMO CABLES • CORDS CABLE • DELTON CABLES • TORRENT CABLES • KEI CABLES 	<ul style="list-style-type: none"> • CMI LTD., • INDUSTRIES LIMITED • GOYOLENE FIBRE (I) PVT LTD • ASSOCIATED CABLES PVT LTD • SUYOG ELECTRICALS LTD • ADVANCE CABLE TECHNOLOGY (P) LTD

NTPL- FGD_C&I Sub- Vendor List

		<ul style="list-style-type: none"> • ELKAY TELELINKS • POLYCAB CABLES • SPECIAL CABLES • TC COMMUNICATION PVT LTD • KEC INTERNATIONAL LTD 	<ul style="list-style-type: none"> • IMT CABLES PVT LTD • GUPTA POWER INFRACTURES LTD • GEMSCAB INDUSTRIES LIMITED • TEMPESENS INSTRUMENT (I) PVT LTD • SHYAM CABLE INDUSTRIES • N.C.CABLES LIMITED • PAGODA CABLES PVT LTD • SRINI LINK • INCOM CABLES PVT LTD • GRID INDIA POWER CABLES PRIVATED LIMITED • ALLIED ENGINEERING WORKDSPVT LTD • NANGALWALA INDUSTRIES PVT .LTD • CMI ENERGY INDIA PRIVATE LIMITED
16	Thermocouple cable	<ul style="list-style-type: none"> • CORDS • DELTON • THERMOCABLES • PARAMOUNT • POLYCAB • KEI 	
17	Fibre Optic Cable	<ul style="list-style-type: none"> • FINOLEX • AKSH OPTIC FIBRE • D-LINK • BIRLA 	<ul style="list-style-type: none"> • R&M • SCHNEIDER-DIGILINK • TYCO/AMP • RPG CABLES

NTPL- FGD_C&I Sub- Vendor List

		<ul style="list-style-type: none"> ERICSSON • HFCL 	<ul style="list-style-type: none"> • AKASH FIBRE
18	Control Valves with Smart Positioner	<ul style="list-style-type: none"> • MASONEILAN • EMERSON (FISHER) • INSTRUMENTATION LTD • KOSO INDIA PRIVATE LIMITED • MIL CONTROLS • BOMFA SPECIAL VALVE SOLUTIONS PVT LTD • FORBES MARSHALL ARCA PVT.LTD • MASCOT VALVES PVT. LTD • SAMSON CONTROLS PVT. LTD. • SEVERN GLOCON INDIA PVT. LTD. • GE OIL & GAS INDIA PRIVATE LIMITED • COPES VULCAN 	<ul style="list-style-type: none"> • FUJIKIN • FORBES ARCA • EMERSON PROCESS MANAGEMENT • R.K.CONTROL INSTRUMENTS PVT. LTD., • SUZHOU DELAN ENERGY SCIENCE & TECHNOLOGY CO., LTD., • VALVITALIA S.P.A. • WALDEMAR PRUSS ARMATURENFABRIK GMBH

8

NTPL- FGD_C&I Sub- Vendor List

S.No	Item	CAT-1	CAT-2
CLASS-II			
1	Junction Box	<ul style="list-style-type: none"> • PYROTECH • RITTAL • CHEMIN • BCH • PRAMMEN • HENSEL 	<ul style="list-style-type: none"> • SAJAS ELECTRICALS • SHIBSHA INSTRUMENT INDIA P LTD • WIN POWER • ACE ELECTRICAL EQUIPMENTS (I) PVT LTD • SVG CONTROL SYSTEMS PRIVATE LIMITED • TECH-UP ENGINEERING PVT. LTD • SAHYADRI ELECTRO CONTROLS (INDIA) PRIVATE LTD., • SRI VISHNU INDUSTRIES • KEAS CONTROL SYSTEMS INDIA PRIVATE LIMITED • BALAJI ELECTROCONTROLS PVT. LTD., • MAIKA METALS PVT LTD • PANAM CONTROLS • TECHNO GRIP • SOUTH INDIA SWITCH GEAR CO. • ASSOCIATED ENGINEERS • MANISHA COMPOSITEK PRIVATE LIMITED • SUCHITRA INDUSTRIES • DEVI POLYMERS PRIVATE LIMITED • EPP COMPOSITES PRIVATE LIMITED • K.S. INSTRUMENTS PVT. LTD., • FICOM ENGINEERING PVT LTD

2

NTPL- FGD_C&I Sub- Vendor List

			<ul style="list-style-type: none"> • SHRENIK & COMPANY • ALLIED MOULDED ENCLOSURE PRODUCTS (INDIA) PVT LTD • K.S. INSTRUMENTS PVT LTD, • SHRENIK & COMPANY • SUDHIR SWITCHGEARS PVT LTD, • FLAMEPACK • BALIGA • FCG FLAMEPROOF CONTROL GEARS • ELECTROMECHANICAL
2	LIE/LIR	<ul style="list-style-type: none"> • CHEMIN • PYROTECH • SAJAS ELECTRICAL • PRAMMEN 	<ul style="list-style-type: none"> • PRAMMEN INDUSTRIES, • PROCON INSTRUMENTATION (P) LTD., • INSTRUMENTATION LTD
3	Panels/ cabinets	<ul style="list-style-type: none"> • PYROTECH • RITTAL 	<ul style="list-style-type: none"> • BHEL • ADARSH CONTROL
4	Control desk, workstation tables, printer tables and chairs, file racks, document storages	<ul style="list-style-type: none"> • PYROTECH • RITTAL • OTS • GODREJ AND BOYCE MANUFACTURING CO LTD • FEATHERLITE OFFICE SYSTEMS PVT. LTD 	<ul style="list-style-type: none"> • HARMONY SYSTEMS • COSMOS MEDIA PRODUCTS PVT LTD , • CHEMIN CONTROLS AND INSTRUMENTATION • ADARSHA CONTROLS SYSTEMS PVT LTD • HARMONY SYSTEMS • COSMOS MEDIA PRODUCTS PVT LTD
5	Terminal Blocks	<ul style="list-style-type: none"> • CONNECTWELL • ELMEX • PHOENIX • WEIDMULLER • WAGO 	<ul style="list-style-type: none"> • ELMAX

NTPL- FGD_C&I Sub- Vendor List

6	AC to DC Converter (for Control cabinets)	<ul style="list-style-type: none"> • COSEL • PHOENIX • WEIDMULLER • SIEMENS 	
7	Interposing Relays	<ul style="list-style-type: none"> • JYOTI • OEN • OMRON • SIEMENS • SCHNEIDER • PARAMOUNT 	<ul style="list-style-type: none"> • ELESTA • JYOTHI • GUARDIAN • OMRAN
8	Proximity sensor/switch	<ul style="list-style-type: none"> • OMRON • P&F • BRUEL & KAJER • MEGGITT 	<ul style="list-style-type: none"> • GE • FORBES MARSHALL • MAGNUM CONTROLS • EM ELECTRONIX PVT. LIMITED • TECHNIC EUCHNER ELECTRONIC P L
9	Pressure Gauges/DP Gauge	<ul style="list-style-type: none"> • WIKA • AN INSTRUMENTS • BAUMER • H GURU • MANOMETER • GOA THERMOSTATIC • FORBES MARSHALL • GAUGES BOURDON (INDIA) PVT. LTD. 	<ul style="list-style-type: none"> • WALCHANDNAGAR INDUSTRIES LTD. • PRECISION MASS PRODUCTS PVT. LTD • THERMAL INSTRUMENT INDIA PVT. LTD.
10	Temperature Gauges	<ul style="list-style-type: none"> • WIKA • AN INSTRUMENTS • BAUMER • H GURU • GOA THERMOSTATIC • FORBES MARSHALL 	<ul style="list-style-type: none"> • GAUGES BOURDON (INDIA) PVT. LTD. • PRECISION MASS PRODUCTS PRIVATE LIMITED (EARLIER ASHCROFT) • GOA INSTRUMENTS INDUSTRIES PRIVATE LTD • THERMAL INSTRUMENT INDIA PVT. LTD. • WALCHANDNAGAR INDUSTRIES LTD.

NTPL- FGD_C&I Sub- Vendor List

			<ul style="list-style-type: none"> • GAUGE BOURDON
11	Pressure & Differential Pressure Switches, Temperature Switches	<ul style="list-style-type: none"> • GIC • SWITZER • INDOSS • TRAFAG 	<ul style="list-style-type: none"> • PRECISION MASS PRODUCTS PVT. LTD • GAUGES BOURDON (INDIA) PVT. LTD • BAUMER TECHNOLOGIES INDIA LTD • GOA THERMOSTATIC
12	Level Switches (Float , Displacer Type, Capacitance) & Level Gauges	<ul style="list-style-type: none"> • EIP • ENVIRO • MAGNATROL • V-AUTOMAT • E&H • SBEM • PUNE TECHTROL • LEVCON • NIVO CONTROL • EIP ENVIRO 	<ul style="list-style-type: none"> • SIGMA INSTRUMENTS COMPANY • IGEMA GMBH. • D.K.INSTRUMENTS PVT. LTD • CHEMTROLS SAMIL (INDIA) PVT. LTD. • DELETED • ECKARDT AG-STUTTGART • ENDRESS + HAUSER INSTRUMENTS, • HI TECH INSTRUMENTS • D K INSTRUMENT • SIGMA
13	Level Switches (RF type)	<ul style="list-style-type: none"> • EIP • ENVIRO • V-AUTOMAT • E&H • SBEM • PUNE TECHTROL • LEVCON • NIVO CONTROL • EIP ENVIRO 	<ul style="list-style-type: none"> • IGEMA GMBH . • D.K.INSTRUMENTS PVT. LTD • HI TECH INSTRUMENTS
14	Level Switches (Conductivity type)	<ul style="list-style-type: none"> • EIP • E&H • SBEM • PUNE TECHTROL • NIVO CONTROL 	<ul style="list-style-type: none"> • LEVELSTATE SYSTEMS LTD • SOLARTRON TRANSDUCER • RAMAN INSTRUMENTS PVT. LTD • IGEMA GMBH • HI-TECH SYSTEMS & SERVICES LTD • HI TECH

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NTPL- FGD_C&I Sub- Vendor List

			INSTRUMENTS
15	Flow Switch	<ul style="list-style-type: none"> • V-AUTOMAT • SWITZER • PUNE TECHTROL • LEVCON 	<ul style="list-style-type: none"> • D K INSTRUMENT
16	Flow Meters (All type)	<ul style="list-style-type: none"> • ABB LIMITED • EMERSON PROCESS MANAGEMENT • KROHNE • YOKOGAWA INDIA LIMITED, • HONEYWELL AUTOMATION INDIA LTD., • E&H • ENDRESS + HAUSER 	<ul style="list-style-type: none"> • SIEMENS
17	Sight Flow Indicator/Rota Meter	<ul style="list-style-type: none"> • EUREKA • INSTRUMENTATION ENGINEERS PVT LTD • FLOW STAR • SCIENTIFIC DEVICES • PLACKA 	<ul style="list-style-type: none"> • TRANSDUCER & CONTROL PVT LTD • FLUIDYNE INSTRUMENTS PVT. LTD. • TANSI EQUIPMENTS PVT. LTD. • FLOWTECH INSTRUMENT SERVICES • EUREKA AND SCIENTIFIC DEVICES
18	I/P Converters	<ul style="list-style-type: none"> • FAIRCHILD • IMI NORGREN 	
19	Air Filter Regulator	<ul style="list-style-type: none"> • PLACKA • SHAVO NORGREN • NORGREN 	<ul style="list-style-type: none"> • DIVYA CONTROL ELEMENTS PVT LTD • PARKER
20	Solenoid Valves	<ul style="list-style-type: none"> • AVCON • ASCO • HERION • DANFOSS 	<ul style="list-style-type: none"> • ROTEX AUTOMATION LIMITED • IMI NORGREN HERION PVT. LTD
21	Power Cylinders	<ul style="list-style-type: none"> • INSTRUMENTATION LIMITED • SMC PNEUMATICS (INDIA) PVT. LTD 	<ul style="list-style-type: none"> • KERALA STATE ELECTRONICS DEVELOPMENT CORPORATION LTD • VELJAN HYDRAIR LIMITED

NTPL- FGD_C&I Sub- Vendor List

			<ul style="list-style-type: none"> • GG PNEUMATICS & HYDRAULICS • NUCON PNEUMATICS PVT LTD • RMEBS CONTROLS PRIVATE LIMITED • DUNCAN ENGINEERING LIMITED • REXROTH • PARKER • EATON POWER • L&T
22	Industrial grade Firewall	<ul style="list-style-type: none"> • CISCO • HIRSCHMAN • MOXA 	
23	Bulk Material Handling Switches like Pull cord, Zero speed, Belt sway, Chute block, etc.	<ul style="list-style-type: none"> • AG SYSTEM • EIP CONTROLS • PROTOCONTR OL • JAI BALAJI • PARAMETRIC • JAYASHREE 	<ul style="list-style-type: none"> • BETA SYSTEMS ENGINEERING • INSTRUMENTS (I) PVT LTD • P&F

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ANNEXURE-13

SPARES for Wet ball mill Piping (Water, Slurry & Instrument Air), Valves, Pneumatic distributor box and instruments

SL NO	SUB TITLE	ITEM DESCRIPTION	MAT CODE	QTY to be quoted
1	LIMESTONE SLURRY VALVES	COMPLETE VALVES ASSEMBLY	BA9789172010	TWO (2) NOS. FOR EACH TYPE AND SIZE
2	LIMESTONE SLURRY VALVES	SEAT, DISC, SPINDLE WITH NUTS & BOLTS	BA9789172028	TWO (2) NOS. FOR EACH TYPE AND SIZE
3	LIMESTONE SLURRY VALVES	DIAPHRAGMS FOR VALVES	BA9789172036	TWO (2) NOS. FOR EACH TYPE AND SIZE
4	LIMESTONE SLURRY VALVES	FLAPS FOR NON-RETURN VALVES	BA9789172044	TWO (2) NOS. FOR EACH TYPE AND SIZE
5	LIMESTONE SLURRY VALVES	ACTUATOR FOR CONTROL/ISOLATION	BA9789172052	TWO (2) NOS. FOR EACH TYPE AND SIZE
6	LIME STONE SLURRY PIPES AND FITTINGS	LIMESTONE SLURRY PIPE	BA9789172060	5% OF TOTAL LENGTH EQUIREMENT FOR THE SYSTEM
7	LIME STONE SLURRY PIPES AND FITTINGS	LIMESTONE SLURRY PIPE BENDS & FITTINGS	BA9789172079	2 NOS. FOR EACH TYPE & SIZE
8	OTHER VALVES	OTHER VALVES-COMPLETE VALVES	BA9789172087	1 NO EACH TYPE AND SIZE
9	OTHER VALVES	OTHER VALVES-SEAT, DISC, SPINDLE WITH NUT	BA9789172095	1 SET FOR EACH TYEP
10	OTHER VALVES	OTHER VALVES-DIAPHRAGMS	BA9789172109	2 SET FOR EACH TYEP AND SIZE OF DIAPHRAGM TYPE VALVES
11	OTHER VALVES	OTHER VALVES-FLATS OF NONRETURN VALVES	BA9789172117	1 SET FOR EACH TYEP AND SIZE
12	C&I-FIELD INSTRUMENTS	ELECTRONIC TRANSMITTERS (PRESSURE, DIFFERENTIAL PRESSURE, LEVEL, SPEED ETC.) ALL TYPES	BA9789172125	5% OR MINIMUM 1 NO. (WHICHEVER IS HIGHER) OF EACH TYPE AND MODEL/RANGE USED IN THE SYSTEM
13	C&I-FIELD INSTRUMENTS	SWITCH (PRESSURE, DIFFERENTIAL PRESSURE, LEVEL, FLOW, TEMPERATURE ETC.)	BA9789172133	10% OR MINIMUM 1 NO. (WHICHEVER IS HIGHER) OF EACH TYPE AND MODEL/RANGE USED IN THE SYSTEM
14	C&I-FIELD INSTRUMENTS	THERMOCOUPLE	BA9789172141	10% OF EACH TYPE AND LENGTH OF THE TOTAL NOS. USED IN THE SYSTEM OR MINIMUM 2(TWO) NOS. WHICHEVER IS MORE
15	C&I-FIELD INSTRUMENTS	RTD	BA9789172150	10% OF EACH TYPE AND LENGTH OF THE TOTAL NOS. USED IN THE SYSTEM OR MINIMUM 2(TWO) NOS. WHICHEVER IS MORE
16	C&I-FIELD INSTRUMENTS	THERMO-WELL FOR BOTH TC AND RTD	BA9789172168	ONE NO. FOR EACH TYPE AND RATING/LENGTH USED IN THE SYSTEM
17	C&I-SOLENOID VALVE	COMPLETE SOLENOID VALVE ASSEMBLY	BA9789172176	2 NOS. FOR EACH TYPE AND RATING USED IN THE SYSTEM
18	C&I-SOLENOID VALVE	COIL (SINGLE OR DOUBLE COIL TYPE)	BA9789172184	10% OF TOTAL NOS. USED IN THE SYSTEM OR MINIMUM 5(FIVE) NOS. WHICHEVER IS MORE FOR EACH TYPE AND RATING.
19	C&I-FIELD INSTRUMENTS	GAUGE (PRESSURE, DIFFERENTIAL PRESSURE, TEMPERATURE, LEVEL)	BA9789172192	10% OF TOTAL NOS. USED IN THE SYSTEM OR MINIMUM 1(ONE) NO. WHICHEVER IS MORE FOR EACH TYPE AND RANGE.
20	C&I-FIELD INSTRUMENTS	AIR FILTER REGULATOR COMPLETE SET WITH PRESSURE GAUGES	BA9789172206	5 no's
21	C&I-FIELD INSTRUMENTS	GAUGE GLASS / LEVEL INDICATOR	BA9789172214	1NO. FOR EACH TYPE AND SIZE
22	C&I-CONTROL VALVE	PNEUMATIC DIAGHRAGM FOR DIAGHRAGM ACTUATED VALVE	BA9789172222	2(TWO) NOS. FOR EACH TYPE OF ACTUATOR
23	C&I-CONTROL VALVE	ACTUATOR SEAL KIT FOR PNEUMATIC CYLINDER ACTUATED VALVE	BA9789172230	2(TWO) NOS. FOR EACH TYPE OF ACTUATOR
24	C&I-CONTROL VALVE	GLAND PACKING	BA9789172249	1(ONE) SET FOR EACH TYPE OF CONTROL VA
25	C&I-CONTROL VALVE	PLUG, SEAT, CAGE, STEM ETC.	BA9789172257	1(ONE) SET FOR EACH TYPE OF CONTROL VA
26	C&I-CONTROL VALVE	RETAINER RING, SEAL RING ETC.	BA9789172265	1(ONE) SET FOR EACH TYPE OF CONTROL VA
27	C&I-CONTROL VALVE	GASKET	BA9789172273	2(TWO) SETS. FOR EACH TYPE OF CONTROL VALVE
28	C&I-CONTROL VALVE	ACTUATOR SEAL KIT	BA9789172281	2(TWO) NOS. FOR EACH TYPE OF POWER CYLINDER
29	C&I-CONTROL VALVE	GASKET	BA9789172290	2(TWO) SETS FOR EACH TYPE OF POWER CYLINDER
30	C&I-CONTROL VALVE	COMPLETE SET OF POWER CYLINDER	BA9789172303	1(ONE) NO. EACH TYPE FOR ALL APPLICATION
31	C&I-COMMON ITEMS FOR CONTROL VALVES	POSITION TRANSMITTER COMPLETE SET	BA9789172311	10% OF TOTAL QUANTITY USED IN THE SYSTEM OR MINIMUM 2(TWO) NOS. WHICHEVER IS MORE FOR EACH TYPE AND MODEL.

32	C&I-COMMON ITEMS FOR CONTROL VALVES	CONTROL VALVE/POWER CYLINDER E/P POSITIONER COMPLETE SET	BA9789172320	10% OF TOTAL QUANTITY USED IN THE SYSTEM OR MINIMUM 2 (TWO) NOS. WHICHEVER IS MORE FOR EACH TYPE AND MODEL.
33	C&I-COMMON ITEMS FOR CONTROL VALVES	COMPLETE SET OF SOLENOID VALVE FOR PNEUMATIC TYPE ON/OFF VALVE/POWER CYLINDER	BA9789172338	2NOS. FOR EACH TYPE & RATINGS
34	C&I-COMMON ITEMS FOR CONTROL VALVES	SOLENOID COIL FOR PNEUMATIC TYPE ON/OFF VALVE/POWER CYLINDER	BA9789172346	5 NOS. FOR EACH TYPE & RATINGS
35	C&I-COMMON ITEMS FOR CONTROL VALVES	POSITION LIMIT SWITCH FOR PNEUMATIC TYPE ON/OFF VALVE/POWER CYLINDER	BA9789172354	10NOS. FOR EACH TYPE & RATINGS