

RAICHUR POWER CORPORATION LIMITED
2X800 MW YERAMARUS TPS

**TECHNICAL SPECIFICATION
OF
MILL REJECT HANDLING SYSTEM**

SPECIFICATION NO.: PE-TS-384-160-A001



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
PPEI, NOIDA, INDIA



TITLE: **TECHNICAL SPECIFICATION FOR
MILL REJECT HANDLING SYSTEM**

2X800 MW YERAMARUS TPS, KARNATAKA

BHEL DOCUMENTS NO.: PE-TS-384-160-A001

DEPT: MAX

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SECTION - A

INTENT OF SPECIFICATION




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INTENT OF SPECIFICATION


- 1.1** The specification is intended to cover design, engineering, manufacture, inspection and testing at vendor's/ sub-vendor's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation at site, mandatory spares, E&C spares and special maintenance tools and tackles, Erection & Commissioning, minor civil works as required Performance and guarantee testing and handing over of **Mill Reject Handling System** as per details in different sections of this specification for **2x800MW THERMAL POWER PLANT AT YERAMARUS, KARNATAKA**.
- 1.2** It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance herewith.
- 1.3** The extent of work under the contract includes all items shown in the flow diagram, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly extent of work also includes all items mentioned in the specification and/or schedules, notwithstanding the fact that such items may have been omitted in the drawing.
- 1.4** The general term and conditions, instructions to tendered and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.5** While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Normally, in case of any contradiction in requirements between section-C and section-D, the requirements in Sec-C shall govern. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice


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either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

- 1.6** Deviations, if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.
- 1.7** In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

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1.0	Owner	: Raichur Power Corporation Ltd 22/23, Sudarshan Complex, IInd floor, Sheshadri Road, Bangalore-560 009 Karnataka, India
2.0	Consultant	: M/s Evonik Energy Services (I) Pvt. Ltd.,A-29, Sector 16 Noida-201301(UP), India
3.0	Project Title	: 2x800 MW Yermarus Thermal Power Station
4.0	Location	: Yermarus Raichur Dist Karnataka State, INDIA It is situated at about 8 Kms from Raichur on the Raichur-Hyderabad State Highway-13 and 12 kms away from Bank of river Krishna and about 5 kms from Raichur Thermal Power Station
5.0	Nearest Railway	: Chicksugur Railway Station which is about 2 kms from site.
6.0	Nearest Airport	: Hyderabad around 200 kms
7.0	Nearest Port	Chennai around at about 470 kms from site.
8.0	Latitude and Longitude	: Latitude – 16° 16' 55.9"N Longitude – 77° 20' 38.6"E
9.0	Elevation above mean sea level	: 350-375 meters
10.0	<u>Climatic Conditions</u>	
	(a) <u>Ambient Temperature</u>	
	i. maximum temperature	: 45° C
	ii. minimum temperature	: 6° C

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<div><div><div><div>iii. Design Temperature : 50° C Ambient for all Electrical/ Mechanical Equipment</div><div>(b) Relative Humidity</div><div><div>i. Maximum during monsoon : 85%</div><div>ii. Minimum : 20%</div><div>iii. Average : 65%</div></div><div>(c) <u>Rainfall</u> Annual average rain : 720 mm Max. for one day : 115 mm Max. intensity : 38 mm/hr Period : June to September</div><div>(d) <u>Wind Speed</u><div><div>i. Prevailing wind : West, South-East, North-West, direction South-West</div><div>ii. Maximum mean wind : 15.9 Kms / hr speed (4.42 m/s)</div><div>iii. Average : 9.61 Km/hr (2.67 m/s)</div></div></div></div><div><div>11.0 Wind Load Calculations for wind effect shall be in accordance with IS:875- (Part-3) latest revision taking into account the following :</div><div><div>(a) Basic wind speed of 39 m/sec as given in Fig.1 of the code.</div><div>(b) Factor K1 shall be taken as 1.06</div><div>(c) Terrain category shall be 2 and corresponding values shall be taken for K2</div><div>(d) Factor K3 shall be taken as 1.0</div></div><div><div>12.0 Wind Loading for Stack</div><div><div>(a) For wind pressure as per clause 11.0 above</div><div>(b) For RC stacks as per IS: 4998</div></div></div></div></div></div>			

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13.0	Seismic data (as per IS:1893 latest issue)		
	(a)	Zone	: Zone III (as per IS:1893- latest)
	(b)	Importance factor (I)	: 1.75
14.0	Auxiliary power supply		

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<p>(h) AC solenoids, </p>			



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SPECIFIC TECHNICAL REQUIREMENTS



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1.0 SCOPE OF WORK

Design, engineering, manufacture, inspection and testing at vendor's/ sub-vendor's works, painting, forwarding, proper packing, shipment and delivery at site, unloading, handling & transportation at site, Erection & Commissioning, minor civil works as required, Performance and guarantee testing and handing over of Mill Reject Handling System as per details in different sections of this specification.

Detailed system write-up & control philosophy shall be furnished by the successful bidder during detail engineering & the same shall be subject to customer approval during detail engineering.

1.1 SCOPE OF SUPPLY

Scope of supply shall comprise of but not necessarily limited to the following:

- a) 16 nos. of pyrite hoppers complete with sizing grid, flexible/expansion joint at its inlet, rupture disc, by pass chute, oversize material chute, water spray nozzles & supporting structures.
- b) 16 nos. of pneumatic cylinder operated plate/ knife gate valve (200 Nb) with open and close limit switches at mill outlet/pyrite hopper inlet.
- c) 16 nos. of hand wheel operated plate/knife gate valve (200 Nb) at pyrite hopper outlet for pyrite hopper isolation with open and close limit switches for interlock.
- d) 16 nos. of pneumatic cylinder operated plate/knife gate valve (200 Nb) at oversize discharge chute of pyrite hopper provided with open & close limit switches for interlock with pyrite hopper inlet knife gate valve.
- e) 16 nos. of pneumatic cylinder operated plate/knife gate valve (200 Nb) at by pass chute of pyrite hopper provided with open & close limit switches for interlock with pyrite hopper inlet knife gate valve.
- f) 32 nos. (2 Nos. per pyrite hopper) of Level probes for pyrite hoppers.
- g) 16 nos. of Temperature Switches for pyrite hoppers.
- h) 16 nos. of transporter vessel / denseveyor complete with pneumatically operated dome/ material handling valve, Alloy CI outlet bend, local control panel etc.
- i) 16 sets of MS ERW Heavy grade pipe for mill reject conveying from denseveyor/ transporter vessel to Mill Reject Storage bunker.
- j) One lot of Alloy CI bends (400BHN).
- k) 4/suitable sets of terminal boxes (Two/suitable sets per unit) with up stand on bunker top for terminating the reject conveying pipes.
- l) Four (4) nos. mill reject bunker along with structure, complete with SS-409 lining(in conical portion) and pneumatic operated bunker discharge gate (with manual over ride) with canvas chute at bunker outlet , staircase, operating & maintenance platform, hand railing , bag filter, level probe(RF type level Probe), pressure relieve valve, chain pulley block with traveling trolley and monorail arrangement etc.



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- m) 4 nos. (2W+2S) oil free screw air compressor with drive motor, local control panel, instruments and all other accessories.
- n) Four (4) nos. conveying air receivers (i.e. two no. per unit) & one no instrument air receiver (for plant), complete with drain traps, safety relief valve, instruments and all accessories.
- o) Four (4) nos. fixed/portable type sump pump complete with suction (min 5 m long) & discharge hose (min 10 m long) for pumping out water drains from local pit to nearest plant drain, control panel, instruments and all other accessories.
- p) 1 lot of piping , fittings, valves & instruments for conveying air, instrument air, cooling water for dome valve top plate (if applicable), cooling water quenching in the pyrite hopper, cooling water for air compressor etc
- q) 1 lot of Local Control Panel/pneumatic panels/JBs (1 no. for each pyrite hopper) properly mounted on rack. (supplier's scope)
- r) 1 lot of insulation & cladding, if required, to maintain surface temperature of pyrite hopper within 60° C
- s) All structures including pipe cum cable rack required for supporting of various pipes in bidder's scope. Bidder may take support from existing mill bunker bay structures wherever possible.
- t) All insert plates, embedment plates, foundation bolts/ anchor bolts etc. required for bidder's equipment.
- u) Initial charge of all lubricants and fluids.
- v) Electrical and C&I scope as per enclosure elsewhere in the specification.
- w) One set of Erection & commissioning spares as required for the complete system.
- x) One set of special maintenance tools & tackles, if any. These tools shall not be used for erection/ commissioning purposes and shall be in an unused and new condition when they are handed over to the customer at site. Each tool shall be stamped so as to be identified easily for its use. The tools shall be supplied in a steel toolbox.
- y) All counter- flanges with nuts, bolts and gaskets at all the terminal points.
- z) Relevant scope of supply as per GTR, GCC & SCC.
- aa) Any other instrument, item required for making the installation complete in all respect within battery limits and for satisfactory operation of the system, unless specifically EXCLUDED from scope under Clause No. 2.0 below.
- bb) DCS based control system as specified in C&I specification.

1.2 SCOPE OF SERVICES

Scope of services shall include but not necessarily limited to the following:

- a) Unloading, Storage, handling and transportation at site
- b) Minor civil work like pinning, chipping of foundation, grouting supply of EPs/ insert plates etc.
- c) Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary instrumentation for pre-commissioning activities shall be arranged by the successful bidder at their own cost.



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- d) Erection & Commissioning of Mill Reject Handling System.
- e) Inspection & testing, PG test/Functional Guarantee (FG) test
- f) Painting of all equipment within the battery limit
- g) Electrical scope of services as per enclosure elsewhere in the specification
- h) Preparation of Civil input drawings & documents for foundation details (including load data, GA, foundation pocket details etc.) of storage bunkers/silos, compressors, air receivers, pipe rack and pit / trench details for denseveyor / transporter vessel and reject conveying pipes.
- i) Review of Civil drawings prepared by BHEL based on civil input drawing furnished by the successful bidder.
- j) Preparation of all necessary drawings/data/ documents for obtaining necessary approval of statutory authorities on behalf of the customer. Necessary fee for obtaining such approval shall also be borne by the bidder.
- k) Relevant scope of services as per GTR, GCC, ECC & SCC.
- l) Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system, unless specifically EXCLUDED from scope under Clause .No. 2.0 below.

2.0 EXCLUSION

- a) Civil work for Mill Reject Handling system including
 - i) Road approach for various facilities related to Mill Reject Handling System.
 - ii) Denseveyor/ Transporter vessel foundation
 - iii) Pit & Trench as required in mill bay
 - iv) Mill Reject compressor & Air receiver foundation
 - v) Mill Reject bunker foundation
 - vi) Various cable trenches, pipe pedestals & pipe rack foundation.

However, location, sizing and loads and any other input related to above as applicable for above shall be given by the successful bidder within 8 weeks of placement of LOI.

- b) Fire Protection system for compressor house
- c) Lighting of Mill bay, Compressor house & bunker area
- d) Electrical exclusion as per Electrical scope sheet enclosed elsewhere in the specification
- e) Relevant exclusion as per GTR, GCC, SCC & ECC.

3.0 SERVICES TO BE PROVIDED BY THE CUSTOMER

- (A) Instrument air: Tapping terminated with an isolation valve for Instrument air shall be provided at first column of each bunker bay or as intimated during detailed engineering, at pressure of 5-7 Kg/Sq cm.



- (B) Service water: Tapping terminated with an isolation valve for service water shall be provided at first column of each bunker bay or as intimated during detailed engineering, at pressure of 2.5 - 3 Kg/Sq cm.
- (C) Auxiliary Colling Water Water: Supply and return water Tapping terminated with an isolation valve for ECW circuit. Equipment water shall be provided at 5m from compressor at a pressure of 5 Kg/sq cm (Approx). Pressure drop will be of 10-12 MWC.

4.0 TERMINAL POINT

- Mill Reject inlet towards pyrite hopper side : Mill reject spout (tramp iron) as per details indicated in enclosed GA of Mills. Work downstream up to mill reject bunker outlet with canvas chute and discharge gate is by bidder.
- Mill Reject outlet towards road tanker : Mill reject bunker outlet with canvas chute. Bidder shall terminate his work with the canvas chute and lever operated discharge gate.
- Cooling water (ECW) : At Inlet & Outlet header at distance of 5m from MRS compressor house (Location)
- Service Water : At First Col of each mill bay
- Instrument Air : At First Col of each mill bay.

5.0 PERFORMANCE /FUNCTIONAL GUARANTEES & LIQUIDATED DAMAGES

PG /FG test shall comprise of

Category – I Guarantees (Liquidated damages are applicable for these guarantees).

- i) Guaranteed auxiliary power consumption for conveying air compressor(refer schedule-Vol III)

If the contractor is not able to demonstrate the guarantees, CLIENT/ BHEL will have the right to Reject the equipment / system / plant and recover the payments already made or accept the equipment / system after levying liquidated damages.

- ii) Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system.
- iii) Following shall be demonstrated at site for compressor
- Capacity and discharge pressure of each air compressor
 - Power consumption of each air compressor at its rated duty point with its own motor.

Category – III Guarantees



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- I. Guarantees of all equipment as per approved data sheet & quality plan.
- II. Particulate emission rate from bag filters less than 50 mg/nm^3 of air shall be demonstrated at site
- III. Vibration and noise level of each compressor and any other rotating equipment shall be demonstrated at site.
- IV. Parallel operation of air compressors, if applicable, shall be demonstrated at site.

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar, shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

In case during test it is found that the equipment/system has failed to meet the guarantees, the contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer. However, if the contractor is not able to demonstrate the guarantees, even after the above modifications/replacements within a reasonable period allowed by CLIENT/BHEL, after the tests have been completed, CLIENT/BHEL will have the right to Reject the equipment / system / plant and recover the payments already made or accept the equipment / system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by Client/BHEL.

6.0 ERECTION, PRE-OPERATIONAL TESTING/STARTUP & COMMISSIONING PROCEDURE

This shall be as furnished by the successful bidder during detail engineering for customer's review and acceptance.



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7.0 PAINTING/CORROSION PROTECTION REQUIREMENT

Successful bidder shall furnish detailed Painting Schedule for Mill Reject System (based on painting schedule attached with specification elsewhere) for customer / client approval during detail engineering

8.0 LAYOUT REQUIREMENTS

Piping and equipment installation shall be according to the regulations and recommendations of recognized Indian / International Standards, Codes and Statutes, as and where applicable, practice in vogue (to be supported with back up document to the satisfaction of customer)

The mill reject compressors will be located in Main Plant Compressor room. Area required for locating the same shall be indicated by the bidder in their bid.

9.0 EQUIPMENT DESIGN CRITERIA

9.0.1 The minimum design criteria to be followed for various equipment shall be as per requirements indicated under Annexure-II, standard technical specifications & Data Sheet-A for Mill Reject Handling System. In case of *any contradictory requirement* in specification of particular equipment, the requirement given in section C shall prevail over those indicated in Section-D. Further in case of any contradictory requirement within the same section and clarifications not having been sought by the bidders wrt the same within the stipulated period, the most stringent requirement as per interpretation of the customer will prevail. Successful bidder will furnish detailed data sheets/ specifications/design calculations for various equipment for customer/ consultant's approval during detail engineering. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.

9.0.2 Technical details (constructional features, MOC etc) of conveying air compressor, if being offered by any of the bidders, shall be finalized during detail engineering and the same shall be subject to customer's /client's acceptance without any commercial implication.

9.0.3 Properties of Mill Rejects to be considered for sizing /selection /design of various equipments shall be as follows:

Normal size	:	(-) 25 mm (about 90% of total reject)
Maximum size	:	50 mm (about 10% of total reject)
Temperature °C (Normal/Design)	:	180/200 (**)
Bulk density	:	1.6 T/m ³ for volumetric calculation
	:	2.4 T/m ³ for structural calculation

(**) Note: Mill Reject System design shall also consider the presence of occasional burning coal particles along with the rejects, which would increase the reject temperature.

Note: All pipe sizing and equipment sizing, capacity of pyrite hopper and pyrite vessel shall be subject to customer's approval during detail engineering without any cost implication to the customer.



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10.0 QUALITY PLANS, INSPECTION & TESTING PROCEDURE

All QPs / CLs shall be submitted by the bidder for Customer/Consultant's review and approval. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.

11.0 DRAWINGS/ DOCUMENTS REQUIRED WITH THE BID

The drawings and documents to be submitted with the bid shall strictly be as per clause 15.0.1 below. Any documents other than those indicated therein will not be reviewed and will not form part of contract.

12.0 DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

The tentative list of drawings and documents required (minimum) during detail engineering shall be as per clause 15.0.2 below. The list, however, will be finalized with the successful bidder prior to start of detail engineering.

13.0 DRAWING/DOCUMENT DISTRIBUTION SCHEDULE

Refer Volume III

14.0 DRAWINGS ENCLOSED WITH THE SPECIFICATION

The following drawings/ sketches enclosed will form part of the specification.

- a) Flow Diagram - Mill Reject Handling System
- b) Main Equipment Plan
- c) General Arrangement and Foundation of MILL
- d) Mill Plant Project

The flow diagram shows the minimum requirement to be followed including minimum requirement of instruments. Any additional equipment/instruments required for safe, efficient & reliable operation of the system within the battery limit shall also be considered as included in bidder's scope without any commercial/ cost implication to BHEL.

15.0.1 LIST OF DRAWINGS / DOCUMENTS TO BE FURNISHED ALONG WITH OFFER

Refer Volume III – Annexure V

15.0.2 LIST OF DRAWING/DOCUMENTS TO BE FURNISHED AFTER PLACEMENT OF LOI

Refer Volume III – Annexure VI

16.0 SPECIFIC C&I REQUIREMENT

16.0.1 The bidder will terminate all signals from instruments/sensors on each pyrite hopper/ transporter vessel on local control panel/ pneumatic panel dedicated to each pyrite hopper/ transporter vessel. Analogues & binary signals shall be terminated on separate Terminal boxes for wiring to SG C&I. Alternatively bidder may provide JB's for each pyrite hopper/denseveyor. In such case, separate JB's shall be provided for terminating analogue & binary signals.



TITLE:

**TECHNICAL SPECIFICATION FOR
MILL REJECT HANDLING SYSTEM****2X800 MW YERAMARUS TPS, KARNATAKA**

BHEL DOCUMENTS NO.: PE-TS-31 I -160-A001

VOLUME **II-B**

SECTION -C

REV. NO. 00

DATE:

Page

16.0.2 The bidder will terminate all signals from local & field instruments /sensors related to compressor on compressor control panel. Analogues & binary signals shall be terminated on separate terminal boxes for wiring to SG C&I. Alternatively bidder may provide JB's properly mounted on rack and local to the compressor for terminating field & local signals from compressor control panel. In such case, separate JB's shall be provided for terminating analogue & binary signals.

16.0.3 Signals from mill reject bunker, air receivers, service water & instrument air line shall be directly connected to SG C&I.



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SUPPLY CONTRACT AGREEMENT
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12.0 LIST OF DRAWINGS ENCLOSED



SYSTEM DESCRIPTION

1.1 MECHANICAL

1.1.1 Scheme of Mill Reject Handling

Dense phase pneumatic conveying system shall be employed for handling of the mill rejects as per **Enclosed drawing (E072-03-MRHS-M-03-01-R0)**. Each mill reject discharge hopper shall be fitted with a dense phase pneumatic conveying vessel which shall discharge the mill rejects through pipe lines into a storage 'silo' having a collection capacity of about 35m³ each. The transmitting vessel shall operate on level probe mode with timer back-up.

1.1.2 Mill Reject System

There are 8 numbers of mills for each steam generating unit. The configuration of the Coal Mills and silo location of each boiler unit is as per the **Enclosed drawing (E072-03-MRHS-M-03-01-R0)**. Each mill is provided with collection and transportation equipment comprising of one no. Pyrite Hopper with plate valves at inlet & outlet, sizing grid, oversize discharge chute, by-pass chute. Plate valve at bypass chute, plate valve at oversized discharge chute, water spray quenching system and a denseveyor or similar pneumatic bulk conveying equipment/vessel. Each vessel shall be connected to a storage silo via conveying pipeline of MS ERW Heavy Duty, welded ends and flanged joints at strategic points & bends of Alloy CI and a terminal box. Each mills are connected to a pipe line and are called one conveying stream hence there will be total of eight (08) nos. of conveying streams per unit. There will be two (2) nos. of storage silos each of about 35 m³ (55 MT) storage capacity per unit. The silo shall be of MS Construction (parent material 12mm thick) & 3 mm SS 409 Liner on conical portion shall be provided with One (01) no. Pneumatically/ motorized operated sector gate at its outlet to discharge mill rejects into the trucks as and when required. Mill reject silos will be located at suitable location.

1.1.3 Conveying Air System

2x100% (1W+1S) screw compressors for each unit with drives shall be housed in MRHS compressor house. Compressors for both the units will be housed in MRHS compressor house and shall be located at suitable



location between both the 800MW units. The compressed air system shall have one air receivers for each unit.

1.1.4 Instrument Air System

Instrument air requirement shall be met by taking a tapping from the Main plant instrument Air Header. Isolation Valves shall be provided at tapping point for isolation of instrument air pipeline of mill reject handling system. A separate receiver for instrument air of adequate capacity shall be provided for each unit.

1.1.5 Cooling Water System

Cooling water requirements of Conveying Air Compressor shall be met from DMCW circuit. Necessary pipe work-supply & return shall be provided in this system. One tapping for ACW circuit shall also be provided in DMCW circuit inlet and return line.

1.1.6 Pipe supports

The pipes in mill bay area shall be supported from mill bay columns wherever possible; pipes from/to compressors shall be taken on pipe rack to mill bay, utilizing pipe rack. However, where such pipe rack/structures are not available, Contractor shall provide independent pipe rack.

1.2 ELECTRICAL

1.2.1 Plant Area

Power Supply to Mill reject system shall be sourced from the nearby LT MCC of either Coal Handling or Ash Handling systems. Local Push Button Stations of all LT drives shall be provided with "Start / Stop PB" to enable Starting / Stopping of all equipment locally for maintenance purposes. Automatic changeover is considered for switchgears having two incomers and a bus coupler. All equipments body are earthed at minimum two points and connected to nearby station grid at minimum four points.

1.3 CONTROL AND INSTRUMENTATION

C&I system will consist of all local instruments Viz. Pressure Gauge, Level gauge, Temperature Gauge, all field sensors, local panel, push button station, erection hardware and interconnecting cables required for control & monitoring of the Mill Reject System. DCS based control systems shall be provided for operation, control, interlocking, tripping of the equipment/ system whenever required under specified abnormal conditions.



2.0 SCOPE OF WORK

- 1) The scope of supply and work for **Mill Reject Handling System** under the specification covers the design, engineering, manufacture, supply, assembly and testing at manufacturer's works, inspection, packing, forwarding, delivery FOR site, and handling, storage at site (i.e. taking delivery of materials from carriers, transportation to site), fabrication (as needed), construction, erection, commissioning, trial run, PG testing including painting protection of all items as specified hereinafter but without excluding any other necessary components, which are not mentioned herein but are required for the completeness and; efficient, easy and reliable operation of the system.
- 2) The supplier will provide the equipment including all necessary features, components, accessories, electrical and C&I accessories and appurtenances for efficient and reliable erection operation and maintenance whether mentioned in this specification or not. The equipment will consist of the following main components (however, not limited to the items listed).
- 3) All necessary tools and tackles required for the maintenance of the proposed system shall also be supplied along with mandatory spares.

2.1 MECHANICAL

The scope under this package shall be deemed to include all such items which although are not specifically mentioned in this section but are needed to make the system complete in all respect for safe, reliable, efficient and trouble free operation. The scope shall include but not be limited to followings:

- 1 Eight (8) Nos. of Pneumatic cylinder operated Plate valve, for each unit.
- 2 One (1) lot of RF Type Level Probes for Pyrite Hopper High / Permissive for each unit.
- 3 Eight (8) Nos. of manual Operated Plate Valve at Pyrite Hopper outlet of each unit.
- 4 Eight (8) nos. of pneumatically operated Plate valve at over size discharge chute of Pyrite Hoppers of each unit.
- 5 Eight (8) nos. of pneumatically operated Plate valve at By Pass chute of Pyrite Hoppers of each unit.



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- 6 Eight (8) nos. of Denseveyor/Mill reject transporter complete with Dome valve/butterfly valve/material inlet valve and Pneumatic Panel for each unit.
- 7 One (1) lot of Terminal Boxes.
- 8 Two (2) nos. steel construction Mill Reject Storage silos i.e, one no silo for a set of four mills for each unit.
- 9 One (01) no. pneumatically/motorized operated sector gate at each silo outlet, with provision of hand wheel operation.
- 10 One (1) no. Bag Filter on each silo top with associated instruments.
- 11 One (1) no. of RF Type Level Probes for high Level in each silo.
- 12 One (1) no. Pressure Relief valve for each silo.
- 13 MS ERW Pipes for Mill rejects conveying and associated Ni-hard bends.
- 14 Two (2) nos. (1W+1S) of conveying air screw compressors for each unit.
- 15 Two no. of conveying Air Receivers of adequate capacity with instruments & accessories shall be installed for each unit.
- 16 One Lot of Pipe work for conveying Air and Instrument Air application, complete with valves, fittings, temperature / pressure gauges, pressure switches and other instruments.
- 17 One Lot of Pipe work for compressor cooling with DMCW circuit complete with valves (including isolation valves at terminal point), fittings, temperature/pressure gauges, pressure switches and other instruments.
- 18 One Lot of Pipe work for compressor cooling with ACW circuit complete with valves (including isolation valves at terminal point), fittings, temperature/pressure gauges, pressure switches and other instruments.
- 19 Contractor to include all structural works for steel silos, pipe racks, supports including pyrite hoppers, supports, galleries/walkways etc. Foundation for trestles, storage silos, compressors, receivers with cable trenches are included in the contractors scope.
- 20 Suitable spray quenching system, solenoid operated spray nozzle to cool reject in the pyrite hopper and cooling water line for dome valve top plate cooling (if applicable).
- 21 Adequate No. of lifting devices of minimum one (1) ton capacity to handle the mill reject handling equipments at silo top.
- 22 Suitable ventilation system for the MRHS compressor house.
- 23 Air conditioning to be provided for control room of MRHS and wherever DCS/RIOPs are located.



2.2 ELECTRICAL

2.2.1 Scope and Brief Description of Work

2.2.1.1 The scope of Contractor shall include Engineering design, manufacture, inspection, supply including transportation to site, transit insurance, storage at site, transportation from place of storage to erection site, erection, testing and commissioning and handing over in fully operable condition satisfactory to Owner of all electrical equipment required for the Mill reject Handling System for 2X800 MW Yeramaras Thermal Power Project, besides obtaining all statutory clearances such as clearance from chief Electrical inspector to Government including furnishing of all Drawings, data etc. to the satisfaction of the statutory authorities shall be in the scope of the Contractor. The entire cost including all necessary fees, incurred for obtaining such approval / clearances, shall be borne by the contractor.

2.2.1.2 **Control Panel / JB/ PB** – Control panels pertaining to Mill reject, Local start / stop PB for all motors, as well as PB's and JB's required to meet requirements shall be provided. All outdoor JB's shall be of FRP / die cast aluminum make with canopy, IP-65 degree of protection. Local push button stations will be with IP-65 with canopy for outdoor use and IP-54 for indoor applications.

2.2.1.3 **Cable & Cable Carrier System** – shall consist of but not limited to the following:

- a) One lot LV Power, control, Instrumentation, trailing cable and any other special cables required for proper operation, monitoring and control of the MRHS system. Sizing of the cable is to be designed as mentioned in the specification.
- b) Cable raceway system consisting of cable racks, cable trays, Cable rack / tray supporting structures, support members / channels for cable trays, cable tray covers, cable trenches, Duct Banks, conduits, pipe sleeves, hume pipes, associated foundation and civil works, cable tray accessories, etc., as required.
- c) Cable laying and cable termination including all necessary accessories like cable termination kits, cable jointing kits, glands, lugs, tools for termination, ferrules, identification tags etc.,
- d) Necessary fire protection systems like fire barriers, fire breaks, fire stops, and fire proof sealing for wall/floor openings (after laying of all cables) and fire protective coating systems etc., as necessary.



- 2.2.1.4 All the above items and any other item required for completing the Cable carrier system shall be provided for the entire MRHS.
- 2.2.1.5 **Primary and Secondary Earthing and Lightning protection system:** For the entire MRHS System area, buildings, etc., complete with buried peripheral earthing and earth electrodes or earth pits for the entire area shall be provided in this package. This shall include earthing conductors buried in soil, earthing conductors embedded in concrete inside the buildings, equipment earth conductors, treated earth pits, earth rods, all above ground earth conductors to which all the electrical equipment & metallic structures are connected to have earth continuity for safety reasons. The primary earthing shall be interconnected with the main grid at minimum four points. The system is to be designed in such a way that the earth resistance is less than 0.5 ohm when it is isolated from the main earth grid.
- 2.2.1.6 Lightning protection (as applicable) complete with vertical air termination rods, horizontal roof conductors, down comers, test links and pipe electrodes shall be provided for all structures for which the safety norms dictate requirement as per relevant standards.
- 2.2.1.7 **Special tools and tackles** as required for installation, operation and maintenance of electrical equipment shall be supplied.
- 2.2.1.8 **Essential and Start-up spares** for all equipment shall be included in the scope. Contractor shall furnish a comprehensive list of the same.
- 2.2.1.9 **Control room alarms/indications/SER points:**
- a) Remote Control, monitoring, alarm and indication for the electrical system such as switchgears, transformers, DC system etc shall be from DCS system provided in the MRHS control room. All Control, Digital & Analog signals as required shall be included and shall be subject to approval by owner during detail design stage. All necessary communication protocol shall be taken care by contractor.
 - b) Control, monitoring, measurement and annunciation of complete electrical system shall be possible from MRHS control room DCS through HMIs. Control of MRHS equipment/motor breakers shall be possible from DCS and the same shall be linked with plant DCS located in the main control room for monitoring. Remote position, service position, breaker healthy i.e. trip circuit healthy, spring charged (as applicable), reset position of trip relay, other permissives, interlocks, etc., shall be considered as input to DCS system.



c) The operation, indications and fault alarms for the motors of the auxiliaries shall be displayed.

2.2.1.10 Any other electrical equipment which are not specifically listed above but are required to make the MRHS complete in all respects as per specification shall be included in the scope of work.

2.2.1.11 The scope shall also include preparation and submission of all required drawings (as applicable) for Owner's approval not limited to:

- i) Protection and metering One Line Diagram clearly indicating the detailed protection and instrumentation provided by the vendor.
- ii) Layout drawings – Electrical equipment layout drawings including General Arrangement layouts for MRHS areas/ buildings/ equipment, Cable tray and trench layout drawings, lighting layout drawings, Earthing & Lightning Protection layout drawings including earthing details etc., as required by Owner with all supporting calculations and documentation.
- iii) Scheme drawings for all Switchgear / MCC /Motor modules/Control Panels.
- iv) Block Logic Diagrams for 11, 3.3 kV & 415 V systems.
- v) Vendor drawings for all equipments covered in the scope.
- vi) Relay Setting calculations, relay co-ordination studies, largest motor starting study and recommended relay settings.
- vii) Foundation drawings with supporting calculations.
- viii) The scope shall include submission of all required design calculations for the following:
 - o Cable Sizing –All Power Cables.
 - o Voltage Dip Calculations.
 - o Earthing Conductor and below and above ground earthing sizing.
 - o Lightning Protection System Design

2.2.1.12 The contractor shall include all the required schedules including the following in the scope:

- Drawing control schedule
- Cable Schedules – For all Power, Control and Instrumentation Cables.
- Interconnection cable Schedule for all cables supplied and installed by contractor.
- Relay setting schedules
- Procurement schedule etc



2.2.1.13 Data Sheets for all equipments included in the scope shall be submitted for review & approval by Owner.

2.2.1.14 MQP & Field Quality Plan (FQP) are to be submitted for Owner's approval.

2.3 CONTROL AND INSTRUMENTATION

1. The operation & control of Mill Reject System shall be performed from its own dedicated DCS based system for each unit and located in common Mill Reject System control room for both units & local panel in a completely integrated manner. Mill Reject System DCS and associated peripherals shall include following as minimum:
 - a) Redundant processor, redundant communication controller, redundant power supply modules, data bus at all level, I/O cards, one no. 21" TFT based operator work station, one no. 21" TFT based operator work station cum engineering station with dedicated keyboard, printers and Time synchronisation facility with plant GPS master clock (time format shall be as per GPS master clock requirement including cabling and termination upto main plant DCS/GPS) shall be provided for Mill Reject System. For more details regarding number of HMI, Printers, LCD/TFT display units and others contractor shall refer MRS DCS configuration diagram **E072-03-MRS-I-03-08-R1**.
 - b) One no. A3 colour medium speed laser and one no. high speed (132 columns) dot matrix printer shall be provided in common Mill Reject System control room.
 - c) Modular control desk for operator and standard make furniture.
 - d) Bidirectional high speed Redundant TCP/IP fast Ethernet connectivity with plant DCS for monitoring including cable, both side required hardware/software are under contractor scope. Contractor shall also co-ordinate with Main Plant DCS supplier for achieving suitable interface between Mill Reject Handling System DCS and Main Plant DCS.
 - e) Few hardware signals exchange between MRHS DCS and DCS provision has to be made.
2. All junction boxes, local push button stations, all Interconnected cabling between sensors to I/O card, card to DCS system operator station, Instrumentation/ special cables/ RTD cables/ pre-fabricated cable/ earthing cable, cable glands, Lugs, ferrules, cable trays, conduits, instrument racks,



impulse/ air supply pipes/ tubes, erection hardware, instrument isolation valves, instrument fittings (double compression type) and other accessories within battery limits.

3. All field instruments/ / sensors/ switches, final control elements with actuators as per finalised P&IDs, schemes, operation & control philosophy & logics approved during detailed engineering stage within the Mill Reject System package.
4. Hopper/Silo level switches and other sensors.
5. Licensed software required for complete DCS operation as well as for interface of Mill Reject System DCS with plant DCS.
6. Redundant UPS power supply requirements & conversions to required voltage levels and further distribution of entire Mill Reject System shall be in the scope of contractor.
7. DCS I/O cards and relays for control and monitoring of all instruments, drive and equipment are housed in air-conditioner environment (room/enclosure).
8. Any other item not covered herein but essential for successful installation and commissioning of the Mill Reject System and integrity of the system shall be included by the contractor.
9. All necessary Vendor/Drawing/documents shall be subjected to approval from Owner.

2.4 CIVIL

1. The work to be performed under this specification include all civil and structural works for the mill reject system and shall generally comprise (but not limited to) all necessary survey, investigation, detailed design and preparation of detailed drawings including getting the same approved by owner's consultant for construction, fabrication, erection as per approved drawings and specification, supply of materials and labour etc., for the following:
 - Mill Reject conveying pipes shall be routed taking support of mill bay column.
 - Foundations for mill reject silo within junction tower area.
 - Foundations for equipments like compressors, pumps, air receivers etc.
 - Trenches to house mill reject equipment like conveying vessel, pyrite hopper etc.
 - Trenches near mills for accommodating dome conveyor with pipes.



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- Construction of common control room and common compressor room with necessary foundations and cable trenches.
 - RCC pavement in silo area and necessary drainage arrangements in the area leading to the nearest plant drain.
2. Fabrication & erection of mill reject silo and other structural steel fabrication/ erection work is covered under mechanical section of the specification.



3.0 TERMINAL POINTS AND EXCLUSIONS

3.1 TERMINAL POINTS

For terminal points please refer, Ammendment No-2 of LOA No: RPCL/TDY/BHEL/02. Dated: 09.04.2010 and RPCL/TDY/E/BHEL/03 Dated: 09.04.2010

3.1.1 Mechanical

- One point from nearest DMCW circuit for compressor cooling
- Service water line at one point one meter away from Mill reject Compressor house.
- Main plant instrument air header for Instrument air piping of Mill reject handling system.

3.1.2 Electrical –

- Uncabled breaker terminals of nearby CHP or AHP LT switchgear of Unit 1 and Unit 2
- Uncabled feeder terminals of nearby CHP or AHP LT switchgear for UPS power supply
- Nearby station earth grid at minimum four (4) points.

3.1.3 Control and instrumentation

1.	Critical MRHS Signals	Critical MRHS signals shall be made available in main plant DCS through maxNET.
2.	SOE – Points for MRHS	Critical MRHS signals shall be made available in main plant DCS through maxNET.
3.	Interfacing Cable for MRHS DCS with main plant DCS	All required software/hardware, cable (including laying and termination) up to main plant DCS system.

3.2 EXCLUSION

No Exclusions



4.0 TECHNICAL REQUIREMENTS

4.1 MECHANICAL

Following parameters shall be considered for designing the mill reject handling system:-

1.	Duty	Continuous
2.	Number of mills working per boiler at 100%BMCR (with worst coal)	7W+1S
3.	Design extraction rate of mill reject from pyrite hopper	1.0% of coal consumption at 100% BMCR considering worst coal or 0.80 TPH per Mill.
4.	Design Maximum size of mill reject to be handled	(-) 40mm
5.	Bulk density of mill rejects for volumetric computation	1600 kg/m ³
6.	Bulk density of mill rejects for loads/strength computation	2400 kg/m ³

4.1.1 Mill Discharge Spout and Pyrite Hopper

4.1.1.1 Each coal mill has a discharge spout with an Air electric cylinder operated knife gate valve for discharging rejects into a pyrite hopper of adequate capacity. This hopper shall serve to store the mill rejects between each operating cycle of dense phase system. Minimum effective storage capacity shall be two to three cycles.

4.1.1.2 Each pyrite hopper shall be provided with air cylinder operated plate/ dome type valve of approved design at the bottom, adequately sized manhole/ inspection door, impingement deflector plate, sizing grid and emergency chute with manually operated flap gate. Any platform required to maintain the above equipment shall also be provided. One (1) no. manually operated gate valve shall also be provided before pneumatically operated plate/ dome valve. Necessary explosion vent of proven design shall be provided in each pyrite hopper.

4.1.1.3 Each emergency chute shall be provided with a pneumatically operated gate valve with provision of manual hand wheel to transfer mill rejects



from pyrite hopper to ground or to Owner's trolley. The gates shall be of robust construction and suitable for trouble free operation. The lever / gear wheel arrangement for manual operation shall be designed such that minimum effort is required to operate the gate. Necessary access and platform shall be provided.

4.1.1.4 Each pyrite hopper shall be provided with two level switches – one to start the operating sequence and the other to indicate the high level of oversize particle over grid.

4.1.1.5 The sizing grid shall be provided inside the pyrite hopper to prevent oversized mill rejects, tramp iron etc, from entering the conveying vessel. The pneumatically operated plate/knife edge valve with provision of manual hand wheel shall be provided from safety aspect as reject shall be hot. The arrangement shall be finalized during detail engineering. The grid shall be made of minimum 10 mm dia. M.S. bars IS-2062 with clear opening to allow only (–) 40 mm size mill rejects to pass through.

4.1.2 Mill Rejects Valves

4.1.2.1 Valves isolating pyrite hopper and mill rejects conveying vessel shall be of plate type, pneumatically operated, quick opening and closing remote controlled design. The valve shall be of reliable and proven quality. It shall be possible to operate it cutting through the material flow. These shall be provided with proper sealing arrangement such that whenever the material is being conveyed from vessel to the silo, there shall not be any leakage of air from vessel to pyrite hopper/ atmosphere. Solenoid valves and air piping shall be included in contractor's scope, 'Open' and 'close' limit switches shall be provided for panel indication of open/close status of valve. For isolating downstream equipment from pyrite hopper, a manually operated gate valve shall be provided above pneumatically operated plate/ dome valve.

4.1.2.2 The valves shall be tested hydraulically to a pressure of minimum of 1.0 time (for seat) and 2.0 times (for body) the maximum pressure encountered. Air tests shall be conducted to detect seat leakage.



4.1.2.3 Material of Construction

- a) The valve components shall be suitable for trouble free operation while handling hot mill rejects.

Body	C.I. IS:210/Grade 260
Dome / Plate	Alloy C.I. /Stainless steel (Min. 350 BHN) with leak proof seat
Shaft	Stainless steel (AISI : 316)

- b) Suitable Control valves and pneumatic actuators details shall be as provided.

4.1.3 Compressed Air Line Valves

- 4.1.3.1** Remote actuated main valves on compressed air pipe lines shall be pilot operated solenoid pneumatic cylinder operated 100% leak proof valve.

- 4.1.3.2** Spring balanced two/ three position control valve to actuate the pneumatic cylinder of main valves shall be either solenoid operated or pilot air pressure operated. In addition, mechanical lever for manual operation of valves shall be provided Material of construction is subject to approval during detail engineering stage. Material of construction shall have minimum surface friction and shall be rust and weather proof.

- 4.1.3.3** Pneumatic actuators shall be completely enclosed type, double acting. The pneumatic cylinders for operation of valves shall be selected considering minimum 3 Kg /cm² (g) inlet pressure. Material of construction shall be stainless steel. Integral micro limit switches for 'OPEN' or 'CLOSE' position shall be provided. External pointer for valve position and manual operation facility shall be provided.

- 4.1.3.4** The main valves shall be tested hydraulically to a pressure of minimum 1.5 times (for seat) and 2.0 times (for body) the maximum pressure encountered. Control valves and pneumatic cylinders shall be tested to a pressure of minimum 1.5 times the maximum pressure encountered.



- 4.1.3.5 Above valves shall meet the requirements of international/ Indian Standard Codes. Contractor shall clearly indicate in his offer the applicable standard / code.
- 4.1.4 **Conveying System**
- 4.1.4.1 From each surge pyrite hopper Mill Rejects shall be pneumatically conveyed along with a pipe line in dense phase using a pressure vessel (conveying vessel) as discharge device. Conveying vessel shall be of bottom discharge type.
- 4.1.4.2 Supply pressure of compressed air shall be in the range of 5–7 kg/cm² (g). Suitable pressure adjustment device shall be provided by the Contractor before each conveying vessel to obtain the required pressure in the conveying vessel.
- 4.1.4.3 Mill Rejects shall be conveyed in the pipe line in intermittent mode i.e. conveying vessel is filled up periodically and all the contents of conveying vessel are emptied at a time. Conveying system shall be idle till sufficient mill rejects are accumulated in surge hopper. This shall be repeated cyclically. Number of cycles of discharge per hour shall be optimised for minimum air consumption considering 0.80 T/hr in flow of Mill Rejects into surge pyrite hopper.
- 4.1.4.4 Bulk mean velocity of material in the conveying pipe line shall be between 3 – 6 meters/sec. Average velocity shall be computed from actual cycle time and length of piping (material travel path) during a number of conveying cycles.
- 4.1.4.5 Guaranteed Bulk mean solid / Air weight ratio shall be as per proven design practice, which shall be discussed and finalized with the Owner.
- 4.1.4.6 Once optimum quantity of mill rejects are collected in the surge pyrites hopper, first level switch shall give cycle initiation signal to various valves. Sequential operation of various valves to complete the conveying cycle shall be effected by either pneumatic controls or solenoid valves with relay based controls or a combination of both. However, complete pneumatic controls shall be provided for the Mill Reject inlet valve to conveying vessel, to close with a time delay after opening. In case the first level switch fails to operate, another level switch provided slightly



above the first one shall give an alarm to the operator indicating failure of the first level switch.

4.1.4.7 All the pneumatic and solenoid valves associated with each surge pyrite hopper conveying system shall be mounted locally in a water and dust tight enclosure. Degree of protection of enclosure shall conform to IP-54. Manual operation of the system from local shall be possible from this valve enclosure in case of failure of remote operation system.

4.1.4.8 Pneumatic conveying system shall be designed to empty even the completely filled up surge pyrite hopper through conveying vessel in a number of automatic conveying cycles.

4.1.5 Conveying Vessel

4.1.5.1 Conveying vessel shall be designed and tested based on BS/ASTM standard for pressure vessels. Temperature of the Mill Rejects coming into the conveying vessel shall be considered at 200°C. Design pressure shall be the maximum pressure the vessel is subjected to during any operating condition. In any case it shall not be less than 10 Kg/cm² (g).

4.1.5.2 The conveying vessel shall be constructed with tested quality mild steel plates. They shall withstand the abrasive action and hot condition of mill rejects and the operating air pressure. The conveying vessel shall be supported independently on steel columns.

4.1.5.3 The vessel shall have suitably located and adequately numbered air connections for supply of compressed air for conveying mill rejects through pipes to overhead silo.

4.1.5.4 The isolating valve at the top of vessel and the outlet bend piece at the bottom of the vessel shall be connected to vessel through air tight flanged joints. The material of construction for the outlet bend shall be alloy C.I. with minimum 400 BHN.

4.1.5.5 Conveying vessel shall be tested hydraulically for 1.5 times the design pressure.



4.1.6 Mill Rejects Conveying Piping, bends Fitting and Accessories

4.1.6.1 Minimum 125NB, 5.4 mm thick ERW steel pipe as per IS: 1239. Heavy class shall be supplied for mill rejects conveying piping.

4.1.6.2 The pipe work shall be of such design as to enable quick dismantling repairs with flanged type joints. The flanges shall be slip on flat faced flanges as per ANSI B16.5 rating, fabricated out of carbon steel plates to IS : 226 / IS:2062 / applicable International Standards. Gaskets shall be of compressed asbestos fibre with minimum 3 mm thickness.

4.1.6.3 All fittings (i.e. bends, specials etc.) used in the lines shall be as per good engineering practice, commensurate with the service conditions. The material of construction of fittings shall be alloy C.I. with minimum hardness of 400 BHN.

4.1.6.4 The specification includes the supply of all steel hangers supports and steel pipe bridge for routing of mill rejects piping. Mill rejects piping in the coal mill area may be supported on purchaser's columns / floor.

4.1.7 Mill Rejects Storage silo

4.1.7.1 The reject silo shall be fabricated out of minimum 12 mm thick steel plates with adequate stiffeners. The minimum valley angle of silo shall be 60deg. The inside surfaces shall be provided with removable 3 mm thick stainless steel SS 409 plate liners in conical portion. Explosion diaphragm/pressure relief valve shall be provided to release the air from the silo, in case the pressure exceeds 1.0 Kg/cm²(g).

4.1.7.2 The silo shall be sized at least to above mentioned capacities and shall be designed & located such that they can be emptied from bottom into Owner's trucks (10T capacity) at regular intervals.

4.1.7.3 Access and platform shall be provided with 32 mm thick MS grating 32 NB GI pipe hand railing shall be provided wherever required.

4.1.7.4 Pneumatically/electrically operated shall be provided at the mouth of each reject silo. Gate shall be double pivoted sector type. Suitable levers, pulleys /sheaves, ropes etc. shall be provided for operating the gate from the operating platform and ground level. The gear shall be made of cast steel and suitably hardened. The gate shall be designed for heavy duty application.

4.1.7.5 Suitable vent with filters shall be provided at the top external to the silo. Vent filters shall have adequate number of bags made from synthetic



fabric suitable for coal dust. Maximum air to cloth ratio ($\text{NM}^3/\text{min}/\text{M}^2$) shall be considered as 1.0 with isolation of 10% bags. The material of filter bags shall be suitable for prolonged operation up to a temp of 200°C without losing its collection efficiency and durability. Filter bags shall be suitably treated to minimize the chances of filter bags catching fire. It shall be possible to plug opening for the damaged bag filters, if any, to facilitate uninterrupted operation of the unit. The guaranteed particulate emission rate from the filter shall not be more than $50 \text{ mg}/\text{Nm}^3$ of air. Sequential cleaning cycle shall be initiated with pressure drop signal across the bag filter once sufficient cleaning air pressure is available. Solenoid/pneumatic valves shall be provided for this purpose.

4.1.7.6 Bag cleaning mechanism shall be automatic, and shall comprise of solenoid valves, air nozzles, adjustable solid state timer, pressure switches, piping and fittings etc. Nozzles shall be placed just above the filter bags to facilitate individual cleaning of each bag.

4.1.7.7 The reject conveying pipes shall be terminated at the top of silo in individual terminal boxes. The terminal boxes shall be of steel construction with necessary deflector or impingement plate to take care of impact and wear due to high velocity reject particles discharging into the silo.

4.1.7.8 The silo, supporting structures etc. shall be suitable for storing hot reject particles at 200°C .

4.1.7.9 One (1) no. level switch shall be provided in the silo to indicate 'silo Full' condition.

4.1.8 Air Line, Cooling Water and Drain Piping, Valves, Fittings and accessories

4.1.8.1 Piping

- a) The Contractor shall work out the sizes of air piping for the various services and pipe sizing data to the 'Owner' for approval.
- b) All pipes shall be tested hydraulically after installation to minimum 1.5 times the maximum pressure encountered.



- c) The compressed air piping shall be as per IS: 1239 Heavy Grade.
- d) The water piping shall be as per ASTM-A-36/ASTMA-53 Type 'E' Gr. B/IS:3589/IS:1239.
- e) For compressed air piping for instrument and control following standard shall be adopted.

Size between 25 NB to 50 NB – Galvanized and as per IS1239 Heavy grade.

Size below 25 NB – Galvanized and as per IS1239 Heavy grade.

- f) Following line velocities shall be assumed for estimating pipe sizes :

Pipe Sizes		Velocity m/sec.		
		Below -50mm	50-150mm	200mm and up
Compressed Air				
i)	Pressure below 2Kg/cm ² (g)	15-20	20-30	25-35
ii)	Pressure above 2Kg/cm ² (g)	20-30	25-40	35-45
Water		1.2-1.8	1.8-2.4	2.1-2.5

- g) Screwed couplings shall be used.

4.1.8.2 Valves

- a) Code and Standards:
 - IS : 778 – Gunmetal gate, globe and check valves for general purpose.
 - IS : 780 – Sluice valve for water works purposes (50 to 300mm)
- b) Any other BS or equivalent international standard.
- c) For valves of 40 mm size and above and up to a working pressure of 10 Kg/cm²(g) :

i)	Type	– Bolted bonnet, outside screw and yoke, rising stem, flat faced flanged eng.
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ii)	Material of construction	–	Body – Cast iron (IS: 210 Gr. 25) with 0.30% max. (P) and 0.12% max. (S) Trim & Stem – Gun metal
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- d) For valves below 40 mm size and up to a working pressure of 10Kg/cm²(g):

i)	Type	–	Union bonnet, rising stem, screwed end.
ii)	Material of construction	–	Body –Gun metal, Trim & Stem – Gun metal

- e) All valves will be tested hydraulically to minimum 1.5 times (for body) and 1.0 times (for seat) the maximum pressure encountered Air tests shall be conducted to detect seat leakage.

4.1.9 Air Compressors (including Intake Filter and Silencer, Intercooler)

4.1.9.1 Air Compressors

Air Compressors shall comply with the following requirements and will cater to the conveying air & instrument air requirement of the mill reject handling system:

4.1.9.2 Type

The type of Compressors will be **Oil Free, Multistage Screw Compressors**.

4.1.9.3 Discharge Pressure

Discharge pressure shall be selected as per vendors proven design.

4.1.9.4 Drive Motor Rating

The drive motor rating should be at least 15 % more than the maximum power demand of compressors.

4.1.9.5 Noise Level

Noise level should not exceed 85 dBA when measured at distance of 1.0 meter from compressor and at a height of 1.5 m above the floor.

4.1.9.6 Duty

To be designed for continuous, Load Unload & On–Off mode operation.



Parallel operation of one or more compressors shall be possible without any undue vibration & noise.

4.1.9.7 Site Design Data

(a)	Ambient air temp	45.6°C (max)/14.6°C (min)
(b)	Ambient relative	11% (min) & 70% (max)
(c)	Design condition for air compressor sizing	45°C & 75% RH
(d)	Altitude	360 m above MSL

4.1.9.8 Material

The material of various components shall confirm to the applicable BIS/BS/ASTM/DIN standard or any other reputed standards.

Refer **Data sheet-A** for material details of various components of compressors

4.1.9.9 Design/Construction

- i) Compression chamber Wall Thickness to withstand maximum design pressure.
- ii) Casing with a large inlet port for fast filling and low air velocity.
- iii) To provide suitable arrangement for cleaning of the cooling water jackets during maintenance of compressor.
- iv) Dynamically balanced, one piece Rotors with asymmetric profile, to keep leakage losses to a minimum and ensure high efficiency.
- v) Rotor shaft mounted, oil lubricated, highly precise timing gears shall be designed to counter act the axial forces incurred in compression.
- vi) Shaft Seals of floating restrictive ring type design.
- vii) The shaft seal rings and retainers shall be free for radial self-adjustment on the rotor shafts.
- viii) Minimum design service factor for the Integral, oil lubricated type, step-up Gear Box shall be of 1.5.
- ix) To provide safety valves on low pressure and high pressure stages.
- x) A direct driven positive displacement type oil pump connected to the main drive shaft is preferred. Alternatively a separate motor driven oil pump may be provided.
- xi) The lubrication system to include oil pump, oil filter, oil cooler and oil tank/sump.



- xii) Cooling shall be by closed circuit De-mineralized water.
- xiii) Drive shall be directly coupled, constant speed squirrel cage induction motor.

4.1.9.10 Accessories

Each compressor to include Suction filter, silencer Intercooler with moisture separators, automatic drain traps, instruments, Control panel Base plate, Coupling guard, Foundation bolt, nuts, ant vibration pads, Eye bolts and operation and maintenance tools.

4.1.9.11 Intake Filter and Silencer

Intake Air Filter & Silencer shall comply with the following requirements:

- a) Performance
 - (i) Filtering efficiency should be minimum 99% to 10 microns.
 - (ii) Maximum pressure drop across filter at design flow rate in new condition be 250 mm of Water column.
 - (iii) Design Airflow rate corresponding to compressor airflow.
- b) Type/Design

Heavy-duty type
- c) Construction
 - i) To provide densely packed, replaceable type paper as filtering media.
 - ii) Filter to be designed to have sound suppressing characteristics.
 - iii) Preferable filter & silencer should be combined type.
 - iv) Filter to take suction from outside & not from compressor room.

4.1.9.12 Intercooler

Inter cooler and after cooler shall comply with the following requirements:

- a) **Performance**
 - i) Outlet temperature of air from intercooler to suit the equipment offered.
 - ii) Outlet temperature of air from inter cooler should be limited to 10 °C of inlet cooling water temperature.
- b) **Type**

Plate Type Heat Exchanger



c) Construction

- i) Design pressure in airside: 2Kg/cm² more than air inlet pressure.
- ii) Design pressure in waterside: Not less than shut off head of DM cooling water pump.

4.1.9.13 After cooler

After cooler shall comply with the following requirements:

4.1.9.14 Performance

- i) Outlet temperature of air from after cooler to suit the equipment offered.
- ii) Outlet temperature of air from after cooler should be limited to 10 °C of inlet cooling water temperature.

4.1.9.15 Type

Shell and tube type

4.1.9.16 Construction

- i) Design code: TEMA Class 'C' or equivalent.
- ii) With removable tube bundle type.
- iii) With internal baffling.
- iv) Design pressure in airside: 2Kg/cm² more than air inlet pressure.
- v) Design pressure in waterside: Not less than shut off head of DM cooling water pump.

4.1.10 Air Receivers

4.1.10.1 The design, manufacture and performance of air receivers shall be in accordance with the latest applicable Indian / British / American / DIN standards. The latest editions of the following shall be followed in particular:

IS : 2825 – Code for unfired pressure vessels.

ASME – Section – VIII, Division – 1.

BS – 487 – Fusion welded steel air receivers.

IS: 7938 – Air receivers for compressed air installation.



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- 4.1.10.2** The materials of the various components shall conform to applicable IS/BS/ASTM/DIN standards.
- 4.1.10.3** The air receivers shall be vertical self-supporting cylindrical vessels with supporting stands for resting on the civil foundation.
- 4.1.10.4** The receiver shall be designed as per IS:7938.
- 4.1.10.5** Receivers shall be of welded construction with a minimum number of joints. Longitudinal seams in adjacent sections of shell shall not be in the same line.
- 4.1.10.6** Receivers shall be provided with gasket inspection openings.
- 4.1.10.7** Receivers below 500 mm diameter shall have at least two inspection holes. For receivers of larger diameter, one manhole of minimum 450 mm diameter shall be provided. These openings shall be placed as far as possible from any welded seam and in no instance shall pierce any seam.
- 4.1.10.8** All welding shall be performed in accordance with relevant codes. Filler material that will deposit weld metal with a composition and structure as near as that of the material being welded shall be used. All welding electrodes shall be got approved by the Owner. The electrodes shall be dried in ovens immediately before use to ensure freedom from porosity. All the circumferential and longitudinal butt welds of the air receiver shall be subjected to 100% radiography in accordance with IS:2825. Tee joints and dished welding shall be subjected to 100% radiography.
- 4.1.10.9** All other welding on the air receiver, including fillet weld and nozzle connection shall be DP tested as per IS:2825.
- 4.1.10.10** Each finished receiver complete with all welded attachments shall be hydraulically tested at 150% of the design pressure. The test pressure shall be maintained for at least 30 minutes. All joints shall be gently hammered during the test.
- 4.1.10.11** Receivers shall be provided with relief valve of the capacity and set pressure as necessary. The spring in the relief valve in service for pressure upto and including 250 psi shall not be reset for any pressure more than 10% above or below the design set pressure. For higher



pressures, the spring shall not be reset for any pressure more or below 5% design set pressure.

4.1.10.12 Each air receiver shall be complete with drain connection of 25 mm NB with a trap station consisting of a trap, strainer, isolation and bypass valves.

4.1.10.13 The receiver shall be provided with necessary number of nozzles. The orientation of the nozzles shall be subjected to the approval of the Owner.

4.1.10.14 Local instruments like pressure gauge and thermometer of suitable range if asked for in the data specification sheet shall be supplied.

4.1.10.15 The Contractor will have all welding procedures & welders qualify in accordance with the relevant codes prior to commencing any welding at the works.

4.1.10.16 These tests will be witnessed by Owner's representative.

4.2 ELECTRICAL Power and control cables

4.2.1.1 LT Power Cables

LV Power Cable shall be 1100 V grade, single / multicore, stranded aluminium conductor, extruded XLPE insulated, dry cured with extruded PVC inner sheathed of type ST-2, galvanized round steel wire armoured and with extruded outer sheath made of FRLS PVC compound of type ST-2 conforming to relevant standards. The cables used for DC system shall be of single core type. Minimum conductor cross section of power cables shall be 4 sq.mm.

4.2.1.2 Control Cables

Control cables shall be 1100V grade, multicore, minimum 2.5 sq.mm cross section, stranded copper conductor having 7 strands, extruded PVC insulated, extruded inner PVC sheathed of type ST-1, galvanised steel wire armoured and extruded outer sheath made of FRLS PVC compound of type ST-1 confirming to relevant standards. In situations where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. For all the CT & PT cables, minimum 4 sq.mm cables shall be used.

4.2.1.3 Cable Properties



- (i) All single core power cables shall have wire armouring of aluminium, whereas multicore power cable shall have galvanised steel round wire armouring.
- (ii) The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.
- (iii) The inner and outer sheath of FRLS PVC compound shall meet the following performance requirements:
 - (a) The critical oxygen index value shall be minimum 29 when tested at $27 \pm 2^{\circ}\text{C}$ as per ASTM-D-2863-77 and the temperature index shall be minimum 250°C at oxygen index value of 21 when tested as per NES-715.
 - (b) The maximum acid gas generation as determined by titration method shall be less than 20% by weight when tested as per IEC-754-1
 - (c) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2843-7.
 - (d) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53387.
- (iv) The finished cable shall pass the flammability test as per IEC-332-1 and IEEE-383. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475.

4.2.1.4 Design Criteria for Cable Sizing

4.2.1.5 Power cables

- (i) Power cable sizes shall be selected on the following basis:
- (ii) Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like ambient air/ground temperature, grouping, method of laying, short circuit withstand capacity for applicable fault, maximum voltage drop limits, etc.



- (iii) Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Fault clearing times for 3300 V motor feeders and transformer feeders having high-set instantaneous protection shall be 0.16 secs, whereas tie between two 415 V switchgear and any two 3300 V switchgear shall be 0.5 secs, and for incomers and tie feeders 1.0 sec.
- (iv) For 3300 V motors controlled by vacuum contactors with back-up HRC fuses, the minimum cross-section of cables shall be based on the cut-off current of the fuses and its fusing time.
- (v) For the cables to 415 V motors and feeders protected by fuses, the cross section shall be chosen according to the cut-off current of the fuse and its fusing time or full load current, whichever is higher.
- (vi) Voltage dip at motor terminals during starting of motors will be limited to the following values:
 - For all motors – 15% of the rated voltage.
- (vii) Voltage drop in feeder cables shall be limited to 3% during full load running condition.
- (viii) For power supply to valve actuator motors, actuators of various isolating and regulating dampers and exhaust fans, 3 core 2.5 sq. mm stranded copper conductor cable may be used in view of ease of termination. These cables shall be in other respects similar to cables described above.

4.2.1.6 Control Cables

- (i) Current transformers leads shall be checked for the lead burden vis-à-vis the current transformer VA capacity and 4 sq.mm cables shall be used for connection of CT to loads. In case 4 mm² conductor imposes unacceptable high burden on CTs, higher cross section of conductor shall be used.
- (ii) Voltage transformer leads shall be checked for voltage drop with 4 sq.mm, which shall be limited to within 1% for all cases. In case the



voltage drop with 4 sq. mm conductors exceed this value, higher conductor sizes shall be used.

- (iii) In multi core control cables the following minimum reserve cores shall be provided.

4 to 7 cores – One reserve core

10 cores – Two reserve cores

14, 19 & 24 cores – Three reserve cores

- (iv) Copper cables shall be used for all power and control circuits of cranes/hoists as applicable.

4.2.1.7 Cable Terminations

- (i) All termination kits shall be of heat shrinkable type and suitable for XLPE insulation and the same shall have been tested for short circuit as per relevant standards. Double compression type cable glands and copper lugs shall be used for termination.
- (ii) All 1100 V termination for XLPE / PVC power cables and control cables shall be by crimping type tinned copper lugs and double compression type cable glands.

4.2.1.8 Cable Joints

- (i) Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length, they shall be heat shrinkable type having a short circuit with stand capacity of 50 kA for 0.5 sec. for 11 kV and 1100 V grade cables, 40 kA for 1.0 sec for 3.3 kV grade cables .

4.2.1.9 Cable Carrier System

- (i) The cable carrier system shall be designed considering the following:
- Facility for easy laying of cables.
 - Access to maintenance.
 - Neat and aesthetic appearance.
 - Safety of equipment & personnel.
 - Ground water seepage.



- (ii) Following cable carrier system shall be adopted in various areas as indicated below.

(i)	MRHS	:	Cable trays/Cable trenches/ buried
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- (iii) Direct burial of cables shall be avoided as far as possible. The Contractor shall prepare detailed cable routing diagram, cable tray layouts, cable schedules, interconnection schedules for all cables being supplied under this Contract. It is anticipated that a few cables supplied outside this Contract would be required to be routed in the cable carrier system being provided by this Contractor. The details of these cables would be made available to the Contractor to prepare integrated cable layout/routing drawing considering the cable being installed by others.

4.2.1.10 Cable Trench

- (i) Cable trenches shall be of different sizes depending on the number of cables laid in that route.
- (ii) Preferred working space between the cable support arms and the wall are as follows. Contractor shall design the trenches accordingly.

Trench depth	Width of Trays	Working Space
1500 mm (5 tiers)	600 mm	750 mm
1200 mm (4 tiers)	600 mm	750 mm
1000 mm (3 tiers)	600 mm	750 mm
700 mm (2 tiers)	300 mm	350 mm

4.2.1.11 Buried Cables

Cables in trenches shall be laid on 8 cm of riddled sand and covered with 8cm of riddled sand. RCC slabs shall be provided for covering these trenches. On top of RCC slabs / bricks, the earth shall be back filled, rammed and levelled. Suitable separation shall be provided when more than one cable is laid in the same trench. The maximum trench depth shall normally be 1.5 m and thickness of top cover of 75 mm. If the trench is to cross railways tracks/roads or any load bearing area the cables shall be taken through suitable GI conduits / pipes / ducts.

4.2.1.12 Cable Trays

- (i) Cable trays of prefabricated ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be



fabricated from 12 gauge (2.5 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge (1.70 mm thick) MS sheets.

- (ii) Cable trays, accessories and covers shall be hot dip galvanised. Galvanising thickness shall be minimum 75 microns and mass of Zinc coating not less than 610 gm/m².
- (iii) The spacing of rungs for ladder type of trays shall be not more than 250 mm.
- (iv) Vertical raceways shall be formed by either structural members or slotted angles or by running the prefabricated trays vertically.

4.2.1.13 Conduits & Pipes

- (i) The galvanised steel conduits shall be used for sizes up to 63.5 mm. The conduits shall be manufactured by electric resistance welding process and shall be hot dip galvanised. The conduits and fittings shall comply with IS: 1653, 3837 & 2667.
- (ii) Galvanised steel pipes shall be used for sizes from 80 mm on wards. They shall be medium duty class-B type as per IS. The pipes shall be manufactured by electric resistance welding and hot dip galvanised. The pipes and fittings shall comply with IS.
- (iii) Flexible steel conduits shall be manufactured with electro galvanising process. The flexible conduits and their fittings shall comply with IS: 3480, 4649.
- (iv) The hume pipes/RCC pipes shall comply with IS:458.

4.2.1.14 Cable / Cable tray supports

- (i) Cable tray supports shall be fabricated from standard steel structures of different sizes. The sizes selected shall be adequate for the weight of cables/trays encountered.
- (ii) The steel members shall be cleaned thoroughly for rust and painted as follows:
 - For indoor – One shop coat of red oxide zinc chromate primer and two site coats of aluminum alkali paint.
 - For outdoor & corrosive areas like battery room– Hot dip galvanized.



4.2.1.15 Cable Carrier Installation Practice

- (i) Minimum level difference between two tiers of horizontal cable trays in building, trenches, shall be 300 mm (clear space between top of bottom tray and bottom of upper tray). In vertical raceways with multi tiers the tiers shall be located at least with 400 mm intervals.
- (ii) In trenches & tunnels the width of the cable tray shall be limited to 600 mm.
- (iii) Separate cable trays/tiers shall be provided for 11 kV, 3.3 kV power, 415 V / 240V power, DC Power, control cables and instrumentation cables.
- (iv) Cable trays shall be supported at every 1000 mm interval.
- (v) Cable trays shall be welded to the mounting/carrier structures.
- (vi) All outdoor cable trays shall be erected in vertical plane. Vertical trays (raceways) and all outdoor cable trays shall be provided with removable 16 gauge galvanised MS sheet covers.
- (vii) Each continuous laid out length of cable tray shall be earthed at minimum two places by GI flats of minimum size 25 mm x 3 mm, the distance between earthing points shall not exceed 10 meters.
- (viii) When cables are taken in vertical raceways /trays and they pass from one floor & other floor pipe sleeves in concrete shall be provided.
- (ix) In heat zone areas as far as possible the cables shall be taken away from that area to avoid heat. If Cabling in heat zones cannot be avoided, the cables shall be terminated in a junction box of IP 67 protection class away from the heat zones and small length of cables may be laid from junction box to the respective equipment to facilitate easier replacement in case of fire. Bunching of cables in the heat zones and boiler areas shall be avoided and laid in separate groups.

4.2.1.16 Cable Installation

Cables to each circuit shall be laid in one continuous length. Cable jointing and splicing shall be avoided. Jointing will be allowed only for the



cases where the route length is more than the maximum possible drum length.

4.2.1.17 Outdoor cable installation

- (a) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in hume or steel pipes. For road crossings, the pipe for the cable shall be buried at not less than 600 mm. Hume pipes shall be preferred to steel pipes from the point of view of corrosion.
- (b) The cables shall be tied to tray rungs by means of 3 mm dia. nylon cord at an interval of 5000 mm and also at bends.
- (c) For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls/slabs for passage of cables into a building from cable trays/racks/cable trenches located outside the building.

4.2.1.18 Cables in Trays / on Racks

- (a) Different voltage grade cables shall be laid in separate trays. When trays are arranged in tiers, HV cables shall be laid in top trays and cables of subsequent voltage grades in lower tiers of trays.
- (b) The HV power cables shall be laid in trays/on racks as follows:
 - i) In single layer only without exception.
 - ii) 3 core cables to be laid in touching formation.
 - iii) Single core cables to be laid in trefoil groups.
- (c) 1100 V grade power cables of 120 mm² size and above shall normally be laid in single layer in trays/on racks.
- (d) Smaller 1100 V grade power cables below 120 mm² may be run in double layers, where required, due to space restrictions.
- (e) Control and instrumentation cables can be laid up to a maximum of three layers in each tray/rack.
- (f) Single core power cables for 3 phase AC circuits laid in trays/racks/trenches in trefoil groups shall be held in trefoil clamps placed at an interval of 3 m. The trefoil groups of cables shall be additionally tied by means of 3 mm dia. nylon cord as follows:
 - (i) At an interval of 1m when laid in cable trays/racks.
 - (ii) At an interval of 750 mm when laid in trenches without cable trays.
- (g) Control cables and small power cables on racks shall be run in ladder type cable trays supported on rack carrier arms. The cables shall be tied to tray rung by means of 3 mm dia. nylon cord at an interval of 5000 mm and also at bends.



4.2.1.19 Bending radii for cables

- (i) The bending radii for various types of cables shall not be less than those values specified by the cable manufacturer.
- (ii) Terminations, clamping and miscellaneous details:
 - (a) Cable entry to motors, push button stations and other electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.
 - (b) Identification tags made from aluminium sheet shall be attached to each end of each cable by means of GI binding wire. Tags shall be additionally put at an interval of 30 metres on long runs of cables and in pull boxes.
 - (c) All cable terminations shall be done with solderless tinned copper crimping type lug. Cable terminations shall be done with double compression type brass cable glands. For transformer feeders, HT motors, LT motors of 110 kW and above only RPCL approved make lugs shall be used at both motor and switchgear ends.
 - (d) Control cable termination: RPCL approved make of connectors shall be used.
 - (e) Saddle type clamps to suit number of cables to be clamped at a particular location shall be used for clamping cables running along walls, ceilings, structures, etc. at 750mm interval.
 - (f) The armour and semi-conducting screen of single core cables shall be earthed at one end. The continuity of armour and semi conducting screen shall not be broken at each joint. The unearthed end of armour and screen shall be insulated.

4.2.1.20 Testing and commissioning of cables

- (a) Cables shall be checked for insulation resistance before and after jointing.
- (b) High voltage testing
All cables of 1.1 kV grade 400 mm² and above and all HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 4 in IS : 1255.
- (c) Type test certificates for each type & size of the cable supplied by the Contractor shall be submitted. In case Type test certificate for similar type & size is not available, the same shall be conducted in presence of Purchaser or his representative if Purchaser so desires, at no extra cost to the purchaser.



4.2.1.21 Earthing

- a) Metallic sheaths, screens and armour of all multi core cables shall be earthed at both equipment and switchgear end.
- b) Sheath and armour of single core power cables shall be earthed at switchgear end only. For long lengths of cables multiple earthing may have to be adopted to safeguard against the presence of standing voltages under normal as well as fault conditions.

4.2.1.22 Fire proof sealing system (FPS)

- a) Fire proof sealing system shall consist of:
 - (i) Fire-stops/fire-seals for sealing of cable/cable tray and conduit/pipe penetrations, both horizontal and vertical, through brick or RCC walls/floors, to prevent the spread of fire from one area, which is separated from others by fire-resistant barriers.
 - (ii) 'Fire-breaks' provided on long runs of cable racks/trays to prevent the propagation of fire along the cable rack, within a single fire-area or fire- zone.
- b) The FPS system shall also include all the necessary accessories and equipment required for supporting, holding in position, fixing and installation of the fire-stop/fire-break.
- c) The FPS system shall comply in all respects with the requirements of the codes and standards listed below:
 - IEEE-634
 - ASTM-E-814 / ASTM-E-119
 - ANSI-IEEE-383
 - IEC-331
 - IEEE 383
 - IS 3144 / BS 476 / IS 3809 / IS 12458

4.2.1.23 Fire Stop/Seal

The FPS system adopted for cables or cable trays penetrating through walls and floor openings, or cables passing through embedded conduits/pipes/ pipe-sleeves, constitutes a 'fire stop/seal', which is meant to prevent spreading of fire between areas separated by fire-resistant barriers.

4.2.1.24 Fire Break



The fire proofing system, other than fire-stops, adopted to retard flame propagation along long runs of horizontal or vertical cable trays in the same fire zone or area, in an event of a fire, shall constitute a 'fire-break' and shall be provided by applying a suitable fire-resistant coating on cables and cable trays for the required length, with or without a fire resistant panel, at the point of the fire break to obtain the fire-rating specified.

4.2.1.25 Performance Requirements

(i) Requirement of fire stops

- The material, design and construction of the fire stops shall be such as to provide the fire-rating of 120 minutes for a fire on any side and meet all requirements listed in this specification and the relevant codes and standards.
- The materials used in the fire stops shall be non-hygroscopic, compatible with the type of cables.
- The fire stops shall be suitable for retrofitting of cables through the penetration seal without disturbing the sealing of the cables already existing.

(ii) Requirements of fire breaks

- Each firebreak shall have a fire-rating of 30 minutes and shall be capable of withstanding for the duration specified, a fire on any side of the fire break.

4.2.1.26 Application of fire proof sealing system

(i) Fire stops

Fire stops shall be provided for cable penetration openings listed below:

- The passage of cables/cable trays pipe sleeves/embedded conduits through walls / floors.
- Vertical raceways, which carry cables between successive floors, through openings provided in the RCC floor slab, shall be sealed by fire stops at each floor level.
- Cable entry through openings in floor slabs below HT/LT switchgear, MCCs, various control and relay panels and other bottom entry panels, shall be effectively sealed by fire stops.

(ii) Location of fire breaks

- Firebreaks shall be provided on both cable rack and trenches at all cable tray intersections and tee-offs.



- On linear runs of cable trays between fire stops or fire breaks, fire breaks shall be provided at intervals of 15 metres on horizontal cable runs and 5 m on vertical cable runs.
 - Fire breaks in linear runs of cable trenches between intersections and tee-offs shall be provided at intervals of 30 metres.
- (iii) Contractor shall furnish the test certificates for the fire stops and fire breaks after award of Contract for Purchaser / Purchaser's Representative review. If the certificates are not satisfactory all the tests shall be conducted free of cost. The offered system i.e. fire stops and fire breaks shall be identical (or better) with the system which is successfully type tested for the specified rating i.e. the composition density of the material, thickness of coating in case of fire breaks and any other properties of the material / system offered shall be identical or better than the tested system and shall be subject to Purchaser / Purchaser's Representative approval.

4.2.1.27 Performance Tests: Tests on Fire Stops

- a) The fire stops shall be subjected to the following type tests:
- Fire Rating Test
 - Hose Stream Test
- b) Type tests shall be conducted on different fire stop test specimens described above as per IEEE-634. The sizes of the fire stop test specimens, shall be similar to the largest of the sizes being used in the plant.
- c) Preconditioning of fire stop test specimens
- d) Before conducting the fire rating and hose stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.
- e) Test on Fire Stops
- During the fire rating test, the transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self ignition temperature of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, with a maximum temperature limit on the unexposed surface of 200°C.
- f) Tests on fire breaks
- Firebreaks shall undergo the following tests as per ANSI-IEEE-383:
- Ampacity test



- Flame test

4.2.1.28 Tests on Cables

4.2.1.29 Shop Tests

The Cables shall be subject to shop tests in accordance relevant IS/IEC standards to prove the design and general qualities of the Cables as below:

- Routine tests on each drum of cables.
- Acceptance tests on drums chosen at random for acceptance of the lot.
- Type tests on each type of cable, inclusive of measurement of armor D.C resistance of power cables.

4.2.1.30 Additional Tests

- Following additional acceptance tests shall also be performed on each type of cables having outer sheath with improved fire performance (category C1 Type FR/ Category C2, Type FRLS):
 - Oxygen index test (for both C1 & C2) the Oxygen index shall not be less than 29.
 - Temperature Index Test (for both C1 & C2)
 - The measured value of temperature index shall be 21 at a temperature of 250°C
 - Flame Retardance test on single cable and on bunched cables (for both C1 & C2)
 - After the test, there should be no visible damages on the test specimen within 300 mm from its upper end.
 - After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly.
 - Halogen acid gas evolution test (for category C2).
 - The level of HCL evolved shall not exceed 20 per cent by weight
 - Smoke density test (for category C2)
 - The cables shall meet the requirements of light transmission of minimum 40% after the test.)
 - Test for specific optical density of smoke (for category C2)
 - Test for rodent & termite repulsion property
 - The test shall be carried out to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is



that a few chippings of the PVC compound are slowly ignited in a porcelain dish or crucible in a muffle furnace at about 600°C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium sulphide solution is placed on a thick filter paper and it is allowed to soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti-termite & rodent compound.

4.2.2 Instrumentation Cables

4.2.2.1 General Requirement

1. Contractor shall test, supply, erect, and terminate all instrumentation cables for control and instrumentation equipment/devices/ system included under contractor's scope ensuring completeness of the control system.
2. Any other application where it is felt that instrumentation cables are required due to system /operating condition requirements, are also be in contractor scope.
3. Contractor shall supply all cable erection and laying hardware like cable trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.
4. In addition to above, contractor shall supply all the cable including co-axial cables, OFC cable and required converters for interconnecting main plant and other subsystems in contractor scope.
5. Generally the following cable types shall be used.
 - Overall and pair shielded armored cables for Analog Signals & overall Shielded armored cables for Digital Signals.
 - Overall and triad shielded armored triad cables for RTD signals.
 - Suitable compensating/ Extension cable shall be used for thermocouple signals.
6. Signal cables shall be minimum 0.5 Sq.mm. All these cables should be FRLS type.

4.2.2.2 Detailed Requirements

Instrumentation cables shall be 1.1 kV grade with stranded high conductivity annealed, tinned copper, twisted pair (with min. 20 twists per meter) extruded PVC insulated with overall and / or individual screening, extruded PVC inner sheathed, extruded outer sheathed with FRLS PVC compound and galvanized steel wire armoured. The conductor



size shall be minimum 0.5 Sq.mm. Triplex cable similar to instrumentation cables can be used for RTDs. The cables shall confirm to relevant latest standards.

4.2.2.3 Cable Properties

- 1) All cable shall have galvanised steel round wire armouring. The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.
- 2) The outer sheath of FRLS PVC compound shall meet the following performance requirements:
 - i) The critical oxygen index value shall be minimum 29 when tested at $27 \pm 2^{\circ}\text{C}$ as per ASTM-D-2863-77 and the temperature index shall be minimum 250°C at oxygen index value of 21 when tested as per NES-715.
 - ii) The maximum acid gas generation as determined by titration method shall be less than 20% by weight when tested as per IEC-754-1
 - iii) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2843-7.
 - iv) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53387.
- 3) The finished cable shall pass the flammability test as per IEC-332-1 and IEEE-383. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475.
- 4) All the instrumentation cables shall be provided with overall shielding. However multi pair cables carrying analog signals shall be provided with individual pair shielding in the addition to overall shielding. Shielding shall be of Aluminum-Mylar tape with 100% coverage and with at least 20% overlapping. Separate drain wires for the individual pair shield (wherever applicable) as well as overall shield shall be provided.
- 5) Cable parameters such as mutual capacitance between conductors, conductor resistance, insulation resistance, characteristic impedance, cross talk and attenuation figures at 20 deg. C($\pm 3^{\circ}\text{deg. C}$) for various



types of cables as applicable shall be as specified in Data sheet A. Identification of the cores & pairs shall be done with suitable colour coding & band marking as well as by numbering of cores/pairs as per VDE: 0815.

- 6) All prefabricated cables shall have 10% spare cores which will not be connected to pin connectors.
- 7) Voltage grade of the instrumentation cables shall be 1.1 kV grade
- 8) Thickness of outer sheath shall not be less than 1.8 mm in any case. The variation in diameter and the ovality at any cross section shall not be more than 1.0 mm.
- 9) All instrumentation cables shall be suitable for continuous operation at 70 deg. C, except for high temperature resistant Teflon insulated cables, which shall be suitable for continuous operation at 205 deg. C. The cables shall be suitable for laying in trays, conduits, ducts.

4.2.2.4 Panels / Cabinets Internal Wiring

- 1) Internal panel / cabinet wiring shall be of multi stranded copper conductor with FRLS PVC insulation without shield and outer sheath.
- 2) Wiring to door mounted devices shall be done by 19 strand copper wire provided with adequate loop lengths of hinge wire so that repeated door opening shall not cause fatigue breaking of the conductor.
- 3) All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.
- 4) 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.
- 5) All the special tools as may be required for solder less connections shall be provided by C&I Vendor.
- 6) Wire sizes to be utilized for internal wiring:



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- a) Current (4–20 mA), low voltage signals (48V) – 0.5 Sq.mm.
- b) Ammeter/voltmeter circuit, – 1.5 Sq.mm.
control switches etc. for electrical system.
- c) Power supply and internal illumination – 2.5 Sq.mm.

4.2.2.5 Terminal Blocks

- 1) All terminal blocks shall be rail mounted/post mounted, cage clamp type/other standard type with high quality non-flammable insulating material of polyamide/ melamine suitable for working temperature of 100 deg. C. The terminal blocks in field mounted junction boxes, racks, etc., shall be suitable for cage clamp type/ other standard type connections as approved by Owner.
- 2) All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug, transparent covers, support brackets, distance sleeves, warning label, marking, etc.
- 3) The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.
- 4) The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and panel / junction box walls.

4.2.3 LT Motor

4.2.3.1 LT Motor Specification

Motors shall be general purpose, constant speed, squirrel cage three-phase induction type, shall be rated for continuous duty. The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

4.2.3.2 Constructional Features



- a) Motors shall be squirrel cage type except for cranes. The motor winding shall be of copper. Motor shall be suitable for voltage variation of $\pm 10\%$, frequency variation of $\pm 5\%$ and combined voltage and frequency variation of 10%.
- b) Motor rating shall have a minimum margin of 10% over the required kW requirement of driven equipment.
- c) Motor shall run continuously at rated output over the entire range of voltage and frequency variations.
- d) Motors shall be suitable for 415 V, 3 phase, 50Hz power supply.
- e) Motor frame size shall be so chosen such that maximum interchangeability is achieved over the entire plant.
- f) Motors ≤ 160 kW shall be 415V rating. Motors of rating > 90 kW shall be ACB operated.
- g) Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of rated voltage. If such operation is envisaged for a period of one-second pull out torque of the motor shall be it at least 205% of full load torque.
- h) The motor shall be capable of operating satisfactorily at full load for 5 minutes commencing from hot condition without injurious heating with 85% rated voltage at motor terminals.
- i) The motor shall be capable of resuming normal operation after a system disturbance causing temporary loss of supply voltage for periods up to 0.2 sec. (fault clearing time) followed by sudden restoration to 70% rated voltage.
- j) Starting current, starting time, starting voltage etc shall be compatible with the supply voltage and its parameters, protection system.
- k) The motors shall be designed to be energy-efficient, eff-1 as per IS-12615 Motors shall be capable of starting and accelerating to full speed at 80% of the nominal voltage and shall not stall at 70% of nominal voltage for one (1) minute. With voltage and frequency within permissible variation band, the motors shall be capable of 3 equally spaced starts in 1 hour with motor initially at temperature not exceeding rated operating temperature. 2 start in succession with motor initially at a temperature not exceeding rated operating temperature
- l) The torque characteristics of all induction motors shall be as required to accelerate the inertia loads of the motor and driven equipment to full speed without damage to the motor or the equipment at any voltage from 80 percent to 110 percent of motor nameplate voltage except those



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to be individually considered. A voltage drop greater than 10 percent from the specified motor nameplate rating shall be individually considered for proper motor starting and operating.

- m) The motor shall be self ventilated type, totally enclosed fan cooled (TEFC). All insulated winding shall be of copper and. impregnated. 2 RTD duplex type in each phase of the winding slots with terminals brought out in a junction box shall be provided. All motors shall have class F insulation, but limited to class B temperature rise as per IS: 325
 - n) All motors shall be DOL started.
 - o) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
 - p) The motor shall start smoothly and rapidly and maintain steady operation. The motor characteristics such as speed, starting torque, acceleration time etc. shall be properly coordinated with requirement of driven equipment.
 - q) The outdoor motors are to be provided with Canopy.
-
- 1) The **locked rotor withstand time** under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage by at least 2.5 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.
 - 2) All motor enclosures shall conform to the degree of protection IP-55/ IPW-55 unless otherwise specified. For hazardous area approved type of increased safety enclosure shall be furnished. Motor shall be designed on 50 Deg C ambient temperature and should be suitable for bi directional rotation.
 - 3) Cable box for 415 V motors shall be non-phase segregated type. Cable box shall withstand maximum fault current for duration of 0.25 sec.
 - 4) Motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.
 - 5) Motor shall be provided with sealed and optimum lubricated anti friction bearings, Provision of replacing lubricant without opening the bearing by use of greasing gun/ drain plug shall be provided.



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- 6) The **Noise level** shall not exceed 85 db (A) at 1.5 M from motor at no load condition. The maximum double amplitude **vibrations** for motors up to 1500 rpm shall be 40 microns and 15 microns up to 3000rpm.
- 7) Motor **terminal box** shall be located in accordance with Indian Standards clearing the motor base plate/foundation. It shall be split type with removable cover with access to connections and shall have the same degree of protection as motor. It shall have sufficient space inside for termination connection of XLPE insulated armored aluminum cables. It shall be capable of withstanding maximum system fault current for duration of 0.25 sec.
- 8) The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.
- 9) In addition to the minimum information required by IS, the information about Temperature rise in Deg.C under rated condition and method of measurement, Degree of protection, Bearing identification no. and recommended lubricant should be shown on motor rating plate.
- 10) Motor of rating above 30 kW shall be provided with **space heaters**. The space heater shall be rated 240 V, 1 phase 50 Hz and sized.
- 11) All accessory equipment such as space heater, temperature detector shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box. Motors shall have perfectly located drain plug. Motors weighing 25 kg or more shall be provided with eyebolt or other adequate lifting provisions.
- 12) Drawings, Documents, Data and Manuals shall be submitted with the bid and in quantities and procedures as specified in Conditions of Contract and/or elsewhere in this specification for approval and subsequent distribution after the Effective Date of Contract.
- 13) The **type tests** must have been conducted not earlier than five years from the date of bid opening. Type Test certificates shall be furnished for motors of similar design. Alternatively, type tests shall be conducted afresh with no cost to owner. The contractor shall furnish two sets of the following tests as per IS/IEC along with the offer.



- All routine tests including IR of winding before and after HV Tests, IR of space heater, Resistance Measurement etc.
- No load saturation and loss curves up to approximately 115% of rated voltage.
- Temperature rise test at rated voltage whichever is critical (90% VR or 110% VR).
- Momentary over load tests (160% for 15 sec.)
- Pull out Torque Measurement.
- Load test at 25%, 50%, 75% and 100% of rated kW.
- 20% over speed test for 2 minutes
- Noise level measurement
- Degree of protection test for the enclosures.
- Terminal box fault level withstand test for each type of terminal box of LT motors only.
- IP 55 first and second numeral test.
- Operation of LT motor at full load at 85% VR for 10 min. upto 110 KW and 80 % V_R for motors above 110 KW.

- 14) Finally certified reports of all the tests carried out at the works shall be furnished in requisite no. of copies for approval of the Owner. The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports.

4.2.3.3 Motor Operated Valve Actuators

- (i) The actuator motors shall be designed for short time duty (S2) in accordance with IEC 34-1. Degree of protection for actuator motor enclosure shall be IP-65 and IP-67 for indoor and outdoor respectively.
- (ii) The actuator shall be electrically operated electronically controlled type. It shall be sized to achieve valve/damper closure at the specified differential pressure.
- (iii) The actuator motor shall be time rated for at least 15 minutes or twice the valve stroking time, whichever is higher at an average load of at least 33% of the maximum valve torque. For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour. It shall be capable of starting at 85% of rated voltage. Torque switch must trip at maximum driven equipment torque at 90% rated voltage.



- (iv) Motor shall have minimum class 'F' insulation with temperature rise restricted to class 'B'.
- (v) Motor shall be suitable for operation under voltage variation of + 10%, frequency variation of + 5% and combined voltage & frequency variation of 10% absolute.
- (vi) Motor shall be suitable for direct on-line (DOL) starting and starter shall be integral to the motor.
- (vii) The actuator shall be complete with all accessories viz. torque limit switch, endof- travel switch, adjustable position limit switch, hand-wheel etc.
- (viii) Complete actuator shall be tested at factory as per IEC before dispatch.

4.2.3.4 Codes and Standards

1.	Induction motors – three phase	IS: 325 and efficiency should be as per IS12615 EEF 1 or equivalent standard
2.	Measurement and evaluation of vibration rotating electrical machines	IS: 12075
3.	Code of practice for climate Proofing	BS – CP 1014
4.	Degrees of protection provided by enclosures for rotating electrical machinery	IS 4691
5.	Classification of hazardous areas for electrical installation	IS 5572
6.	Terminal marking for rotating electrical machinery	IS 4728
7.	Designation of methods of cooling for rotating electrical machines	IS6362
8.	Guide for testing three phases induction motors	IS 4029
9.	Dimensions of slide rails for electric motors	IS 2968
10.	Designation for types of construction & mounting arrangements of rotating electrical machines	IS 2253
11.	Classification of maximum surface temperatures of electrical equipment for use in explosive atmospheres	IS 8239



12.	Flame proof enclosure of electrical apparatus	IS 2148
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4.2.4 Installation / Erection

4.2.4.1 General

The following section describes the general specification is to be followed for Installation and Erection, the MRHS contractor is to consider relevant portion of the specs applicable to his scope of work only.

4.2.4.2 Design Criteria

Equipment erection

- i) All equipment, conductors, hardware, insulators & clamps etc. will be installed outdoor in a hot, humid & tropical atmosphere. All erection work shall be carried out in a neat and efficient way so as not to impair their normal functioning in any way.
- ii) The maximum temperature in any part of the clamps, connectors, conductors etc. at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.
- iii) All equipment, conductors, clamps, connectors, insulators etc. shall be capable of withstanding the dynamic & thermal stresses of maximum short circuit current without any damage or deterioration.
- iv) In order to avoid concentration of stresses, all sharp edges of clamps, connectors etc. shall be rounded off. Bi-metallic connectors shall be used for any connection between dissimilar materials.
- v) Expansion joints shall be provided in the Aluminium tube bus system, whenever necessary, to eliminate undue stresses on the equipment terminals and post insulator stacks.
- vi) Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply to all equipment. The proper fire sealing as per relevant standard is under the scope of the contractor. The grounding system shall comply with Indian Electricity Rules, I.S. specifications & I.S. Code of Practice.

General Requirements

4.2.4.2 Codes and Standards

- i) All materials and accessories shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard (IS) except where modified and/or supplemented by this specification.



- ii) The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS codes of Practice and Indian Electricity Act. In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

4.2.4.3 Completeness of Supply

- i) It is not the intent to specify completely herein all detail of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design & workmanship.
- ii) Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any extra charge.
- iii) The Contractor shall supply all brand new equipment, material and accessories as specified herein with such modification and alteration as agreed upon in writing after mutual discussion.

4.2.4.4 Erection Schedule

- i) The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the contractor to the Owner for his approval.
- ii) The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the erection Contractor. If, for any reason beyond the control of the Contractor, the work is held-up then the Contractor shall bring it to the notice of the Owner's Engineer without any delay.

Detailed Requirements

4.2.4.5 Equipment & Materials

- i) Equipment and materials furnished shall be complete & operative in all details.



- ii) All accessories, fittings, supports, hangers anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.
- iii) All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.
- iv) After the treatment of steel surfaces damaged during transit sufficient quantity of anti-corrosive paint shall be applied and subsequently finished with two coats of final paint of approved shade.

4.2.4.6 Cable Trays

- i) Ladder type cable trays shall be pre-fabricated sheet steel, minimum 2.5 mm thick, with hot dip galvanized (zinc coating not less than 610g/sq. m).
- ii) The sizes of the trays shall be as follows:
 - a) 300 mm wide & 100 mm deep.
 - b) 450 mm wide & 100 mm deep.
 - c) 600 mm wide & 100 mm deep.
- iii) The straight sections shall be supplied in 2.5m standard length.
- iv) Cable trays shall be complete with all necessary hot dip galvanized accessories such as, coupler plates, ground continuity connections, nuts, bolts, washers hangers, clamps, supports, horizontal/vertical bends, tee, reducers etc.

4.2.4.7 Conduits & Accessories

- i) Conduits shall be of rigid steel, hot dip galvanized, furnished in standard length of 3 metres, threaded at both ends.
- ii) Conduits up to and including 25 mm size shall be of 16 SWG & conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 19 mm.



- iii) Each piece of conduit shall be straight, free from blister & other defects, internal surface shall be of smooth finish & covered with capped bushings at both ends.
- iv) Flexible conduits shall be made with cold rolled, annealed & electro-galvanized mild steel strips coated internally with epoxy and externally PVC.

4.2.4.8 Cable Termination & Jointing Kits

- i) The contractor shall supply cable termination & jointing kits for HT/L.T. power and control cables along with all accessories of RPCL approved make only.
- ii) For the cable termination and straight through joints both HT/L.T. power and control cables, supply of items of jointing kit such, as, necessary boxes, if any, sealing compounds, ferrules, tapes, lugs, glands, shall be of reputable make approved by RPCL.

4.2.4.9 Cable Glands

Cable glands shall be nickel plated brass gland, double compression heavy duty type complete with necessary armour clamp and tapered washer etc. Cable glands shall match with the sizes of different HT/L.T. power, control & Instrumentation cables.

4.2.4.10 Cable Lugs

Cable lugs shall be heavy duty tinned copper suitable for termination of different cross-section of HT/L.T. power, control & Instrumentation cables of AL & CU conductor. Lugs for power, control & Instrumentation cables shall be crimping type.

4.2.4.11 Cable Opening Sealing Compound

Sealing compound shall have adequate fire protection rating and shall be RPCL approved fire seal type or approved equivalent suitable for sealing both vertical and horizontal cable penetrations through wall in control Building. The sealing compound shall form effective fire seals. The sealing compound shall have special property to allow for thermal expansion of cables both under normal and short circuit conditions.



4.2.4.12 Grounding Materials

All materials for grounding work like earth mat, risers, structure and equipment connections, shield wire etc. shall be supplied by the Contractor.

Specific Requirements – Services

4.2.4.13 Responsibility of Erection

- i) The Contractor shall be fully and finally responsible for proper erection, safe and satisfactory operation of plant and equipment under his scope of work to the entire satisfaction of the Owner.
- ii) The work shall be executed in accordance with the directions, instructions, approved drawings and specifications.
- iii) Equipment and material which are wrongly installed shall be removed and re-installed to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner without any cost implication to Owner.

4.2.4.14 Extra Work

The Contractor shall, when requested by the Owner, perform extra work and furnish extra materials not covered under his scope of work, but necessary to complete the installation without any price implication.

4.2.4.15 Methods and Workmanship

- i) All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved. The erection work shall be supervised by competent supervisors preferably holding relevant supervisory license from the Government.
- ii) All details on installation shall be electrically and mechanically correct. The installation shall be carried out in such a manner as to preserve access to other equipment installed.

4.2.4.16 Protection of Work

- i) The Contractor shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering. Finished



work where required shall be suitably covered to keep it clean and free from defacement or injury.

- ii) For protection of his work Contractor shall provide fencing and lighting arrangement, connect up space heaters and provide heating arrangement as necessary or directed by the Owner. Contractor shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to Contract.
- iii) Contractor shall insure his entire workman against accidental injury/death. The Contractor shall also takeout insurance policies which would cover the risk of losses / damages of his tools & tackle and material/equipment which is in his custody as also loss/ damages to any personnel.

4.2.4.17 Safety Measure

- i) All safety rules and codes as applicable to work shall be followed without exception. All safety appliance and protective devices including belts, hand gloves, aprons, helmets, shields, goggles etc. shall be provided by the Contractor for his personnel.
- ii) The Contractor shall provide guards and prominently display caution notices if access to any equipment/area is considered unsafe and hazardous.

4.2.4.18 Co-operation

- i) The Contractor shall at all times work in close coordination with the Owner's supervising personnel and afford them every facility to become familiar with erection and maintenance of the equipment.
- ii) The Contractor shall arrange his schedule of work and the method of operation to minimize inconvenience to other Contractors working on the project. In case of any difference between Contractors', the decision of the Owner's Engineer shall be final and binding on all parties concerned.



4.2.4.19 Erection programme and progress

- i) The Contractor shall submit at such times and in such forms as may be requested by the Engineer, schedule showing the programme and the order in which the Contractor proposes to carry out the work with dates and estimated completion time for various parts of the work.
- ii) Such schedules shall be approved by the Owner prior to starting the erection. The Contractor shall adhere to this approved programme for all practical purposes. If for any reason the work is held up, the Contractor shall bring it to the attention of the Owner in writing without any delay.
- iii) During the progress of work the Contractor shall submit monthly progress report and such other reports on erection work and organisation as the Owner may direct.
- iv) If in the opinion of the Owner the progress of erection work by the Contractor at any stage needs expediting so as to ensure completion of work within stipulated time, the Owner shall have the right to instruct the Contractor to increase Contractor's manpower in appropriate categories and/or the working hours per day and/or erection tools and tackles and the Contractor shall comply with such instruction forthwith.

4.2.4.20 Consumables and Hardware

- i) The Contractor shall furnish all erection materials, hardware and consumables required for the complete installation.
- ii) The Materials shall include but not limited to the following:
 - a) Consumables :Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials, cleaning cloths, cotton waste etc.
 - b) Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims ferrules, socket, PVC sleeve, cotton thread, adhesive / non adhesive PVC tapes, anchor fasteners etc.

4.2.4.21 Erection Tools & Tackle



- i) The Contractor shall provide all tools, tackle, implements, mobile equipment such as crane, trailers, scaffoldings, ladders, welding machines, gas cutting, bending machine, hand cart, chain pulley blocks wire clues, hydraulic jack / motorized jack, wooden slipper, drill machine, hand/ hydraulic compression tools for cable termination, vacuum cleaners box spanner of various size etc. which are required for transportation, handling and erection of the plant and equipment.
- ii) Special erection tools, if any & if supplied by the manufacturer along with the equipment may be used by the Contractor. Such tools shall be returned in good conditions to the Owner on completion of work. Owner's tools and equipment may be made available on payment of charges if and when available.

4.2.4.22 Testing Equipment

- i) The major testing equipment that are required to be provided by the Contractor are listed below:
 - a) Power operated Megger of 2.5 kV, 5 kV & 10 kV grade for Insulation testing.
 - b) Hand operated Megger of 500 V & 1 kV grade for Insulation testing and 5000 V motor operated Megger for power circuits, bus bars connections above 11 kV.
 - c) Hand driven earth resistance **Megger** of range 0-1/3/30 ohms.
 - d) Tong testers of suitable ranges.
 - e) High potential test set suitable for 3.3 kV and 415 V (A.C.) systems.
 - f) Contact Resistance measuring set for Micro-ohms.
 - g) Torque Wrench of various sizes.
 - h) Current Transformer Primary injection set.
 - i) Relay testing and checking bench including phase shifter, secondary injection set, meters etc.
 - j) Multimeters, test lamp, field telephone with buzzer set, walkie-talkie, spirit level, continuity tester, db-meter, phase sequence tester, different gauges etc.
 - k) Tan delta test kit
- ii) Other testing equipment as required shall also be arranged by the Contractor.



4.2.4.23 Taking Delivery

- i) The Contractor shall make his own arrangement to store all the materials supplied by him. Materials delivered shall be stored or brought to the erection site or erected as necessary.
- ii) The Contractor shall submit a detailed account of materials after completion of work and transport back the excess materials to Owner's stores.

4.2.4.24 Opening of Case

- i) All packing cases and packages shall be opened in presence of Owner or his authorized representatives. Packing cases shall be opened carefully to avoid damage to timber. Nails and strips shall be collected separately in boxes and not to be thrown away at random.
- ii) All packing materials, timbers, nails and strips shall become property of the Owner and shall be delivered to the Owner or disposed of as directed by the Owner.

4.2.4.25 Checking and Cleaning of Parts

- i) All equipment, accessories and materials shall be carefully inspected and checked with packing list and identified with the erection drawings. All parts shall be thoroughly cleaned, all rust removed and surface polished as required.
- ii) Cleaned and polished parts shall be coated with anticorrosive paints where necessary and stored with care, ready for erection.

4.2.4.26 Installation – General

- i) Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available. All necessary jobs required for statutory clearances will under Contractor's scope.
- ii) Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented. The contractor shall assemble all equipment furnished in disassembled condition at site,



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mount and wire-up loose equipment, fittings and accessories and complete all connections.

- iii) The Contractor shall ensure that instruments and gauges to be used for testing and inspection have valid calibration and the accuracy can be traced to National Standards.
- iv) The Contractor shall design, fabricate and supply the supporting structures, base frame, holding down bolts etc, as required, of all equipments. All erection work shall be carried out in strict compliance with manufacturer's instructions and shall include all necessary adjustments, checks and measurements.
- v) It shall be the Contractor's responsibility to obtain valid license and approval from local statutory authorities including Electrical Inspector/CEA, wherever applicable, for carrying out any work or for installation carried out which comes under the purview of such authorities. The entire cost, including all necessary fees, incurred to obtain such license and approvals, shall be borne by the contractor.
- vi) It is the responsibility of the Contractor to provide watch & ward and security for the equipment / component parts covered in this contract.
- vii) The Contractor shall ensure workmanship of good quality and shall assign qualified supervisors/Engineers and competent labour who is skilled having valid licence/authorisation/work permit, careful and experienced in carrying out similar works. The Purchaser/Engineer shall reserve the right to reject non-competent person employed by the Contractor, if the workmanship is not found satisfactory. Wherever required the Contractor shall include loaning of skilled/unskilled personnel for work by Purchaser/other agencies, on Man-hour / Man day rates, for normal & overtime work to meet the project schedule.
- viii) All internal wiring of the equipment which has been left incomplete because of shipping split or which requires minor modifications shall be carried out by the Contractor. The Contractor shall record results of all erection tests and measurements. The Contractor shall submit copies of those test results to the Owner for his reference and record.
- ix) It shall be the responsibility of the Contractor to obtain necessary Licence/ Authorization/permit for work for his personnel from the Licensing Board of the locality/state where the work is to be carried out.



The persons deputed by the Contractor's firm should also hold valid permits issued or recognised by the Licensing Board of the locality/state where the work is to be carried out.

4.2.4.27 Installation Work Scope

4.2.4.28 Temporary Lighting arrangement for the work Area

The Contractor shall on his own arrange for the temporary lighting arrangement for the work area to carry out the installation work in the plant premises.

4.2.4.29 Construction Power

- (i) Construction power for construction activities only will be made available at one point & suitable number of outlets to cater to all the requirements shall be derived by the Contractor.
- (ii) The construction power supply will be 11 kV, 3 Phase, and 50 Hz. The Construction Power system by its design and nature shall be a temporary system and not part of the permanent power supply. The Contractor acknowledges that electricity sourced may be unreliable in quality and availability and its interruption or non-availability or variations in supply voltage of frequency for any reason shall not constitute a condition for claim of extra time or costs on part of the Contractor. Further, Contractor shall be responsible for making necessary arrangements to ensure that uninterrupted Construction Power supply (DG sets) is available.
- (iii) Without limiting the generality of the foregoing, such temporary supplies of Construction Power shall include without limitation:
 - a) Power for all construction offices or trailers, temporary warehouses and storage areas, and other temporary buildings used during the performance of the Work.
 - b) Power for temporary equipment put in place until such time as permanent Plant Power supply systems are installed. Such temporary equipment shall include temporary construction lighting on buildings and power to cranes and hoists.
 - c) Power utilised by Contractor and sub-contractor on the Site for the purposes of performance of the Work such activities to include curing,



welding, forming, stress relieving and provision of power for all electrical construction equipment.

d) Other requirements of construction power as set-forth in the Bid Documents.

4.2.4.30 Installation of Transformer

- (i) The transformers and their accessories and mountings like radiators, conservator, Silica-gel breathers, marshalling box, rollers etc shall be assembled at site after cleaning by the contractor in proper sequence as per manufacturer's drawings.
- (ii) Contractor shall place the transformers on the channel at the location indicated in the layout drawing of outdoor yard. Suitable stoppers shall be provided both in front as well as rear of transformer to keep it stationary in its position. For the front wheels such stoppers shall be screwed on the channels.
- (iii) BDV of the transformer oil shall be tested before energisation of power transformer. Drying out of transformer shall be carried out to get required dielectric strength as per relevant Indian Standards.
- (iv) Oil shall be filled up to the mark shown.
- (v) Wherever the power/control cables project above the ground, for termination to cable box/marshalling box, the same shall be run in GI pipes of suitable cross section upto the height of 2.0 m from ground and the same shall be supported properly and pipe ends shall be sealed with bitumen compound.
- (vi) The contractor shall ensure the following checks on the Transformers:
 - Physically checking and inspecting, paying particular attention to the following components to ensure that the same are in sound conditions;
 - Tank sides or cooling tubes
 - Protruding fittings
 - Oil sight glass
 - Bushings
 - Tightness of Bolts



- Oil leakage
- Transportation to erection site
- Proper erection on foundation/channels
- Assembly of transformer
- Checking of oil level filtration / drying of oil
- Alignment
- Anchoring and tack welding
- Mechanical Work
- Laying, meggering, termination, dressing and clamping of cables
- Tagging and marking of cables
- Testing of cables
- Earthing of transformers, earthing strip, earth resistance to comply with IER (latest revision)
- Testing of assembled plant
- Testing and calibration of meters, relays, CTs, PTs, etc.
- Connection of busbars/cables to primary and secondary of transformers
- Series of tests on transformers as per engineer's instructions.

(vii) IS 1886 and manufacturer's recommendations.

Note: All high voltage tests shall comply with IS 2071 Part I and II and all works in connection with the transformers shall comply with IS 1886 and IER (latest revision).

4.2.4.31 Interconnection of Equipments

- (i) The arrangement of connections shall be such that the connected apparatus are not subjected to any mechanical stress due to expansions, contractions etc., of the connections.
- (ii) The connections shall ensure good electrical contact. The connector and joints shall be rigid to withstand all mechanical and electrical stresses. Suitable bimetallic clamps shall be used for all the connections between the conductors of different materials.
- (iii) All live parts shall have sufficient practical clearances from earthed parts and ground. The clearances of strung busbar shall be decided considering the effect of sag.



- (iv) The contractor shall be responsible for supplying and installing the various conductors required for connection of the various equipment. The tenderers scope shall include all bolts, nuts and washers required for installation. All connections etc. shall be so made that stress between connecting terminals will be reduced to the minimum.
- (v) The physical layout of the system shall be such that the system extension or conversion can be carried out with minimum changes and easy methods. Further, it shall be ensured that all civil works for the foundations are completed by the agency before taking up erection of structure.

4.2.4.32 Installation of Switchgear Panels

- (i) The base frame of all panels shall be welded to the structures or to the civil inserts provided on the floor. Fabrication of support/frames, wherever required, shall be done by the contractor.
- (ii) The shipping section shall be placed in position before removing the protective covering to eliminate scratch/damage. The shipping section shall be moved by using rollers under the shipping skids wherever lifting cranes are not available. The contractor shall do the assembly at site as per the manufacturer's General Arrangement drawings and installation instructions. While assembling a complete board comprising several unit type cubicles, the board as a whole shall be aligned.
- (iii) The panels shall be properly leveled prior to grouting the holding down bolts or welding the panels to the inserts. All interconnection of the bus-bars and wiring between the panels shall be done as per manufacturer's instructions and drawings. Welding work on the panels shall only be carried out after consultation with the purchaser. Damage to the paint during welding shall be rectified by the contractor.
- (iv) After mechanical installation of the board is completed, instruments shall be installed wherever required and wires shall be connected to the instruments. The wiring of intermediate terminal strips between two panels, wherever disconnected for transport, shall also be connected.

4.2.4.33 Installation of Grounding / Earthing

- (i) Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity rules.



- (ii) The principal requirements of the grounding are:
 - o Low resistance and adequate current carrying capacity.
 - o Uniform and near uniform ground potential on all structural metal work on all metal enclosures and/ or supports of equipment and apparatus.
- (iii) The resistance of earthing network shall be less than 0.5 ohm.
- (iv) The contractor's scope of installation will also include all the civil works associated with complete earthing network.
- (v) All earth connections shall ensure a permanent low resistance contact. Earth connections required to be removed for the purpose of testing of equipment/ earthing network shall have bolted connections and joints fastened. All earthing connections shall be visible for inspection.
- (vi) Lightning arrestors and transformer neutral shall be connected to two independent earth electrodes as per IS 3043 (as applicable).
- (vii) Air termination rods of lightning protection systems shall be connected to earthing network as per IS 3043 (as applicable).
- (viii) The grounding connection to the lightning arrestors, air termination points of lightning protection system shall be as short as possible. Sharp turns in these conductors shall be avoided.
- (ix) It has to be ensured that main earth bus in the installation as well as earth buses in individual sections/areas shall form complete ring and they shall be interconnected.
- (x) Duplicate earthing (two separate and distinct connections with earth) shall be employed for all equipments.
- (xi) Wherever burying of earth conductors is specified, they shall be buried as per approved drawings.
- (xii) Wherever any earth conductor crosses the road, it shall be taken through GI pipes.
- (xiii) At all the terminations of earth conductors on equipments, sufficient length shall be left for any movement of the equipment from its position for alignment purpose.
- (xiv) Wherever not detailed, the route of the conductor and location of the earth pit shall be arranged so as to avoid obstruction, crossing etc, according to convenience at site and shall be got approved by the owner's representative in-charge of the works.

4.2.4.34 Installation of Earth Pits



- (i) The arrangement of earth electrode/ pit shall be as shown in IS 3043. Termination arrangement of interconnecting earth strips is included in the scope of earth pit. Interconnecting earth flats shall be jointed by welding to the termination arrangement on the electrode. Electrode will be 50 mm dia GI pipe of 3 m length medium class, in a single piece.
- (ii) The distance between two pits shall be at a minimum distance of twice the length of electrodes.
- (iii) All accessories required for the earth pits such as electrodes, charcoals, salt, clamps, clips, bolts/ nuts washer, GI pipes, funnel cast iron cover and also the masonry works of the pits including supply of necessary materials, bricks, cement and excavation of earth for providing earth pits shall be part of the scope.
- (iv) The electrodes shall be well packed with earth, charcoal and salt mix up to the level of connections.

4.2.4.35 Joints/Terminations of Earth Strips

- (i) All joints of bare galvanised earth strips shall be welded so as to form rigid earth ring. All such welded joints shall be given necessary coating of cold galvanized paint as per relevant standards and a coat of suitable bitumen compound to prevent corrosion.
- (ii) In case the joints are made by using suitable connectors the entire joint shall be fully sealed by suitable compound so that no metallic part is exposed.
- (iii) The contractor shall make his own arrangements for necessary crimping tools, soldering equipments drilling machines and other tools and tackles which are necessary for completing the installation.

4.2.4.36 Installation – Bus duct

Bus ducts (Segregated/ non-segregated) shall be erected by the Contractor in accordance with specified code of practice, manufacturer's instructions. Indoor portion of the busduct may be supported from the floor or ceiling beams and outdoor portion of the busduct shall be supported from ground below on suitable foundation. Wall frame assembly shall also be installed as per Contractor's drawings, wherever called for.



4.2.4.37 Motors

The installation, commissioning of the motors shall be as per the applicable code of practice and the Manufacturer's instructions.

4.2.4.38 Battery and Chargers

Each cell of the battery bank shall be inspected for breakage and condition of cover seals as soon as received at site. Each cell shall be filled with electrolyte in accordance with the Manufacturers instructions. Battery shall be set up on racks as soon as possible after receipt, utilizing lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals.

4.2.4.39 Installation – Neutral Grounding Equipment

The Contractor shall install, test and commission the neutral grounding equipment (NGR etc.) as per MANUFACTURER's instructions / relevant codes and standards.

4.2.4.40 Installation – Cabling

A. General

- (i) Cable installation work shall mean supply and erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches, tunnels, overhead trays, in conduits etc. dressing and clamping, jointing inclusive of supply of necessary jointing kits, lugs, glands, ferrules, tapes etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.
- (ii) Grounding installation work shall mean supply and erection of grounding materials, jointing/brazing/welding, connection and painting, testing of ground conductors.

B. Cable Trays

- (i) Pre-fabricated cable trays and accessories shall be assembled & erected at site as per instructions of Manufacturer.



- (ii) Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the drawings.
- (iii) Steel inserts will be provided / embedded by contractor in wall/floor/ceiling surfaces. The Contractor shall have to secure rack/tray supports by welding to those inserts or other available building steel surfaces. Inserts are to be supplied by the vendor.
- (iv) In case of non-availability of embedded steel inserts in certain tray routes, the Contractor shall have to secure the supports on wall/floor/ceiling surfaces by suitable anchoring system having adequate load bearing capability & anchor fastener to be supplied by the vendor.
- (v) As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side. The cable trays shall be supported in general at a span of 1000mm.
- (vi) Sufficient spacing generally 300 mm but not less than 275 mm shall be provided between trays and maintained to permit adequate access, for installing and maintaining the cables.

C. Cable, Conduit & Accessories

- (i) The contractor shall install, terminate and connect all cable and conduits as per approved layout drawings and approved cable schedules. The approved drawings shall be strictly followed except where obvious interference occurs. In such cases, the routing shall be changed as directed and/or approved by the Owner
- (ii) The Contractor shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/ jointing. Conduit/pipes shall be used only in short lengths in certain areas where required and/or as directed by the Owner. The Contractor shall furnish all conduits complete with accessories as required.
- (iii) Conduits shall be flexible or rigid depending upon nature of application. Except for inside an enclosure wherever the cable enters or leaves the



conduit, the conduit shall be sealed by suitable sealing compound having fire withstand capability.

D. Cables – Storage and Handling

- (i) Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e. with flange horizontal.
- (ii) Rolling of drums shall be avoided as far as practicable for short distance; the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.
- (iii) For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending. The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.
- (iv) While laying cable, cable roller shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.

E. Cable laying

- (i) Cable shall be installed in ladder type trays except for some short run in rigid / flexible conduit for protection or crossings. Cables laid on trays and risers shall be neatly dressed and clamped at an interval of 1500 mm.
- (ii) Clamps for multicore cables shall be fabricated out of 25x3 mm aluminum flats. All power cables shall be clamped individually and control cables shall be clamped in groups of three or four cables. All single core power cables shall be laid in trefoil formation and suitably clamped with 25 mm wide 14 SWG aluminum strips or fibre glass mould pieces of appropriate quality and sizes.
- (iii) Prior to laying of cables inside both indoor and outdoor trenches, the contractor shall properly clean inside those trenches. In outdoor areas, buried cables, wherever called for, shall be laid and covered with



sand/riddled earth and protected from damage by bricks at sides and precast slab at top. Slabs and bricks shall be supplied by the Contractor.

- (iv) When buried cables cross road/railway track, additional protection shall be provided in the form of hume/ galvanised iron pipes. In order to prevent fire protection through cable penetrations of wall/floor/ceiling as well as through cable shaft openings, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using pieces of mineral wool butted to one another and spraying with anti-fire propagation liquid such as `Flammastik` or approved equivalent. Also the cable runs both before and after the fire seals shall be suitably sprayed with anti-fire propagation liquid at least for 1 m length.
- (v) After completion of installation and prior to connection, insulation resistance shall be measured for all power cables and control cables.

F. Cable Tags & Markers

- (i) Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, every 15.0 m and exit from any equipment, junction box.
- (ii) The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription `cable-joint`.
- (iii) The Contractor shall furnish and install all tags and markers stated above. For buried cable, the marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction.

G. Cable Termination and Connection

- (i) The termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, approved drawings and/or as directed by the Owner.
- (ii) The work shall include all clampings, fitting, fixing, soldering, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be furnished by the Contractor.
- (iii) Furnishing of all consumable materials, such as, soldering material, electrical tape, sealing material as well as cable jointing kits shall be



included in the offer. Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the Contractor. Guarantee for termination shall also have to be given by Contractor.

- (iv) The Contractor shall perform all drilling, cutting on the panel blank plate and any minor modification work required to complete the job. If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the Contractor at the discretion of Owner.
- (v) Control cable cores entering switchgear/distribution board etc. shall be neatly bunched and served with PVC perforated type tape to keep it in position at the terminal block. The Contractor shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic and interlocked type.
- (vi) Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number. Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.
- (vii) All cable entry points shall be properly sealed and made vermin and dust-proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

H. Cable Joints

- (i) Cables shall be installed without joints. However, in exceptional cases, joints may be allowed by Owner for which prior approval has to be taken.
- (ii) Grounding – Overground & underground Grid for Equipment Connection
- (iii) The Contractor shall carry out the grounding and lightning protection of all electrical equipment, steel structures etc. Excavation and backfilling shall be performed by the Contractor at no extra cost.
- (iv) The grounding shall be done by flat of suitable sizes and the same shall be connected to the risers of main ground mat. All ground conductor connections shall be made by electric arc welding unless otherwise



specified. Ground connections shall be made from nearest available ground grid risers.

- (v) All ground conductors shall be painted black for easy identification. Equipment ground connections, after being checked and tested by the Owner, shall be coated with anti-corrosive paint.
- (vi) Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment, switchboards, panels, cabinets, junction boxes, switches, fittings, fixtures, structures etc. shall be effectively grounded.
- (vii) Transformer ground connections and neutral earthing shall be in the scope of Contractor.
- (viii) 2 nos, earth electrodes to be provided for each transformer body earthing & neutral earthing. For Neutral earthing of transformer, plate type earthing to be done. For Electronic parts separate redundant earth pit shall be provided (Copper Electrode).

4.2.4.41 Painting

- (i) The contractor shall paint steel fabrications at site with two (2) coats of red oxide primer and two (2) coats of gray (shade no. 631 of IS:5) synthetic enamel paint.
- (ii) All damaged parts shall be cleaned and coated with two (2) coats red oxide primer paint followed by a finishing coat of approved colour. Only touch up painting shall be done.
- (iii) All damaged galvanized surfaces shall be coated with cold galvanising paint. All equipment after erection shall be touch up painted only. All primer and paint including touch up paints shall be supplied by the Contractor.

4.2.4.42 Structure Grounding

All steel structures are required to be grounded from ground mat. Laying, supporting along with foundation connecting at ground mat are within the scope of this specification.



4.2.4.43 Installation – Earthing & Lightning Protection System

- 1) The installation work shall include unloading at site, storing, laying, fixing, jointing / termination, testing and commissioning of equipment associated with the safety earthing system of the plant and lightning protection system for buildings and allied structures. All welding / brazing equipment, necessary tools and testing equipment shall be furnished by the Contractor.
- 2) The Contractor shall be responsible if any installation materials are lost or damaged during installation. All damage and thefts shall be made good by the Contractor till the installation is handed over to the Purchaser.
- 3) The earthing of cable supporting structure, cable carriers, cable trays shall be in the scope of the Contractor.
- 4) The Contractor shall carry out the lightning protection and earthing of all equipment/ panels / structures as indicated in the Project drawings. Whether specifically shown in drawings or not, building columns, handrails, miscellaneous items such as junction / marshalling boxes, field switches, cable boxes, etc. shall be earthed.
- 5) The Contractor shall install bare / insulated, copper / aluminium / steel conductors, braids etc. required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting/coating, drilling, brazing /soldering/welding, clamping, bolting and connecting on to structures, equipment frames, terminals, rails or other devices shall be in the Contractor's scope of work. All incidental hardware and consumables such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bitumastic compound, welding rods, anti corrosive paint as required for the complete work shall be deemed to be included by the Contractor as part of the installation work.
- 6) If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the Contractor where required, together with associated civil work such as excavation, concreting and



surface finish. The concrete cover over the conductor shall not be less than 50 mm.

- 7) The scope of installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth upto 600 mm deep and 450 mm wide, laying of conductor at 600 mm depth brazing/ welding/ cad welding if required, of main grid conductor, joints as well as risers of length 500 mm above ground at required locations and then backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilising pneumatic tampers or other approved means, If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable soil from outside.
- 8) The scope of installation of earth connection leads to equipment and risers on steel structures/walls shall include laying the conductors, welding/cleating at specified intervals, welding/brazing to the main earth grids, risers, bolting at equipment terminals and coating welded/brazed joints by bitumastic paint. Galvanised conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/structure.
- 9) The scope of installation of electrodes shall include installation of these electrodes (a) directly in earth, (b) in constructed earth pits, and connecting to main buried earth grid, as per project drawings / relevant standards. The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe/rod/plate electrodes in test pits and connecting to main earth grid conductors.
- 10) The scope of installation of lightning conductors on the roofs of buildings shall include construction of upstands, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.



- 11) The scope of installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.
- 12) Wherever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.
- 13) Earth leads between earthing riser and equipment earthing terminals shall follow as direct and as short a path as possible.
- 14) Neutral connection shall never be used for the equipment earthing.
- 15) Each neutral point of a transformer shall be connected to two separate treated type earth electrodes.
- 16) Crane and track rails shall be bonded with the rail boards and connected to the earthing system. Adjacent railway tracks shall be bonded across fish plates.
- 17) Wherever earthing conductor passes through walls, galvanised iron sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed using suitable waterproof compound.
- 18) All connections in the main earth conductors in earth/concrete and connection between main earthing conductor and earth leads shall be of welded/brazed type. Cad welding type connections shall be done only if specifically indicated.
- 19) Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.
- 20) All joints shall be made such that contact resistance is negligible.
- 21) All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.
- 22) Metallic conduits and pipes shall be connected to the earthing system.



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- 23) Lightning protection system down conductors shall not be connected to any earthing conductors above ground level. Also no intermediate earthing connection shall be made from support structure of lightning arrester (as applicable).
- 24) Transformer earthing shall be directly connected to the earth electrode.
- 25) Electrodes shall as far as practicable, be embedded below permanent moisture level.
- 26) Wherever required, test pits with concrete covers, for periodic testing of earth resistivity, shall be provided. Installation of rod / pipe / plate electrodes in test pits shall be suitable for watering. All the necessary materials required for test pits shall be supplied and installed by Contractor. The installation work shall also include connection to main earth grid and civil work such as excavation.
- 27) Earth pits shall be treated with salt and charcoal if average resistivity of soil is more than 20 ohm metre.
- 28) The lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during severe weather conditions.
- 29) Air termination system shall be connected to earthing system below ground by down conductors as shown in various project drawings. The down conductors shall follow a direct path to earth. There shall not be any sharp bends, turns and kinks in the down conductors.
- 30) All joints in the down conductors shall be of welded/brazed type. All metallic structures within 2 meters from down conductors shall be bonded to lightning protection system.
- 31) The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However all metal projections, railings, vents, tanks etc. above the roof shall be bonded together to form a part of roof grid.



4.2.4.44 Excavation and Back Filling

- (i) The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.
- (ii) Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.
- (iii) The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation. All excavation shall be backfilled to the original level with good consolidation.

4.2.4.45 Cleaning up of Work Site

- (i) The Contractor shall, from time to time remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive- ways.
- (ii) Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

4.2.4.46 Inspection & Testing

- (i) On completion of erection works, the Contractor shall request the Owner for inspection and tests with minimum fourteen (14) days advance notice.
- (ii) The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.
- (iii) The installation shall be then tested and commissioned in presence of the Owner and put on trial run for stipulated Contract period. The Contractor shall arrange for inspection of his installation work by electrical inspector and shall obtain necessary approval/certificate for his installation work.
- (iv) All rectification, repair of adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.



4.2.4.47 Commissioning and Trial Run

- (i) Following successful inspection and testing, the equipment shall be commissioned and put on trial run along with the main plant in a manner mutually agreed upon based on the commissioning schedule of main plant.
- (ii) The Contractor shall assist the purchaser in commissioning and trial run with men and material as required and/or as directed by the Owner.

4.2.4.48 Taking over of Installation

- (i) On successful testing, commissioning and trial run, the Contractor shall request Owner in writing for taking over the installation.
- (ii) The Owner, on receipt of the request, shall arrange to take over the installation either wholly or in part as the case may be after a final inspection.
- (iii) Till such taking over, the responsibility of the whole installation against theft or damage of any kind shall remain with the Contractor.
- (iv) Till the equipments taken over by the owner, the equipment will be operated and maintained by the contractor, however elimination of defects and complete readiness of equipments for taking over by the owner should be done not beyond 6 months from the date of commissioning/first trial run of the equipment

Applicable standards

	Description	Code No
(a)	Installation and Maintenance of Transformers	IS:10028
(b)	Installation and Maintenance of Switchgear	IS:10118
(c)	Installation and Maintenance of Induction Motors	IS:900
(d)	Guide for safety procedures and Practices in Electrical work	IS:5216
(e)	Hot dip galvanizing	IS:2629
(f)	Electrical wiring installations for voltages > 650V	IS:732
(g)	Fire safety of buildings (General)- Electrical Installations	IS:1646



4.2.4.49 Guarantee

In the installation if any trouble arises due to the use of defective or faulty material and/or bad workmanship within a period of 12 months from the date of taking over, the Contractor shall guarantee to replace or repair the defects to satisfaction of the Owner free of charge.

4.2.5 Earthing System

4.2.5.1 General

- (i) The main objectives of grounding system are to:
 - a) Provide safety to personnel from contact of dangerous potential caused by ground fault.
 - b) Ensure sufficient grounding current for effective relaying.
 - c) Stabilize circuit potential with respect to ground.
- (ii) The grounding system is to be designed to meet the above objectives.
- (iii) All electrical equipment, noncurrent carrying metal parts, structures, building steel, lightning protection system shall be connected to main plant ground grid to have earth continuity for safety.

Design Criteria

4.2.5.2 Fault Current & Duration

The earthing conductor shall be designed for 50 kA for duration of 3 second. The minimum below ground conductor dia shall be 40 mm.

4.2.5.3 Conductor Material

The earthing system conductors and accessories shall be as follows:

(a)	Conductors above ground level and in trenches	Galvanised steel
(b)	Conductors buried in ground or embedded in concrete	Mild Steel
(c)	Electrodes	GS Pipe / Rod
(d)	Lightning protection air termination and down conductors for buildings	GS Flat

The Contractor shall undertake the soil resistivity measurements at site and select suitable type of conductors.

4.2.5.4 Size of Conductors

(i) Main Earthing Conductors

The earthing conductor sizes shall be calculated as per the following formulae:

$$\frac{I}{S} = K \frac{1}{\sqrt{t}} \text{----- IS 3043 Cl.12.2.2.1}$$

I = Maximum A.C. rms ground fault current amperes.

S = Cross-section area in sq.mm

t = Operating times of the protective device to disconnect the faulty circuit, in secs.

K = Factor depending on the earthing conductor, the insulation and other parts, and the initial and final temperature.

The factor “K” is determined by the formula

$$K = \sqrt[Q_c]{\frac{(B+20)}{\delta_{20}} \ln_e \frac{(B+\theta_f)}{(B+\theta_i)}} \text{----- IS 3043 Cl.12.2.2.1}$$

δ_{20} = Electrical resistivity of conductor material at 20 deg. C (ohm-mm).

Q_c = Volumetric heat capacity of conductor material (J/deg.C.cu.m).

B = Reciprocal of temperature co-efficient of resistivity at 0 deg. C for the conductor.

θ_i = Initial temperature of conductor, (deg.C).

θ_f = Final temperature of conductor, (deg. C)

The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.



Resistivity of soil Ohm- Metric		Reduction in thickness/diameter, mm	
> 0	<10	8.0	
>10	<25	7.0	
>25	<50	5.5	
>50	<75	4.5	
>75	<100	3.0	
>100		1.5	

(ii) Rod Electrodes

Galvanised steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits, electrodes shall be heavy-duty type (Class - C) GI pipe of suitable diameter with perforations. Electrodes installed in the test pits shall have disconnecting facilities. For treated earth pits, GI pipe shall be provided as per IS 3043 including charcoal, salt etc. Necessary number of treated earth pits shall be provided for power transformer and for all LT transformer Neutral & body earthing.

(iii) Earthing of Electrical equipment on cranes and travelling machines (as applicable):

- a) Every electrical equipment shall have double earthing.
- b) A ring earthing system shall be provided within the crane / machine to which electrical equipment shall be connected at least at two places. The earth ring on the crane/machine shall be connected to the plant earthing system through gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails.
- c) Each end of each gantry rail shall be bonded to the plant earthing system. In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks. Flexible copper bonds shall be provided across any gap in the running gantry rails.
- d) For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.



(iv) Equipment Earthing Leads

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043 and also with a view to minimize the number of sizes.

(v) Conductors for lightning protection system

The size of conductors for lightning protection system shall be decided based on mechanical strength.

4.2.5.5 Earthing System Layout

- (i) The earthing system design and installation shall generally comply with the following standards:

(a)	IS-3043	:	Code of practice for Safety Earthing
(b)	IEEE-80	:	Guide for safety in Alternating current sub-station grounding
(c)	Indian Electricity Rules		

- (ii) The Contractor shall submit the earthing drawing/layouts to electrical Inspector/CEA for his approval. All necessary fees for obtaining such approvals shall be borne by the contractor. Necessary modification wherever required shall be carried out by the Contractor and got approved by the Inspector at no extra cost to the Purchaser. After installation the resistance of the ground grid shall be tested in presence of Purchaser/Consultant as per the IE rules. After the test, report shall be submitted to Electrical Inspector/CEA for approval. The submission of Earthing layout, drawings and obtaining Electrical Inspectorates final clearances & approval shall be within the responsibility of the Contractor. If the resistance is observed to be not less than 0.5 ohm, the Contractor shall drive additional earth pits such that resistance is less than 0.5 ohm.

4.2.5.6 General

- (i) Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used if rated voltage of equipment is above 250V. If the rated voltage is 250V



or below, one earth lead shall be provided. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.

- (ii) Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.
- (iii) All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.

4.2.5.7 Earthing Conductors Inside Building

- (i) Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover.
- (ii) In case, the building has more than one floor, each floor shall be provided with earth grid. Floor earthing grids shall be interconnected.
- (iii) Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.
- (iv) Cable trays, steel pipes / conduits, steel columns, etc. shall not be used as earth continuity conductors.
- (v) Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment.
- (vi) Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.
- (vii) Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

4.2.5.8 Earthing System Installation

- (i) The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.



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- (ii) Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.
- (iii) The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.
- (iv) When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall be sealed after installation.
- (v) The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.
- (vi) Metallic conduits, and pipes shall not be used as earth continuity conductor.
- (vii) Flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.
- (viii) Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc.
- (ix) Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound.
- (x) Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
- (xi) The cable screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.
- (xii) All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.



4.2.5.9 Lightning Protection System

Lightning protection system shall consist of vertical air termination rods, horizontal roof conductors, down comers, and pipe electrodes.

4.2.5.10 Need for Protection

The need for providing the lightning protection system shall be established by calculating risk index value for each building structure, etc., as per procedure given in IS-2309 and any building whose risk index is more than 40 shall be provided with lightning protection.

4.2.5.11 Lightning Protection System Layout

- (i) The lightning systems design and installation shall generally comply with IS: 2309 code of practice for the protection of building and allied structure against lightning.
- (ii) Each down conductor shall be connected to a rod electrode, which in turn shall be connected to the station earthing system through test links.

4.2.5.12 Lightning Protection System Installation

- (i) Conductors of lightning protection system shall not be connected with conductors of safety earthing system above ground level.
- (ii) The down conductors shall be welded to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Wherever welded, the weld locations shall be treated to provide rust protection. Each down conductor is connected to main earth grid through a test pit.
- (iii) Each down conductor shall be provided with a test link at a height of about 1000mm above ground level.
- (iv) All the metallic structures within a vicinity of 2000 mm shall be connected to the lightning protection conductors.
- (v) The minimum sizes of equipment earthing leads given below are typical and shall be as per IS 3043:



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Sl. No.	Type of Equipment	Size (MM)	Material	No. Of Leads
1	Risers	70 X 10	Galvanised MS Flat	N.A.
2	Runway conductor/ main earth lead along columns	70 X 10	Galvanised MS Flat	N.A.
3	11 kV / 3.3 kV / 415 V Switchgear / MCC	70 X 10	Galvanised MS Flat	Two
4	System Neutrals	70 X 10	Galvanised MS Flat	Two
5	415 V Distribution Boards	70 X 10	Galvanised MS Flat	One for each section
6	Fuse Distribution Boards	50 X 8	Galvanised MS Flat	Two
7	HT Motors	70 X 10	Galvanised MS Flat	Two
8	415 V Motors : above 55 kw	65 X 10	Galvanised MS Flat	Two
9	415 V Motors : 22 to 55 kw	25 X 6	Galvanised MS Flat	Two
10	415 V Motors : 1 to 22 kw	25 X 3	Galvanised MS Flat	Two
11	Fractional HP motors	8 SWG	G S Wire	Two
12	Control panel, control desk, welding receptacles	25 X 6	Galvanised MS Flat	Two
13	Push button station & junction box	8 SWG	G S Wire	Two
14	Cable trays, columns & structures	70 X 10	Galvanised MS Flat	Two
15	Bus duct enclosures			Two
(i)	Isolated phase bus duct	70 X 10	Galvanised MS Flat	Two
(ii)	Segregated phase/ non segregated phase bus duct	70 X 10	Galvanised MS Flat	Two
16	Rails & metal parts, fence	25 x 6	Galvanised MS Flat	Two



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Sl. No.	Type of Equipment	Size (MM)	Material	No. Of Leads
17	Transformer tanks/ radiators	70 X 10	Galvanised MS Flat	Two
	Transformer neutral	70 X 10	Galvanised MS Flat	Two
18	Lighting equipment			Two
(i)	LDB/ Lighting panel	50 X 8	Galvanised MS Flat	Two
(ii)	Welding sockets	50 X 6	Galvanised MS Flat	Two
(iii)	Lighting poles	25 X 3	Galvanised MS Flat	Two
(iv)	Fixtures & sockets	12 SWG	G S Wire	Two

Materials

Above ground : Galvanised Steel– Galvanizing as per IS 2629–1985

Below ground : MS

4.2.6 Control Panels & Cabinets and Miscellaneous Electrical Equipment

- 1) Indoor control panels provided for control of miscellaneous systems in the plant viz., air conditioning, evaporative air cooling, etc. shall comply with the requirements (as applicable) outlined under technical requirements below.
- 2) All the meters provided on the panel shall be min. 96 sq.mm with an accuracy class of 0.5. All meters shall be digital type.
- 3) For motor circuits, ammeters shall have a suppressed extended scale to indicate the motor starting current.
- 4) The facia annunciation windows if provided on the panel, shall conform to requirements outlined under instrumentation and control section.
- 5) The required 240V, 1 phase AC supply required for panel illumination and receptacle and space heating shall be derived in the control panel itself.



4.2.6.1 Technical Requirements

S.N.	Description	Requirements
1	Location	Indoor/Outdoor depending on location
2	Type of mounting	Wall/Floor
3	Cable entry	Top/bottom depending on layout
4	Paint Finish: Outside/Inside	Dark admiralty Grey shade no.632 (epoxy) as per IS-5/Glossy white.
5	Supply voltage	415V, 3 phase, 4 wire
6	Space heater, lighting supply voltage	240V, 1 phase AC
7	Degree of protection of Enclosure	IP 54 class for Indoor & IP 55 class with canopy for outdoor

- 1) Following miscellaneous equipment shall be included in Contractor's scope.
 - a) Local push button stations.
 - b) Junction boxes (JBs)
 - c) Danger boards
 - d) Rubber mats
 - e) Welding Sockets

4.2.6.2 Local Push Button Stations (LPBS)

- 1) Local push button station shall be provided for all the drive motors of the plant (415V motors) (start / stop push buttons shall be provided for unidirectional motors (LT motors), start/stop/reverse push buttons shall be provided for bi-directional motors (LT motors) as per scheme requirement.
- 2) The degree of protection of LPBs shall be IP65 with canopy for outdoor and IP54 for indoor applications.
- 3) All PBs shall be push to actuate type and the stop PB shall be lockable in off position as per the scheme requirement.
- 4) All push buttons shall be provided with 2 nos. NO and 2 nos. NC contacts for various interlocking purposes. One contact of stop PB shall



be directly wired to the switchgear module for direct tripping and another contact to control system.

- 5) Terminals to be suitable for 2 cores of 2.5 sq mm conductors with 20% spare terminals.
- 6) All LPBs shall be of Poly Carbonate material.

4.2.6.3 Junction Boxes (JBs)

- 1) The JBs used in outdoor areas shall have DOP of IP 65 with canopy and weatherproof type. Sheet steel thickness of JBs shall be minimum 2.0 mm and hot dip galvanized.
- 2) Junction boxes/marshalling boxes (JBs/MB) shall be provided to enable running a large core cables from (JB/MB) to control panels, terminal cabinets, etc.
- 3) All JBs, shall be of polycarbonate material.
- 4) Danger boards shall be provided in line with the statutory requirements.
- 5) Rubber mats shall be provided to meet the safety and other statutory requirements.

4.2.6.4 Welding Sockets

Industrial type 63 A and 100 A (welding purpose) sockets shall be provided in sufficient number to facilitate extension of power supply to various machine tools, welding sets etc., the same shall be decided during detailed Engineering.

4.2.6.5 Testing

The following testing shall be conducted on all equipments at works.

- a. IR Test before and after HV Test
- b. HV Test with 2.5 kV meggar

4.3 CONTROL AND INSTRUMENTATION

I&C system will consist of all local instruments Viz. Pressure Gauge, Level gauge, Temperature Gauge, all field sensors, local panel, push button



station, erection hardware and interconnecting cables required for control & monitoring of the Mill Reject System. DCS based control systems shall be provided for operation, control, interlocking, tripping of the equipment/ system whenever required under specified abnormal conditions.

4.3.1 DCS System

4.3.1.1 DCS system shall be redundant with respect to Power Supply, Processor and Communication bus. Redundant Input card shall be used for measurement of Critical points related to protection of the equipment. All output commands to MCC/ SWGR shall be provided through interposing relay and output redundancy commands for critical drives. The control panel shall be minimum IP 22 protection class for the cabinets inside the air conditioned control room, for others IP 55 or better class.

4.3.1.2 All alarms shall be generated in the DCS system and system shall be connected with 24" TFT for alarm & other display. The control system shall have hooter with required hardware and driven from DCS output. Test, Accept and Reset Push Button shall be connected to the DCS system and programmed for alarm annunciator.

4.3.1.3 A modular control desk of approved quality. HMI with 24" TFT monitor editable programming software with latest configuration hardware and quantities as per DCS configuration.

4.3.1.4 Interfacing with Plant DCS

Contractor shall provide interface requirements with plant DCS as per architecture drawing. Mill Reject System DCS shall be linked with plant DCS through bidirectional redundant TCP/IP fast Ethernet connectivity in addition to some hardware interface signals. Any device/ software required for the same shall be in contractor's scope. Contractor shall co-ordinate with the DCS vendor in achieving the interface successfully & complete. A typical DCS based control system configuration block diagram for Mill Reject System is provided for reference, DRG No: E072-03-MRHS-I-03-08-R1.

4.3.2 General Requirements

4.3.2.1 The control and instrumentation system for Mill Reject System shall be designed and constructed to meet all the specification requirements. All instruments/equipments offered shall be capable of satisfactory operation for prolonged period of time and shall perform accurately and



safely under the environmental & operating conditions described in the specification.

- 4.3.2.2** All equipment, and accessories furnished under the specification shall be from the latest proven control and instrumentation product range of qualified manufacturers whose successful performance has been established by a considerable record of satisfactory operation in power stations. C&I devices & systems shall employ latest state-of-the art technology to guard against any obsolescence. In any case, it shall be required to ensure supply of spare parts for lifetime of the plant.
- 4.3.2.3** Design requirements as specified in the specification shall be followed while selecting the control and instrumentation items.
- 4.3.2.4** Each item included in this specification shall be inspected and tested by the Contractor in his works for full compliance with specification requirements, completeness, proper assembly, satisfactory operation, cleanliness and state of physical condition as applicable.
- 4.3.2.5** Full details regarding all equipment and systems including complete Bill of Materials, drawings, data, information, technical literature and other details required to fully establish the capability and performance of the equipment and systems offered shall be provided as a part of the contract.
- 4.3.2.6** To ensure smooth and optimal maintenance, easy interchange ability and efficient spare parts management of various C&I items, it shall be ensured that each C&I item is of same make, series and from same family of hardware (as far as practicable).
- 4.3.2.7** All plants and equipments which needs regular operation and monitoring shall be provided with remote operation/ monitoring facilities, at respective control rooms/centers. Automatic control facilities to be incorporated wherever applicable.

4.3.3 Design Criteria

4.3.3.1 Design Codes & Standards

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification for the Mill Reject System shall conform to the latest editions of codes and standards. i.e. ANSI, ASME, IEEE, IEC, NEC, NEMA, ISA, DIN and Indian Standards and their equivalent standards. Contractor shall state clearly which codes and standards are followed for measurement hardware.



Following Codes and Standards shall be applicable:

4.3.3.2 Temperature Measurement

- a) Instrument and apparatus for temperature measurement–ASME PTC 19.3 (1974).
- b) Temperature Measurement – Thermocouples ANSI – MC 96.1 – 1975.
- c) Temperature Measurement by electrical resistance thermometers – IS:2806.
- d) Thermometer–element–Platinum resistance – IS:2848 / DIN 43760.

4.3.3.3 Pressure Measurement

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

4.3.3.4 Electronic Measuring Instruments and Control Hardware

- a) Safety requirements for electrical and electronic measuring and controlling instrumentation – ANSI C 39.5/ 1974.
- b) Dynamic response testing of process control instrumentation – ANSI MC 4.1 (1975) – ISA –S26 (1968).
- c) Surge withstand capability (SWC) tests – ANSI C 70.90A (1971) IEC– 255.4.
- d) Printed circuit boards – IPC TM–650, IEC 326C.
- e) General requirements and tests for printed wiring boards – IS–7405 (Part-I)/1973.

4.3.3.5 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

4.3.3.6 Enclosures

- a) Types of enclosures – NEMA Standard ICS–6–110.15 through 110.22 (Type 4 to 13).
- b) Racks, panels and associated equipment – EIA : RS–310–B (ANSI C83.9 – 1972).

4.3.3.7 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.

4.3.3.8 Annunciator

- a) Specifications and guides for the use of general purpose annunciator – ISA PR 18.1.
- b) Surge withstand capability tests – ANSI C37.90 a – 1971 and IEEE Standard 472-1974.

4.3.3.9 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.

4.3.3.10 Instrument Tubing

- a) Seamless Carbon Steel Pipe – ASTM-A-106.
- b) Material for socket welds fittings – ASTM-A-105.
- c) Dimensions of fittings – ANSI-B16.11.
- d) Code for pressure piping, welding, hydrostatic testing ANSI-B 31.1.
- e) Nomenclature for instrument tube fittings – ISA-RP 42.1 / 1982.
- f) Seamless stainless steel tube ASTM A-312 TP 304.

4.3.3.11 Cables

- a) Thermocouple extension wires / cables – ANSI C96.1.
- b) Color coding of single or multi-pair cables – 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.



4.3.3.12 Cable Trays, Conduits

- a) Guide for the design and installation of cable system in power generating station (cable trays, support systems and conduits) IEEE Standard 422, NEMA VE-1, NEC-1981.
- b) Guide for the design and installation of cable system in power generating station (cable trays, support systems and conduits) IEEE Standard 422, NEMA VE-1, and NEC-1981. Test Standards NEMA VE-1-1979.
- c) Galvanizing of carbon steel cable trays – ASTM A-386.

4.3.4 Control and Instrumentation Items

4.3.4.1 Contractor shall include complete control & instrumentation system, all field instrumentation/ sensors / final control elements with actuators & all accessories in his scope of supply. The intent of this specification is to provide the basic guidelines for supply of control & instrumentation system/ instruments for various systems as described below. However if any instruments/ equipment which are not covered in this specification but Contractor feels same are required for completeness of the system, same is to be included by the Contractor in his scope of supply. Contractor shall prepare and implement all required control loops, interlock & protection logics to make the entire system complete for the satisfactory operation & control of the entire system. Contractor shall furnish all control loops along with write-up, Interlock and protection logic diagrams along with write-up, operation & control philosophy, Analog / digital monitoring points, lists etc. for the entire Mill Reject Handling System .

4.3.4.2 The operation & control of Mill Reject System shall be performed from its own dedicated DCS based system for each unit and located in common Mill Reject System control room for both units & local panel in a completely integrated manner. Mill Reject System DCS and associated peripherals shall include following as minimum:

- a) Redundant processor, redundant communication controller, redundant power supply modules, I/O cards, one no.24" TFT based operator work station, one no.24" TFT based operator work station cum engineering station with dedicated keyboard, printers and Time synchronisation facility with plant GPS master clock (time format shall be as per GPS



master clock requirement including cabling and termination upto main plant DCS/GPS) shall be provided for Mill Reject System. For more details regarding number of HMI, Printers, LCD/TFT display units and others contractor shall refer MRS DCS configuration diagram **E072-03-MRS-I-03-08-R1**.

- b) One no. A4 size (B/W), one no. A3 colour medium speed laser and one no. high speed (180 columns) dot matrix printer shall be provided in common Mill Reject System control room.
- c) Modular control desk for operator and standard make furniture.
- d) Bidirectional high speed Redundant TCP/IP fast Ethernet connectivity with plant DCS for monitoring including cable, both side required hardware/software are under contractor scope. Contractor shall also co-ordinate with Main Plant DCS supplier for achieving suitable interface between Mill Reject Handling System DCS and Main Plant DCS.
- e) Critical signals of MRHS DCS system shall be made available in main plant DCS through maxNET.

4.3.4.3 All junction boxes, local push button stations, all Interconnected cabling between sensors to I/O card, card to DCS system operator station, Instrumentation/ special cables/ RTD cables/ pre-fabricated cable/ earthing cable, cable glands, Lugs, ferrules, cable trays, conduits, instrument racks, impulse/ air supply pipes/ tubes, erection hardware, instrument isolation valves, instrument fittings (double compression type) and other accessories within battery limits.

4.3.4.4 All field instruments/sensors/switches, final control elements with actuators as per finalised P&IDs, schemes, operation & control philosophy & logics approved during detailed engineering stage within the Mill Reject System package.

4.3.4.5 Hopper/Silo level switches and other sensors.

4.3.4.6 Licensed software required for complete DCS operation as well as for interface of Mill Reject System DCS with plant DCS.

4.3.4.7 Redundant UPS power supply requirements & conversions to required voltage levels and further distribution of entire Mill Reject System shall be in the scope of contractor.



- 4.3.4.8** DCS I/O cards and relays for control and monitoring of all instruments, drive and equipment are housed in air-conditioner environment (room/enclosure).
- 4.3.4.9** Any other item not covered herein but essential for successful installation and commissioning of the Mill Reject System and integrity of the system shall be included by the contractor.
- 4.3.4.10** All necessary Vendor/Drawing/documents shall be subjected to approval from Owner.

4.3.5 Distributed Control System (DCS)

4.3.5.1 General Design & Constructional Requirements

Distributed Control System (DCS) shall be microprocessor-based system. The DCS shall be versatile, expandable, user friendly and latest state of art technology. The system shall be envisaged for the purpose of sequential operation, protection and interlock, data acquisition system, alarm functions, closed loop control and data archiving for fully automatic operation. Logic controller shall be provided with adequate and reliable protection safeguard for various equipments and to assist the operator for easy safe and efficient starting and stopping of various drives in the process. The system shall be designed by selecting high-grade components of proven quality and proper design of system electronics. The system shall be able to operate satisfactorily with reference to the specified environmental conditions as indicated in the specification. The MRS DCS should have necessary connectivity with DCS to suit operational requirements.

4.3.5.2 Data Communication Facility

- 1) Different systems of the DCS are interconnected through redundant bus communication system. The network for communication shall be based on fault tolerant multi redundant self healing switched Ethernet connection with 100 Mbps or better bus speed between control system and control network. The communication between this package and DCS shall be redundant. Fibre Optic cable shall be used for interfacing of remote RTU. Plant internal bus loading and loading for external communication shall be less than 60%.



- 2) The system shall be modular in construction and expandable 20% in future by adding additional electronic modules, which shall be easily accessible for maintenance and repair. The types of modules shall be kept to minimum possible in order to have interchangeability and spares inventory.
- 3) The system shall have extensive self-diagnostic hardware and software features for easy and fast maintenance of the DCS. Safety barriers shall be provided for intrinsically safe input / output circuits.
- 4) The DCS shall have very high noise immunity in order to ensure safe and reliable operation when subjected to electrical radio frequency interference and electromagnetic disturbances expected in a plant.
- 5) The system shall be programmed as per the logic requirements required for the functioning of the systems and equipment. Contractor shall prepare their own logic / ladder diagrams depending upon the capability of the programmable logic controller offered by them.
- 6) Operation of the DCS shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.
- 7) On-line replacement of any module shall be possible in such a way that the removal and addition of the module shall be possible without de-energizing the system or causing any interruption in the system while replacing a faulty module except for the inputs /outputs which are being handled by that module. However, in case of triple modular redundant or dual DCS configurations, there shall not be any process upset while replacement.

DCS System spare capacity shall be inline with Main contract document Volume-IV, Section D3.4, Clause no.2.01.05.00 as mentioned below,

1. 10% spare channels in each of the input/output modules, fully wired up to marshalling cabinets/terminals. These spare channels shall be assigned with Tag Nos and shall be readily usable in future by connecting the signals.
2. Wired in Spare I/O slots for 10% in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals, such that implementation of any additional services can be achieved only by insertion of necessary electronic modules(s) in system cabinets.



3. Each controller shall have 40% spare functional capacity to implement additional function blocks, over and above implemented logics/loops. Each controller shall be loaded to Max 60% which includes 10% wired spare I/O & 10% spare I/O slot. Each of the corresponding communication controller shall also have same spare capacity as that of controller.
4. The data communication system (including main system bus and other bus system) shall have 50% spare capacity in addition to additional spare capacity specified under the above clause.
5. 20% spare relays of each type and rating, mounted and wired in relays cabinets. All contacts of relays shall be terminated in terminal blocks of relay cabinets. In each of the relay cabinets 20% spares terminal blocks shall be provided so that additional relays can be mounted and wired.
6. MMIPIS shall have capacity to handle 25% or at least 2 Nos. of each type of peripherals additionally, like MMI TFT Montors, keyboards, printers, PCs etc., over and above already specified, without any additional hardware or software.
7. The system shall be capable of handling the long-term storage of data for 90 days and retrieval.
8. The system shall be provided with programming and diagnostic facility, while in operation also.
9. Each processor shall not be loaded not more than 60 % including spare I/Os.

4.3.5.3 DCS System configuration

DCS shall consist of following major subsystems.

A. Input / Output (I/O) subsystem

- (i) I/O subsystem shall be suitable for accepting discrete inputs, BCD inputs and analog inputs. All digital input/output modules shall have 32/16 channel and analog input/output modules 16/8 channel. The I/O modules shall be mounted on the I/O racks. Each I/O shall be electrically isolated from external control circuit by suitable means. Each I/O shall be provided with galvanic isolation. The minimum isolation level between I/O and integral electronics shall be 1000 V DC. Each module shall have LED for each I/O channel to indicate the status of each input / output. Redundancy in I/O level shall be maintained for critical services.



- (ii) DCS inputs shall be provided with potential free dry contacts. All the inputs shall be double ended i.e., two wires per input and not common return for all inputs. The contact interrogation voltage for input contacts shall be 24V DC minimum. Each input channel shall be protected by separate fuse.
- (iii) Output contacts from the DCS shall be potential free dry contacts. Each output shall be short-circuit proof and protected by fuse.
- (iv) Visual indication of fuse blown must be provided for each input and output channel and should be alarmed.

B. Processor subsystem

- (i) The processor sub system shall include CPU, memory, power supply, communication interface etc.
- (ii) Dedicated DCS processor shall be envisaged for each Auxiliary plant. The processor shall have capability to implement all the control functions required. The processor shall have sufficient memory for storage of the program instructions as applicable to the logic requirements. CPU shall be of 32/64 bit or upgraded version of microprocessor. The processor shall not be loaded over 60% of the individual capacity even under the worst data loading conditions.
- (iii) Memory shall be non-volatile, preferably EEPROM type Memory shall be provided with adequate capacity with 40% spare capacity under worst loading condition.
- (iv) The healthiness of processor hardware and software shall be continuously monitored by watchdog timer.
- (v) DCSs shall be provided as a minimum with dual redundant processor subsystem including CPU, memory and power supply. Redundancy shall be provided such that, in case of failure of the main processor, the standby processor shall take over automatically and vice – versa. The changeover shall be bumpless (less than 50 m/s or better) and shall not result any process or system upset.



- (vi) In case of failure of complete processor system i.e., both processors, outputs shall take fail safe state automatically.
- (vii) The scan time of programmable controller shall be of the order of 100–250 milliseconds or better for OLCS and CLCS. Scan time of DCS is defined as the cycle time taken by the system to read input, process input executing logic and update control output for all the logics configured within the system. Other activities like diagnostic routines, output / dump of data to peripherals, or any other activity which consume processor time shall also be accounted while computing scan time.

C. Communication subsystem

- (i) The redundant communication subsystem shall provide reliable and high speed data transfer between the processor subsystem, I/O subsystem, DCS cubicles, DCS and operator work station and other devices connected to the system.
- (ii) Redundancy in communication subsystem shall be provided, such that on the failure of the active device, communication link or bus, the redundant device communication link or bus shall take-over automatically without interrupting the system operation and same shall be suitably alarmed /logged. The communication bus shall be of coaxial / fiber optics type.
- (iii) Information about the failed device shall be displayed locally as well as on the DCS console. It shall be possible to manually switch-over the communication from main bus device to redundant bus device without interrupting the DCS functions.

D. Design Requirements

- (i) The control, interlock and protection, monitoring, mimic displays, Alarm reporting (on HMI monitors /window facia) etc shall be achieved through DCS based automation system and Operating Station provided at the control room.
- (ii) The DCS based automation system shall be capable of acquiring the status of equipments, acquiring the analog and digital signals, displaying of status in the form of mimic diagram, video trend, bar graph, bar chart, over view, group over view, loop overview, alarm overview display, periodic display, logs such as hourly/ shift/daily logs, log on request,



- alarm logs etc. with the help of TFT monitor and key board and mouse.
- (iii) Process control and monitoring for each DCS based system listed earlier shall be envisaged through operator's station, keyboard and mouse. However, direct local switching of individual drives and actuators shall be possible for maintenance purpose with the necessary basic protection incorporated.
 - (iv) Wherever sequential operation is envisaged, the operator shall pre-set the operating steps and sequences as required for the implementation of the automatic operation of the plant. Subject to completion of the necessary permissive and sequence interlocks operator "Start" initiations of the appropriate lines would automatically select and start the programmed operation sequences.
 - (v) Once started, the systems shall continue in automatic operation as programmed. It shall be possible for the operator to make on-line adjustments to timings, routings, selections etc., with appropriate 'selection checks' before "Command" initiation. Also programme interruption shall be possible to effect unscheduled or out of sequence extractions before return to the original programme.
 - (vi) The DCS system shall be designed for fully automatic operation of the entire system in both auto and manual operation.
 - (vii) The following functional requirements shall be provided:
 - a) Complete control of system operations with protection, interlocking, alarm functions, sequential operation and closed loop controls.
 - b) system shall have provisions to modify the logic system, control system, graphic display etc.
 - c) For operator request display the response time shall be 1 to 2 seconds under all loading condition.
 - d) On the operator's station all dynamic parameters shall be updated in 1 sec. interval

E. DCS OWS

- (i) DCS OWS shall be provided as operator Interface station for control and monitoring of the plant. This shall be done through dynamic mimic displays and control displays.
- (ii) The OWS/EWS station shall also be used for program storage, display, fault diagnostic and alarm monitoring. It shall be possible to modify, add



or delete the application program on-line without affecting the outputs. It should be possible to modify or create new displays from DCS OWS/EWS.

- (iii) Each console unit shall have latest configured CPU with 24" TFT/LCD monitor, bulk memory, DVD read/write disk drive, keyboard and mouse.
- (iv) DCS Console shall consist of color TFT monitor of 24" size, mouse, the programming keyboard, operating keyboard and laser printer. The TFT Monitor and Laser printer shall meet the specification requirement indicated in the specification.
- (v) Isolation shall be provided between programming terminal and related subsystems, if there is any possibility of high voltage from monitor being transmitted to other subsystems.
- (vi) Contractor shall provide necessary modular control desk and standard make furniture for installation of Operator Work Station /Engineering Work Station in the control room.

F. Displays

- (i) The system shall be capable of reading the status of equipments, acquiring the analog signals, displaying the status in the form of mimic diagram, video trend, bar graph, periodic display, alarm display, alarm overview display, logs such as hourly/shift/daily logs, alarm logs etc.
- (ii) Displays include plant mimic diagrams, which shall include the complete auxiliary plant system indicating each major components of the system and the operating status of individual equipment and devices.

G. Alarm Monitoring on Operator's station:

- (i) The system shall display history of alarms in chronological order of occurrence on the Operator Station. At least three (3) levels of alarm priority shall be available which shall be displayed in different colours. It should be possible to display and print alarms. System shall have all alarm related functional keys like acknowledge, reset etc. Other design features like set point/ dead band adjustment, alarm priority, manual and automatic inhibition based on predefined logic etc. shall be provided, which shall be as finalised during detail engineering.



- (ii) The alarm display shall be built bottom up with the most recent alarm at the top of the list. When a point returns to normal, the associated alarm line shall change colour suitably and on acknowledgement, the line shall be blanked out. The alarms below the blank lines shall move upward to fill the empty lines. If the capacity of the monitor display page is exceeded, alarm history shall be stored in memory to accept the overflow. This alarm history shall be displayed upon operator demand. The format and details of alarm displays shall be finalised during detail engineering.
- (iii) When a point goes into an alarm state and appears on the alarm screen, the time of alarm shall flash until acknowledged by the operator. Acknowledgement by the operator shall cause the time to stop flashing. All alarm initiations and return to normal, shall be logged on a printer.

H. System Software

- (i) The system software shall include all programs for the DCS and DCS console which are required to perform all the DCS functions including communication and self-diagnostics.
- (ii) Diagnostic software shall have the capability to provide information about the failed module/ system either in the form of a system configuration display or provide information in the form of a statement.
- (iii) The Contractor shall provide software license for all the software provided for the project and shall not be machine specific. All software licenses shall be valid for the continuous service life of the plant and equipment. Password security shall be provided in order to ensure security level to the plant operation.
- (iv) The contractor shall provide software license for all software being used in the system. The software license shall be provided for the project and shall not be hardware/ machine specific. That is, if any hardware / machine is upgraded or changed, the same license shall hold good and shall not be necessary for purchaser to seek a new license/renew license due to upgradation/change of hardware/machine in system at site. All licenses shall be valid for the continuous service life of the plant.



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- (v) All the software listings including source code for application software. All specific -to-project data files etc. shall be submitted by the contractor.
- (vi) The contractor shall furnish a comprehensive list of all system /application software documentation after finalisation for owner review and approval.

I. Peripherals

- (i) All peripherals shall conform to the minimum requirements indicated in the specification, the exact make and model number shall be as approved by the OWNER during detailed engineering stage.
- (ii) All terminals/Operator's stations shall be 24" colour monitor with mouse and key board. Operator's stations shall be provided with graphic and mimic capabilities with minimum 64 distinct colours. The graphic resolution shall be 1280 x 1024 dots minimum with 0.25 mm dot pixel and refresh rate shall be 85 Hz or better. Suitable optical filter for minimum secondary glare shall be provided.
- (iii) Dot matrix type character printer 132/136 column with minimum speed 400 cps shall be provided for printing operator requested functions and graphics. Paper width and line spacing shall be selectable. Noise level shall not exceed 60 db at a distance of one (1) metre from printer. Sound proof enclosure shall be provided. Facility to lock or release the printers on demand shall be provided. Automatic back up facility of printer functions shall be provided. The operator shall be able to direct logs, reports etc. to any printer from any of the HMI stations. Furniture for keeping the printer shall be provided. The printer shall have self contained test and diagnosis to aid in trouble shooting. The interface shall be either RS232C or RS422A or any other latest protocol.

J. Alarms & Inter locks for DCS Systems

- (i) The Contractor shall provide alarms and interlocks as recommended by the manufacturer and as felt necessary for safe and smooth running of the process and equipment offered.



- (ii) The System Control Panels shall house the controls for the plant including tripping and status indications. Interlock and protection logics for equipments and process shall also be provided at the panel. The panel shall accommodate indicators, annunciators, push buttons, selector switches, indicating lamps, control switches, auxiliary relays, contactors, DCS etc as required. The location and design of panel shall be subject to Owner's approval.

- (iii) Contractor shall refer the typical configuration of the DCS systems of Mill Reject System provided in the following drawing: DCS System Configuration Diagram of Mill Reject System: **EO72-03-MRHS-I-03-08-R1**

K. Power Supply System

Separate independent UPS system shall be provided for DCS system located in Mill Reject System control rooms. UPS system shall consists of 2 x100%, 1-Phase, 240 V, 50 Hz parallel redundant UPS with 50% load sharing mode and stand by servo stabilizer to supply power at full load to CPU, Monitor, Printer with 60-minute battery back-up shall be provided for DCS. The battery of 2V, plante type with long life shall be provided. Voltage regulation shall be within 1%. All the necessary chargers, inverters, isolation transformers, surge protection devices shall be provided. For CPU / I/O cards power supply shall be derived from UPS by providing redundant 240V UPS AC/DC 24 V DC convertor for each cubicle.

4.3.6 Field Instruments

All field instruments shall have microprocessor based transmitter with self configurable keypad and portable communicator of HART/MODBUS protocol.

4.3.6.1 Pressure Transmitter

Pressure Transmitter shall be provided:

- For all control applications and as demanded by the process. It shall be noted that for all critical control applications, 3 transmitters shall be provided.
- The Drive protection trip due to pressure shall be derived from LVM of transmitter signal and not through switches.



Specification:

Micro-processor based indicating type (LCD display), rack mounted with accuracy of $\pm 0.1\%$ of span, external zero and span adjustment. Repeatability: $\pm 0.05\%$ of FSR or better. Linearity: $\pm 0.1\%$ of FSR or better. Hysteresis: $\pm 0.1\%$ of FSR or better. Self diagnostics, temperature sensor for compensation. Powers supply 24 V DC; output signal of 4–20 mA DC. IP 65 or equivalent degree of protection. Aluminium housing with epoxy coating, 316 SS sensing element. Accessories like snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armored capillary for corrosive and oil services 3 way manifold & name plate, etc. Material for accessories will be SS. Remote communication with field communicator/ control system. HART protocol output shall be available in each transmitter.

4.3.6.2 Differential Pressure Transmitter

- a) Differential Pressure Transmitter shall be provided
- b) For the measurements of Diff. pressure, flow, level
- c) Wherever indicating type transmitters are provided, local indicators shall not be provided.

Specification

Microprocessor based indicating type (LCD display), rack mounted with accuracy of $\pm 0.1\%$ of span, external zero and span adjustment. Self-diagnostics, temperature sensor for compensation. Powers supply 24 V DC; output signal of 4–20 mA DC. IP 65 or equivalent degree of protection. Aluminium housing with epoxy coating, haste alloy sensing element. Accessories like snubbers for pump discharge applications, chemical diaphragm with 10 m PVC covered SS armoured capillary for each limb for corrosive and oil services and 5 way manifold & name plate, etc. Material for accessories will be SS. Accuracy: $\pm 0.25\%$ of FSR or better. Repeatability: $\pm 0.05\%$ of FSR or better. Linearity: $\pm 0.1\%$ of FSR or better. Hysteresis: $\pm 0.1\%$ of FSR or better. Remote communication with field communicator/ control system. HART protocol shall be available in each transmitter.



4.3.6.3 Flow Transmitters

- a) For most applications the transmitter shall be DP type measuring differential pressure across the primary flow element – orifice / flow nozzle / aerofoil.
- b) The transmitter shall provide suitable 4–20mA dc output signal for control and indication/recording. Converters if necessary shall be provided to generate the 4–20mA signal.

4.3.6.4 Level Transmitter

- a) Level transmitters shall be provided on process equipments where continuous remote monitoring and/or control of level are envisaged. The transmitter shall provide suitable 4–20mA dc output signal for control and indication/recording.
- b) The instrument will be displacer type for tanks normally under vacuum. For all other tanks the instrument will be differential pressure type.

4.3.6.5 Temperature Indicators

- 1) Temperature indicators (Thermometers) shall be provided:
 - a) On all process lines where local indication is warranted by the system either for monitoring or testing.
 - b) On the inlet/outlet of equipments such as desuper-heaters, Heat Exchangers & Coolers for both the fluid media.
 - c) Capillary type temperature indicators shall be used in vibration prone areas.
 - d) Thermowell shall be provided for all temperature indicators.
 - e) Local indications/gauges shall be provided as per approved P&IDs during detail engineering.
- 2) Thermometers shall be Indicating type, field mounted, filled system with ten (10) metres SS capillary with SS armour and six (6) inch dial (white dial with black numerals with micrometer pointer) housed in aluminum casing (epoxy coated) with an accuracy of $\pm 1\%$ of span, response time of 2–4 seconds, auto temperature calibration, linear calibration over the range and SS bulb with 316 SS, thermowell having a process connection of M33 x 2 thread or 150 RF flanged. Material of accessories (name plates, mounting brackets, etc.) will be SS. IP 65 or equivalent degree of protection for enclosure.



4.3.6.6 Thermowells

Pipe/equipment mounted temperature/ test wells of 316 SS with a process connection of M33 x 2 threads or 150 RF flanged. Accessories like name plate, plugging with chain, etc. shall be provided. Material of accessories will be SS. Thermowell shall be hex head of bar stock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermowell construction shall meet the ANSI 19.3-1994 (latest) requirements.

4.3.6.7 Temperature Elements

- 1) All RTD's as required for implementation of control & monitoring shall be supplied.
- 2) Thermowells shall be provided for mounting of all temperature elements.
- 3) The elements shall be duplex type with integral thermowell (except for metal temperature thermocouples).
- 4) Resistance Temperature Detectors (RTD's) shall be provided for all 6.6/3.3 kV motors, for winding temperature monitoring. Each element shall be 3 wire types, duplex with thermowell assembly.
- 5) All temperature elements shall be supplied with associated junction box with IP 65 protection class.
- 6) 1 no. duplex RTD shall be provided for each bearing of HT equipment.

4.3.6.8 Resistance Temperature Detectors (RTD)

Duplex PT-100 type with accuracy of $\pm 0.5\%$ of span, response time 1-2 seconds; Spring loaded mineral insulated three (3) wire RTD assembly housed in aluminium casing (epoxy coated), IP 65 or equivalent degree of protection for enclosure. RTD shall be supplied as an assembly complete with thermowells meeting ANSI 19.3-1994 (latest) requirements. Thermowell shall be 316 SS having a process connection of M33 x 2 thread or 150 RF flanged. Thermowell with hex head with screwed cover & SS chain, bar stock assembly. Element lead size will be 18 AWG. The insulation resistance at 540°C shall not be less than 5M



ohms. Repeatability over full range shall be better than 0.02%. RTDs shall be ungrounded. Material of accessories (name plate, etc.) will be SS.

4.3.6.9 Pressure switches

Pressure Switches shall be provided:

- a) On all process lines/equipments where parameter abnormality/ status including pre trips alarms are to be communicated to the operator in control room.
- b) For all permissive conditions governed by safety operation of the equipments e.g. pressure adequate conditions.
- c) For all interlock conditions which govern starting of standby equipment or subsequent equipments for safety operation of the system.
- d) Inlet and outlet of filters/strainers.

Specification

Non indicating type, field mounted Pressure Switches of aluminium casing (epoxy coated), and 316 SS element and accuracy of $\pm 1\%$ of span, including accessories like siphons for steam services, snubber for pump discharge applications and chemical diaphragm for corrosive and oil services, name plate & mounting brackets. Material of accessories will be SS. Auto reset micro switch with internal adjustment for set values with 2 SPDT contacts rated for 0.2 A at 220 V DC. IP 65 or equivalent degree of protection for enclosure. Over range protection 50% above maximum pressure. Scale for setting shall be provided.

4.3.6.10 Differential Pressure Switches

Differential Pressure Switches (Indicating type) shall be provided across filters/strainers for remote monitoring.

Specification

Bellows or diaphragm operated indicating field mounted type; aluminium casing (epoxy coated); 316 SS pressure element nylon movement; an accuracy of $\pm 1\%$ of span with adjustable contact, including accessories like snubbers for pump discharge applications, chemical diaphragm with 15 m capillary for each limb for all corrosive and oil services and 5 way manifold, name plate & mounting brackets, etc. Material of accessories will be SS. Auto reset micro switch with tamper proof external adjustable



set values with 2 SPDT contacts rated for 0.2 A at 220 V DC. IP 65 or equivalent degree of protection. Over range protection will be 50% above maximum pressure. Repeatability shall be $\pm 0.5\%$ FSR.

4.3.6.11 Level Switches

- a) Level Switches shall be provided on Tanks for remote monitoring and interlocks. Level switches shall be Float or Displacer type for water tanks.
- b) The instrument shall be external float type with SW connection with isolation facility for surface mounted tanks and top mounted with still pipe for all sumps. Still pipes will be provided with adequate supports.

Specification

Float or Displacer type with dual process connections. an accuracy of $\pm 1\%$ of span with adjustable contact, Auto reset micro switch with tamper proof external adjustable set values with 2 SPDT contacts rated for 0.2 A at 220 V DC. IP 65 or equivalent degree of protection. Repeatability shall be $\pm 0.5\%$ FSR.

4.3.6.12 Pressure indicator/gauges

Pressure indicators shall be provided for

- a) Suction and discharge lines of pumps, including on header section, if two or more pumps are employed for the same service.
- b) Suction and discharge lines of fans, including on header section if 2 or more fans are employed for the same service.
- c) All input and output lines of process equipments.
- d) Inlets and outlets of heat exchangers and desuperheaters.
- e) Local gauges shall be provided as per approved P&IDs during detail engineering.

Specification

Direct reading, pipe mounted Pressure gauges of aluminium casing (epoxy coated) with 4 1/2 inch / 6 inch phenolic dial (white dial with black numerals), 316 SS Bourdon tube, AISI 304 movements and micrometer type adjustable aluminium pointer, an accuracy of $\pm 0.5\%$ of span including accessories like siphons for steam services, snubbers



for pump discharge applications and chemical diaphragm for corrosive and oil services and name plate, etc. Material of accessories will be SS. IP65 or equivalent degree of protection for enclosure. Over range protection will be 50% above maximum pressure. Armoured capillary of 15 M shall be provided as required.

4.3.6.13 Differential Pressure Indicators

Direct reading type, pipe/ rack mounted, bellows or diaphragm operated differential pressure indicators; aluminium casing (epoxy coated) with six (6) inch dial (white dial with black numerals), with micrometer type pointer, 316 SS pressure element; an accuracy of $\pm 0.5\%$ of span including accessories like snubbers for pump discharge application, chemical diaphragm with 15 m PVC covered SS armoured capillary for each limb for corrosive and oil services and 5 way manifold & name plate, mounting brackets, etc. Material of accessories will be SS. IP 65 or equivalent degree of protection. Over range protection will be 50% above maximum pressure.

4.3.6.14 Level gauges

Level gauge glasses shall be provided on all tanks and the maximum length of one gauge glass shall not exceed 1 meter. The gauge glasses shall be stacked to cover the complete height of the tanks including over flow level. There shall be an overlap of minimum 150 mm, when more than one level gauge is required. Suitable platforms shall be provided for purpose of taking measurements and during maintenance.

Specification

Tubular type level gauges for low-pressure up to 7 kg/cm² & reflex type for high-pressure water & steam services & vacuum services with automatic ball check valves, illuminator (240 AC) Pyrex/ borosilicate glass, mica shield, brass guard rods & brass holders. Material of accessories (name plate, etc.) will be SS. Tubular glass OD will be 5/8". Vent & drain valves shall be provided. Connection shall be screwed or flanged (ANSI class 150 RF).

4.3.7 Solenoid Valves

- 4.3.7.1 Solenoid Valves Solenoid valves shall be provided with control valves/ pneumatic control valves hooked up with process interlock requirements



and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

- a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
- b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
- c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.

4.3.7.2 Solenoid Valve coils shall be Class-H high-temperature or Class-F construction with temperature rise class -B as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4.

4.3.8 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. Instrument air shall confirm to ISA-7.0.01 for quality standard for instrument air.

4.3.9 Drive Control Philosophy

4.3.9.1 Interface of the system with M.C.C/ Switchgears, AC Solenoids, DC Solenoids and contactors (AC&DC) shall be in the form of potential free contacts via interposing relay modules mounted in the respective switchgear or MCC unit. All other interfacing relays shall be mounted in a separate cabinet or a separate section of the cabinet. For AC solenoids



and contactors directly driven from output cards, arc suppressors shall be provide across the coil.

4.3.9.2 The Drive control Philosophy is as follows:

SL. NO.	Description	Type of I/O	No of I/O
1.	DCS INTERFACE FOR UNIDIRECTIONAL HT DRIVE / LT BREAKER CONTROL DRIVE (Signal Exchange has been envisaged between DCS and switchgear)		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	Swgr Disturbance (Overload relay operated/ control supply fail/Emergency LPBS stop)	DI	1
f.	Electrical Trip (Motor Protection Relay)	DI	1
g.	Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged)	DI	1
h.	Pump / Fan bearing temperature measurement	RTD	2
i.	Motor Bearing temperature measurement	RTD	2
j.	Motor Winding temperature measurement	RTD	6
k.	Current Transducer input	AI	1
2.	DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (Signal Exchange has been envisaged between DCS and PMCC/MCC)		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
e.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/Emergency LPBS stop)	DI	1
f.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
3.	DCS INTERFACE FOR BIDIRECTIONAL LT DRIVE- For Integral starters (Signal Exchange has been envisaged between Actuator and DCS.)		
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Integral starters Fault	DI	1
d.	Open limit switch feedback	DI	1



SL. NO.	Description	Type of I/O	No of I/O
e.	Close limit switch feedback	DI	1
f.	Open Torque switch feedback	DI	1
g.	Close Torque switch feedback	DI	1
h.	Position Transmitter (For inching type Drive)	AI	1
4.	DCS INTERFACE FOR BIDIRECTIONAL LT DRIVE-For Non-Integral starters (Signal Exchange has been envisaged between Actuator and DCS)		
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/Emergency LPBS stop)	DI	1
d.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
e.	Open limit switch feedback	DI	1
f.	Close limit switch feedback	DI	1
g.	Open Torque switch feedback	DI	1
h.	Close Torque switch feedback	DI	1
i.	Position Transmitter (For inching type Drive)	AI	1
5.	DCS INTERFACE FOR SOLENOID DRIVE (Single coil)		
a.	Energise or DeEnergise	DO	1
b.	Open limit switch feedback	DI	1
c.	Close limit switch feedback	DI	1
6.	DCS INTERFACE FOR SOLENOID DRIVE (Double coil)		
a.	Energise	DO	1
b.	DeEnergise	DO	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1

4.3.10 Instrumentation Cables, Wiring & Terminals

Please refer Electrical section for Instrumentation Cables.

4.3.11 Instrumentation Interconnection Philosophy

Cable interconnection philosophy is to be adopted such that extensive grouping of signals at field shall be done by use of junction boxes,



transmitter racks so that multi pair cables can be used from junction boxes to marshalling cabinets/RTU.

4.3.12 Junction Box (JB)

4.3.12.1 Junction Boxes shall have following features:

- a) Double door type with cable entry from bottom.
- b) 12/24/36/48/64/72/96/128 way with 20% spare terminals.
- c) Spring-loaded terminals shall be used.
- d) 4mm thick fiberglass reinforced polyester.
- e) Door shall be screwed at all four corners. Door handle shall be self-locking with common key. Door gasket shall be of synthetic rubber.
- f) Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in C&I Vendors scope of supply.
- g) Terminals shall be rail mounted cage-clamp type suitable for conductor size up to 2.5 mm². An M6 earthing stud shall be provided.
- h) Enclosure shall be minimum IP: 55 or better for all applications except CHP. For CHP application the protection class shall be IP 65 minimum.

4.3.13 Erection & Commissioning

Instrumentation and Control, Erection, Field Testing and Commissioning Requirements.

4.3.13.1 **Erection requirements**

- 1) The actual location of transmitters, junction boxes and other instruments shall be decided depending on the site conditions considering the layout and maintenance aspects.
- 2) The Vendor shall get prior approval as per approved quality assurance plan of the Owner/ Consultant before any installation work starts.
- 3) Impulse/sample piping, air supply and pneumatic tubing, cable trays and equipment shall be supported rigid enough to prevent vibration and anchored sufficiently to prevent strains on equipment installed. Supporting clamps shall be provided at least at every one metre distance for better rigidity. Impulse/ sampling piping shall be provided with adequate slope, (preferably 1:10). Hangers and supports shall be so installed as not to interfere with free expansion



and contraction of the piping and tubing between anchors. Suitable vibration dampeners, etc., shall be provided wherever necessary. In addition, care should be taken that the arrangement of impulse piping, air supply and pneumatic tubing shall be safe from mechanical injury. Impulse pipes joints shall be welded type unless otherwise specified. Argon arc welding shall be employed. Impulse tubing/ pneumatic tubing joints shall use double compression fittings.

- 4) All the panels, desk, cabinets supplied by the Vendor shall be bolted to the floor channel.

4.3.13.2 Testing requirements

- 1) The Vendor shall set up his own instrument laboratory. The calibration equipment shall cover complete range and shall have the desired accuracy of not less than 0.1%. All the calibration equipment shall have the certification from National Physical Laboratory (NPL) or 'IDEMI' for the duration of Contract Period.
- 2) The Vendor shall follow the standard procedures for calibration of various instruments and as set by the manufacturer of instruments and as instructed by the Owner including any requirements of field calibration. First, the calibrations shall be carried out independently by the Vendor and later in the presence of Owner who shall certify the same. Proper documentation in this regard shall be maintained and handed over to the Owner.
- 3) All the instruments shall be calibrated for the entire range of the instrument for which it is designed. Calibration shall include test for repeatability.
- 4) All switches shall be tested for the actuation of both normally open and normally closed contacts at the desired set points and also for the fixed/ differential settings.
- 5) All the float operated level switches shall be tested for the movement of the float and linkages to make to break the switch contacts by filling up with water before installation. For such tests, necessary testing set up required shall be arranged by the Vendor. All the conductivity type



probes and switches shall be tested for functionality before installation.

- 6) Air leak tests shall be performed on all impulse lines, air supply and pneumatic lines. Necessary equipment such as portable compressor, connecting pipes, materials, cables and test gauges shall be provided by the vendor.
- 7) For all electrical actuators of the valves, functioning, setting and performance of limit switches/ torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated.
- 8) Pneumatic actuators shall be calibrated at site.

4.3.13.3 Commissioning requirements

- 1) Prior to taking the instruments in service, all impulse lines, sampling lines and air supply lines shall be blown as required with the establishment of adequate line pressure and temperature conditions to keep the lines thoroughly clean.
- 2) On-line i.e. without removing control valves from the pipe calibration of the positioners and stroking of control valves/ control dampers shall be carried out as required during control system tuning.
- 3) After delivery of the equipment, the Vendor shall locate all the equipment including electronic cards in final position, check all the power wiring, grounding and interconnection cables, all in accordance with manufacturer's recommendations. The Vendor shall perform initialisation of system power, field loading of system configuration/ software and data base, demonstration of system functionality to verify conformance with manufacturer's instructions and specifications, tuning of control loops, implementation of any configuration changes including hardware, software and additional tappings/ instruments, cabinets as required and providing general trouble shooting and final solutions to application and/ or instrument problems.



4.3.14 Training

4.3.14.1 Further to relevant clauses regarding training specified elsewhere, The manufacturer/supplier has to provide the technical training to Owner's technical team (10 members including both maintenance & operational personal) in the following areas:

- Operator training
- Hardware /Software maintenance training
- Any other specialised training as required for system operation and maintenance.

4.4 CIVIL

4.4.1 General

- 1) The scope of civil works to be carried out under the contract is as detailed here. The items, though not specifically mentioned, but are needed to make the system complete shall be treated as though included and the same shall also be furnished and erected/constructed unless otherwise specifically mentioned as excluded.
- 2) This specification covers the methodology to be followed for design and construction of all civil and architectural works for mill reject handling. For detailed civil work specifications, Part C of this document shall be referred.
- 3) Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as CIVIL WORKS. For project and geotechnical data, reference shall be made to project synopsis.
- 4) If certain items/ areas, though not specifically mentioned, but are needed to make the system complete, shall be treated as though included and the same shall also be furnished and erected / constructed unless otherwise specifically mentioned as excluded.
- 5) The work to be performed under this specification consists of design, engineering and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the



specifications including revisions and amendments thereto as may be required during the execution of work.

- 6) Supply of all materials including cement, reinforcement steel and structural steel and all other materials necessary for the completion of the CIVIL WORKS are included in the scope of the Contractor.
- 7) The contractor shall make necessary arrangements to conduct all relevant tests required for the civil works.
- 8) The work shall be carried out according to the design/ drawings to be developed by the Contractor and approved by the Owner/Engineer. All necessary layout and details are to be developed by the Contractor keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Contractor's work shall cover complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Owner / Engineer.
- 9) The Contractor shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Government department as per the directions of the Owner/Engineer. The Contractor's offer shall cover the complete requirements as per the best prevailing Engineering Standards and Practices and to the complete satisfaction of the Owner.
- 10) The Contractor shall be solely responsible for the correctness of the layout and levels and shall provide necessary instruments, materials, access to works, etc., to the Owner/Engineer for general checking of the correctness of the civil works.
- 11) All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.
- 12) The Contractor shall inspect the site, examine and obtain all information and data required and fully appraise himself of the prevailing conditions at the proposed site, access to site, communications, transport, right of way, availability of local labour, materials and their rates, local working conditions climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and



contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

13) In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Contractor without any extra cost to the Owner/Engineer.

4.4.1.1 Construction water

The Construction water will be arranged by the owner free of cost at ground level reservoir within the plant area. Arrangements for drawing the water from ground level reservoir and distribution of pipe line network for various locations as required shall be arranged by the Contractor at his own cost. In case of shortage of water, the Contractor has to make alternative arrangements at his own cost.

4.4.1.2 Statutory Requirement

Contractor shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Loss prevention association, Water act for Pollution control, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied. Statutory clearances shall be obtained and norms of State Pollution Control Board shall be followed. Statutory body /Act requirements shall be fulfilled by the CONTRACTOR and in case any modifications/ additions to the building/ Structures are to be made as per the above, shall be carried out by the Contractor at no extra cost to the owner.

4.4.1.3 Submissions

- 1) Commencement of fabrication and erection and construction shall be done after approval of the relevant documents and drawings. All drawings shall be of standard sizes (Metric System) and shall be prepared using AutoCAD (latest). All documents shall be made using MS office. Contractor shall submit two sets of soft copies (in editable format) of all documents and drawings on CDs along with requisite sets of hard copies of the same.
- 2) In addition to the requirements specified elsewhere in the specification 3D/2D structural frame analysis preferably using STAAD pro or



equivalent software and design for the plant structures shall also be submitted (in editable format) by the contractor for Owner/Engineer's review and approval.

- 3) The documents and drawings as listed below are to be submitted for the approval of the Owner/Engineer unless specified otherwise. The list given below is not exhaustive but indicative only.
- i. A 'General Layout Plan' drawing showing complete mill reject handling system with coordinates of major items in his scope.
 - ii. Project design intent document giving the basis of design, which shall cover all the aspects, parameters, assumptions, references, structural idealization/ mathematical model, loading cases, load combinations etc.
 - iii. Structural analysis, design calculations and drawings of substructure and super structures for all the structures in his scope.
 - iv. All reports of tests/ studies/ investigations including model studies carried out by the Contractor.
 - v. Shop drawings/ fabrication drawings of all structural steel works (only for reference) and design calculations for important joints/ connections.
 - vi. Construction and erection procedure for all major structures covered under the Contractor's scope.
 - vii. All other design details/drawings or any other submission as may be indicated elsewhere in this specification and as required by the Owner/Engineer.
 - viii. Details of corrosion protection measures for all structures.
 - ix. Construction drawings shall include total quantity of concrete (grade wise), reinforcement steel and structural steel (section wise).
 - x. Field Quality Plan with procedures.
 - xi. Material test certificates.
 - xii. As built drawings with quantities of various items of work duly certified by Site after execution of work for information/ record.
 - xiii. One Complete set of applicable standards, references, specifications, code of practice, other than BIS (Bureau of Indian Standards) etc to the Owner/Engineer for use at site.



- xiv. Wherever applicable, scheme for dewatering, shoring, strutting/ sheet piling and scheme for blasting (including controlled blasting) of hard rock.

4.4.2 Codes & Standards

The following Indian codes and standards shall be used for analysis, design and construction and quality control system of all civil and structural works. In all cases latest revisions with amendments, if any shall be followed. Apart from the specific codes mentioned herein, all other relevant and related codes concerning the specific jobs under consideration and/or referred to in these codes and technical specification shall be followed wherever applicable. (All codes shall be latest as on the date of issuing the Tender/Bid document).

EXCAVATION AND FILLING	
IS: 2720	(Part-II, IV to VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.
IS: 9758	Guide lines for Dewatering during construction
PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS	
IS: 269	Specification for ordinary Portland cement, 33 grade
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 432	Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement
IS: 455	Specification for Portland slag cement
IS: 702	Specification for Industrial bitumen
IS: 808	Rolled steel Beam channel and angle sections
IS: 1077	Specification for common burnt clay building bricks
IS: 1161	Specification of steel tubes for structural purposes
IS: 1363	Hexagon head Bolts, Screws and nuts of production grade C
IS: 1364	Hexagon head Bolts, Screws and Nuts of Production grade A & B
IS: 1367	Technical supply conditions for Threaded fasteners
IS: 1786	Specification for high strength deformed bars for concrete reinforcement



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IS: 2062	Specification for steel for general structural purposes
IS: 2116	Specification for sand for masonry mortars
IS: 2386(Parts-I to VIII)	Testing of aggregates for concrete
IS: 3150	Hexagonal wire netting for general purpose.
IS: 4082	Recommendations on stacking and storage of construction materials at site
IS: 8112	Specification for 43 grade ordinary Portland cement
IS: 8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary Portland cement
IS: 12894	Specification for Fly ash lime bricks
CAST-IN-SITU CONCRETE AND ALLIED WORKS	
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding
IS: 4656	Specification for form vibrators for concrete
IS: 4925	Specification for batching and mixing plant
IS: 4990	Specification for plywood for concrete shuttering work
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work
IS: 5624	Specification for foundation bolts
IS: 6461	Glossary of terms relating to cement concrete
IS: 9103	Specification for admixtures for concrete
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction
IS: 10262	Recommended guidelines for concrete mix design
IS: 11384	Code of practice for composite construction in structural steel and concrete
FABRICATION AND ERECTION OF STRUCTURAL STEEL WORK	
IS: 2016	Specification for plain washers
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products
IS: 3502	Specifications for chequered plate
IS: 6911	Specification for stainless steel plate, sheet and strip



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IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts
IS: 6649	High Tensile friction grip washers
IS: 800	Code of practice for use of structural steel in general building construction
IS: 816	Code of practice for use of Metal Arc Welding for General Construction
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel
IS: 817	Code of practice for Training and Testing of Metal Arc Welders
IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 7215	Tolerances for fabrication steel structures
IS: 12843	Tolerance for erection of structural steel
IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels
SP: 6 (Part 1 to 7)	ISI Hand book for structural Owner/Engineers
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube
IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel
IS : 2595	Code of Practice for Radio graphic testing
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding
IS : 3658	Code of practice for Liquid penetrant Flaw Detection
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds
PAINTING AND ALLIED WORKS	
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying
IS:2395	Code of practice for painting concrete, masonry and plaster



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	surfaces
Part-I	Operations and workmanship
Part-II	Schedule
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing
IS:2933	Specification enamel paint, under coating and finishing
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products
IS:5410	Specification for cement paint
IS:6278	Code of practices for white washing and colour washing
PILING AND FOUNDATION	
IS:1080	Code of practice for design and construction of simple spread foundations
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation
IS:2974 (Part-I to V)	Code of practice for design and construction of machine foundations
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation
IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads
Part-I	Shallow foundations
Part-II	Deep foundations
IS:12070	Code of practice for design and construction of shallow foundations on rocks
SAFETY	
IS:3696 (Part I & II)	Safety code for scaffolds and ladders
IS:3764	Safety code for excavation work
IS:7205	Safety code for erection on structural steelwork
IS:7293	Safety code for working with construction machinery
IS:7969	Safety code for handling and storage of building materials



5.0 OPERATION & CONTROL PHILOSOPHY

5.1 MECHANICAL

5.1.1 Description & Operation of DCS Based System

The operation and control of the Mill Rejects Handling System for all the two (2) units shall be performed from its own dedicated DCS located in the mill reject handling Control Room (common for both units). The Mill Rejects Handling System DCS shall be linked to DCS through high speed redundant TCP/IP fast Ethernet connectivity as well as hardwired signals for monitoring purposes.

5.1.2 Control System for a Typical Denseveyor

5.1.2.1 One no. plate valve is provided between the denseveyor & the pyrite hopper. This is a maintenance valve & shall generally remain open.

5.1.2.2 One no. Bag Filter along with level probe and pressure switch for checking the clogging of bag filter is provided on Bunker. The Bag Filter is to be switched on by the operator before starting the Denseveyor system. Mill rejects from the Pyrite hopper shall be conveyed through the Denseveyor to the respective bunkers provided the level of that particular bunker is not high (checked from the level probe of the bunker). In case of clogging of bag filter, alarm is initiated, the conveying cycle in progress shall be completed, system shall stop and alarm shall be raised.

5.1.2.3 All the conveying systems are identical. Denseveyor can work in timer as well as in level probe mode. In probe mode as the Pyrite hopper level picks up or in timer mode after a preset lap of time, the conveying cycle starts.

5.1.2.4 If during conveying, any system observes the line block condition and does not get cleared for next 5 minutes (adjustable), this shall be considered as system not conveying. Conveying from other Denseveyor systems shall continue.

5.1.3 System Operational Philosophy

5.1.3.1 Complete Mill Rejects system shall be operated from its own dedicated DCS based control system. Mimic/graphic shall be available on operator work station for both the units and common facilities.



5.1.3.2 Whenever a fault is generated, respective flag shall start flashing and alarm shall be raised. When accept is initiated through reset button on operator work station, sound shall be muted and flashing shall be stopped.

5.1.3.3 Conveying System operation shall also be controlled through DCS based operator work station.

5.1.4 Logic of Operation for Mill Rejects Systems

5.1.4.1 Operation of all the systems is totally independent of each other. Conveying cycle for any system could be started/ stopped at any time irrespective of status of any other systems.

- a) Complete Mill rejects system shall be operated in auto mode from DCS based operator work station.
- b) One no. Start/Stop selector switch shall be provided on Denseveyor pneumatic panel of each system for manual operation as and when required. These selector switches are normally kept in start position. Similarly, Start/Stop selection shall also be provided on operator work station. The system can't run if it has been stopped from pneumatic panel or control desk.
- c) A timer is generated in the system to select only conveying systems (one from each unit/ mill bay) out of 6 (operating 5 mills maximum). In case of emergency, additional streams shall be force started from operator station.

5.1.4.2 Whenever "Conveying System stop" button is pressed from control desk, the running systems of that unit shall complete their current conveying cycles and then stop.

5.1.5 Pneumatic Panel for Denseveyor and associated plate valves

5.1.5.1 One no. Pneumatic panel common for each Denseveyor and associated plate valves at Pyrite hopper inlet and outlet shall be provided.

5.1.5.2 This panel shall be mounted on the pyrite hopper support structure. One Start/ Stop selector switch shall be provided on this panel, which shall be wired up in series through DCS based system with the Start/ Stop selector switch.



5.1.5.3 The pneumatic panel selector switch shall always be kept in start position to enable the operation of the Denseveyor. This switch shall be put to stop position only during maintenance.

5.1.5.4 Besides this switch, one push button for Purge operation & another push button for Probe override operation shall also be provided on this panel.

5.1.5.5 Power on indication shall also be provided on the pneumatic panel.

5.1.5.6 Open and close buttons are also provided on pneumatic panel for plate valve at pyrite hopper inlet and outlet for maintenance purpose.

5.1.5.7 Pressure switches, Pressure gauges, solenoid valves etc. are provided inside this panel as per the system requirement.

5.1.6 Air Compressors

5.1.6.1 The compressors shall be operated from Main Plant Control Room in remote mode & from the compressor house in local mode.

5.1.6.2 All the critical alarms & status shall be indicated in the main plant DCS.

5.1.6.3 The auto operation of the compressors & the HOC shall be controlled by DCS.

5.1.6.4 Each compressor should be able to operate under continuous, "Load-Unload", "On-Off" mode (i.e.) "Dual control modes".

5.1.6.5 It should be able to select any of the compressors from control panel to operate either for base duty (Auto Load-Unload) or Standby (Auto On-Off).

5.1.6.6 In "Base Duty" mode, whenever air supply from compressors exceeds the demand, control system shall:



- a. Operate the load Un-Load circuit at a predetermined set pressure.
- b. Throttle the inlet valve
- c. Open the blow off valve

Thereby unloading the compressor to run in idling mode and when system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve.

5.1.6.7 In "Stand-by" duty the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor shall be started to unloaded condition. After a suitable time delay, the compressor shall be fully loaded.

When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period. (Set by a timer), the compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a pre-set time.

5.1.6.8 The pressure and duration of time to be set shall be adjustable at site from the panel.

5.1.6.9 Further all interlocks for the Contractor shall provide safe and proper operation of the compressors.

5.1.6.10 All pressure and temperature conditions used for tripping the compressor shall be provided with pre-trip annunciation in the control panel.

5.1.6.11 Independent switches shall be used for alarms (annunciations) and tripping or interlock.

5.1.6.12 An electrically operated automatic valve shall be provided on cooling water supply line of each compressor which will automatically shut off the cooling water supply, in case compressor is not running for more than set time duration. Suitable interlock shall also be provided for opening the valve before starting of the compressor.

5.1.6.13 An electrically operated motorized valve shall be provided to interconnect the instrument air header (after the air compressors & before the ADPs) to the service airline (before service air receiver). In case of fall of pressure of instrument air (on the instrument air header after the IA receivers) this valve shall close immediately to discontinue the service air supply.



5.1.7 Air Drying Plant

- 5.1.7.1 Sequential operation of the adsorber towers & air compressors shall be controlled automatically (DCS based controls) with a provision for manual take over.
- 5.1.7.2 Automatic operation of adsorber tower under drying, operation of the other tower under regeneration, changeover of towers, starting and stopping of blowers, slow depressurization & repressurisation of towers etc shall be timer controlled. During the process, in case, operation is taken over manually from the panel through push bottom or selector switch, the sequential operation shall start with the manual initiation for each of the steps.

5.1.8 List of Annunciations

- 5.1.8.1 In the event of faults listed below, respective indication on annunciation on operator work station starts flashing followed by sound. Once the operator presses the 'Accept' button provided on the operator station the sound mutes & the flashing becomes steady. Upon pressing 'Reset' button provided on operator station the colour resumes original provided the fault is cleared.
- 5.1.8.2 Annunciation Points
- Silo level High
 - Seal Fail Fault
 - Convey Air Fail
 - Line Block
 - Plate Valve at Pyrite hopper inlet and outlet fail to Open
 - Mill rejects silo level Hi-Hi
 - Instrument Air Fail
 - Service water Pr. Low
 - Compressor – 1 / 2 Fault/ Trip



6.0 PERFORMANCE GUARANTEE

- 1) All equipment shall be guaranteed by the contractor for workmanship, materials and satisfactory performance. The guarantee for performance shall cover individual items and systems including electrical for their ratings/ outputs as well as for the integrated operation of the equipment and its auxiliaries as a whole.
- 2) On completion of satisfactory commissioning, the contractor shall conduct performance/ acceptance tests on the equipment and system as a whole for demonstrating the guaranteed performance parameters specified. All instruments, gauges installed for the normal operation of equipment shall be made use of during the acceptance test as far as practicable. If additional instruments are required for the tests, these shall be brought by contractor free of cost and shall be taken back after performance test.
- 3) The following parameters shall be guaranteed while demonstrating performance guarantee test run at site.
 - a. Functional Test of the equipment under worst coal condition at 100% BMCR.
 - b. Function test of control panels and associated auxiliaries for smooth operation.
 - c. The conveying capacity and the power consumption of the mill reject handling system.
 - d. Power consumption and capacity of compressors.



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7.0 SPARES (NOT INCLUDED)



8 DRAWINGS, DATA AND INFORMATION TO BE FURNISHED

8.1 DATA TO BE FURNISHED WITH THE BID

8.1.1 Mechanical

- a) Completely filled in DATA SHEET-B as given in this specification.
- b) Project execution network schedule.
- c) Technical write-up of the system.
- d) Features provided in the system to achieve guarantee availability.
- e) Flow Diagrams of mill reject system.

In addition to above, drawings/data/information as called elsewhere in the specification shall also be submitted along with the bid.

8.1.2 Electrical

- a) Completely filled data sheet B
- b) Deviations from the tender specs
- c) Sub vendor list
- d) QAP format for Contractor's scope equipment

8.1.3 Control and Instrumentation

- a) Clause wise confirmation / deviation list with respect to I&C requirement as per specification.
- b) P&ID (Process and Instrumentation drawings) indicating primary and secondary Instruments and the destination/functionality of the signals.
- c) Control philosophy / operation philosophy / Design philosophy / Redundancy philosophy.
- d) DCS system configuration drawing with write-up.
- e) Power supply scheme for DCS system including Peripheral & Remote I/O.
- f) Completely filled in Data Sheet-B.
- g) QAP format
- h) List of sub-vendors with their credential.



8.2 DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

8.2.1 Mechanical

8.2.1.1 The Contractor shall submit the following data/ information documents/ drawings to the Purchaser, who in turn will review and furnish comments on only important drawings/ documents. Contractor shall furnish a list of data/ drawings / documents which will be submitted to the Purchaser with due dates of submission immediately after award of Contract. The list shall be updated by the Contractor on fortnightly basis. Drawings, documents and calculations as required for review shall be submitted by the contractor to owner/consultant on case to case basis.

8.2.1.2 All drawings shall be generated in AUTO CAD 2004 edition.

- a) Equipment general arrangement drawings including, elevation and cross section of the equipment with major dimensions and all connection details and other relevant data.
- b) Foundation design, criteria including loading details of individual equipment system.
- c) Complete load list for the system
- d) Instrument set points.
- e) Sub Vendor List.

8.2.1.3 Design Data

- a) Drive motor schedule
- b) Compressor sizing calculations
- c) Compressed air and mill reject piping calculations
- d) Technical data sheet of all equipments
- e) Sequence interlocks and block logic diagram

8.2.1.4 Drawings

- a) Flow scheme
- b) Key plan of mill reject system
- c) General arrangement drawings of all the equipments i.e. compressors, air receivers, air drying plant, valves etc.
- d) Layout of mill reject compressor house.



8.2.2 Electrical

1. LT Motors

S. No	Description
1	Dimensional General Arrangement drawing
2	Foundation Plan & Loading
3	Cable end box details
4	Space requirement for rotor removal
5	Thermal withstand curves hot & cold
6	Starting and speed torque characteristics at 80% & 100% voltage
7	Complete motor data
8	Erection & Maintenance Manual
9	Test reports

2. LT power, Control & Instrumentation cables

S. No	Description
1	Confirmed cable data
2	Test reports
3	Guaranteed Technical Particulars
4	Quality assurance plan
5	Shop Test reports

3. Erection Package

S. No	Description
1	A network showing the proposed construction schedule specifically indicating the milestone event.
2	Consolidated Bill of Materials.
3	Loadings of all equipment and structures.
4	Cable/ conduit routing, cable schedule & interconnection
5	Data Sheet and technical leaflets on cable trays, conduit, junction boxes, grounding material etc.
6	Dimensional drawings and data sheets for different equipment supplied under the specification.
7	Technical leaflets and data sheet on each piece of equipment/device



4. General

S. No	Description
1	QAP
2	BOQ
3	Any other document / drawing required by the Owner

8.2.3 Control and Instrumentation

8.2.3.1 Document/Drawing to be furnished under Approval Category

- 1) Process & Instrumentation Diagram (PID) indicating primary sensors and secondary instruments, destination reference (alarm, control etc).
- 2) DCS BOQ
- 3) Calculation of data bus, processor, memory loading.
- 4) DCS configuration drawing/ system architecture drawing including HMI and peripherals.
- 5) Control Room Layout
- 6) Factory Acceptance Test (FAT) procedure/ Availability test procedure/PG test procedure for C & I equipment (including DCS).
- 7) Input/output List
- 8) List of instruments / drive / solenoid valve.
- 9) Control philosophy / operation philosophy / Design philosophy / Redundancy philosophy.
- 10) Instrument Installation drawings
- 11) Control panel/desk GA and layout
- 12) Power distribution scheme
- 13) Panel heat dissipation data
- 14) Process mimics
- 15) Control schemes / logic diagrams
- 16) List of logs with point assignment
- 17) Earthing schemes
- 18) Cable grouping and Marshalling philosophy
- 19) QAP along with test certificates
- 20) Data sheets of DCS equipment and all field Instruments
- 21) As built drawing after commissioning and O&M manual
- 22) Wiring diagrams for panel, local panel, junction boxes, actuators, starters etc.

8.2.3.2 Document/Drawing to be furnished under Information Category

- 1) Cabinet / Panel wiring diagrams and internal layout drawings
- 2) Cabinet / Panel terminal details
- 3) Cable schedule and interconnection drawing:
 - a. Between field to DCS
 - b. Between field to MCC
 - c. Between DCS to MCC



9.0 **LAYOUT AND MAINTENANCE REQUIREMENTS**

While deciding the layout of buildings namely MRH (mill reject handling) compressor house building the Contractor shall consider the following parameters:

- a. Minimum clear working space around the equipment shall be 1200 mm.
- b. In case of space provided is acting as the handling space for the equipment by handling arrangement i.e. overhead crane/hoist, the space shall be maximum size of equipment being handled plus the clearance of 500 mm minimum on either side with the stationary equipment.
- c. Withdrawal spaces of equipment.
- d. One maintenance bay of 6m (minimum) x the width of the building shall be provided.
- e. Suitable approach for operating all the equipments shall be provided.

10.0 **VENDOR LIST**

The contractor shall furnish sub-vendor list for Mechanical, Electrical and C&I, items / equipments / systems for RPCL review and approval along with credentials of the firm and performance certificates of the items / equipments / systems.



11.0 DATA SHEETS - A

A. MECHANICAL

1) Air Compressors

S.No	Item	Requirement
1	No. of Compressors	2 nos.(1W+1S) per unit
2	Compressor Capacity	As required for evacuation of four mills at a time.
3	Design inlet DBT and RH	45.6°C (Max.); 14.6°C (Min.)/ 70% (Max.); 11% (Min.)
4	Discharge pressure at compressor outlet	Contractor to decide
5	Cooling water inlet	33°C (normal) 36°C (maximum)
6	Noise level	85 dBA at 1m distances from equipment.
7	Compressor type	Oil Free, multi-stage Screw type Compressor
8	Location	Indoor
9	Suitable for parallel operation?	Yes
10	Compressor control	Load/unload for working compressor, start-stop control for as standby compressor
11	Motor	415 V, 3 phase, 50 Hz, TEFC squirrel cage induction motor
12	Intercoolers and after-coolers	Designed as per TEMA C and ASME Code, shell and tube type. Provided with automatic draining arrangement After-cooler approach to inlet water temperature 5.6 °C (max)
13	Moisture Separators	To be located at After Cooler outlet. Provided with automatic draining arrangement
14	Intake filter efficiency	Not less than 99.5% for particle size 2 microns and larger



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S.No	Item	Requirement
15	Material of Construction	
15.1	Compressor cylinder	CI, IS – 210, grade – 260
15.2	Piston	Aluminium
15.3	Piston rod	EN – 8 as per BS –970
15.4	Connecting rod	Forged steel as per IS – 1875 CI IV
15.5	Piston ring	Teflon with 25 – 30% carbon
15.6	Crank case	CI, IS: 210Grade FG –260
15.7	Suction and delivery valves	SS as per EN – 56 of BS –970
15.8	Air receiver	MS as per IS 2062
15.9	For other parts	As per latest IS / BS / ASTM / equivalent standards depending upon the parts.
16.0	Air Receivers	
16.1	Numbers offered (Nos)	2 for each unit
16.2	Material of construction	
16.2.1	Shell/Body	MS : IS 2062 Gr. A
16.2.2	Design code/ standard	As per IS: 2825
16.3	Accessories	
16.3.1	Safety relief valve	One No
16.3.2	Auto drain & Y type Strainer	One No.
16.3.3	Pressure gauge	One No.
16.3.4	Pressure switch	One No.

2) Piping, Valves and Fittings

Sl.N.	Item	Requirement
1	Design Code	ANSI B 31.1
2	Piping material for IA/SA	IS-1239 heavy grade ERW up to 150mm, galvanized as per IS 4736
3	Fittings for IA	A 105/A 234 Gr. WPB, galvanized or as compatible with the pipe material
4	Valves for IA	CI/Cast Steel/Forged Steel body with SS/ internals as per BIS/BS/ASTM



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Sl.N.	Item	Requirement
		standards
5	Joints	Threaded or screwed sockets/unions
	Cooling Water	
7	Piping	IS-1239 heavy grade (10 kg/cm ² pressure rating), ERW galvanized
8	Fittings	A 105/A 234 Gr. WPB, galvanized
9	Valves	Plate valves/Globe valves shall be provided for shut-off/control. Material-CI with SS/gun metal internals As per IS/BS/ASTM standards.
10	Joints	Threaded unions or flanges
11	Velocity inside pipe	2 m/s

3) Valves

S.N.	Part	Material
1. For Cast Steel Valves		
a.	Body & bonnet (Cast C.S.)	ASTM A 216 Gr. WCB (above 1½" NB) ASTM A 105 (up to 1½" NB)
b.	Disc for non-return valves	(Cast C.S, Forged C.S.) ASTM A 216 Gr. WCB (above 1½" NB) ASTM A 105 (up to 1½" NB)
c.	Trim.	ASTM A 182 Gr. F6
2. For Cast Iron Valves		
a.	Body & Bonnet	BS 1452 Gr. 14 / IS-210 Gr. FG 260
b.	Seating surfaces and rings	13% chromium steel
c.	Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr. FG-260
d.	Hinge pin for non-return valves	13% chromium steel
e.	Back Seat	3% chromium steel
For Cast Iron Butterfly Valves		
a.	Body & Disc	ASTM A 48, Gr. 40 with 2% Ni/ IS: 210 FG-260, with 2% Ni and epoxy coated
b.	Seating ring	18-8 Stainless Steel



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S.N.	Part	Material
c.	Shaft	BS 970 431 S: 291 /EN 57, orAISI-410

4) Pneumatic handling system

1.	Duty	Continuous
2.	Number of mill reject storage silo and capacity	One (1) no. to store mill reject for 16 effective running hours considering four (04) mills of one bay of unit operating simultaneously.
3.	Silo location	At Suitable location. BHEL-PEM to furnish layout indicating coordinates in equipment plan
4.	Mill reject quantity per mill (Max.)	0.80TPH
5.	Number of mills working per boiler at 100% BMCR (with worst coal)	7W+1S
6.	Design extraction rate of mill reject from pyrite hopper	1.0% (guaranteed conveying rate of 0.80TPH per mill) of coal consumption 100% BMCR considering worst coal.
7.	Maximum temp. of rejects	200°C
8.	Maximum size of mill reject to be handled	(-) 50mm
9.	Bulk density of mill rejects for volumetric computation	1600 kg/m3
10.	Bulk density of mill rejects for LOADS / STRENGTH computation	2400 kg/m3
11.	Air to cloth ratio	1 NM ³ /min/M ²
12.	Dust loading condition of outlet air	Not more than 50 mg/nm ³
13.	Inlet/outlet valves of mill reject discharge silo	Pneumatically operated knife edge gate valve.
14.	Inlet valve of the vessel	Plate valve/dome valve/butterfly valve/cone valve.
15.	Emergency ** discharge chute with manually	Yes.



	operated knife edge gate valves	
16.	Plate valve/knife gate valve	Pneumatically operated with hand wheel provision. Body -CI (IS-210, Gr. FG-260), Knife gate/plate- SS (ASTM A-240 type 304)
17.	Piping	MS IS:3589 * Piping for mill reject conveying shall be as per IS3589 or IS1239 heavy grade
18.	Bends/Fittings Laterals	Alloy CI to hardness 400 BHN

* In case the contractor expects higher size from pyrite hopper outlet then suitable capacity crusher shall be provided to bring down the size of reject to (-) 50 mm for pneumatic type system offered.

** The wearing parts of all the valves shall be provided with abrasion resistant material of hardness of 350-400 BHN.

B. ELECTRICAL

1) LT power cables

S.No	Description	Particulars
1.	Conductor	Stranded and compacted plain aluminium of grade H2 and class 2 generally conforming to IS: 8130
2.	Insulation	Extruded XLPE insulation conforming to type C of IS: 5831.
3.	Inner Sheath	Extruded PVC compound conforming to type ST2 of IS: 5831 for multicore cable. Single core cables shall have inner sheath.
4.	Armor	Galvanized single round steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminium single round wire conforming to H4 grade for single core cables.
5.	Overall Sheath	Extruded FRLS PVC compound conforming to type ST2 of IS: 5831
6.	Highest System Fault Current	50 kA for 1 second.
7.	Drum/ Length/Tolerance	Wooden/1000/500metre/± 5%
8.	Permissible Voltage and	



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S.No	Description	Particulars
	frequency variation	
	Voltage	+/-10%
	Frequency	+/-5%
	Voltage & frequency	10% (absolute)
	Permissible conductor temperature corresponding to maximum current	90 deg C
	Maximum permissible conductor temperature foe emergency overloading	130 deg C
	Conductor temperature allowed for short circuit duty	250 deg C

2) LT Control cables

S. No	Description	Particulars
1.	Conductor	Class 2/stranded, high conductivity annealed plain copper generally conforming to IS:8130.
2.	Insulation	Extruded PVC compound conforming to type C of IS:5831.
3.	Inner Sheath	Extruded PVC compound conforming to type ST2 of IS:5831 for multicore cable. Single core cables shall have inner sheath.
4.	Aarmor	Galvanized single round steel wire armour.
5.	Overall Sheath	Extruded FRLS PVC compound conforming to type ST2 of IS: 5831
6.	General requirement	1100 V grade, 90°C rating, XLPE power cable conforming to requirement and in line with IS-1554, IS-5831, IS-8130 & IS-3975



3) Instrumentation cables

Table – A: Cable Parameter				
Conductor Size	0.5 Sq.mm.			
Parameter/ Type of Cable	Individual and overall shielded (Type F)	Overall Shielded (Type-G)	Individual and overall shielded Teflon Coated (Type I)	Compensating Cables (with/without Teflon coating) (Type A, B, C)
Mutual capacitance at 0.8 kHz (max.)	120 nF/Km.	100 nF/Km.	120 nF/Km; 100 nF/Km.	200 nF/Km
Conductor Resistance (max.)	73.4 ohm/km (loop) For Type F	73.4 ohm/km (loop)	73.4 ohm/km (loop)	
Insulation resistance	100 M ohm/ Km	100 M ohm/ Km	100 M ohm/ Km	100 M ohm/ Km
Cross-Talk figure at 0.8 kHz (min.)	60 dB	60 dB	60 dB	60 dB
Characteristic impedance (max.)	320 ohm	340 ohm	320 ohm; 340 ohm	
Attenuation at 1 kHz (max.)	1.2 dB/Km for Type F	1.2 dB/Km for Type G/0.8 dB for Type E	1.2 dB/Km	

4) Description of Various Types of Cables

Description of Various Type of Cables		
Type	Conductor Size	Description
A	0.5 mm ²	Two pair shielded and twisted pair T/C extension cable, ANSI type KX, stranded copper conductor.
B	0.5 mm ²	Two pair shielded & twisted T/C extension cable ANSI type SX, stranded copper conductor.
C	0.5 mm ²	Two pair shielded & twisted heat resistant Teflon insulation & Outer sheath T/C extension cable ANSI type KX, stranded copper conductor.
F	0.5 mm ²	Multi pair individual pair & overall shielded twisted pair instrumentation cable (2/4/8/12/16/20/24 pair) for analog signals with stranded annealed, tinned copper conductor.



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G	0.5 mm ²	Multi pair overall shielded & twisted pair instrumentation cable (2/4/8/12/16/20/24/48 pair) for binary signals with stranded annealed, tinned copper conductor.
I	0.5 mm ²	Type F cable/type G cable with heat resistant Teflon insulation & outer-sheath for high temperature application.
S	As per specific Standard / Requirement for each application	Multi core/ Multi pair shielded cable for system specific cables. Like conductivity type level switches, Vibration monitoring system cable, System Bus cable, Bus communications cable etc. as applicable.

5) LT Motor

1.	Description	
a.	A.C. Motor	: 415V
2.	Type & Rating	
a.	Type of Motor	: Squirrel Cage
b.	Duty Cycle/ Designation	: Continuous
c.	Normal/Energy efficient	: Energy Efficient (EFF1)
d.	Rated Voltage & % Variation	: 415V ± 10%
e.	Rated Frequency & % Variation	: 50Hz ± 5%
3.	Efficiency at rated Voltage & Frequency	
a.	Full Load %	: >90%
4.	Performance	
a.	Method of Starting	: DOL
b.	Starting Current at rated Voltage	: <7.2 p.u.
c.	Motor torque at 70% of rated voltage	: Minimum full load torque
d.	Pull out torque of the motor	: Atleast 205% of full load torque
e.	Motor operation from hot condition without injurious heating at 85% rated voltage at motor terminal	: Minimum 5 minutes
5.	Construction	
a.	Type of Ventilation	: Self ventilated
b.	Degree of Protection of Enclosure	: IP-55
c.	Method Of Cooling	: Totally enclosed fan cooled (TEFC)
d.	Insulation Class	: Class 'F' with temp. rise restricted to class 'B'
e.	Tropicalized	: Yes



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6.	Motor Terminal Box	
a.	Short circuit withstand time duration	: 0.25 sec
7.	Accessories	
c.	Voltage, phase & frequency	: 240V, 1Phase, 50 Hz

C. CONTROL AND INSTRUMENTATION

1) DCS System

S.No.	Description	Essential/Minimum Requirements
	CPU	
1.0	Type	32 / 64 BIT
2.0	Processor speed	100 MHz
3.0	CPU Memory	1 MB
4.0	Flash Memory	Built in 256 KB
5.0	Drive	DVD read/write
6.0	Boolean Execution Speed	0.4 micro sec/ Boolean function
7.0	Floating Point Maths	Yes
8.0	Embedded Communication	Serial
9.0	Built In Serial Port	Contractor to decide
10.0	Discrete I / O processing	6000
11.0	Analog I / O processing	8 KB
12.0	Protocols Supported	As per Contractor's standard
	Discrete Input Module	
1.0	Input Module	24 V DC Positive/ Negative Logic, Intelligent Type
2.0	Module Function	Input
3.0	Input Rated voltage	24 V DC Positive / Negative
4.0	Inputs per Module	32 / 16
5.0	Input Group	Four (4) isolated Groups of eight (8) input each.
6.0	Channel Indication	LED for each channel
7.0	Fault Indication	Module Fault Indication on the module
8.0	Discrete Input Voltage Range	0 - 30V DC
9.0	ON State Voltage	13.5 - 30 V DC
10.0	OFF State Voltage	0 - 5 V



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S.No.	Description	Essential/Minimum Requirements
11.0	Isolation between circuit and back plane	1500 V rms
12.0	Isolation between input circuits	500V rms
13.0	Surge withstand capability	1000V DC/500V AC from point to point/1000V AC/DC from point to system ground
14.0	Surge Immunity	1kV peak
15.0	Impedance	20 K Ohms (Typical)
16.0	Proximity Switch Compatible	Yes
	Discrete Output Module	
1.0	Module Type	Discrete , Intelligent type
2.0	Module Function	Output
3.0	Outputs per Module	32/16
4.0	Output Group	Four (4) Isolated groups of eight (8) output each
5.0	Channel Indication	LED for each channel
6.0	Fault Indication	Module Fault Indication on the module
7.0	Discrete output voltage range	20 – 60 V DC
8.0	Response time ON	1 ms Max.
9.0	Response time OFF	1 ms Max.
10.0	Isolation between any output and back plane	1500 V rms
11.0	Isolation between output circuits	500V rms
12.0	Surge withstand capability	1000V DC/500V AC from point to point/1000V AC/DC from point to system ground
13.0	Surge Immunity	1kV peak
	Output Relay Module	
1.0	Module Type	Discrete
2.0	Module Function	Output
3.0	Discrete Output Type	Relay
4.0	Discrete Output Relay Voltage	24V DC
5.0	Outputs per Module	32 Non-Latching Type



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S.No.	Description	Essential/Minimum Requirements
6.0	Channel Indication	LED for each channel
7.0	Fault Indication	Module Fault Indication on the Module
8.0	Response time ON	10 ms with 1 ms typical bounce time
9.0	Maximum Power	60W Typical
10.0	Maximum Switching Voltage	As 220V DC, 250V AC resistive load.
11.0	Maximum Switching Current	2 Amps DC, AC resistive load.
12.0	Contact Type	Silver alloy (gold clad)
13.0	Contact Resistance	50 mw (by voltage drop 6V DC 1A) typical
14.0	Built in serial ports	Required.
Analog Input Module		
1.0	Module Type	Analog
2.0	Analog Input Type	Current
3.0	Inputs per module	16/8
4.0	Analog Input Current	4-20 mA
5.0	Channel Indication	LED for each channel
6.0	Fault Indication	Module Fault Indication on the Module
7.0	Response Time	5 ms Typical
8.0	Resolution	0 to 1 micro amp per LSB step on 4-20Ma
9.0	Accuracy	± 0.05 % of full scale
10.0	Isolation between any output and back plane	1500 V rms
11.0	Isolation between output circuits	500V rms
12.0	Isolation between channel to channel	1000V DC/AC
13.0	Isolation between channel to logic	1000V DC/AC
14.0	Surge Immunity	1kV peak
Analog Output Module		
1.0	Module Type	Analog
2.0	Module Function	Output



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S.No.	Description	Essential/Minimum Requirements
3.0	Output Type	Current
4.0	Analog Outputs per Module	16/8
5.0	Analog Output	4-20 Ma / 0-20 Ma
6.0	Channel Indication	LED for each channel
7.0	Fault Indication	Module Fault Indication on the Module
8.0	Isolation between any output and back plane	1500 V rms
9.0	Isolation between output circuits	500V rms
10.0	Isolation between channel to channel	1000V DC/AC
11.0	Isolation between channel to logic	1000V DC/AC
12.0	Surge Immunity	1kV peak
13.0	Impedance	> 10 Mega Ohm, 0- 25 V
14.0	Resolution (Voltage)	12 Bits
I / O Interface Module		
1.0	Module Type	Bus Interface
2.0	Electrical Isolation	Non-isolated differential communication
3.0	Built in serial port	Two (2) nos.
Communication Module		
1.0	Module Type	Redundant (Hot Stand by)
2.0	Effective Data Transfer rate	500 KB / sec
3.0	Electrical Isolation	Non-isolated differential communication
4.0	Built in serial port	Two (2) nos.
5.0	External communication module	Fibre optic compatible
Power Supply		
1.0	Module Function	Power Supply
2.0	Power Source	240 V AC, 50Hz
3.0	Output Power	As per System requirement

2) Electronic Transmitter –Pressure, D.P., Flow, Level

Sl.No.	Features	Essential/Minimum Requirements
1.	Make	Contractor to state



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Sl.No.	Features	Essential/Minimum Requirements
2.	Model No.	Contractor to state
3.	Type of Transmitter	Microprocessor based, 2 wire type, HART protocol compatible.
4.	Accuracy	$\pm 0.1\%$ of calibrated span (minimum)
5.	Output signal range	4–20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
6.	Turn down ratio	10:1 for vacuum/very low pressure applications. 30:1 for other applications.
7.	Stability	$\pm 0.1\%$ of calibrated span for six months for Ranges up to and including 70 Kg/cm ² . $\pm 0.25\%$ of calibrated span for six months for Ranges more than 70 Kg/cm ² (g).
8.	Zero and span drift	+/- 0.015% per deg.C at max span. +/-0.11% per deg.C at min. Span.
9.	Load impedance	500 ohm (min.)
10.	Housing	Weather proof as per minimum IP-55 with durable corrosion resistant coating.
11.	Over Pressure	150% of max. Operating pr.
12.	Connection (Electrical)	Plug and socket type
13.	Process connection	1/2 inch NPT (F)
14.	Adjustment/calibration/maintenance	Continuous, tamper proof, Remote as well as manual adjustability from instrument with zero suppression and elevation facility. Centralized PC based system. In addition total two (2) no. of hand- held type universal calibrators per unit, compatible with HART protocol, shall be provided.
15.	Accessories	–Diaphragm seal, pulsation dampeners, Siphon etc. as required by service and operating condition.



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Sl.No.	Features	Essential/Minimum Requirements
		-3-valve manifold for gauge/ vacuum pressure transmitters and 5 valve manifold for DP/level/flow transmitters. -For hazardous area, explosions proof enclosure as per NEC article 500.
16.	Diagnostics	Self Indicating feature
17.	Power supply	24V DC \pm 10%.
18.	Repeatability	\pm 0.05% of span or better
19.	Sensitivity	0.05% of span or better
20.	Hand held calibrator	Yes

Notes:

1. LVDT type is not acceptable.

- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided.

3) For Temperature Gauge

S.N.	Features	Essential/Minimum Requirement
1.	Make	Contractor to state
2.	Model No.	Contractor to state
3.	Sensing Element and material	Mercury in steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary.
4.	Body material	Die-cast aluminum
5.	Dial size	150 mm
6.	End connection	3/4" NPT (F)
7.	Accuracy	\pm 1% of span
8.	Scale	Linear, 270° arc graduated in °C
9.	Range selection	125% of max. of scale
10.	Over range test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C.
11.	Housing	Weather and dust proof as per minimum



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		IP-55
12.	Zero/span adjustment	Provided
13.	Identification	Engraved with service legend or laminated phenolic name plate
14.	Accessories	SS Thermo well
15.	Material of Bourdon/ movement	316 SS / 304 SS
16.	Repeatability	Less than 0.5% of FS.
17.	Response Time	40 seconds
18.	Over range Protection	120% up to 400 Deg. C 115% above Deg. C
19.	Applicable Standard	BS 1401
20.	Others	Capillary and case compensation zero adjusting by screw from front.

4) Pressure and D.P. Gauges

S.N.	Features	Essential/Minimum Requirement
1.	Make	Contractor to state
2.	Model No.	Contractor to state
3.	Sensing Element and material	Bourdon for high pressure, Diaphragm/Bellow for low pressure Of 316 SS
4.	Body material	Die-cast aluminum
5.	Dial size	150mm
6.	End connection	1/2 inch NPT (F)
7.	Accuracy	±1% of span
8.	Scale	Linear, 270° arc graduated in metric units
9.	Range selection	Cover 125% of max. of scale
10.	Over range test	Test pr. for the assembly shall be 1.5 to the max. Design pr. at 38°C.
11.	Housing	Weather and dust proof as per minimum IP-55
12.	Zero/span adjustment	Provided
13.	Identification	Engraved with service legend or laminated phenolic name plate
14.	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal (if required by



		process) gauge isolation valve
15.	Material of Bourdon/ movement	AISI 316 SS / 304 SS or non-ferrous for Phosphor Bronze Bourdon.
16.	Enclosure	Die cast Aluminum, conforming IP 65.
17.	Applicable standard	IS: 3624/PTC 19.2
18.	Accessories	Pulsation dampener, Syphon, Diaphragm seals, 2 valve manifold etc. as required.

Notes:

- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

5) Level Gauges

Sl.No	Features	Essential/Minimum Requirement
1.	Make	Contractor to state
2.	Model No.	Contractor to state
3.	Sensing Element and material	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
4.	Body material	Forged carbon steel/304 SS, AISI 316 SS (liquid chamber), Tempered Borosilicate (glass)
5.	Dial size	Tubular covering entire range
6.	End connection	Process connection as per ASME PTC and drain/vent 15 NB
7.	Accuracy	± 2%
8.	Scale	Linear vertical
9.	Range selection	125% of max. of scale
10.	Over range test	Test pr. for the assembly shall be 1.5 to the max. Design pr. at 38°C.
11.	Housing	CS/304 SS leak proof
12.	Identification	Engraved with service legend or laminated phenolic name plate



13.	Accessories	Gasket for all KEL-F shields for transparent type vent and drain valves of Steel/SS as per CS/Alloy process Requirement.
14.	Visible Length	Shall cover the complete tank height.
Notes:		
<ul style="list-style-type: none"> Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided. 		

6) Temperature Switches

Sl. No	Features	Essential/Minimum Requirement
1.	Make	Contractor to state
2.	Model No.	Contractor to state
3.	Sensing Element	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (10 m minimum)
4.	Material	Bourdon, Bulb & capillary-316 SS Armoring-SS, Movement-AISI 304 SS
5.	End connection	½ inch NPT (F)
6.	Over range proof pressure	–
7.	Repeat-ability	± 0.5% of full range
8.	No. of contacts	2 No.+2NC. SPDT snap action dry contact
9.	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS or DCS)*
10.	Elect. Connection	Plug in socket
11.	Set point/ dead band adjustment	Provided over full range
12.	Enclosure	Weather and dust proof as per minimum IP-55
13.	Accessories	Thermo well of 316 SS and packing glands
14.	Mounting	Suitable for rack mounting or direct mounting
15.	Over range Protection	120% upto 400 Deg. C 115% upto 400 Deg. C



7) Pressure and D.P. Switches

Sl. No	Feature	Essential / Minimum Requirement
1.	Make	Contractor to state
2.	Model No.	Contractor to state
3.	Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum
4.	Material	AISI 316 SS
5.	End connection	½ inch NPT (F)
6.	Over range proof pressure	150% of max. design pr.
7.	Repeat-ability	+ 0.5% of full range
8.	No. of contacts	2 No. + 2NC. SPDT snap action dry contact
9.	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS or DCS)*
10.	Elect. Connection	Plug in socket
11.	Set point/ dead band adjustment	Provided over full range
12.	Enclosure	Weather and dust proof as per minimum IP-55
13.	Accessories	Syphon, snubber, chemical seal, pulsation dampeners as required by process
14.	Mounting	Suitable for enclosure/ rack mounting or direct mounting
15.	Switch Type	Snap acting micro switch, shock & vibration proof.
16.	Accuracy	+1%

8) Level Switches

Sl. No	Feature	Essential / Minimum Requirement
1.	Make	Contractor to state
2.	Model No.	Contractor to state
3.	Sensing Element	Radio-frequency/ Ultrasonic type for mill reject silo
4.	Material	AISI 316 SS (Float & Wetted)
5.	End connection	Manufacturer standard



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Sl. No	Feature	Essential / Minimum Requirement
6.	Over range proof pressure	150% of max. design pressure
7.	Repeat-ability	+ 0.5% of full range
8.	No. of contacts	2 No.+2NC. SPDT snap action dry contact
9.	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS or DCS)*
10.	Elect. Connection	Plug in socket
11.	Set point/ dead band adjustment	Provided over full range
12.	Enclosure	Weather and dust proof as per minimum IP-55
13.	Accessories	All mounting accessories
14.	Switch type	Snap acting, magnetically operated hermetically sealed, shock & vibration proof.

9) RF Type Level Switch

Sl.No	Feature	Essential / Minimum Requirement
A.	Application	: Silo / Bunker level measurement
B.	Electronic Controller	: 240 V AC, 50 Hz
	Input Supply	:
	Body material	: Cast Aluminium Housing
	Relay Output	: 2 Nos. Relay Changeover Potential Free Contacts (2SPDT)
	Contact Rating	: 5A at 240 V AC / 0.25 at 220 V DC
	Class of Protection	: IP-66
	Ambient Temperature	: 55 Deg. C (Max)
	Local Indication	: Local LED Indications
	Green	: Normal Level
	Red	: Alarm Level
	Yellow	: Probe Healthy
	Cable Connection	: 3/4" ET (2 Nos.) for Supply and Output 5/8" ET(1 No.) for Probe Connection
	Repeatability	: 100%
C.	Sensing Probe	:



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Sl.No	Feature		Essential / Minimum Requirement
	Type of Probe	:	Rigid
	Material	:	Stainless steel SS 316
	Probe Head Housing	:	Cast Aluminium
	Insulation (B/W Active& Shield And Shield& Ground)	:	PTFE
	Probe Head Protection	:	IP-66
	Mounting	:	Side Mounted
	Cable Connection	:	5/8" ET(1No.)
	Process Connection	:	40 NB BSP THREADED
D	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller(@ 10 Mtrs. Per Level Probe)

10) Radar Level Transmitter

Feature		Essential / Minimum Requirement
Type	:	Guided Wave Radar
Application	:	Bunker / Silo level measurement
Environment Class	:	Highly abrasive with Gases and Fumes
Orientation	:	Vertical
Probe Type	:	Flexible Single lead with chuck
Probe Material	:	SS 316L
Connection Size & Type	:	2" Flanged ANSI 150 lb
Connection material	:	SS 316L
Accuracy	:	+/- 5 mm
Type(Transmitter)	:	SMART, 2 Wire
Operating Principle	:	Time Domain Reflectometry
Output	:	4-20 mA, DC
Electrical Connection	:	½" NPT
Enclosure Class	:	IP 66
Electrical Power	:	11-42 V DC
Housing material	:	Die Cast Aluminium
Local Display	:	LCD Display
Units of Measurement	:	Length mm



11) Ultrasonic Level Transmitter

Feature		Essential / Minimum Requirement
Principle of	:	Detection of reflected ultrasonic Operation pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq	:	10KHz to 50 KHz (typical)
Display	:	Large alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo- level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	240 V AC 50 Hz / 24V DC
Signal Output	:	4-20 mA DC (isolated) - 600 Ohm load.
Hysteresis	:	Fully adjustable preferred
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	0.25% of span or better
Resolution	:	0.1% of span
Operating temp	:	Transmitter-50° C and Sensor -80° C
MOC Sensor	:	Body- PVC and Face -Polyurethane
Humidity	:	1% to 95% non condensing.
Enclosure	:	IP-65 Epoxy painted die cast aluminium or Polycarbonate housing.
Cable Connection	:	3/4" ET
Mounting	:	2" for sensor and Transmitter on panel.
Accessories	:	Cable gland, prefab cable, mounting accessories.



D. CONTROL AND INSTRUMENTATION

12) DCS System

S.No.	Description	Essential/Minimum Requirements
	CPU	
1.0	Type	
2.0	Processor speed	
3.0	CPU Memory	
4.0	Flash Memory	
5.0	Drive	
6.0	Boolean Execution Speed	
7.0	Floating Point Maths	
8.0	Embedded Communication	
9.0	Built In Serial Port	
10.0	Discrete I / O processing	
11.0	Analog I / O processing	
12.0	Protocols Supported	
	Discrete Input Module	
1.0	Input Module	
2.0	Module Function	
3.0	Input Rated voltage	
4.0	Inputs per Module	
5.0	Input Group	
6.0	Channel Indication	
7.0	Fault Indication	
8.0	Discrete Input Voltage Range	
9.0	ON State Voltage	
10.0	OFF State Voltage	
11.0	Isolation between circuit and back plane	
12.0	Isolation between input circuits	
13.0	Surge withstand capability	
14.0	Surge Immunity	
15.0	Impedance	
16.0	Proximity Switch Compatible	
	Discrete Output Module	
1.0	Module Type	



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S.No.	Description	Essential/Minimum Requirements
2.0	Module Function	
3.0	Outputs per Module	
4.0	Output Group	
5.0	Channel Indication	
6.0	Fault Indication	
7.0	Discrete output voltage range	
8.0	Response time ON	
9.0	Response time OFF	
10.0	Isolation between any output and back plane	
11.0	Isolation between output circuits	
12.0	Surge withstand capability	
13.0	Surge Immunity	
	Output Relay Module	
1.0	Module Type	
2.0	Module Function	
3.0	Discrete Output Type	
4.0	Discrete Output Relay Voltage	
5.0	Outputs per Module	
6.0	Channel Indication	
7.0	Fault Indication	
8.0	Response time ON	
9.0	Maximum Power	
10.0	Maximum Switching Voltage	
11.0	Maximum Switching Current	
12.0	Contact Type	
13.0	Contact Resistance	
14.0	Built in serial ports	
	Analog Input Module	
1.0	Module Type	
2.0	Analog Input Type	
3.0	Inputs per module	
4.0	Analog Input Current	
5.0	Channel Indication	
6.0	Fault Indication	



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S.No.	Description	Essential/Minimum Requirements
7.0	Response Time	
8.0	Resolution	
9.0	Accuracy	
10.0	Isolation between any output and back plane	
11.0	Isolation between output circuits	
12.0	Isolation between channel to channel	
13.0	Isolation between channel to logic	
14.0	Surge Immunity	
	Analog Output Module	
1.0	Module Type	
2.0	Module Function	
3.0	Output Type	
4.0	Analog Outputs per Module	
5.0	Analog Output	
6.0	Channel Indication	
7.0	Fault Indication	
8.0	Isolation between any output and back plane	
9.0	Isolation between output circuits	
10.0	Isolation between channel to channel	
11.0	Isolation between channel to logic	
12.0	Surge Immunity	
13.0	Impedance	
14.0	Resolution (Voltage)	
	I / O Interface Module	
1.0	Module Type	Bus Interface
2.0	Electrical Isolation	
3.0	Built in serial port	
	Communication Module	
1.0	Module Type	
2.0	Effective Data Transfer rate	
3.0	Electrical Isolation	



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S.No.	Description	Essential/Minimum Requirements
4.0	Built in serial port	
5.0	External communication module	
	Power Supply	
1.0	Module Function	
2.0	Power Source	
3.0	Output Power	

13) Electronic Transmitter –Pressure, D.P., Flow, Level

Sl.No.	Features	Essential/Minimum Requirements
1.	Make	
2.	Model No.	
3.	Type of Transmitter	
4.	Accuracy	
5.	Output signal range	
6.	Turn down ratio	
7.	Stability	
8.	Zero and span drift	
9.	Load impedance	
10.	Housing	
11.	Over Pressure	
12.	Connection (Electrical)	
13.	Process connection	
14.	Adjustment/calibration/maintenance	
15.	Accessories	
16.	Diagnostics	



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Sl.No.	Features	Essential/Minimum Requirements
17.	Power supply	
18.	Repeatability	
19.	Sensitivity	
20.	Hand held calibrator	

Notes:

2. LVDT type is not acceptable.

- Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided.



DATA SHEET-B: DATA TO BE FILLED BY THE CONTRACTOR

A. MECHANICAL

1) Pneumatic Handling System

Sl.No.	System Parameter	Values
1.		
3.	Number of mills working per boiler	
4.	Design value of reject	
5.	Maximum temp. of rejects	
6.	Maximum size of mill reject to be handled	
7.	Bulk density of mill rejects for volumetric computation	
8.	Bulk density of mill rejects for LOADS/STRENGTH computation	
9.	Inlet/outlet valves of mill reject discharge silo	
10.	Inlet valve of the vessel	
11.	Sizing grid	
12.	Emergency ** discharge chute with manually operated knife edge gate valves	
13.	Piping	
14.	Bends/Fittings Laterals	
15.	Material of construction for denseveyor vessel	

2) Compressed air system

S.N.	Item	Unit	Particulars
1	Air Compressor		
1.1	GENERAL		
	Manufacturer		
	Model No.		
	Type of Compressor		
	Numbers offered	Nos.	
1.2.	Guaranteed Performance		
	Capacity of each Compressor	NM ³ /min	
	Discharge Pressure at Compressor HP outlet	Kg/cm ²	



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S.N.	Item	Unit	Particulars
	Discharge Pressure of Instrument Air at ADP outlet	Kg/cm ²	
	Capacity considering design ambient condition (i.e., 45°C & 75% RH) (FAD)	M ³ /min	
	Outlet Air Temperature after HP stage of compressor at design capacity	°C	
	Outlet Air Temperature after cooler of Plant Air system.	°C	
	Outlet Temperature after ADP for IA system	°C	
	Input Power required at the compressor shaft at design condition	kW	
	Input Power required at the compressor shaft at fully unloaded condition	kW	
	Guaranteed Power consumption at motor input terminals at rated conditions (i.e., without any tolerance)	kW	
	Motor Rating of Drive Motor	kW	
	Drive Motor speed	rpm	
1.03	Material of Construction		
	Compressor Chamber		
	Rotors		
	Inlet Throttle Valve		
	Housing of Valve		
	Timing Gears		
	Max. Weight to be handled / lifted during erection and during maintenance		
2.	INTAKE AIR FILTER & SILENCER		



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S.N.	Item	Unit	Particulars		
	Type				
	Efficiency with corresponding particle size in microns	%			
	Pressure drop across filter at rated flow in new condition	MMWC			
	Filtering Medium				
	Silencer Feature incorporated				
3.	Air Receivers				
	Capacity	M ³			
	Numbers offered	Nos			
	Design Code				
	Design Pressure	Kg/cm ²			
	Material of Construction				
4.	Intercooler, After cooler & Heat Exchangers of ADP		Intercooler	After cooler	Heat Exchanger for HOC type ADP
	Numbers per compressors or ADP offered	Nos			
	Temperature				
	Compressed Air inlet/outlet	°C			
	Cooling Water inlet / outlet	°C			
	Moisture separator provided as per specification?	Yes / No			
	Level gauge, automatic drain trap etc provided as per specification?	Yes / No			
	Material of Construction (Suitable for DM Water)				
	Tube				
	Shell				
	Tube sheet				
5.	Interconnecting Pipes Valves				



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S.N.	Item	Unit	Particulars
	Etc.		
	Whether all piping valves pipe supports fitting sampling connections instruments and other accessories provided as per specified and as per system requirements?		

B. ELECTRICAL

1) LT Power and Control Cables

S.No	Description	Particulars
A)	GENERAL	
1.	Make	
2.	Type	
3.	Applicable Standard	
4.	Manufacturer's name and address	
5.	Location of factory	
6.	Voltage grade	
7.	Suitable for system with service voltage	
B)	CONDUCTOR	
1.	Applicable Standard	
2.	Maximum conductor temperature (°C)	
	i) Continuous	
	ii) Short time	
3.	Material copper/aluminium/grade	
4.	Size	
5.	Nominal cross-sectional area	
6.	Form of conductor circular/shaped	
7.	No. of strands	
8.	Nominal dia. of each strand	
9.	Whether strands are tinned or not	
10.	Temperature co-efficient of resistance at 20°C	
11.	Overall diameter of the cable	
12.	Weight of cable per km.	
C)	INSULATION	
1.	Material	



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S.No	Description	Particulars
2.	Type/Applicable Standard	
3.	Thickness	
4.	Negative tolerance of thickness	
5.	Diameter of core over insulation	
6.	i) Minimum volume resistivity at 27°C	
	ii) Minimum volume resistivity at 70°C	
7.	Colour scheme of identification of cores	
8.	Average dielectric strength	
9.	Suitability with regard to moisture, ozone, acid, oil and alkaline surroundings	
D)	INNER SHEATH	
1.	Material	
2.	Type/Applicable Standard	
3.	Thickness	
4.	Whether extruded	
5.	Approximate outside diameter over sheath	
6.	Whether the inner sheath and the filling material are suitable for the operating temperature of the cable	
E)	ARMOURING	
1.	Material	
2.	Type/Applicable Standard	
3.	Calculated diameter over inner sheath (under armour)	
4.	Size	
5.	D.C. resistance at 20°C	
6.	Short circuit current carrying capacity	
F)	OVERALL SHEATH	
1.	Material	
2.	Type/Applicable Standard	
3.	Thickness	
4.	Colour	
5.	Tolerance of thickness	
6.	Whether extruded	
7.	Calculated diameter under sheath over armour	
8.	Whether anti-termite treatment has been given in the outer sheath	
9.	Whether flame retardant low smoke compound added in outer sheath	
G)	Approximate overall diameter	
H)	Standard drum length with tolerance	
	Net weight of cable	



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S.No	Description	Particulars
I)	Approximate weight of empty drum	
J)	Continuous current rating for Standard IS Condition laid Direct	
	i) In ground	
	ii) In duct	
	iii) In air	
K)	Is the cable guaranteed to safely withstand continuous current for temperature of 90°C and also withstand temperature of 130°C for duration of 500 hrs. per year	

2) Instrumentation Cables

S.No	Description	Particulars
A)	GENERAL	
1.	Make	
2.	Type	
3.	Applicable Standard	
4.	Manufacturer's name and address	
5.	Location of factory	
6.	Voltage grade	
7.	Suitable for system with service voltage	
B)	CONDUCTOR	
1.	Applicable Standard	
2.	Maximum conductor temperature (°C)	
	i) Continuous	
	ii) Short time	
3.	Material copper/aluminium/grade	
4.	Size	
5.	Nominal cross-sectional area	
6.	Form of conductor circular/shaped	
7.	No. of strands	
8.	Nominal dia. of each strand	
9.	Whether strands are tinned or not	
10.	Temperature co-efficient of resistance at 20°C	
11.	Overall diameter of the cable	
12.	Weight of cable per km.	
C)	INSULATION	
1.	Material	
2.	Type/Applicable Standard	



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S.No	Description	Particulars
3.	Thickness	
4.	Negative tolerance of thickness	
5.	Diameter of core over insulation	
6.	i) Minimum volume resistivity at 27°C	
	ii) Minimum volume resistivity at 70°C	
7.	Colour scheme of identification of cores	
8.	Average dielectric strength	
9.	Suitability with regard to moisture, ozone, acid, oil and alkaline surroundings	
D)	INNER SHEATH	
1.	Material	
2.	Type/Applicable Standard	
3.	Thickness	
4.	Whether extruded	
5.	Approximate outside diameter over sheath	
6.	Whether the inner sheath and the filling material are suitable for the operating temperature of the cable	
E)	ARMOURING	
1.	Material	
2.	Type/Applicable Standard	
3.	Calculated diameter over inner sheath (under armour)	
4.	Size	
5.	D.C. resistance at 20°C	
6.	Short circuit current carrying capacity	
F)	OVERALL SHEATH	
1.	Material	
2.	Type/Applicable Standard	
3.	Thickness	
4.	Colour	
5.	Tolerance of thickness	
6.	Whether extruded	
7.	Calculated diameter under sheath over armour	
8.	Whether anti-termite treatment has been given in the outer sheath	
9.	Whether flame retardant low smoke compound added in outer sheath	
G)	Approximate overall diameter	
H)	Standard drum length with tolerance	
	Net weight of cable	
I)	Approximate weight of empty drum	



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S.No	Description	Particulars
J)	Continuous current rating for Standard IS Condition laid Direct	
	i) In ground	
	ii) In duct	
	iii) In air	
K)	Is the cable guaranteed to safely withstand continuous current for temperature of 90°C and also withstand temperature of 130°C for duration of 500 hrs. per year	

Conductor Size 0.5 sq.mm

S.No.	Parameter/Type	Type E,F	Type-G,I	Type A,B&C
(a)	Mutual capacitance at 0.8kHz (max.)			
(b)	Conductor Resistance (max.)			
(c)	Insulation Resistance (min.)			
(d)	Cross-talk figure at 0.8kHz(min.)			
(e)	Characteristic impedance(max.) at 1 kHz			
(f)	Attenuation at 1kHz (max.)			

Type	Conductor size in sq.mm	Remark
A	0.5	DDE, as applicable
B	0.5	DDE, as applicable
C	0.5	DDE, as applicable
D	0.5	DDE, as applicable
E	0.5	DDE, as applicable
F	0.5	DDE, as applicable
G	0.5	DDE, as applicable
H	As per specific standard/ requirement for each application	DDE, as applicable



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3) LT Power, Control & Instrumentation Cables – Other Accessories Details

Sl. No	Description	Value
A)	DRUM	
1.	Drum length	
2.	Tolerance on drum length	
3.	Total weight of the drum	
4.	Dimension of the drum	
B)	ELECTRICAL PROPERTIES	
1.	DC resistance at 20°C	
2.	AC resistance at 20°C	
3.	Reactance at 50 C/S per km.	
4.	Capacitance at 50 C/S per km.	
5.	Impedance at 50 C/S per km.	
6.	Maximum permissible conductor temperature	
	i) Under continuous full load	
	ii) Under transient conditions	
7.	Volume resistivity at rated operating temperature	
8.	Loss tangent at normal frequency	
9.	Partial discharge value at 1.5 times rated voltage	
10.	Charging current at normal operating voltage	
11.	Short Circuit Current for 1 sec.	
C)	OTHER DETAILS	
1.	Recommended minimum installation radius	
2.	Maximum safe pulling force	
3.	Derating factor for following ambient temperature in Air/Ground	
	i) At 30°C	
	ii) At 35°C	
	iii) At 45°C	
	iv) At 50°C	
4.	Group factor for following Nos. of cables laid touching/2x diameter center to center apart	
	i) Single core cable	
	2 Nos.	
	3 Nos.	
	4 Nos.	
	ii) Multi core cable	
	3 Nos.	
	4 Nos.	



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Sl. No	Description	Value
	5 Nos.	
	6 Nos.	
D)	CABLE TRAYS	
1.	Make	
2.	Type/Material/Size	
3.	Manufacturer's name and address	
4.	Location of factory	
5.	Applicable Standard	
6.	Thickness	
	i) Trays	
	ii) Supports	
	iii) Brackets	
7.	Earthing System	
8.	Weight per 100 m	
	i) Trays	
	ii) Supports	
	iii) Brackets	
9.	Distance between parallel layer of trays	
10.	Galvanization of	
	i) Trays	
	ii) Nuts & Bolts	
11.	Painting of support system	
12.	Supporting arrangement system	
E)	CABLE CLAMPS	
1.	Material	
2.	Type	
3.	Thickness	
F)	CABLE TERMINATION KIT	
1.	Make	
2.	Type/Size	
3.	Applicable Standard	
4.	Suitable for voltage grade	
5.	Complete with all accessories	
6.	AC withstand voltage (Ph/Ground & time duration) (kV)	
7.	Partial discharge at 1.1 Ph/ground volt (Pc)	
8.	Impulse withstand 1.2/50 μ s (kV)	
9.	Short circuit current for 1 sec (KA)	
10.	Dynamic short circuit withstand	



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Sl. No	Description	Value
11.	Type test report for above tests plus for humidity and salt-fog tests furnished (Yes/No)	
12.	Kit particulars	
	i) Material of tubing / moulded part	
	ii) Method of stress control	
	iii) Method of environmental seal	
	iv) List of items included in the kit furnished (Yes/No)	
	a) For terminations	
	b) For splices	
G)	CONDUITS	
1.	Make	
2.	Type/Material	
3.	Applicable Standard	
4.	Gauge	
	i) Upto 25mm dia.	
	ii) Above 25mm dia.	
5.	Catalogue furnished?	
H)	JUNCTION BOX	
1.	Make	
2.	Type/Material	
3.	Applicable Standard	
4.	Degree of protection Outdoor/Indoor	
5.	Catalogue furnished?	
6.	Thickness of sheet material	
I)	TERMINAL BLOCK	
1.	Make	
2.	Type	
3.	Applicable Standard	
4.	Current rating	
5.	Catalogue furnished?	
6.	20% spare terminals provide?	
J)	FERRULES	
1.	Make	
2.	Type/Material	
3.	Applicable Standard	
4.	Color	
5.	Interlocked type?	
K)	TREFOIL CLAMPS	



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Sl. No	Description	Value
1.	Make	
2.	Type/Material	
3.	Dynamic force withstand capacity	
4.	FIRE STOP MORTAR SEAL	
5.	Make	
6.	Type	
L)	Fire resistance (hrs.)	
1.	Approval of CPRI	
2.	Material of fire stop	
3.	Pressure withstand capacity of fire stop system	
4.	Weight of fire stop assembly	
5.	Shelf life of fire stop material	
6.	Life of fire stop material	
M)	Fire Retardant Coating Compound	
1.	Make	
2.	Type	
3.	Fire resistance (hrs.)	
4.	Approval of CPRI	
5.	Shelf life in years	

4) Earthing

Sl. No	Description	Value
1	Material and size of earth strip for various places	
2	Gap between earth mat conductors lengthwise, breadth wise	
3	Size of main outer strip	
4	Galvanizing content on GI strips	
5	Value of earthing resistance (proposed to be achieved)	
6	Standard to be followed for galvanizing	
	a) Type of electrodes	
	b) Size of material	
7	Construction of earthing pit as per IS	
8	Riser Connections Material Size	



C. CONTROL AND INSTRUMENTATION

1) maxDNA DCS System

Sl.No.	Features	Contractor Data
1.	Make	
2.	Model No.	
3.	Type of Transmitter	
4.	Accuracy	
5.	Output signal range	
6.	Turn down ratio	
7.	Stability	
8.	Zero and span drift	
9.	Load impedance	
10.	Housing	
11.	Over Pressure	
12.	Connection (Electrical)	
13.	Process connection	
14.	Adjustment/calibration/maintenance	
15.	Accessories	
16.	Diagnostics	
17.	Power supply	
18.	Repeatability	
19.	Sensitivity	
20.	Hand held calibrator	

2) Temperature Gauge

Sl.No	Features	Contractor Data
1.	Make	
2.	Model No.	
3.	Sensing Element and material	
4.	Body material	
5.	Dial size	
6.	End connection	
7.	Accuracy	
8.	Scale	
9.	Range selection	
10.	Over range test	



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Sl.No	Features	Contractor Data
11.	Housing	
12.	Zero/span adjustment	
13.	Identification	
14.	Accessories	
15.	Material of Bourdon/ movement	
16.	Repeatability	
17.	Response Time	
18.	Over range Protection	
19.	Applicable Standard	
20.	Others	

3) Pressure and D.P. Gauges

Sl. No	Features	Contractor Data
1.	Make	
2.	Model No.	
3.	Sensing Element and material	
4.	Body material	
5.	Dial size	
6.	End connection	
7.	Accuracy	
8.	Scale	
9..	Range selection	
10.	Over range test	
11.	Housing	
12.	Zero/span adjustment	
13.	Identification	
14.	Accessories	
15.	Material of Bourdon/ movement	
16.	Enclosure	
17.	Applicable standard	
18.	Accessories	



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4) Pressure and D.P. Gauges

Sl.No	Features	Contractor Data
1.	Make	
2.	Model No.	
3.	Sensing Element and material	
4.	Body material	
5.	Dial size	
6.	End connection	
7.	Accuracy	
8.	Scale	
9.	Range selection	
10.	Over range test	
11.	Housing	
12.	Identification	
13.	Accessories	
14.	Visible Length	

5) Temperature Switches

Sl No.	Features	Contractor Data
1.	Make	
2.	Model No.	
3.	Sensing Element	
4.	Material	
5.	End connection	
6.	Over range proof pressure	
7.	Repeat-ability	
8.	No. of contacts	
9.	Rating of contacts	
10.	Elect. Connection	
11.	Set point/ dead band adjustment	
12.	Enclosure	
13.	Accessories	
14.	Mounting	
15.	Over range Protection	



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6) Pressure and D.P. Switches

Sl.No	Feature	Contractor Data
1.	Make	
2.	Model No.	
3.	Sensing Element	
4.	Material	
5.	End connection	
6.	Over range proof pressure	
7.	Repeat-ability	
8.	No. of contacts	
9.	Rating of contacts	
10.	Elect. Connection	
11.	Set point/ dead band adjustment	
12.	Enclosure	
13.	Accessories	
14.	Mounting	
15.	Switch Type	
16.	Accuracy	

7) Level Switches

Sl. No	Feature	Contractor Data
1.	Make	
2.	Model No.	
3.	Sensing Element	
4.	Material	
5.	End connection	
6.	Over range proof pressure	
7.	Repeat-ability	
8.	No. of contacts	
9.	Rating of contacts	
10.	Elect. Connection	
11.	Set point/ dead band adjustment	
12.	Enclosure	
13.	Accessories	
14.	Switch type	



8) RF Type Level Switch

Sl. No	Feature		Contractor Data
A.	Application	:	
B.	Electronic Controller	:	
	Input Supply	:	
	Body material	:	
	Relay Output	:	
	Contact Rating	:	
	Class of Protection	:	
	Ambient Temperature	:	
	Local Indication	:	
	Green	:	
	Red	:	
	Yellow	:	
	Cable Connectio	:	
	Repeatability	:	
C.	Sensing Probe	:	
	Type of Probe	:	
	Material	:	
	Probe Head Housing	:	
	Insulation (B/W Active& Shield And Shield& Ground)	:	
	Probe Head Protection	:	
	Mounting	:	
	Cable Connection	:	
	Process Connection	:	
D	Signal Cable	:	

9) Radar Level Transmitter

Feature		Contractor Data
Type	:	
Application	:	
Environment Class	:	
Orientation	:	
Probe Type	:	
Probe Material	:	



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Feature		Contractor Data
Connection Size & Type	:	
Connection material	:	
Accuracy	:	
Type(Transmitter)	:	
Operating Principle	:	
Output	:	
Electrical Connection	:	
Enclosure Class	:	
Electrical Power	:	
Housing material	:	
Local Display	:	
Units of Measurement	:	

10) Ultrasonic Level Transmitter

Feature		Contractor Data
Principle of	:	
Measuring Ranges	:	
Signal Processing	:	
Operating Freq	:	
Display	:	
Calibration & Configuration	:	
Diagnosis	:	
Status	:	
Construction	:	
Power supply	:	
Signal Output	:	
Hysteresis	:	
Output contacts	:	
Accuracy & Repeatability	:	
Resolution	:	
Operating temp	:	
MOC Sensor	:	
Humidity	:	
Enclosure	:	
Cable Connection	:	
Mounting	:	



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Feature		Contractor Data
Accessories	:	

11) PC

Sl. No	Feature	Contractor Data
1.	Make	
2.	Model No.	
3.	CPU	
4.	Main memory	
5.	Drives	
6.	Hard disk	
7.	Monitor	
8.	Graphic accelerator	
9.	Communication port	
10.	Expansion slots	
11.	Other Features	
12.	UPS	
13.	Accessories	
14.	Software	

12.0 LIST OF DRAWINGS ENCLOSED

Sl. No.	Drawing No.	Description
1.	E072-03-MRHS-M-03-01-R0	Flow scheme of Mill reject handling system
2.	E072-03-MRHS-M-03-08-R1	PLC configuration block diagram for Mill Reject System



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2X800 MW YERAMARUS TPS, KARNATAKA

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ANNEXURE – I

DATASHEET – A



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DATASHEET-A (MILL REJECT SYSTEM)

S. No.	Items/Description	2X800 MW YERAMARUS TPS, KARNATAKA
1	Type of mill reject system	Pneumatic Pressure Conveying
2	Material handled	Coal Mill reject
3	No of mills/Unit	8 (7W+1S)
4	Reject generation design rate	0.8 TPH
5	Mill layout	Side Mill Arrangement (4 each side)
6	Elevation of Mill Reject outlet spout (wrt FFL in Mill Area)	3.000 M from 0.0M elevation
7	Type of Mills	XRP 1103 Bowl Mill (Planetary Gearbox)
8*	Silo Location	Refer Layout
9	Compressor Location	Refer Layout, Main Compressor house
10	Water spray system (Pyrite quenching)	Required
11	No of compressors	2x100% (1W+1S) for each unit , oil free screw type compressor.(Each sized to cater to air requirement of one unit)
12	Sump Pumps	4 Nos. Fixed/Portable Type (1 per mill bay).
13	Type of control/ Main control panel location	DCS based control system
14	Pneumatic/ local control panel	Yes with DOP of IP 55
15	Mandatory spares	Not Applicable
NOTE	* Silo location is tentative only and final location may vary by 10% which shall be finalized during detail engg.	

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ANNEXURE – II

EQUIPMENT DESIGN/SELECTION CRITERIA



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EQUIPMENT DESIGN/SELECTION CRITERIA

S. No.	Equipment	Design/Selection/Sizing Criteria
01	Conveying Air Compressor	<p>Each compressor shall be selected to meet the following requirements:</p> <ol style="list-style-type: none"> Each Compressor shall be sized such that it can cater air requirement of two units. A margin of 50 % shall be considered over and above the required/ calculated/ minimum compressor capacity arrived for conveying of total reject generated. Guaranteed reject conveying rate 800 kg/hr per mill. RH – As per project information (Climatological table) Air Temperature - As per project information (Climatological table) Height above MSL- As per project information. Noise level- Shall be limited to 85dBA at a distance of 1.0 m in horizontal direction from the nearest surface of the machine and at a height of 1.5 m from the floor level in elevation. Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with calibrated integrating sound level meter meeting the requirement of IEC 651 or BS: 5969 or IS 9779.
02	Air Receiver	<p>As per IS 2825</p> <p>Capacity: The air receiver capacity shall be selected to convey one complete cycle with a minimum margin of 25% provided over and above the arrived air receiver capacity.</p>
03	Pyrite Hopper & Accessories	<ol style="list-style-type: none"> Number of outlet – Three (3) Capacity – 2-3 times denseveyor / transporter vessel capacity. MOC for plates – MS as per IS 2062 Gr. A (min), min 10 mm thk with sizing grid. Explosion vent <ol style="list-style-type: none"> Rupture Disc type (One no. per hopper) Rupture Disc Bursting Pressure – 0.5 kg /cm² (g) Sizing Grid Details – Shall be made from minimum 10 mm dia./thk MS bars/flats with opening suitable for entrapping reject larger than 40 mm in size. Surface Temperature – The surface temperature of the equipment shall be maintained within 60 °C. Insulation, if required, to achieve the same shall be provided by the bidder without any commercial implication. Water Spraying arrangement with Solenoid Valve – Yes Valves



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		<ol style="list-style-type: none"> 1) Inlet valve – Pneumatically operated KGV with expansion joint. 2) Maintenance valve – Manual operated KGV 3) Over size chute – Pneumatically operated KGV 4) Emergency chute – Pneumatically operated KGV f) Min. instruments required <ol style="list-style-type: none"> 1) Two nos. of level switches (High/High-High) 2) One (1) no. of temperature switch
04	Denseveyor (transporter vessel) & its Accessories	<ol style="list-style-type: none"> a) MOC <ol style="list-style-type: none"> 1) Denseveyor – Mild Steel IS – 2062, Gr B 2) Dome Valve / Inlet Valve – Refer S.No.08 below b) Quantity of material to be conveyed per hour by each denseveyor – Refer Datasheet-A c) Capacity of denseveyor - To suit the conveying rate with 85% filling d) Any cooling envisaged for dome valve – Bidder to decide e) Air supply pressure available – Bidder to decide f) Distance over which material is to be conveyed and the lift – Refer Layout Drawing
05	Bunker & its Accessories	<ol style="list-style-type: none"> a) Effective Storage Capacity – 55 T (min) b) Number of outlet - One c) Minimum free board – 500 mm d) Bunker Plate – 12 mm thk. MS Plate conforming to IS 2062 Gr A/B e) Liner – 3 mm SS 409 Liner in complete conical portion of bunker f) Minimum Valley Angle - 60 Degrees g) Discharge Gate <ol style="list-style-type: none"> i. Size – 400 mm x 400 mm (clear open) (min) ii. Type – Twin Sector, Manually Pneumatically/electrically operated, <u>with provision of hand wheel operation.</u> iii. MOC – CI to IS 210/ MS 12 mm thick (min) to IS 2062 (Gr. A min) with 3 mm thick SS 409 liner on inner surface. Min 400 BHN. h) Staircase on Silo: Complete staircase to be provided up to top of silo with operating/ maintenance platform at all levels having any equipment requiring operation & maintenance. i) Level probe (high) shall be as per C&I specification requirement. j) Counter weight type Pressure relief valve designed for max. pressure subjected. <p>Bag Filter</p> <p>Each Bag filter shall be sized considering simultaneous firing of one normal and one emergency cycle.</p> <ol style="list-style-type: none"> a) Material of Filter Cloth – Polyester felt needle suitable for prolonged operation up to a temperature of 200°C without losing its collection efficiency & durability. b) Air to Cloth Ratio – 4.5 1.0 m/min (Further 10 % additional bags shall be provided) c) Bag – MS, IS 2062, Gr. A (min), 3.0 mm thick (min)



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- d) Bag Cage – MS, IS 1079 galvanized.
- e) Outlet Air Quality – 50 mg/nm³ (max)
- f) Bag Cleaning Mechanism – Automatic and shall comprise of solenoid valves, air nozzles, adjustable solid state timer, pressure switches, piping and fittings etc.
- g) Test on bag filter casing: In case bag filter is assembled in casing at site, smoke/ bubble test shall be carried out on the bag filter casing to ensure that the casing is free of welding defect. However, if assembly of bag filter & casing is done at shop, relevant NDT shall be carried out as per approved MQP for checking the soundness of weld.
- h) Chain Pulley Block over bag filter: Shall have 25% margin over weight of bag filter, but in no case the capacity shall be lower than 1.0 T, same shall be as per IS 3832

06

Lines for
Various
Services

Service	Velocity in m/sec		
	Pipe size below 50 mm	Pipe size from 50 mm to 200 mm	Pipe size 200 NB mm to 350 mm
Compressed Air	15	20	25
Water-towards pump suction	0.6	1.0	1.2
Water-towards pump discharge	1.5	2.0	2.5
Mill Reject conveying	3.5 to 5.7 m/s		
Service	Material of Construction & other details		
Mill reject conveying pipe	MS ERW Gr. Heavy to IS 1239 Minimum size of pipe shall be 125 NB. Pipes for reject conveying pipe shall have flanged ends/sleeve coupling.		
Compressed air /Instrument Air /Water Pipe	MS ERW Gr. Heavy to IS 1239 or IS 3589 Gr 410 Instrument air pipe shall be galvanised both internally & externally as per IS 4736. For other services, pipes 65 NB and above shall have flanged ends while pipes 50 NB & below shall have screwed/ socket welded end. Instrument air piping(for 50 Nb and below) shall be screwed ends only.		



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07	Knife Gate/Plate Valve (pyrite hopper inlet, oversize discharge, emergency discharge, hopper isolation/maintenance)	Operation: Manual/Pneumatic – As per flow diagram. Material of Construction Body – CI to IS 210 Gr FG 260 Gate/Plate – SS (ASTM A 240 type 304) with wearing parts provided with abrasion resistant material of hardness 350-400 BHN Size – 200 NB (min) for all valves (All knife gate valve shall be provided with open & close limit switches for interlock and control) Deflection cone : Required before the pyrite hopper inlet knife gate valve																				
08	Dome Valve/ Swing Disk Inlet Valve	Material of construction Body – CI to IS 210 Gr. FG 260 Dome – Alloy CI with hardness as 225 BHN with leak proof seat. Shaft – SS 304 Disk – SS 304/ Alloy CI, hardness of 500 BHN (min)																				
09	Conveying pipe bend	MOC & Hardness – Alloy CI, 400 BHN min with min 2% Ni End connection- Flanged																				
10	Fittings, Flanges, Fasteners & Gaskets	Fittings (Elbow, Tees and Reducers) <table><tr><td>Service</td><td>Requirements</td></tr><tr><td>Instrument Air</td><td>IS 1239, Part-2 (Galvanized)</td></tr><tr><td>Water & Conveying air</td><td>IS 1239, Part –2</td></tr></table> Flanges <table><tr><td>Service</td><td>Requirement</td></tr><tr><td>All services</td><td>Fabricated out of IS 2062 Plates/ Equivalent as per ASME B 16.5</td></tr></table> Fasteners <table><tr><td>Service</td><td>Requirement</td></tr><tr><td>All services</td><td>SA 193 Gr B7 or equivalent/SA 194 Gr 2H or equivalent</td></tr></table> Gaskets <table><tr><td>Service</td><td>Requirement</td></tr><tr><td>All services</td><td>TEFLON suitable for service temperatures, min 3 mm thick.</td></tr><tr><td></td><td></td></tr></table>	Service	Requirements	Instrument Air	IS 1239, Part-2 (Galvanized)	Water & Conveying air	IS 1239, Part –2	Service	Requirement	All services	Fabricated out of IS 2062 Plates/ Equivalent as per ASME B 16.5	Service	Requirement	All services	SA 193 Gr B7 or equivalent/SA 194 Gr 2H or equivalent	Service	Requirement	All services	TEFLON suitable for service temperatures, min 3 mm thick.		
Service	Requirements																					
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All services	TEFLON suitable for service temperatures, min 3 mm thick.																					
11	Valves for Air & Water Lines	Instrument air line Type : Ball Valve full bore, screwed end. MOC : Body – CS, Internals- 13 % chrome SS – 304 ECW (DM Water) line for Compressor cooling Type – Gate/Globe valve. Flat faced with flanged end for size 65 NB & above and SW end for size 50 NB & below. Material of construction: Body – Gun Metal, Internals & Stem – SS316 for size upto 50 Nb Body – CI FG 260, Internals & Stem – 13% Chrome for size above 50 Nb, Seal: Neoprene(if applicable) Service Water line for Quenching & Dome seal cooling Type – Gate/Globe valve. Flat faced with flanged end for size 65 NB & above																				



TITLE:

**TECHNICAL SPECIFICATION FOR
MILL REJECT HANDLING SYSTEM**

2X800 MW YERAMARUS TPS, KARNATAKA

BHEL DOCUMENTS NO.: PE-TS-31 I -160-A001

VOLUME **II-B**


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		and SW end for size 50 NB & below. Material of construction For size 65 NB & above -Body – CI , Internals & Stem – 13% Chrome Steel For size 50 NB & below -Body – Gun Metal, & Stem – Gun Metal
12	Sump Pumps	Capacity – To meet system requirement but not less than 10 m ³ /hr MOC i. Casing & suction bell – 2.5 % Ni-CI to IS 210, FG260 ii. Impeller – 2.5 % Ni-CI to IS 210 , FG260 iii. Shaft/Sleeves – EN-8
13	Hand Operated Chain Pulley Block with Geared Trolley	i. Capacity (In Kg) - To suit the heaviest equipment lifting on silo top. ii. Service condition - Class II outdoor iii. No. of CPB - Four Nos. iv. Lift (m) - To suit the requirement/16 m (min.) v. Type of suspension- Traveling Trolley vi. Head Room - As per Vendor data vii. Type of gear in CPB - Spur Gear viii. Type of bearing - Ball/Roller ix. Grade of Load Chain - Alloy Steel /Gr. 80. x. Grade of Hand Chain - Steel / Gr. 30 xi. Factor of Safety - As per Relevant IS

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ANNEXURE – III

MANUFACTURING QUALITY PLANS AND CUSTOMER INSPECTION REQUIREMENT

MILL REJECT SYSTEM

CLAUSE NO.	QUALITY ASSURANCE
1.00.00	PNEUMATIC CONVEYING SYSTEM
1.01.00	PIPING, VALVES, STRAINERS AND FITTINGS <ul style="list-style-type: none"> (a) All pipes and fittings shall be tested as per applicable code. (b) All valves shall be hydraulically tested for body, seat and back seat (if applicable) as per relevant Standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. Valves shall be offered in unpainted condition only. (c) Functional checks of the valves for smooth opening and closing shall also be done. (d) Strainer body shall be hydraulically tested. One of each type and size of Strainer shall be tested for Pressure drop v/s flow rate, if not tested earlier.
1.02.00	PRESSURE AND STORAGE VESSELS: <ul style="list-style-type: none"> (a) Atmospheric Tank <ul style="list-style-type: none"> (i) All weld joints shall be DP tested and complete tanks shall be water fill tested. (ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to all tests (Hydro, NDT and Vacuum) according to design code as applicable. (b) Pressure Vessel <ul style="list-style-type: none"> (1) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below: <ul style="list-style-type: none"> (i) 100% DPT on root run of butt weld, nozzle welds and finished fillet welds. (ii) 10% DPT on all finished butt welds (iii) 10% RT (covering all 'T'/cross joints) of butt welds (2) Butt Welds of dished ends shall be stress relieved and subjected to 100% RT. (3) Each finished vessels shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.
1.03.00	PACKAGE AIR COMPRESSOR <p>In addition to Hydraulic tests of pressure parts, performance test of the compressor shall be done for FAD, pressure, power consumption, as per relevant code. Noise and vibration shall also be measure.</p>
2x800 MW YERAMARUS TPS, KARNATAKA	

CLAUSE NO.	QUALITY ASSURANCE
1.04.00	BAG FILTERS:
1.04.01	Leakage test shall be carried out for casing and other pressure parts
1.04.02	Pulsing and sequential test on bag filter cages shall be done.
1.05.00	MANO RAIL HOIST/CHAIN PULLEY BLOCKS:
1.05.01	Chain pulley blocks shall be tested as per IS:3832
1.05.02	UT & MPI/DPT shall be done on gear blank, pinion shaft, axles.
1.05.03	Proof Load Test on hooks shall be carried out followed by DPT.
1.05.04	100% Radiography on weld joints under tension and 25% radiography on compression butt joints followed by 100% DPT shall be done for rope drum, girder, end carriage etc.
1.05.05	Complete hoists shall be tested for load and overload test as per IS:3177
1.06.00	VENTILATION SYSTEM:
1.06.01	Shop Run Test for all Centrifugal Fans to check noise, temp. rise & vibration.
1.06.02	Performance test on one fan of each type for capacity, pressure, efficiency and power consumption.
2x800 MW YERAMARUS TPS, KARNATAKA	

AIR COMPRESSOR SYSTEM

CLAUSE NO.	QUALITY ASSURANCE
<p>1.00.00</p> <p>1.01.00</p> <p>1.01.01</p> <p>1.02.00</p>	<p style="text-align: right;">Annexure-QA-1</p> <p><u>AIR COMPRESSOR SYSTEM</u></p> <p>AIR COMPRESSORS :</p> <ul style="list-style-type: none"> <li>a) All pressure parts shall be hydraulically tested at not less than 150% of design pressure prior to painting and lining, if applicable. The test pressure will be maintained for 30 minutes. <li>b) All other parts including inter-connecting piping shall be hydraulically tested wherever possible, as per relevant codes. <li>c) Ultrasonic testing shall be carried out on all forgings and shafts (if dia. >= 50mm) viz. Crank shaft, connecting rod, piston rod, etc. MPI/DP test will be done on machined areas of the above components. <li>d) Pistons shall be subjected to DP testing. <li>e) During assembly all clearances and alignments shall also be checked and recorded. <li>f) Rotor shall be statically and dynamically balanced. <p>PERFORMANCE TEST (SHOP TEST):</p> <ul style="list-style-type: none"> <li>a) Performance test on the compressors shall be carried out in accordance with ISO:1217/eq.. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valves. <li>b) Power consumption at motor input terminal at rated capacity as well as at fully unloaded condition of all the compressor shall be measured. <li>c) Vibration and noise level measurement will be done during shop performance test. <li>d) Test shall be carried out on all compressors with contract drive motor where power consumption for compressors has been indicated as a guaranteed parameter <li>e) Clearance on Type test requirements from Employer's Engg. Shall be reviewed prior to final clearance. <p>INTAKE AIR FILTER & SILENCER</p> <ul style="list-style-type: none"> <li>a) Test for Capacity, Pressure drop and Efficiency shall be
2x800 MW YERAMARUS TPS, KARNATAKA	

CLAUSE NO.	QUALITY ASSURANCE
1.03.00	<p style="text-align: center;">done as per manufacturer's standard.</p> <p>AIR RECEIVER, HEAT EXCHANGERS, MOISTURE SEPERATORS, AIR DRYING PLANT:</p> <ul style="list-style-type: none"> a) Each finished vessel shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes. b) NDT on weld joints shall be as per respective code requirements or the minimum as specified below: <ul style="list-style-type: none"> (i) 100 % DPT on root run of butt welds. (ii) 100% DPT on all finished butt welds and fillet welds (iii) 10% RT on butt welds which shall include all T- joints. c) Tube to Tube sheet joint of the heat exchangers shall be subject to Mock-up test as per the relevant standards. d) Reactivation blowers shall be tested for FAD, temp. rise, noise & vibration. Rotating parts shall be dynamically balanced. e) Completely assembled ADP shall be pneumatically tested at design pressure for a duartion of 5 minutes. Functional and sequential operation testing of the completely assembled ADP shall be demonstrated at shop. Other accessories shall be tested as per relevant code and sections. Dew point measurement shall be done .
1.04.00	<p>H.O.T. CRANE :</p> <ul style="list-style-type: none"> a) Chain pulley Blocks shall be tested as per IS: 3832. b) Following NDT requirements shall be met : <ul style="list-style-type: none"> (i) 100% RT of Butt welds in tension and 10% RT of butt welds in compression. (ii) DP at random on all weldments. <p>Deflection, load, overload & travel check on HOT crane assembly shall be carried out as per IS:3177.</p>
1.05.00	<p>PIPINGS, VALVES, FITTINGS AND OTHER SPECIALITIES</p>
2x800 MW YERAMARUS TPS, KARNATAKA	

CLAUSE NO.	QUALITY ASSURANCE
	<p>a) All pipes and fittings shall be tested as per applicable code. DPT of pipe welds (in case of rolled and welded pipes only) shall be carried out for root and finished welds.</p> <p>b) All valves shall be hydraulically tested for body, seat and back-seat (if applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. All forgings, dia ≥ 50 mm shall be Ultrasonic Tested irrespective of the type, size & rating of the valve. Valves shall be offered for hydro test in unpainted condition. Functional checks of the valves for smooth opening and closing shall also be done.</p>
2x800 MW YERAMARUS TPS, KARNATAKA	

LOW PRESSURE PIPING

CLAUSE NO.		QUALITY ASSURANCE														
LOW PRESSURE PIPING :																
Tests/Check →	Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operational Test	Performance Test	Other Tests	All Tests as per relevant Std	Adhesion/Spark Tests	REMARKS
	1. Pipes & Fittings and Metered Bends	Y ^a	Y ^b		Y		Y									
	2. Diaphragm Valves	Y ^a					Y ⁵			Y				Y ⁶		
	3. Butterfly Valves(Low Pressure)															
	3.a) Cast Butterfly Valves															
	(i)Body (Cast)	Y ^a	Y ^b				Y		Y	Y	Y		Y ⁷			
	(ii)Disc (Cast)	Y ^a	Y ^b													
	(iii)Shaft	Y ^a	Y	Y ^c												
	3.b) Fabricated Butterfly Valves															REF. NOTE 14
	4. Gate/ Globe/Swing Check Valves	Y ^a	Y ^b	Y ^c			Y ⁵	Y	Y				Y ⁸			
	5. Dual Plate Check Valves	Y ^a	Y ^b	Y ^c			Y	Y	Y				Y ⁴			
	6. Rolled & Welded Pipes	Y ^a	Y ³		Y		Y ¹			Y						
	7. Coating & Wrapping of Pipes	Y ²											Y ²			
	8. Tanks & Vessels	Y ^a	Y ^b		Y		Y									
	9. Strainers	Y ^a	Y ^b				Y						Y ¹¹			
	10. Rubber Expansion Joints	Y ^a					Y ¹²		Y				Y ¹³			
	11. Rubber Lining of Pipes	Y ^a	Y ^b		Y		Y			Y				Y ⁹	Y	
	12. Hangers & Supports	Y ^a						Y								
	13. Fasteners	Y ^a		Y ^b				Y								
	14. Site Welding		Y ¹		Y		Y									
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Notes:

1. Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.
2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91
3. DPT on **root** run and after back gouging and on finish welds.
4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test.
5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.
6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.
7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of owner's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.
8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes
9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material
10. 2% of welds shall be subjected to DPT.
11. Pressure drop across the strainer for each type and size as a special test shall be carried out
12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.
13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.
14. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joints of body and disc and post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.
 - (a) One per heat/heat treatment batch/lot.
 - (b) On machined surfaces only for castings and on finished butt welds.
 - (c) For shaft/spindles > or = 50 mm

GENERAL GUIDELINES OR TESTING OF PUMPS, PIPING, VALVES ETC.


CLAUSE NO.	QUALITY ASSURANCE
<p style="text-align: center;"><u>GENERAL GUIDELINES FOR TESTING OF PUMPS, PIPING, VALVES ETC</u></p> <p>1.01.00 CENTRIFUGAL PUMPS</p> <p>(HORIZONTAL / VERTICAL / VERTICAL TURBINE PUMPS / SUBMERSIBLE PUMPS)</p> <p>The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.</p> <p>1.01.01 Hydrostatic Tests</p> <p>A Standard Hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut-off pressure on the head characteristic curve or twice the rated pressure, whichever is higher. While arriving at the above pressure, the maximum suction head specified in Data Sheet shall be taken into account.</p> <p>The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.</p> <p>1.01.02 Performance Tests</p> <p>(a.) All the pumps shall be performance tested at the Manufacturer's Works over for entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at rated flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards, USA or as per applicable equivalent Codes/Standards.</p> <p>(b.) The performance tests shall be conducted at rated speed only.</p> <p>(c.) The pumps for which LD on power consumption is applicable, shall be tested with the actual drive motor being furnished. For other pumps the test may be conducted with calibrated shop motor.</p> <p>(d.) Pumps shall be subjected to strip down examination visually to check for mechanical damages after performance testing at shop.</p> <p>1.01.03 For Vertical Turbine Pumps</p> <p>After the manufacture, the pumps shall be subjected for a prototype performance test at the manufacturer's works to determine the power consumption and the head capacity characteristic in the presence of Owner's representative as per requirements of BS:5316, HIS, USA or equivalent. Performance test at design duty</p>	
2x800 MW YERAMARUS TPS, KARNATAKA	

CLAUSE NO.	QUALITY ASSURANCE
	<p>point shall be done keeping minimum submergence of the pump identical to that specified for the site conditions. Bidder shall submit the test procedure for Owner's approval after award. In case such test facilities are not available at manufacturer's works the test may be carried out at any other test facility with the approval of the Owner. All costs associated with testing at Contractor's works or at any other test facility shall be included in contract price.</p> <p>1.01.04 NPSH test of the pump, where applicable, shall be conducted as per relevant standard.</p> <p>1.01.05 Contractor shall submit along with his offer details to the proposed test facilities available for testing the pumps. The details must include the capacity, head, maximum motor rating, voltage level sanctioned load and permissible starting current.</p> <p>1.01.06 No negative tolerance shall be permitted on head (H), capacity (Q) and the pump efficiency (n) during shop tests. Accuracy of instruments used shall be +1.5% or better for measurement of flow and +0.5% or better for measurement of pressure and power.</p> <p>1.01.07 Noise and Vibration Levels</p> <p>Noise and vibration shall be measured during the performance testing at shop as well as during the site test.</p> <p>Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out all round the pump and motor set at a distance of one meter from the nearest surface of the machine at a height of 1.5m from the floor level. A minimum of six (6) points should be covered for measurement. The tests shall be carried out with the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should be collected during the test.</p> <p>Vibration level check will be done as per Hydraulic Institute Standards. Vibration would be checked at thrust bearing location in horizontal, radial and vertical directions. Acceptable limits would be as per Hydraulic Institute Standards.</p> <p>1.01.08 Mechanical Balancing</p> <p>Rotating components of the pumps shall be subjected to static and dynamic balancing tests as per ISO-1940, Gr.6.3 or better.</p> <p>1.01.09 Visual Inspection</p> <p>Pumps shall be offered for visual inspection to the Owner before shipment. The components of the pumps shall not be painted before inspection.</p>
	<p align="center">2x800 MW YERAMARUS TPS, KARNATAKA</p>


CLAUSE NO.	QUALITY ASSURANCE
<p>1.01.10</p> <p>1.01.11</p> <p>1.02.00</p> <p>1.02.01</p>	<p>Material Test Certificate</p> <p>Materials of the various pump components shall be tested in accordance with the relevant standards. Test Certificates for these shall be furnished for the Owner's approval.</p> <p>Where stage inspection is specified, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by Owner's inspector who shall stamp the material. In case mill test certificates for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by Owner, as per the requirement of specified material standard. The sample for physical and chemical testing shall be drawn up in presence of Owner's inspector who shall also witness the testing.</p> <p>Non-Destructive Testing</p> <p>Non-destructive testing of the pump components shall be conducted in accordance with relevant standards and as specified in Table.</p> <p>Prior to testing, the test procedure and repair procedure shall be submitted for the Owner's approval. All components subjected to testing shall be identified and only those, which are tested successfully, shall be used for the manufacture of final product. All test results shall be submitted by the vendor for Owner's approval.</p> <p>PIPING, VALVES AND FITTINGS</p> <p>Piping & Fittings</p> <p>All the mechanical and chemical tests including optional tests if any as per the relevant standards shall be carried out and the test certificates for the same shall be submitted for owners approval.</p> <p>The minimum hydraulic testing criteria for all the pipes before and after the rubber lining (if provided) shall be at two times, the operating pressure or 1.5 times the maximum attainable pressure for a period of 120 minutes, whichever is greater. However, if the Standard of supplied piping specifies more stringer requirements than the above criteria, then the hydraulic tests shall be conducted as per the piping standard.</p> <p>"All pipes and fittings shall be visually and dimensionally examined as per applicable standards."</p> <p>All rubber lining is to be subjected to the following tests as per IS:4682 part I</p> <ul style="list-style-type: none"> (a.) Adhesion test (b.) Tests to check resistance to bleeding (c.) Measurement of thickness of lining
2x800 MW YERAMARUS TPS, KARNATAKA	

CLAUSE NO.	QUALITY ASSURANCE
<p>1.02.02</p>	<p>(d.) Shore hardness test</p> <p>(e.) Spark test at High voltage 5 KV/mm of thickness</p> <p>Welding procedure and welder performance qualifications shall be carried out.</p> <p>Valves/Gates/Strainers</p> <p>Mechanical tests including optional tests if any shall be performed as per the relevant valve standard and the test certificates for the same shall be submitted for Owner's approval. The performance requirements, such as flow capacity test, torque test, Cv, Co-efficient test etc. of the valves shall also be tested as per the relevant standard.</p> <p>Mechanical test and chemical analysis shall be carried out on fully representative cast test piece for each heat of cast iron casting for body and disc.</p> <p>Chemical composition of all material, castings, forgings, etc. shall be tested for various components of the valves, gates, strainers and test certificates shall be submitted for the owner's approval.</p> <p>All the valves shall be hydraulically tested for the body, seat, back seat (if applicable) and valves shall be pneumatically tested for seat leakage as per the relevant valve standards to which these are designed irrespective of the working pressure for which valves are selected. Check valves shall be tested for seat leakage test at 25% of the specified seat test pressure.</p> <p>For fabricated BF valves, shell disc and flange plates shall be tested for chemical and physical properties as per relevant code/standard.</p> <p>Pressure drop across each type and each size of the valve at various flows shall be conducted, and test reports shall be submitted for Owner's approval. Type test report for this test (if already carried out by the manufacturer) may be submitted to fulfill this requirement.</p> <p>Cast valve disc shall be checked for surface defect by magnetic particle test (MPI).</p> <p>Disc shall preferably be made out of single plate. In case of any weld seam no disc shall be stress relieved if disc thickness is above 30mm.</p> <p>Weld joints of fabricated valve body and disc shall be subjected to 100% radiography test.</p> <p>Studs and drive shaft of valves for diameter 50mm and above shall be subjected to dye penetrant/test for surface defects and ultrasonic test for internal defects.</p> <p>Valve body shall be subjected to hydraulic test as specified in BS EN 593/AWWA C-504.</p> <p>Each valve shall be subject to leak test as per BS EN 593.</p>
	<p align="center">2x800 MW YERAMARUS TPS, KARNATAKA</p>


CLAUSE NO.	QUALITY ASSURANCE
	<p>Disc strength test as per BS EN 593/AWWA-C504 shall be carried out.</p> <p>After complete assembly, each valve with actuator shall be subject to performance test by opening and closing the valve from fully closed to fully open position and reverse under no flow to check the following :</p> <ul style="list-style-type: none"> (a.) Smooth uninterrupted movement of valve (b.) Closing and opening time (c.) Current Drawn by Actuator (d.) Operation of tripping switch and position indicator. <p>In addition to the above tests, Bidder shall furnish test certificate under reputed third party inspection as a proof of having conducted proof of design test as per BS-EN 593/AWWA C-504 for each design/size/rating of the valve similar to the one being offered for this project for review and approval of owner. In case, above test has not been done, the bidder shall conduct the same as per AWWA C-504/BS-EN 593 on one valve of each size/design/rating being offered.</p> <p>For rubber lined valves, body shall be subjected to hydro test before lining.</p> <p>Elastomers wherever coated or lined for the valves shall be tested for the corrosion resistance against the medium for which those are selected as per relevant Standard and the test certificates shall be furnished for owner's approval.</p> <p>Rubber lining on valves Gates/Strainers shall be checked in accordance with IS:4682 Part I for the following tests :</p> <ul style="list-style-type: none"> (e.) Adhesion test (f.) Tests to check resistance to bleeding (g.) Measurement of lining thickness (h.) Shore hardness test (i.) Spark test at high voltage at 5 KV/mm of thickness. <p>Gates shall be tested against leakage and strength as required in the standard.</p> <p>Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.</p> <p>1.03.00 PAINTING</p> <ul style="list-style-type: none"> (a.) All painted surfaces shall be visually checked for uniformity. (b.) The dry film thickness of coating of paint shall be measured.
	<p align="center">2x800 MW YERAMARUS TPS, KARNATAKA</p>


		S/Contractor :- Mfgr:- Works:-			Manufacturing Quality Plan Item :-Local Panels QAP No. LOI Nos:-			Project:- Package :- Mill Rejects System Client :-				
					Contractor :- M/s BHEL			Consultant :-				
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks
1		3	4	5	6	7	8	9	10	C	N	11
1	Materials CRCA Sheet	Visual	Major	Visual	100%	Appr. Drg / IS: 513	Appr. Drg / IS: 513	IR	-	P	-	
		Chem. & Physical.	Major	Chem. & Physical.	100%	Do	Do	TC	✓	V	V	
		Thickness	Major	Measurement	100%	App. Drawing	App. Drawing	IR/TC	✓	V	V	
2	Bought outs Verification of type, size & Make of FLV unit, PG, PS, SV	Visual	Major	Visual	100%	Appr. Drawing / Data Sheet	Approved Drawing / Data Sheet	IR/TC	✓	V	V	
3	Painting Pre Treatment 7 tank process	Physical	Major	DFT / Shade / Finish	100%	Appr. Painting Schedule	Appr. Painting Schedule	IR/TC	✓	V	V	
4	Final Inspection	Visual	Major	Visual	100%	Appr. Drawing / Data Sheet	Appr. Drawing / Data Sheet	IR/TC	✓	P	W	
		Dimension	Major	Measurement	100%	Appr. Drawing / Data Sheet	Appr. Drawing / Data Sheet	IR/TC	✓	P	W	
		Check for Pneumatic Circuit	Major	Visual	100%	Appr. Drawing / Data Sheet	Appr. Drawing / Data Sheet	IR/TC	✓	P	W	
		Check for Wiring / Mountings / Terminations	Major	Visual / Continuity	100%	Appr. Drawing / Data Sheet	Appr. Drawing / Data Sheet	IR/TC	✓	P	W	
		Functional Check for Solenoid Valve	Major	Functional	100%	Appr. Drawing / Data Sheet	Appr. Drawing / Data Sheet	IR/TC	✓	P	W	
5	QA Documents	Review	Major	verification	100%	-	-	-	-	-	-	
		LEGENDS:-			Records identified by ✓ shall be essentially included in QA documentation. TC-Test Certificate, IR - Insp. Report			Document. No.:-				
Manufacturer / Sub Vendor		Contractor			M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N ->CLIENT			Name & Signature of Approving Authority with Seal				
SIGNATURES												

S/Contractor :-			Manufacturing Quality Plan				Project:- Package :- Mill Rejects System Client :-						
Mfg:- Works:-			Item :- Transport vessel QAP No. LOI Nos:-				Contractor :- M/s BHEL						
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks	
1	2	3	4	5	6	7	8	9	10	11			
1								TYPE	D	M	C	N	
1.1	Raw Materials Dome & dome Valve Body	Dimensions	Major	Measurement Visual	100%	App. Drg. / Data Sheet / Standard	App. Drg. / Data Sheet / Standard	-	-	P	-	-	
		Surface Defects						-	-	P	-	-	
		Physical Check		TS & Hardness	1/Heat			TC	✓	P/V	V	V	
		Chemical Check		Chemical Comp.	1/Heat			TC	✓	P/V	V	V	
1.2	Plates for Vessel	Dimensions	Major	Measurement Visual	100%	App. Drg. / Data Sheet / IS Standard	App. Drg. / Data Sheet / IS Standard	-	-	P	-	-	
		Surface Defects						-	-	P	-	-	
		Physical Check		TS & Elongation	1/Heat			TC	✓	P/V	V	V	
		Chemical Check		Chemical Comp.	1/Heat			TC	✓	P/V	V	V	
1.3	Insert Seal	Surface Defects	Major	Visual	100%	Mfr's Drg. / Std	Mfr's Drg. / Std	-	-	P	-	-	
		Hardness						-	-	P	-	-	
1.4	Shaft	Physical Check	Major	TS & Elongation	1/Heat	App. Drg./ IS Std.	App. Drg./ IS Std.	IR	✓	P/V	V	V	
		Chemical Check						TC	✓	P/V	V	V	
2													
2.1	Welders & Welding	In - Process Insp.	Major	Procedure / Qualification	100%	ASME sec - IX	ASME sec - IX	WPS /	✓	P/V	V	V	
		WPQ						ASTM E-165	PQR	IR	P/V	V	Welders to be approved by BHEL / CLIENT
		Welding Defects	Major	DPT on Root run	100%	ASTM E-165	ASTM E-165	IR	✓	P/V	V	V	
			Major	DPT on Final run	10%	ASTM E-165	ASTM E-165	IR	✓	P/V	V	V	
2.3	Machining of Dome & dome Valve	Visual & Dimension	Minor	Visual, Measurement	100%	Mfr's Drg / Standard	Mfr's Drg / Standard	-	-	P	-	-	
2.4	Hydrotst of Vessel	Soundness / Leakage	Major	Visual, Hydro Pressure Test	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	✓	P/V	W	W	
3													
3.1	Final Assly	Final Inspection	Major	Visual / Measurement	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	✓	P/V	W	W	
		Completeness & Dimension						At Painted Condition					
3.2	Run Test / Performance	Operation of Dome Valve	Minor	Visual, 5 times Cycle operation	100%	Mfr's Standard	Mfr's Standard	IR	✓	P/V	W	W	
3.3	Painting	Finish / DFT	Major	Visual, Measurement	100%	App. Painting Schedule	App. Painting Schedule	IR	✓	P/V	W	W	
4													
4.1	TC & IR	QA Documentation	Major	Verification & approval	100%	App. Quality Plan	App. Quality Plan		-	P/V	V	V	
		Completeness											
LEGENDS:-													Document No.
Records identified by ✓ shall be essentially included in QA documentation. TC-Test Certificate , IR - Insp. Report													For Client Use:-
M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT													
P->Perform, V-> Verification, W-> Witness													Name & Signature of Approving Authority with Seal
SIGNATURES													
Manufacturer / Sub Vendor													
Contractor													


			S/Contractor :- Mfr:- Works:-			Manufacturing Quality Plan Item :- Pyrite Hopper QAP No. LOI Nos			Project: Package :- Mill Rejects System Client :-			
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks
1	2	3	4	5	6	7	8	9	10	11	12	
Raw Materials												
1	1.1	Plates for Body	Major	Measurement Visual TS & Elongation Chemical Comp.	100% 100% 1/Heat 1/Heat	App. Drg. / Data Sheet / IS Standard Mfr's Drg. / IS Standard	App. Drg. / Data Sheet / IS Standard	- - MTC MTC	- - ✓ ✓	P P P/V P/V	- - V V	- - V V
1.2	Spray Nozzle	Surface Defects Chemical Check Dimensions	Major	Visual Chemical Comp. Measurement	100% 1/Lot 100%	Mfr's Drg. / IS Standard	Mfr's Drg. / IS Standard	- MTC IR	- ✓ ✓	P P/V P	- V V	- V V
In - Process Insp.												
2	2.1	Welders & Welding	Major	Procedure / Qualification DPT on Root run DPT on Final run	100% 100% 10%	ASME sec - IX ASTM E-165 ASTM E-165	ASME sec - IX ASTM E-165 ASTM E-165	WPS / PQR IR IR	✓ ✓ ✓	P/V P/V P/V	V V W	Welders to be approved by BHEL W -
2.2	Fabrication	Fit up, Marking, Cutting, Grinding	Minor	Visual, Measurement	100%	Mfr's Standard	Mfr's Standard	-	-	P	-	-
Final Inspection												
3	3.1	Final Assy	Major	Visual	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	✓	P/V	W*	* -> Witness 10%
3.2	Painting	Completeness & Dimension Finish / DFT	Major	Visual, Measurement	100%	App. Painting Schedule	App. Painting Schedule	IR	-	P/V	W	Painting shall be Heat Resistance
QA Documentation												
4	4.1	TC & IR	Major	Verification & approval	100%	App. Quality Plan	App. Quality Plan	-	-	P/V	V	
LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC-Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> Client P->Perform, V-> Verification, W-> Witness												
Manufacturer / Sub Vendor						Contractor						Document No.:-
SIGNATURES												
Name & Signature of Approving Authority with Seal												

S/Contractor :-			Manufacturing Quality Plan				Project:- Package :- Mill Rejects System Client :-			
Mfr:-			Item :- Terminal Box QAP No. :- LOI Nos:-				Contractor :- M/s BHEL			
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking	Remarks
1	2	3	4	5	6	7	8	9	10	11
1	Raw Materials									
1.1	Plates for Body	Dimensions Surface Defects Physical Check Chemical Check	Major	Measurement Visual TS & Elongation Chemical Comp.	100% 100% 1/Heat 1/Heat	App. Drg. / Data Sheet / IS Standard	App. Drg. / Data Sheet / IS Standard	- - MTC MTC	- - P/V P/V	- - V V
2	In - Process Insp.									
2.1	Welders Qualification & Welding	WPS / PQR / WPQ Welding Defects	Major	Procedure / Qualification DPT on Root run DPT on Final run	100% 100% 10%	ASME sec - IX ASTM E-165 ASTM E-165	ASME sec - IX ASTM E-165 ASTM E-165	WPS / PQR IR IR	P/V V W	V V V
2.2	Flange Machining and Drilling	Dimensions	Major	Measurement	100%	Mfr/Appr. Drg	Mfr/Appr. Drg	IR	-	-
2.3	Connection -pipe to flange, pipe to body	Fit up	Major	Joint set up, PCD, Orientation	100%	Mfr/Appr. Drg	Mfr/Appr. Drg	IR	-	-
2.4	Fabrication	Fit up, Marking, Cutting, Grinding	Minor	Visual, Measurement	100%	Mfr's Standard	Mfr's Standard	-	-	-
3	Final Inspection									
3.1	Final Assy	Completeness & Dimension	Major	Visual	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	P/V	W
3.2	Painting	Finish / DFT	Major	Visual, Measurement	100%	App. Painting Schedule	App. Painting Schedule	IR	P/V	-
4	QA Documentation									
4.1	TC & IR	Completeness	Major	Verification & approval	100%	App. Quality Plan	App. Quality Plan	-	P/V	V
			LEGENDS:-				Document No.:-			
			Records identified by ✓ shall be essentially included in QA documentation. TC-Test Certificate, IR - Insp. Report							
Manufacturer / Sub Vendor			M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT							
SIGNATURES			P->Perform, V-> Verification, W-> Witness				Name & Signature of Approving Authority with Seal			

		S/Contractor :- Mfr:- Works:-			Manufacturing Quality Plan Item :- Bunker Discharge Gate QAP No. :- LOI Nos:-			Project:- Package :- Mill Rejects System Client :-					
		Contractor :- M/s BHEL			Consultant :-								
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks	
1	2	3	4	5	6	7	8	9	10			11	
Raw Materials													
1.1	Plates for Body	Dimensions Surface Defects Physical Check Chemical Check	Major	Measurement Visual TS & Elongation Chemical Comp.	100% 100% 1/Heat 1/Heat	App. Drg. / Data Sheet / IS Standard	App. Drg. / Data Sheet / IS Standard	- - TC TC	- - P P/V	- - V V	- - V V	- - V V	
1.2	Shaft	Physical Check Chemical Check UT If Dia > 50 mm	Major	TS & Elongation Chemical Comp. Internal defect	1/Heat 1/Heat 100%	do	do	TC TC IR	P/V P/V P/V	V V V	V V V	V V V	
1.3	Cylinder / Actuator	Visual / Specification	Major	Visual	100%	do	do	Mfr's TC	V	V	V	V	
In - Process Insp.													
2.1	Welders & Welding	WPS / PQR / WPQ Welding Defects	Major	Procedure / Qualification DPT on Root run DPT on Final run	100% 100% 10%	ASME sec - IX ASTM E-165 ASTM E-165	ASME sec - IX ASTM E-165 ASTM E-165	WPS / PQR IR IR	P/V P/V P/V	V V W	V V V	Welders to be approved by BHEL / CLIENT	
Final Inspection													
3.1	Final Assy	Completeness & Dimension	Major	Visual	100%	App. Drg. / Data sheet Proper Working	App. Drg. / Data sheet	IR	P/V	W	W		
3.2	Operation with job / shop actuator	Opening & Closing of Gate	Major	Visual	100%	App. Painting Schedule	Smooth Operation	IR	P/V	W	W		
3.3	Painting	Finish / DFT	Major	Visual, Measurement	100%	App. Painting Schedule	App. Painting Schedule	IR	P/V	W	W	Painting before disp.	
QA Documentation													
4.1	TC & IR	Completeness	Major	Verification & approval	100%	App. Quality Plan	App. Quality Plan	-	P/V	V	V		
				LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC - Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N-> CLIENT P->Perform, V-> Verification, W-> Witness			For Client Use:-			Document No.:-			
Manufacturer / Sub Vendor		Contractor											
SIGNATURES		Name & Signature of Approving Authority with Seal											

		S/Contractor :- Mfr:- Works:-			Manufacturing Quality Plan Item :- Pressure Relief Valve QAP No. : LOI Nos:-			Project:- Package :- Mill Rejects System Client :-			
					Contractor :- M/s BHEL			Consultant :-			
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking	Remarks	
1	2	3	4	5	6	7	8	9	10	11	
								TYPE	M	C	K
1	Raw Materials										
1.1	Plates for Body	Dimensions Surface Defects Physical Check Chemical Check	Major	Measurement Visual TS & Elongation Chemical Comp.	100% 100% 1/Heat 1/Heat	App. Drg. / Data Sheet / IS Standard	App. Drg. / Data Sheet / IS Standard	- - MTC MTC	- - P/V P/V	- - V V	- - V V
2	In - Process Insp.										
2.1	Welders & Welding	WPS / PQR / WPQ Welding Defects	Major	Procedure / Qualification DPT on Root run DPT on Final run	100% 100% 10%	ASME sec - IX ASTM E-165 ASTM E-165 Mfr's Standard	ASME sec - IX ASTM E-165 ASTM E-165 Mfr's Standard	WPS / PQR IR IR -	P/V P/V P/V P	V V W -	Welders to be approved by BHEL / KPCL V V V -
2.2	Fabrication	Fit up, Marking, Cutting, Grinding	Minor	Visual, Measurement	100%						
3	Final Inspection										
3.1	Final Assly	Completeness & Dimension	Major	Visual	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	P/V	W	W
3.2	Painting	Finish / DFT	Major	Visual, Measurement	100%	App. Painting Schedule	App. Painting Schedule	IR	P/V	W	- Painting before disp.
4	QA Documentation										
4.1	TC & IR	Completeness	Major	Verification & approval	100%	App. Quality Plan	App. Quality Plan	-	P/V	V	V
		LEGENDS:-			Records identified by ✓ shall be essentially included in QA documentation. TC-Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT P->Perform, V-> Verification, W-> Witness			For Client Use:-			
Manufacturer / Sub Vendor		Contractor			Document No.:-						
SIGNATURES		Name & Signature of Approving Authority with Seal									

S/Contractor :-			Manufacturing Quality Plan				Project:- Package :- Mill Rejects System Client :-						
Mfr:- Works:-			Item :- Air Receiver QAP No. :- LOI Nos:-				Contractor :- M/s BHEL						
Sl. No.	Components / Operations	Characteristics Checked	Category	Type/Method of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks	
1	2	3	4	5	6	7	8	9	10			11	
								TYPE	D	M	C	K	
Raw Materials													
1.1	Plates for Shell, Dished End & Flange	Dimensions Surface Defects Physical Check Chemical Check	Major	Measurement Visual TS & Elongation Chemical Comp.	100% 100% 1/Heat 1/Heat	App. Drg. / Data Sheet / IS Standard	App. Drg. / Data Sheet / IS Standard	- - TC TC	- - ✓ ✓	P P P/V P/V	- - V V	- - V V	
1.2	Formed Dished End	Dimensions Thickness/Thinning DPT of Knuckle	Major	Measurement Measurement DP Test	100% 100% 100%	App. Drg. / Data Sheet ASTM E-165	App. Drg. / Data Sheet ASTM E-165	IR IR TC	✓ ✓ ✓	P P P/V	- - V	- - V	
In - Process Insp.													
2.1	Welders & Welding	WPS / PQR / WPQ Welding Defects do do	Major Major Major Critical	Procedure / Qualification DPT on Root run DPT on Final run Radiography Test on all C/S & L/S including T & X	100% 100% 10% 100%	ASME sec - IX ASTM E-165 ASTM E-165 IS 2825 Class-II /	ASME sec - IX ASTM E-165 ASTM E-165 IS 2825 Class II /	WPS / PQR IR IR RT Film / Report	✓ ✓ ✓ ✓	P/V P/V P/V P/V	V V W V	Welders to be approved by BHEL / CLIENT	
2.2	Fabrication	Marking, Cutting, Rolling, Edge Preparation, Joint & Nozzle set up	Major	Visual, Measurement (Ovality, off set orientation)	100%	Mfr's Standard / Approved Drg.	Mfr's Standard / Approved Drg.	IR	-	P	-	-	
Final Inspection													
3.1	Final Assy	Completeness & Dimension	Major	Visual / Measurement	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	✓	P/V	W	W	
3.2	Hydotest of Vessel	Soundness / Leakage	Major	Visual, Hydro Pressure Test	100%	App. Drg. / Data sheet	App. Drg. / Data sheet	IR	✓	P/V	W	W	
3.3	Painting	Finish / DFT	Major	Visual, Measurement	100%	App. Painting Schedule	App. Painting Schedule	IR		P/V	W	- Painting before disp.	
4	QA Documentation												
4.1	TC & IR	Completeness	Major	Verification & approval	100%	App. Quality Plan	App. Quality Plan	-	-	P/V	V	V	
Manufacturer / Sub Vendor				LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC -> Test Certificate , IR - Inspection Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N-> CLIENT				Document No.:-					
SIGNATURES				Name & Signature of Approving Authority with Seal									


		Sl/Contractor :- Manufacturer :-		Manufacturing Quality Plan Item :- Rupture Disc QAP No. :- LOI Nos:-			Project:- Package :- Mill Rejects System Client :-				
		Contractor :- M/s BHEL			Consultant :-						
Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking	Remarks	
1	2	3	4	5	6	7	8	9	10	11	
								TYPE	M	C	
1	Materials -> Rupture Disc Material	Physical & Chemical Properties	Major	Chemical Analysis, YTS & UTS	1 per Heat	ASTM A240 Type - 304 / Approved Data Sheet / Drg.	ASTM A240 Type - 304 / Approved Data Sheet	MTC	✓	V	V
2	Final Inspection -> Dimension -> Burst Test of Rupture Disc	Measurement Functional	Major Major	Mesurement Burst Test @ 200 Degree Centigrade	100% 1 per lot offered	App. Drawing Approved drawing / Datasheet	App. Drawing Min 0.4 bar (g) @ 200 degree C Max 0.6 bar (g) @ 200 degree C / App. Data Sheet	IR IR / Burst Test Certificate	✓ ✓	P P	W W W
		LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & K ->Client P->Perform, V-> Verification, W-> Witness			For Client Use:-			Document No.:-			
Manufacturer / Sub Vendor SIGNATURES		Contractor			Name & Signature of Approving Authority with Seal						


Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final

S/Contractor :-		Manufacturing Quality Plan				Project:- Package :- Mill Rejects System Client :-						
Manufacturer :-		Item:- CHAIN PULLY BLOCK QAP No. :- LOI Nos:-				Contractor :- M/s BHEL						
Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking	Remarks		
1	2	3	4	5	6	7	8	9	10	11		
1		Materials						TYPE	D	M	C	K
->	Load Chain	Mech. Properties Breaking Load Test, Proof Load test	Major	Review of Mfr's Test Certificate	1 per Lot	IS:6216 /Appr. Drg / Appr. Data sheet	IS:6216 /Appr. Drg / Appr. Data sheet	MTC	✓	P/V	V	
->	Load Sheave	Mech. Properties Chemical Composition	Major	Lab Analysis	1 per Heat	IS:1865 /Appr. Drg / Data sheet	IS:1865 /Appr. Drg / Data sheet	MTC	✓	P/V	V	
->	Gear & Pinion	Chemical Composition	Major	Lab Analysis	1 per Heat	IS:4432/Appr. Drg / Data sheet	IS:4432/Appr. Drg / Data sheet	MTC	✓	P/V	V	
->	Hook	Mech. Properties Chemical Composition	Major	Lab Analysis	1 per Heat	IS:8610 / IS:1875 /Appr. Drg / Data sheet	IS:8610 / IS:1875 /Appr. Drg / Data sheet	MTC	✓	P/V	V	
2		In Process										
->	Hook	Proof Load Test	Major	Load Test	100%	IS:8610 /Appr. Drg / Appr. Data sheet	IS:8610 /Appr. Drg / Appr. Data sheet	MTC / IR	✓	P	V	
		DPT after Load Test	Major	DPT	100%	ASTM E-165	ASTM E-165 / No Defects	IR	✓	P	V	
3		Final Inspection										
->	Assembly	Operation Check	Major	Visual	100%	Smooth Operation / IS 3832 Appr. Drg / App. Data Sheet	Smooth Operation / IS 3832 Appr. Drg / App. Data Sheet	IR	✓	P	W	V
		Functional Test	Major	Visual	100%			IR	✓	P	W	V
		Load Test & Over Load Test	Major	Load Test	100%			IR	✓	P	W	V
		Overall Dimensions Visual (After Load Test)	Major	Measurement Visual	100%	IS 3832	IS 3832	IR	✓	P	W	V
			Major		100%			IR	✓	P	W	V
		LEGENDS:-				For Client Use:-				Document No.:-		
		Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report										
Manufacturer / Sub Vendor		Contractor										
SIGNATURES		P->Perform, V-> Verification, W-> Witness										
Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final						Name & Signature of Approving Authority with Seal						


Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking	Remarks		
1	2	3	4	5	6	7	8	9	10	11		
								TYPE	D	M	C	K
3	Final Inspection											
3.1	Assembly \$-> Pneumatic Test at 1.1 times W/Pressure	Dimensional Pne. test \$of Manifold in Assly.	Major	Measurement Leakage by soap solution	100%	Appr. Drawing Appr. Data Sheet	Appr. Drawing No Leakage	IR	✓	P	W	V
		Functional Test of Pulsing System	Major	Pulse Sequence	100%	Appr. Data sheet / Testing Procedure	Appr. Data sheet / Testing Procedure	IR	✓	P	W	V
4	Painting	Measurement & Visual	Major	DFT / Finish	100%	Appr. Painting Schedule	Appr. Painting Schedule	IR	✓	P	-	-
TESTING PROCEDURE TO BAG FILTER												
1-> Functional test through compressed air , Sequential pulsing through valves and sequential controller on No - Load Condition to be conducted. 2-> The Soenoid valve shall be connected to the sequential timer and suitable electric supply shall be provided. Air header to be connected to supply of compressed air. The Timer is set and Sequential operation of Solenoid operated valve is observed.												
Manufacturer / Sub Vendor		LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT P->Perform, V-> Verification, W-> Witness				For Client Use:-		Document No.:-				
						Name & Signature of Approving Authority with Seal						

Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final


		S/Contractor :- Manufacturer :-		Manufacturing Quality Plan Item :- MS GI ERW Pipes (IS:1239/IS3589) QAP No. :- LOI Nos:-				Project:- Package :- Mill Rejects System Client :-					
				Contractor :- M/s BHEL				Consultant :-					
Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks	
1	2	3	4	5	6	7	8	9	10	11			
								TYPE	D	M	C	K	
1	Final Inspection of Finished Pipes	Physical Dimensional Mechanical Properties Chemical Hydro Test	Major Major Major Major Major	Visual Measurement Tensile, elongation, Bend or Flattening Chemical Analysis Pressure Testing	100% 100% IS: 4711 1 per heat 100%	IS:1239 / IS:3589 / Approved Data Sheet	IS:1239 / IS:3589 / Approved Data Sheet	IR IR IR / TC TC IR / TC	- ✓ ✓ ✓ ✓	P P P / V P / V P	W* W* V V W*	V W* V V W*	* -> Random 5% of offered lot irrespective of size
2	Galvanising (For GI Pipes)	Uniformity & mass of Zinc Coating, Adhesion test, Free bore test	Major	As per IS:4736	As per IS:4736	As per IS:4736 / Approved Data Sheet	As per IS:4736 / Approved Data Sheet	IR	✓	P	W#	V	# one sample for each size
3	Identification	Verification of Batch No. / Mfg stamp / Heat No.	Major	Visual	100%	Mfg Practise / IS 1239 / IS 3589	Mfg Practise / IS 1239 / IS 3589	IR	✓	P	W	V	
4	Review of QA Documents					As per QAP	As per QAP		✓	V	V	V	
NOTES :- For SAIL Pipes verification of reports for the tests mentioned in SI. No. 1 & 2 by BHEL & KPCL. For GI Pipes, Galvanising Check as per relevant standard shall be done. All material shall be as per approved data sheet in case of ambiguity in QAP, material as data sheet shall be final.													
				LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT P->Perform, V-> Verification, W-> Witness				For Client Use:-		Document No.:-			
Manufacturer / Sub Vendor		Contractor											
SIGNATURES						Name & Signature of Approving Authority with Seal							
Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final													


<div></div>		<u>S/Contractor :-</u> Manufacturer :-		Manufacturing Quality Plan Item :- ACI Bends QAP No. :- LOI Nos:-			Project:- Package :- Mill Rejects System Client :-					
		Contractor :- M/s BHEL							Consultant :-			
Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks
1	2	3	4	5	6	7	8	9	10	11		
								TYPE	D	M	C	K
1	<u>Raw Material</u>											
1.1	Scrap Receipt	Chemical	Major	Lab Analysis	Random Sample / Lot	Mfg's Std	Mfg's Std	Mfg's Log Sheet	-	P	-	-
1.2	Ferro Alloys	Chemical	Major	Lab Analysis	Random Sample / Lot	Mfg's Std	Mfg's Std	Mfg's Log Sheet	-	P	-	-
2	<u>Final Inspection</u>											
2.1	Product Analysis	Chemical Analysis	Major	Chemical	1 / heat	Mfg's Standard	Mfg's Standard	MTC	✓	P	V**	V ** Chemical. Analysis to be Witnessed by Vendor
2.2	Leakage	Hydro Test	Major	Pressure Test	100%	Approved Drg / Data Sheet	No Leakage	IR	✓	P	W*	W* 10% by Vendor / BHEL / CLIENT
2.3	Dimension	Dimension	Major	Measurement	100%	Approved Drg / Data Sheet	Approved Drg / Data Sheet	IR	✓	P	W*	W*
2.4	Hardness	Hardness	Major	Measurement	100%	Approved Drg / Data Sheet	Approved Drg / Data Sheet	IR/TC	✓	P	W*	W*
		LEGENDS:-					Document No.:-					
		Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT										
Manufacturer / Sub Vendor		Name & Signature of Approving Authority with Seal										
SIGNATURES		P->Perform, V-> Verification, W-> Witness										

Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final

		S/Contractor :- Manufacturer :-		Manufacturing Quality Plan Item :- Knife Gate Valve [Manual / Pneumatic] QAP No. : LOI Nos:-			Project:- Package :- Mill Rejects System Client :-			
				Contractor :- M/s BHEL			Consultant :-			
Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking	Remarks
1	2	3	4	5	6	7	8	9	10	11
Raw Material / Bought Out's										
1	1.1	Chemical & Mechanical	Major	Foundry TC	1 per Heat	Relevant IS / Appr. Drg / Data Sheet	Relevant IS / Appr. Drg / Data Sheet	TC	P/V	V
	1.2	do	Major	Lab Analysis	1 per lot	do	do	Mill / Lab TC	P/V	V
	1.3	do	Major	Lab Analysis	1 per batch	do	do	do	P/V	V
	1.4	Visual & Functional	Major	Mfr's TC Review	100%	Smooth Operation	Smooth Operation	Mfr's TC	P/V	V
In - Process Inspection										
2	2.1	Dimensional	Major	Measurement	100%	Mfr's Drawing	In-Process Insp. Record	-	P	V
	2.2	Leak Tightness	Major	Hydro Static Test #	100%	Approved Drg / Data Sheet	No Leakage	IR	P	V
Final Inspection										
3	3.1	Dimension	Major	Measurement	100%	Approved Drg / Data Sheet	Approved Drg / Data Sheet	IR	P	W
	3.2	Function	Major	Operation	100%	Smooth Operation	Smooth Operation	IR	P	W
	3.3	Seat Leakage	Major	Hydro Static Test #	100%	Approved Drg / Data Sheet	Approved Drg / Data Sheet	IR	P	W
		LEGENDS:- Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT P->Perform, V-> Verification, W-> Witness				For Client Use:-		Document No.:-		
Manufacturer / Sub Vendor		Contractor								
SIGNATURES		Name & Signature of Approving Authority with Seal								

Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final

		S/Contractor :- Manufacturer :-		Manufacturing Quality Plan Item :- Compressor QAP No. :- LOI Nos:-			Project:- Package :- Mill Rejects System Client :-						
Contractor :- M/s BHEL		Quantum of Check 6		Reference Documents 7		Acceptance Norms 8		Consultant :- Format of Records 9		Agency for Checking 10		Remarks 11	
Sl. No. 1		Components / Operations 2		Classification 4		Type of Check 5		TYPE D		M C		K V	
1 Raw Material / Bought Out's		Chemical & Mechanical		Major		Mfr's TC		Relevent IS / Appr. Drg / Data Sheet		TC		V	
1.1 Cylinder		do		Major		do		do		do		V	
1.2 Frame Head		do		Major		do		do		do		V	
1.3 Outer Head		do		Major		do		do		do		V	
1.4 Crank Shaft		do		Major		do		do		do		V	
1.5 Connecting Rod		do		Major		do		do		do		V	
1.6 Temp. Switch		Mfr's TC		Major		Visual Review		do		do		V	
1.7 Control Panel		Mfr's TC		Major		Visual Review		do		do		V	
2 In - Process Inspection		Leak Tightness		Major		Hydro Static Test		Appr drg. / Data Sheet		IR		V	
2.1 Cylinder, Frame Head & Outer Head		do		Major		do		do		do		V	
2.2 After Cooler		do		Major		do		do		do		V	
3 Final Inspection		Dimension / Visual		Major		Measurement		Approved Drg / Data Sheet		IR		W	
3.1 After Cooler		do		Major		do		do		do		W	
3.2 Control Panel		do		Major		do		do		do		W	
3.3 Compressor Assly		Nozzle Test (Mech. Run Test)		Major		Performance		Approved Drg / Data Sheet / BS 1571 Part-2		IR		W	
LEGENDS:-		Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report		M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT		P->Perform, V-> Verification, W-> Witness		For Client Use:-		Document No.:-			
Manufacturer / Sub Vendor		Contractor											
SIGNATURES													
Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final													

		S/Contactor :- Manufacturer :-			Manufacturing Quality Plan Item :- Sump Pump QAP No. :- LOI Nos:-			Project:- Package :- Mill Rejects System Client -				
		Contractor :- M/s BHEL							Consultant :- .			
Sl. No.	Components / Operations	Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Format of Records	Agency for Checking			Remarks
1	2	3	4	5	6	7	8	9	10			11
								TYPE	D	M	C	K
1	Raw Material / Bought Out's											
1.1	Casing	Chemical, Mechanical, Hardness, Surface Defect	Major	Chem. Comp. Mechanical Hardness Visual	1 per Heat 1 per Heat 1 Per Heat 100 %	Relevant IS / Appr. Drg / Data Sheet	Relevant IS / Appr. Drg / Data Sheet	TC	✓	P/V	V	V
1.2	Impeller	do	Major	do	do	do	do	do	✓	P/V	V	V
1.3	Shaft	Chemical, Mechanical, Surface Defect	Major	Chem. Comp. Mechanical Visual & UT if Dia >50 mm	1 per Heat 1 per Heat 100 %	Relevant IS / Appr. Drg / Data Sheet / ASTM E 388 for UT	Relevant IS / Appr. Drg / Data Sheet / ASTM E 388	do	✓	P/V	V	V
1.4	Shaft Sleeve	Chemical Hardness	Major	Chem. Comp. Hardness	do	do	do	do	✓	P/V	V	V
2	In - Process Inspection											
2.1	Casing	Soundness of Casting / Leakage	Major	Hydro Static Test	100%	Appr drg. / Data Sheet / IS 5120	No Leakage	IR	✓	P	V	V
2.2	Impeller	Residual unbalance	Major	Dyanamic / Static Balancing	100%	Approved Drg / Data Sheet / ISO 1940 Gr. 6.3	ISO 1940 Gr. 6.3	IR	✓	P	V	V
												Hyd. Test at 200% of pump rated head or 150% of Shut off head which ever is higher for 30 min.

[illegible]

		S/Contractor :- Manufacturer :-		Manufacturing Quality Plan Item :-EXPANSION BELOW QAP No. :- LOI Nos:-			Project:- Package :- Mill Rejects System Client :-						
Components / Operations		Characteristics	Classification	Type of Check	Quantum of Check	Reference Documents	Acceptance Norms	Consultant :-)					
Sl. No.	2	3	4	5	6	7	8	9	10	Remarks			
1								TYPE	D	M	C	K	11
1 Raw Material													
1.1	Bellocs	physical & Chemical	Major	Lab Analysis	1 per Heat	AS204 TP304/ Approved Drg.	AS204 TP304/ Approved Drg.	MTC	✓	V	V	V	
1.2	Flanges/ End Pipe	physical & Chemical	Major	Lab Analysis	1 per lot	IS 2062 / Approved Drg.	IS 2062 / Approved Drg.	MTC	✓	V	V	V	
2 In - Process Inspection													
2.1	Bellocs & Pipe ** For Bellocs	Dimension Soundness Of Weld of L-Seam	Major major	Measurement DPT *(Before & After Forming)	100% 100%	Approved Drg. ASTM E- 165	Approved Drg. No Cracks/ Linear Indication	IR IR	✓ ✓	P P	V V	V V	
3 Final Inspection													
3.1	Assembly	DP Test of Fillet Weld of Bellocs to Pipe & Pipe to Flange	Major	visual	100%	ASTM E-165	No Crack / Linear Inication	IR	✓	P	W	V	
3.2	Testing	Dimensions pressure	Major Critical	Measurement Hydraulic	100% 100%	Approved Drg EJMA D.3.2.1/ Data sheet	Approved Drg EJMA D.3.2.1/ Approved Drg.	IR IR	✓ ✓	P P	W W	W W	
		Spring Rate Test (Axial)	Critical	Stiffness Test	100%	EJMA / Data Sheet	EJMA / Data Sheet	IR	✓	P	W	W	
		Deflection	Critical	Deflection Test	100%	EJMA / Data Sheet	EJMA/Data Sheet	IR	✓	p	W	W	
3.30	Painting	Visual/ Measurement	Major	DFT	100%	Approved Painting Schedule	Approved Painting Schedule	IR	✓	p	-	-	
				LEGENDS:-			Document No.:-						
				Records identified by ✓ shall be essentially included in QA documentation. TC- Test Certificate, IR - Insp. Report									
Manufacturer / Sub Vendor		Contractor		M-> Manufacturer/Sub Contractor, C-> Contractor (BHEL) or their nominated agency & N -> CLIENT									
SIGNATURES				P->Perform, V-> Verification, W-> Witness							Name & Signature of Approving Authority with Seal		

Note :- In case of any difference in parameters specified in Drawing / Data Sheet & QAP, Value specified in Drg / Data Sheet shall be Final

Manufacturer's Name & Address :			MANUFACTURING QUALITY PLAN						Project :					
			Item : MS Plates & Structures			QIP No. : Rev. No. : 0			BHEL Ref. :					
			Sub-System :			Date : Page No. : 11 of 1			Contract No. : Contractor : BHEL SUB-CONTRACTOR-					
Sl. No.	Components & Operations	Characteristic/Item	Class	Type/method of check	Extent of Check	Reference Document	Acceptance	Format of Record			Agency		Remarks	
1	2	3	4	5	6	7	8	9	D	P	W	V	11	
	RAW MATERIAL													
1	Steel Plates	Chemical composition and Mechanical test	Major	Review of correlated MTC	One/heat	IS:2062	IS:2062	Mfgr. TC	✓	3		2,1		
2		Visual and dimensional Check	Major	Visual and measurement	100%	Mfgr. TC	Mfgr. TC IS 1852	Mfgr. TC	✓	3	2,1		Refer Note Below	
3		Identification / Marking	Major	Co-relation establish	100%	AS per manufacturing practice IS 2062	AS per manufacturing practice IS 2062	Mfgr. TC	✓	3	2	1		
LEGEND : 1 - BHEL / CUSTOMER 2 - VENDOR 3 - Manufacturer CR - Critical Characteristics MA - Major Characteristics MI - Minor Characteristics														
			P - Agency Performing the Test W - Agency Witnessing the Test V - Agency Verifying the Test				BHEL Doc. No. PE-QP-279-166-A801			Rev. 0				
MANUFACTURER/SUBCONTRACTOR			CONTRACTOR				REVIEWED BY			NAME & SIGNATURE OF APPROVING AUTHORITY				
SIGNATURE														

Notes:

- 1 In case material is despatched directly from SAIL/TISCO plant/stockyard or procured from dealer against co-related TC's witnessing by BHEL is waived off and material will be accepted based on MTC of SAIL/TISCO.
- 2 In case material is procured from dealer and co-related TC's are not available, check on 100% quantity of plates will be performed on sample drawn from each plate at NABL certified/ approved laboratory or any govt approved laboratory for chemical & physical properties, However dimensional check shall be witnessed by BHEL.
- 3 There will not be any inspection by CUSTOMER.




TITLE:
**TECHNICAL SPECIFICATION FOR
MILL REJECT HANDLING SYSTEM**

2X800 MW YERAMARUS TPS, KARNATAKA

BHEL DOCUMENTS NO.: PE-TS-31 I -160-A001	
VOLUME II-B	
SECTION -C	
REV. NO. 00	DATE:
Page	

ANNEXURE – IV
SUB-VENDOR LIST

Bidder shall submit sub-vendor list for BHEL/Customer review and approval. BHEL/customer decision on the list shall be final and binding.

	TITLE: TECHNICAL SPECIFICATION FOR MILL REJECT HANDLING SYSTEM 2X800 MW YERAMARUS TPS, KARNATAKA	BHEL DOCUMENTS NO.: PE-TS-31 I -160-A001	
		VOLUME II-B	
		SECTION -C	
		REV. NO. 00	DATE:
		Page	

ANNEXURE – V

PAINTING SCHEDULE

REV	DATE	ALTERED:	REV	DATE	ALTERED	
		CHECKED:			CHECKED	
						STATUS : CONTRACT
						JOB NO.: 362

CLIENT



RAICHUR POWER CORPORATION LIMITED
(A JVC OF KPCL & BHEL)

OWNER'S
CONSULTANTS

M/s EVONIK ENERGY SERVICE (INDIA) LIMITED

PROJECT

2X800 MW YERAMARUS STPP
UNIT # 1 & 2



BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING MANAGEMENT, NEW DELHI

DEPT. --	CODE A		SCALE -	WEIGHT(KG) -	REF DRG. -	ITEM -
-------------	-----------	--	------------	-----------------	---------------	-----------

PAINTING SCHEDULE

	NAME	SIGN	DATE
PREP	RN		06/07/12
CHKD	VK/SKB		06/07/12
APPD	PKD		06/07/12

DEPT.						CARD CODE	DRAWING NO.	REV
SIGN			N.A.			-	PE-DC-362-100-A001	00
DATE							NO. OF SHEETS 9 EXCLUDING COVER PAGE	

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it must not be used directly or indirectly in any way detrimental to the interest of the company



TITLE

DOCUMENT NO. PE-DC-362-100-A999

PAINTING SCHEDULE

RPCL YERAMARUS TPS (2X800 MW)

REV.NO. 00 DATE 06/07/2012

SHEET 1 OF 3

1.0 GENERAL PAINTING REQUIREMENTS

1.1 Painting of equipment shall be carried out as per the specifications indicated below and attached annexure and shall conform to the relevant IS specification/ international standards for the material and workmanship.

1.2 The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:6278	:	Code of practice for white washing and colour Washing
IS:158	:	Ready mixed paint, brushing, bituminous, black, leadfree, acid, alkali, water and heat resisting
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS: 2932	:	Enamel , synthetic, exterior (a) undercoating (b) Finishing



TITLE

DOCUMENT NO. PE-DC-362-100-A999

PAINTING SCHEDULE**RPCL YERAMARUS TPS (2X800 MW)**

REV.NO. 00 DATE 06/07/2012

SHEET 2 OF 3

1.3 Preparation of Surfaces

All surfaces to be painted shall be thoroughly cleaned of all grease , oil, loose mill scale , dust , rust and any other foreign matter. Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out sand scrapping may be permitted with steel wire brushes and /or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the OWNER/OWNER REPRESENTATIVE. The sheet steel of electrical and instrumentation panels shall be pre-treated through chemical cleaning (7 tank) process of rinsing, degreasing, rinsing, derusting, rinsing, phosphating and rinsing. However, in case mechanical cleaning is also required the Contractor shall carry out the same to get a smooth finish.

1.4 Primer Paint

After the surface is prepared one coat of Zinc Phosphate primer conforming to IS 2074 shall be applied. After this first coat is dried up completely, second coat of primer shall be applied. Primer shall be applied by brushing, spray, roller as per manufacture recommendation to ensure a continuous film. The dry film thickness of each coat shall be as indicated in Ann-I & II enclosed. Insulated surfaces will have only primer coating and no finish painting.


1.5 Finish Paint

Synthetic enamel paint conforming to IS 2932 shall be used for finish coats. The colour /shade for various items is listed in annexure III. After cleaning the dust on the dried up primer, first coat of synthetic enamel shall be applied. After this first coat dries up hard, the surface is wet scrubbed cutting down to a smooth finish and ensuring that at no place the first coat is completely removed. After allowing the water to get evaporated completely, the second finish coat of synthetic enamel paint shall be applied.

1.6 Painting and Corrosion Protection for Pipes & Fittings

1.6.1 All uninsulated piping systems, hangers and supports shall have two coats of Zinc Phosphate Primer (conforming to IS 2074) and finish paint using synthetic enamel paint to give a finish coat. Shades shall be as per IS 5 or as indicated by PURCHASER/OWNER. Service of the pipeline designations shall be painted on all pipes at visible locations.

1.6.2 Before application of paint, Contractor shall clean the pipes of all mill scale, dirt dust, soot grease, rust etc.,

	TITLE	DOCUMENT NO. PE-DC-362-100-A999															
	PAINTING SCHEDULE RPCL YERAMARUS TPS (2X800 MW)																
		REV.NO. 00	DATE 06/07/2012														
		SHEET 3	OF 3														
<p>1.6.3 All pipe lines, piping components shall be adequately protected against corrosion during manufacture, fabrication, shipment and storage by appropriate protective paint.</p> <p>1.6.4 Shop fabricated equipment/items shall be dispatched with final paint. Necessary touch up shall be done at site. Site fabricated equipment/items shall be dispatched with primer painting only and final painting shall be applied at site.</p> <p>1.7 Painting and Corrosion Protection for Valves & Specialties</p> <p>Two coats of primer of thickness as indicated in Ann-It shall be applied to all steel and cast iron exposed surfaces as required to prevent corrosion before dispatch. The use of grease or oil, other than light grade mineral oil, for corrosion protection is prohibited. Bores of all vales shall be covered immediately after testing, draining and drying with suitable plastic end covers to avoid ingress of foreign materials.</p> <p>1.8 Suggested Colour Codes for Painting</p> <p>Suggested colour codes for major items shall be as per annexure III. Colour codes for piping shall be as per IS 2379 with necessary modifications. Where band colour is specified for piping, same shall be provided at 30 metre intervals on long uninterrupted lines and also adjacent to valves and junctions.</p> <p>1.9 Approved Paint Makes</p> <table><tr><td>i) Asian Paints (I) Ltd.</td><td>vi) Shalimar Paints Ltd.</td></tr><tr><td>ii) Berger Paints India Ltd</td><td>vii) Addison Paints Ltd.</td></tr><tr><td>iii) Goodlass Nerolac</td><td>viii) Grand Polycoat</td></tr><tr><td>iv) Jenson & Nicholson (I) Ltd</td><td>ix) Bombay Paints</td></tr><tr><td>v) CDC carboline (I) Ltd.</td><td>x) Hemple Paints (Singapore)</td></tr><tr><td></td><td>xi) Jotun Paints</td></tr><tr><td></td><td>xii) Akzonobel coatings</td></tr></table> <p>2.0 <u>PAINTING SCHEDULES</u></p> <p>2.1 Painting schedules for various systems/ items are furnished as per enclosed Annexures-I and II . Vendors of different packages/ items will furnish detailed painting schedule for customer approval during detail engineering as per this guide specification.</p>				i) Asian Paints (I) Ltd.	vi) Shalimar Paints Ltd.	ii) Berger Paints India Ltd	vii) Addison Paints Ltd.	iii) Goodlass Nerolac	viii) Grand Polycoat	iv) Jenson & Nicholson (I) Ltd	ix) Bombay Paints	v) CDC carboline (I) Ltd.	x) Hemple Paints (Singapore)		xi) Jotun Paints		xii) Akzonobel coatings
i) Asian Paints (I) Ltd.	vi) Shalimar Paints Ltd.																
ii) Berger Paints India Ltd	vii) Addison Paints Ltd.																
iii) Goodlass Nerolac	viii) Grand Polycoat																
iv) Jenson & Nicholson (I) Ltd	ix) Bombay Paints																
v) CDC carboline (I) Ltd.	x) Hemple Paints (Singapore)																
	xi) Jotun Paints																
	xii) Akzonobel coatings																



TITLE

DOCUMENT NO. PE-DC-362-100-A999

PAINTING SCHEDULE

RPCL YERAMARUS TPS (2X800 MW)

REV.NO. 00 DATE 06/07/2012

SHEET 1 OF 2

Annexure-I

Paint Reference Scheme	Surface Preparation Grade / Surface Profile	Primer Coat			Intermediate Coat			Finish Coat			Total DFT in microns
		Premier Paint	No. of Coats	DFT in Microns	Intermediate Paint	No. of Coats	DFT in Microns	Finish Paint (See Note)	No. of Coats	DFT in Microns	
Various type of equipment/valve, etc. (Temp. upto 90°C)	Degreasing and Mech. Cleaning with wire brushing/hand tool (Sa1/St2/St3 as applicable)	HB Zinc Phosphate (alkyd Medium) as per IS:2074	2 35-	45 per coat	- NA	-	-	Synthetic enamel (alkyd med.) as per IS:2932	2 20	- 25 per coat	110 - 140
LP Piping/structures/ Vessels, etc. (Temp. upto 90°)	- do -	HB Zinc Phosphate as per IS:2074 (alkyd medium)	2	35 – 45 per coat	- NA	-	-	Synthetic enamel (alkyd med.) as per IS:2932	2 20	- 25 per coat	110- 140
Equipment with (Temp. upto 250°)	- do -	Heat resistant Al – paint	2 20	per coat	- NA	-	-	NA	Insulated	NA 4	0
Equipment in corrosive areas like CPU (regeneration) Dosing skid, etc.	Blast clean to Sa 2 ^{1/2}	HB Epoxy resin based zinc phosphate primer	1 50	per coat	Epoxy based MIO pigmented paint	1 50	per coat	Polyamide cured Epoxy finish coat	2 25	- 35 per coat	150 - 170
Elect. / Control Panels, etc.	Seven tank process	HB Zinc phosphate (alkyd Medium) as per IS:2074	2	35 – 45 per coat	-NA -	-	-	Synthetic enamel (alkyd med.) as per IS:2932	2 20	- 25 per coat	110 - 140



TITLE

DOCUMENT NO. PE-DC-362-100-A999

PAINTING SCHEDULE**RPCL YERAMARUS TPS (2X800 MW)**

REV.NO. 00 DATE 06/07/2012

SHEET 2 OF 2

Notes:

1. Surface preparation shown is as per Swedish Standards SIS 05-5900 or equivalent Indian std. Degreasing will be as per Standard SSPC-SP1.
2. In case of insulated surfaces, only primer coats shall be applied.
3. GM/SS items with piping and G.I. pipes will not be painted. However these items carrying under Fire Fighting System shall be painted Fire Red as per TAC guidelines. Further SS/GI piping shall be given necessary colour banding for identification as per colour scheme.
4. All instruments shall be painted as per manufacturer standard practice.
5. All structural steel items shall be painted at site. Piping shall go with primer coating & finish paint shall be applied at site. Equipment shall be finish painted at shop.
6. Method of painting application shall be as per paint manufacturer's recommendation.
7. **Based on above painting schedule, detailed painting schedule will be prepared by respective Package supplier and these be submitted to RPCL for their approval.**
8. **This painting schedule is applicable for bought out equipment/packages of PEM. Painting specification for various piping/ equipment in scope of various other BHEL units like Power cycle piping, CW piping, LP piping, R.E. joints, Butterfly valves, Power cycle valve etc., shall be furnished by unit separately.**



TITLE

PAINTING SCHEDULE

RPCL YERAMARUS TPS (2X800 MW)

DOCUMENT NO. PE-DC-362-100-A999

REV.NO. 00 DATE 06/07/2012

SHEET 1 OF 2

ANNEXURE –II

Condensate/DM Water Storage Tank			
	Internal	External	Underneath
Surface preparation	Blast clean to SA 2.5	Hand/Power tool cleaning/ wire brushing to ST-2	Blast clean to SA 2.5
Primer	1 coat of epoxy resin based zinc phosphate high build primer (2 pack), DFT : 50 – 70 microns	2 coats of red oxide zinc chromate primer (IS 2074) of 30 - 35 microns DFT each	1 coat of high build coal tar epoxy suitably pigmented, DFT : 80 – 100 microns
Finish	2 coats of solvent free epoxy paint, DFT – 35 microns each	2 coats of synthetic enamel (IS – 2932) paint of 20 – 25 microns DFT each	N.A
Total DFT	120 – 140 microns	100 – 120 microns	80 – 100 microns

NaOH Breather and Seal Pot			
	Internal	External	Underneath
Surface preparation	Blast clean to SA 2.5	Blast clean to SA 2.5	N.A.
Primer	1 coat of epoxy resin based zinc phosphate high build primer (2 pack), DFT : 50 – 70 microns	2 coats of epoxy resin based zinc phosphate primer of 35-50 microns.	N.A.
Finish	2 coats of solvent free epoxy paint, DFT – 35 microns each	2 coats of polyamide cured epoxy finish paint of 30-35 microns each	N.A.
Total DFT	120 – 140 microns	130 – 170 microns	



TITLE

PAINTING SCHEDULE

RPCL YERAMARUS TPS (2X800 MW)

DOCUMENT NO. PE-DC-362-100-A999

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SHEET 2 OF 2

ANNEXURE –II

LDO/HFO Storage Tank			
	Internal	External	Underneath
Surface preparation	Wire bushing	ST2 (Wire Brushing/ Hand tool cleaning)	Blast clean to SA 2.5
Primer	NA	2 coats of red oxide zinc chromate primer (IS 2074) of 30 - 35 microns DFT each	1 coat of high build coal tar epoxy suitably pigmented, DFT : 80 – 100 microns
Finish	2 coats of double boiled linseed oil	2 coats of synthetic enamel (IS – 2932) paint of 20 – 25 microns (DFT) each	N.A
Total DFT		100 – 120 microns	80 – 100 microns



TITLE

PAINTING SCHEDULE

RPCL YERAMARUS TPS (2X800 MW)

DOCUMENT NO. PE-DC-362-100-A999

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SHEET 1 OF 2

ANNEXURE-III

SUGGESTED COLOUR CODES FOR PAINTING

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
1.0	Structures, platforms, galleries, ladders and handrails	Dark Admiralty Grey	632	-	-
2.0	Fans, pumps, motors, compressors, Blowers	Light Grey	631	-	-
3.0	Tanks (without insulation and cladding)				
3.1	Outdoor, Stand pipes, vent pipes	Aluminum	-	-	-
3.2	Indoor	Aluminum	-	-	-
4.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631	-	-
5.0	Switchgear	Light grey	631	-	-
6.0	Control & relay panels	Light grey	631/7078 of IS 1650	-	-
7.0	Transformers	Dark Admiralty Grey	632	-	-
8.0	Machinery guards	Signal red	537	-	-
9.0	Piping (without insulation and cladding)				
9.1	Water System				
a)	Boiler feed	Sea green	217	-	-
b)	Condensate	Sea green	217	Light brown	410
c)	D M Water	Sea Green	217	Light orange	557
d)	Soft water	Sea green	217	French blue	166
e)	Bearing cooling water	Sea green	217	French blue	166
f)	Potable & filtered water	Sea green	217	French blue	166
g)	Service & clarified water	Sea green	217	French blue	166
h)	Raw water	Sea green	217	White	-
i)	Cooling water	Sea green	217	French blue	166
9.2	Compressed Air System				
a)	Service air	Sky Blue	101	-	-
b)	Instrument air	blue	101	White	-
9.3	Oil system				
a)	Fuel oil	Light brown	410	French Blue	166
b)	Light oil	Dark Brown	412	Brilliant green	221
c)	Lubricating oil	Light brown	410	Light grey	631



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PAINTING SCHEDULE**RPCL YERAMARUS TPS (2X800 MW)**

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SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
d)	Control oil	Light brown	410	Light orange	557
e)	Transformer oil	Light brown	410	Light orange	557
9.4	Gas system				
a)	Carbon dioxide	Canary yellow	309	Light grey	631
9.5	Fire services	Fire red	536	-	-
9.6	Drainage	Black	-	-	-
9.7	Stand pipes and all Vent pipes	Aluminum	-	-	-

Notes:

1. This color code basically refers to IS:2379 for piping with necessary modifications.
2. Where band color is specified, same shall be provided at 10 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.



TITLE:
**TECHNICAL SPECIFICATION FOR
MILL REJECT HANDLING SYSTEM**

2X800 MW YERAMARUS TPS, KARNATAKA

BHEL DOCUMENTS NO.: PE-TS-31 I -160-A001

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~~ANNEXURE – VI~~

~~LOW PRESSURE PIPING SPECIFICATION~~


~~VOID~~

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ANNEXURE – VII

SPARES

(Mandatory spares not applicable)

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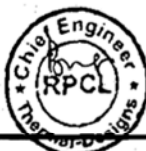
ANNEXURE – VIII

DRAWING/DOCUMENT DISTRIBUTION

2X800 MW YERMARUS STPP
TECHNICAL SPECIFICATION OF MILL REJECT HANDLING SYSTEM

THIS IS A PART OF THE SPECIFICATION NO. PE-TS-384-160-A001
REVISED DRAWING DOCUMENT DISTRIBUTION SCHEDULE

Sl. No.	Description	RPCL			Contractor (BHEL)				
		Bangalore (Thermal Design)	YTPS (Site)	Consulting Engineer M/s.EESI	PS- Marketing	Units/ PEM	Site	PMG	PSSR
A	Correspondence – soft copy (email) & Hard copy as per requirement								
1	Post Contract	1 1 1 1* 1	Nil Nil S 1 1	Nil S Nil 1 Nil	S Nil Nil Nil 1*	1* Nil 1* 1* 1*	1* Nil 1 1* 1*	1 Nil 1 1 S	1* Nil 1 1* 1*
B (a)	Contractor Drawings								
1	Preliminary/ resubmission	PDF+1 Hard copy	Nil	PDF	Nil	S	Nil	P	Nil
2	Return preliminary with comments	PDF	Nil	S	Nil	PDF	Nil	P	Nil
3	Final approved drawings for stamping (Hard copy)	Nil	Nil	4	Nil	S	Nil	P	Nil
4	Return of stamped copies by EESI (Hard copy)	1	Nil	S	Nil	2	Nil	P	Nil
5	Distribution by contractor (Hard copy)	4	4	Nil	Nil	S	4	P	Nil
6	As-Built drawings/ Erection Drawings	1CD + 1 hard copy	1CD + 4 hard copies	Nil	Nil	S	1	P	Nil
B (b)	All design calculations/design memorandum/data sheet/MQP								
1	Preliminary/ resubmission	1	Nil	1	Nil	S	Nil	P	Nil
2	Return preliminary with comments	1	Nil	S	Nil	1	Nil	P	Nil
3	Final approved documents for stamping (Hard copy)	Nil	Nil	4	Nil	S	Nil	P	Nil
4	Stamped copies	1	Nil	S	Nil	2	Nil	P	Nil
5	Distribution	2 CD	Nil	Nil	Nil	S	1*	P	1*



**2X800 MW YERMARUS STPP
TECHNICAL SPECIFICATION OF MILL REJECT HANDLING SYSTEM**

**THIS IS A PART OF THE SPECIFICATION NO. PE-TS-384-160-A001
REVISED DRAWING DOCUMENT DISTRIBUTION SCHEDULE**

Sl. No.	Description	RPCL			Contractor (BHEL)				
C	Progress Reports (Monthly)								
1	Contractor	3	Nil	Nil	Nil	Nil	Nil	S	Nil
2	Consultant	3	Nil	S	Nil	Nil	Nil	1	Nil
D	Manuals								
1	Erection & Commissioning	3	5	Nil	Nil	Nil	3	P	S
2	Operation & maintenance	3	5	Nil	Nil	S	3	P	P

Abbreviations:

- RPCL: Raichur Power Corporation Limited
- Consultant: M/s Evonik Energy Services (India) Pvt. Ltd., (EESI)
- S: Source
- T: Transparency
- CD: Compact Disc
- 1*: One copy case to case basis
- P: Only transmittal/covering letter
- PDF: Soft copy in pdf format



Note :

- Quantity of prints may change during detailed engineering stage based on BHEL / Customer requirement. However the same will be adhered by the bidder without any delivery/commercial implication to BHEL.
- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.
- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copies whichever is later.
- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.
- Vendor to come for meeting with the concerned dealing persons as per BHEL or customer (KPCL) requirement in a short notice.
- Bidder to also furnish the auto cad copy of the following documents after award of contract. However any other auto cad copy/editable format of any other document as per the insistence of BHEL / customer will also be submitted by the bidder without any delivery/commercial implication to BHEL.
 - Equipment lay out of the service vessel are and regeneration area.
 - Cable tray lay out.
 - Civil scope drawings.
 - Piping lay out drawing.



TITLE:

**TECHNICAL SPECIFICATION FOR
MILL REJECT HANDLING SYSTEM****2X800 MW YERAMARUS TPS, KARNATAKA**

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“Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.

- Internet explorer version – Minimum Internet Explorer 7
- Internet speed – 2 mbps (Minimum preferred)
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked
- Vendor’s Internal proxy setting should not block DMS application’s link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)”



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2X800 MW YERAMARUS TPS, KARNATAKA

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VOLUME – II B
SECTION – C2
SPECIFIC TECHNICAL REQUIREMENTS
ELECTRICAL SPECIFICATION



TECHNICAL SPECIFICATION FOR
2 X 800 MW YERAMARUS SUPER CRITICAL TPP
MILL REJECT HANDLING SYSTEM
(ELECTRICAL PORTION)

SPECIFICATION NO. PE-TS-384-174-A001
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SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

- 1.1 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure-I to Section – C [Scope of Work (Electrical)].
- 1.2 Make of various equipment/ items in the scope of bidder shall be to approval of owner during detailed engineering stage without any commercial implications.
- 1.3 Bidder shall furnish all AC as well as DC loads required for the system at different voltage levels (eg. 415V AC, 240 V AC, 220 V DC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.
- 1.4 All electrical equipment shall be suitable for the power supplies, fault levels and climatic conditions indicated in project information enclosed with the specification.
- 1.5 All drawings, data sheets, Quality Plan, calculations, test reports, test certificates, etc. shall be submitted during detailed engineering stage as per formats enclosed. The same shall be subject to approval without any commercial implications.
- 1.6 Technical requirements shall be as per specifications listed in Clause 4.1, 4.2 & 4.3 below.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:
 - a) A copy of this sheet "Electrical Equipment Specification for MILL REJECT HANDLING System and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
 - b) List of Erection and Commissioning spares.
 - c) List of Erection & Maintenance tools & tackles.
 - d) Electrical load requirement in the load data format.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

- 4.1 Electrical scope between BHEL & vendor (Annexure-I).
- 4.2 Technical specification no. PE-SS-999-506-E101, Data Sheets (A & C) for 415V Electric Motors.
- 4.3 Quality Plan for motors.
- 4.4 Load data format (Annexure-II).

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (ANNEXURE-I)

PROJECT: 2X800 MW YERAMARAS STPP

PACKAGE: MILL REJECT SYSTEM (MAUX)

REV: 0 DATE: 28/03/2013

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	1. 415 V AC/240 V AC supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract including power supply equipment (battery charger etc) required for the PLC/control panel (as applicable) for the system supplied by vendor. 2. Interposing relays (RE 302 of Jyoti make or equivalent), if required for PLC and microprocessor based systems, shall be provided by BHEL in MCCs. Requirement of these relays shall be furnished by vendor during detailed engineering stage.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL/Vendor	1. Sizes and quantity of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL). Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by BHEL except for cabling in vendor scope. 3. Termination at BHEL equipment terminals by BHEL. 4. Termination at Vendor equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	
5	Cable trays, accessories & cable trays supporting system	BHEL	BHEL	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass glands. 2. Solder less crimping type heavy-duty tinned copper lugs for power cables. 3. Heavy duty tinned copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be rigid steel, hot dip galvanised furnished in standard length of 3 metres. Conduits & fittings shall comply with IS: 1653, 3837 & 2667. Makes of conduits shall be subject to customer/ BHEL approval at contract stage.
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	BHEL	BHEL	
10	Below grade grounding	BHEL	BHEL	
11	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
12	Mandatory spares	Vendor	-	Vendor to quote as per specification.
13	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
14	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies in the BHEL cable schedule format.
16	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Electrical equipment layout drawing shall be to BHEL approval.
17	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. For skid mounted system, 2 nos. (1W+1S) supply of 415 V, 3 phase AC shall be provided by BHEL. Complete electrical distribution for the skid including changeover between feeder/starters/LCP/inter-locks/protection devices / any other supply etc. shall be in bidder's scope.


	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101 VOLUME NO. : II-B
		REV NO. : 00 DATE : 29/08/2005 SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 1 OF 4

1.0 INTENT OF SPECIFICATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS


3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A


3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.


3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

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		VOLUME NO. : II-B
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		SHEET : 2 OF 4
<p>The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.</p> <p>3.3.3 The following frequency of starts shall apply</p> <p>i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.</p> <p>ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)</p> <p>iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor</p> <p>3.4 Running Requirements</p> <p>3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.</p> <p>3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.</p> <p>3.5 Stress During bus Transfer</p> <p>3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.</p> <p>3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.</p> <p>3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.</p> <p>3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.</p> <p>4.0 CONSTRUCTIONAL FEATURES</p> <p>4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP : 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy</p> <p>4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.</p> <p>Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled</p> <p>4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.</p>		

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
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4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class ‘F’ insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class ‘B’ insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet “A”.	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bare live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
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4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW sh all be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters sh all be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 **INSPECTION AND TESTING**

5.1 All m aterials, com ponents and equipm ents c overed under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not m ore than 5 year shall be furnished. In the absence of these, ty pe tests shall have to be conducte d by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 **DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**

a) OGA drawing showing the position of terminal boxes, earthing connections etc.

b) Arrangement drawing of terminal boxes.

c) Characteristic curves:
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).

i) Current vs. time at rated voltage and minimum starting voltage.

ii) Speed vs. time at rated voltage and minimum starting voltage.

iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipm ent. In case motor is coupled with m echanical equipment by fluid coupling, the above cu rves shall be furnished with and without coupling.

iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

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OF

**GENERAL TECHNICAL REQUIREMENTS
OF
MV MOTORS**

SPECIFICATION No.

PES-505-02



MV MOTORS

1.0 GENERAL

1.1 This specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's works and packing of medium voltage (MV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

1.2 Motors having a voltage rating of 1000V and above are referred to as medium voltage (MV) motors.

2.0 CODES AND STANDARDS

Unless otherwise specified, the latest revisions of codes/standards specified in Annexure-I enclosed are applicable and shall be referred to.

3.0 DESIGN REQUIREMENTS3.1 General Requirements

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet A and project information (SECTION-B). Outdoor duty motors shall be suitable for outdoor application in extreme site conditions outlined in Volume II Section B. The design ambient temperature shall be as indicated in DATA SHEET 'A'.

3.2 Supply Voltage and Frequency

3.2.1 Unless otherwise specified in Data Sheet 'A'/Section C, voltage & supply variation shall be as follows :

Voltage variations $\pm 10 \%$

Frequency variations $\pm 5 \%$

Combined voltage and frequency variation (sum of absolutes) 10%

3.2.2 Motors shall be capable of running continuously at rated output for each of the conditions specified.

3.2.3 When the motors are operating at the extreme conditions of voltage and frequency variations as given in Data Sheet-A, the temperature rise may be exceeded by 10°C for motors of output upto and including 1000 kW and 5°C for motors of output exceeding 1000 kW.

3.3 Motor Rating

Motor ratings shall be adequate to meet the requirements of the driven equipment. Motors shall be continuously rated at the design ambient temperature specified in DATA SHEET 'A' and other site conditions specified in Volume II, Section-B. Motor ratings shall have at least a 10 % margin over the continuous maximum demand of



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the driven equipment under entire operating range including voltage & frequency variations specified.

3.4 Starting Requirements

3.4.1 Motors shall start smoothly and rapidly. Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly coordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.4.2 Motors shall be capable of starting and accelerating the load with direct-on-line starting. The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be constant value of 80 % rated voltage except for mill motors for which it shall be 85% rated voltage.

3.4.3 The locked rotor current of the motors shall not exceed six times full load current for all auxiliaries except BFP motor, where the starting current is limited to 4.5 times full load current, subject to tolerance as given in IS:325.

3.4.4 The following frequency of starts shall apply:

- a) Two starts in succession with the motor initially at temperature not exceeding the rated load operating temperature.
- b) Three equally spread starts in an hour, the motor initially at a temperature not exceeding the rated load operating temperature (not to be repeated in second successive hour).

3.4.5 Locked rotor withstand time of hot motors at 110 % rated voltage shall be as follows:

- a) For motors with starting time upto 20 seconds. : At least 2.5 sec more than the starting time.
- b) For motors with starting time above 20 seconds. : At least 5 sec more than the starting time.

The starting time of the motor referred above is at minimum voltage. Only in extreme cases where the above requirement cannot be complied with, speed switch of suitable type shall be provided to bypass the locked rotor protection for a preselected time during starting of the motors, subject to mutual agreement between the purchaser and the supplier. The speed switches shall be of approved make and shall have 1NO+1NC or 2 changeover contacts, single pole double throw snap action contacts having maximum interrupting capacity of 5 Amps at 240 V AC and 0.5 Amps at 220 V DC. Provision of speed switch is to be clearly brought out in the offer for purchaser's acceptance.



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3.5 Running Requirements

3.5.1 Motors shall run satisfactorily at a supply voltage of 75 % of rated voltage for 5 minutes with full load without injurious heating.

3.5.2 Motors shall not stall due to voltage dip in the system causing momentary drop in voltage to 70 % of the rated voltage.

3.6 Stress During Bus Transfer

3.6.1 Motors shall withstand the voltage and torque stress developed due to the application of 100 % of the rated voltage when the motor residual voltage has dropped down to 50 % and is in phase opposition to the applied voltage during the auto bus transfer.

3.7 Noise Level

Maximum noise level measured at a distance of 1.5 meters from the outline of the motor shall not exceed 85 db (A) as per BS-4999 Part 51.

3.8 Vibration

The double amplitude of motors vibration shall be within the limits specified in IS: 12075 or as agreed between manufacturer and supplier.

4.0 CONSTRUCTIONAL FEATURES

4.1 Degree of protection : Motors shall conform to degree of protection IP: 55 as per IS: 4691, without any sealing compound at joints.

4.2 Enclosure and Cooling

4.2.1 a) Motors of rating less than 2000 kW shall have one of the following enclosure and cooling:

(i) Totally enclosed fan cooled (TEFC) conforming to IC 0141 as per IS 6362.

(ii) Totally enclosed, tube ventilated (TETV), integral heat exchanger conforming to IC 0151 as per IS:6362.

(iii) Totally enclosed closed air circuit air cooled (CACA) mounted heat exchanger conforming to IC 0161 as per IS: 6362. However, motors below 1000 kW will be subject to purchaser's approval. For BFP motor rating less than 2000 kW, CACW motor can also be accepted subject to purchaser's approval.

b) Motor of rating 2000 kW and above shall have one of the following enclosure and cooling:



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(i) Totally enclosed, closed air-circuit water cooled (CACW) machine mounted heat exchanger conforming to ICW 37 A 81 as per IS:6362.

(ii) Totally enclosed, closed air-circuit, air cooled (CACA) machine mounted heat exchanger conforming to IC 0161 as per IS:6362 subject to purchaser's approval.

(iii) Totally enclosed tube ventilated (TETV), integral heat exchanger conforming to IC 0151 as per IS:6362.

4.2.2 In case of motors with enclosure of closed air circuit water cooled type (CACW), the following provisions shall be made:

- a) Suitable visual indication for detecting the tube failures.
- b) Visual indication for observing flow of water.
- c) Flow switch for initiating alarm under no flow conditions. The switch shall be provided with two contacts.
- d) Cooling materials of the cooler tube and tube plates shall be suitable for the cooling water specified in Data Sheet-A.

4.2.3 In case of motors with enclosure of closed air circuit water cooled type (CACW), the following shall be provided in connecting pipe line external to the cooler:

- a) Temperature gauge for inlet and outlet water temperature and air temperature.
- b) Cooling water pressure switch with two contacts.

The above are not in the scope of motor supplier.

4.2.4 Motors shall be designed with cooling fans suitable preferably for both directions of rotation.

4.2.5 Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.2.6 For motor having CACA or CACW enclosure, a dial type capillary thermometer shall be provided to measure the temperature of motor internal air circuit at its maximum hot point. Separate temperature switch shall be provided for alarm indication. The temperature switch shall be single pole double throw type and the contacts rating shall be 2 Amp at 240 V AC and 0.5 Amp at 220 V DC.

4.2.7 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point, with two number drain holes with plugs one on either end of the motor.



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4.3 Class of Insulation

Tropicalised insulation material of class 'F' shall be used for the motors. Motor windings shall be given special treatment to render them non-hygroscopic and oil resistant. For class 'F' insulation the temperature rise shall be limited to that of class 'B'.

4.4 Bearings

Bearing shall be of roller type, except where motor and shaft loading indicate otherwise. Vertical motors shall have combined thrust and guide bearings in upper bracket and guide bearing in lower bracket. The thrust bearing designed to carry all axial thrust conditions imposed by the driven equipment as given in Data sheet-A. Anti-friction bearing shall also be acceptable in case motors have to take thrust due to its own rotor weight only.

4.4.1 Anti Friction Bearings

4.4.1.1 Anti-friction type bearings shall be of ball/roller type. These shall be pressure grease gun lubricated and fitted with grease nipple and grease relief devices. Bearings shall be so constructed that the loss of grease and its creeping along the shaft into the motor housing is prevented. Dirt and water getting into the motors shall also be prevented.

4.4.1.2 The minimum life of ball/roller bearings shall not be less than 30,000 working hours.

4.4.1.3 For the motors equipped with ball/roller bearings adequate means shall be provided during stand-still period to prevent the brinelling effect. During transport and shipping such motors shall receive a special bearing insert or a suitable arrangement to block the movement of rotor.

4.4.2 Sleeve Bearings

4.4.2.1 Sleeve bearings shall be of the split type, readily accessible and replaceable. These shall be either ring-oil lubricated type or forced-oil lubricated type. If forced-oil lubrication is used, the lubricating oil system shall be common to both motor and the driven equipment. The forced - oil lubricating system comprising oil pump, oil tank, piping, oil coolers, valves, etc. shall not be supplied along with motors. These shall be arranged separately by the purchaser.

4.4.2.2 Motors with sleeve bearings shall be fitted with a sight gauge marked with the proper oil level and shall be supplied with the oil fill and oil drain plugs. Proper means shall also be provided for observing oil-ring rotation when the motors are running.

4.4.2.3 When the forced-oil lubrication is provided for the bearings, ring-oil lubrication shall also be provided for starting and emergency shut down which shall be adequate for starting the motors and allowing continuous operation for at least 10 minutes without the forced-oil lubrication system in operation and without damage to the bearing.



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4.4.3 Combined Thrust and Guide Bearings

- 4.4.3.1 For vertical motor combined thrust and guide bearings shall be provided to withstand the normal downward thrust due to operating loads and rotor weight as well as the maximum anticipated upward thrust. The guide bearings shall be of sleeve type. Both thrust and guide bearings shall be housed in a common upper bracket and a guide bearing in lower bracket. In upper bracket, the oil for thrust and guide bearings shall be common.

4.4.4 General requirements for Bearing

- 4.4.4.1 Except in the case of totally enclosed motors, means of access shall be provided to the rotor air gap, without disturbing the bearing housings, to permit the use of air gap gauges to check bearing wear.

- 4.4.4.2 In case of independently supported bearings, motor and bearing pedestals shall be fitted on a common base plate.

- 4.4.4.3 Flow of shaft currents through bearings shall be positively blocked in all motors rated above 1000 kW as also in smaller motors where considered necessary by the manufacturer. In the case of pedestal mounted bearings, both bearing shall be insulated, and an earth bonding link shall be provided at the driving end, the link shall be removable for insulation testing. Where the bearings are mounted directly in the motor end frames, the non-driving end shall be permanently insulated. It shall be possible to carry out maintenance without damaging the insulation. All oil and water pipes, direct-driven oil pumps etc., shall be insulated where necessary to prevent flow of any shaft current. The insulation provided to avoid shaft currents, shall be meggered at 500 volts at manufacturer's work.

In case of water cooled oil bearings, proper insulation shall be provided at the connecting point of water pipe to bearing bodies to prevent the bearings leakage current through the water pipes.

- 4.4.4.4 Sleeve and thrust bearings shall be provided with temperature gauges of mercury in-steel type with micro-switch with a minimum of one meter flexible capillary and having alarm and trip contacts. The contacts rating shall be 2 Amps at 240 V AC or 0.5 Amp at 220 V DC.

- 4.4.4.5 Sleeve and thrust bearings shall be provided with duplex platinum resistance temperature detectors (RTD) for remote indication of bearing temperature. The DC resistance of the RTDs shall be 100 Ohms at 0°C. The RTDs shall be of three wire type. The terminals of the RTDs shall be brought out to the winding RTDs terminal box or in a separate terminal box. The bearing RTDs terminals shall be marked as B1, B2, etc.

4.5 Winding Resistance Temperature Detectors(RTDs)



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Motors shall be provided with a minimum of six Nos. RTDs of platinum resistance duplex type or 12 Nos. simplex type having a DC resistance of 100 Ohms at 0 deg C. The RTDs shall be embedded in the stator windings at locations where highest temperature are expected. The RTDs shall be of three wire type. The terminal box, shall be complete with removable front and cable gland plate. RTD leads shall be marked as 1,2,3 etc.

4.6 Terminals and Terminal Boxes

4.6.1 Terminal, terminal leads, terminal boxes, windings details and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet - A for a duration of atleast 0.25 second.

The test reports for terminal boxes shall be furnished for approval.

4.6.2 Unless otherwise specified or approved, main phase terminal boxes shall be positioned on the left hand side of the motor when viewed from the non-driving end. The main terminal box location shall be subject to purchaser's approval.

4.6.3 Motors with rating of 2000 kW and above shall be star connected and six leads shall be brought out. Line and neutral terminals of these motors shall be located in separate terminal boxes having provision for mounting differential protection current transformers.

4.6.4 Power terminal boxes shall have a phase separated (not phase segregated) construction. However, for motors which would have single core cables, three separate terminals boxes, one for each phase would also be acceptable. A minimum clearance of 100 mm between the lugs/bare live parts of different phases and 90 mm between lugs/bare live parts and earth shall be provided in the terminal boxes for 6.6 kV motors. For high voltages the clearances shall be subject to purchaser's approval.

The distance between gland plate and the terminal studs shall not be less than 500 mm. The terminal boxes shall be capable of withstanding a system fault level specified in Data Sheet-A for at least 0.25 seconds. A suitable provision of releasing the pressure developed during faults shall be made. Terminal boxes shall be suitable for top and bottom entry of cables.

4.6.5 Connections shall be such that when the supply leads R,Y & B are connected to motor terminals A, B & C OR U, V & W respectively, motors shall rotate in desired direction when viewed from the non-driving end as specified in data sheet-A.

4.6.6 Motor, terminals and terminal leads shall be fully insulated with no bare live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.6.7 Degree of protection for terminal boxes shall be same as that of motors as specified in Clause 4.1.



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4.6.8 Dessicator shall be fitted inside the terminal box and shall have an indicating head visible from outside the box.

4.6.9 Detachable cable box shall be fitted on the main phase terminal box and the design of cable box shall be suitable for terminating the cables specified in Data Sheet - A.

Details of cable boxes shall be submitted for approval. Cable boxes shall be mounted in such a way that the incoming cable does not foul with the foundation block. Double compression nickel plated brass cable glands for all terminal boxes and copper cable lugs for main terminals shall be included in bidder's scope.

4.6.10 Separate terminal boxes shall be provided for RTDs, CTs and space heaters. Detachable gland plates with double compression glands shall be provided in terminal boxes.

4.6.11 Main phase terminal boxes shall be suitable for 180 deg. rotation.

4.7 Earth Terminals

Two separate earth terminals suitable for connecting copper or MS strip grounding conductor of size given in Data Sheet - A shall be provided on the motor frame.

4.8 General

4.8.1 Motor provided for similar drives shall be inter-changeable.

4.8.2 Motors and their enclosures shall be constructed to permit easy dismantling and reassembly at site. All heavy parts should have means for attaching the lift tackle.

4.8.3 Rotors shall be dynamically balanced.

4.8.4 An arrow block shall be screwed on the body of the motors on the non-driving end to indicate the normal direction of rotation of the motors.

4.8.5 Suitable foundation bolts are to be supplied alongwith the motors.

4.8.6 Motors shall be provided with eye bolts, lugs or other means to facilitate safe lifting.

4.8.7 The CTs for differential protection for motors shall be arranged by purchaser but the mounting and connections are to be done by the motor supplier.

5.0 SPACE HEATERS

All motors shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be connected to a supply of 240 V AC, single phase 50 Hz.



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The leads from space heaters of each motor shall be brought out to a separate terminal box. Space heaters shall be mounted inside the motor in accessible place so that their removal and replacement is simple.

6.0 NAME PLATE

Motors shall have anodized brass/stainless steel name plate with all particulars as per IS: 325. The rating plate shall also indicate the following additional information :

- a) Maximum continuous rating in kW and corresponding temperature rise, as applicable for cooling medium temperature specified in Data Sheet -A.
- b) Bearing identification numbers (In case of ball/roller bearing and recommended lubricant)

7.0 PAINTING

- a) Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 as per IS:5. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions. Motors frame shall also be painted to withstand corrosion.
- b) All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

8.0 SHOP INSPECTION AND TESTS8.1 Stage Inspection and Tests

All materials, components and equipment covered in this specification shall be procured, manufactured as per approved standard quality plan and shall be complied with.

8.2 Type tests

First motor of each type and rating shall be subjected to tests as per IS:325. In addition to this, the following tests shall also be done on first motor of each type and

- a) Over speed test at 20% overspeed for 2 minutes.
- b) Polarization index test. The test value shall be more than 2 when determined as per IS:7816
- c) Degree of protection as per IS 4691. Type test for D.O.P. of similar enclosure design can also be subject to purchaser's approval.



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- d) Measurement of noise level as per BS:4999 Part 51.
- e) Tan delta and dielectric loss measurement on each phase of motor stator winding.

8.3 Routine Tests

All motors shall be subjected to routine tests as per IS:325. All motors except the one which has been subjected to type test shall be subjected to the following tests in addition to the routine tests:

- a) Measurement of stator resistance.
- b) Verification for direction of rotation relative to phase sequence of the supply.
- c) Measurement of vibration as per IS: 12075.
- d) Axial play for the rotor having sleeve bearing.

8.4 The following additional Special Tests shall also be conducted:

- a) Surge withstand test on the sample coils at $(4u+5)$ kV and with at least five impulses of 1.2/50 micro sec. wave where u is the line to line voltage in kV.
- b) Surge withstand test at 25.5 kV (PEAK) with 0.3/3 micro sec wave on 6.6 kV motor sample coils with at least five such impulses. For 11 kV motor sample coils, the test voltage value shall be mutually agreed between purchaser & manufacturer.

9.0 SITE TESTS

9.1 Site checks/tests shall be done at site by the equipment supplier (by purchaser in case of supply contract) to ascertain the compliance of the motor with specification and the test specification and the test certificates as per relevant standards and other tests as agreed with BHEL site.

- a) Measurements of insulation resistance.
- b) Measurements for starting current.
- c) Check on motor vibration.
- d) Polarization index.
- e) Correctness for phase sequence.



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10.0

PERFORMANCE GUARANTEES

Bidders shall guarantee that motors offered shall meet the rating and performance requirements as stipulated in this specification and as confirmed by them in technical data sheets and motor characteristics curves. In case the performance of motors at site is not as per the performance guarantee, the bidders have to replace the motors at site free of cost. Regarding performance guarantee refer section 'C' of specification also.

11.0

DRAWINGS

11.1

Drawings to be submitted with offer:

- a) Data Sheet B
- b) Dimensional outline drawing.
- c) Standard Quality Plan (Enclosed in Vol. III) after putting signature and seal of acceptance.
- d) Field Quality Plan for quality checks to be observed at site during erection, testing and commissioning, as per standard BHEL format.
- e) Test certificates for equipment of similar rating and design.
- f) Clause wise deviations, if any.

11.2

Drawings/Data to be submitted after award of contract

- a) Data Sheet C
- b) Final Quality Plan & Field Quality Plan
- c) OGA drawing showing the position of terminal boxes, earthing connections, temperature sensing devices, etc.
- d) Arrangement drawing of terminal boxes.
- e) Characteristic Curves
 - (i) Current versus time at rated voltage and minimum starting voltage.
 - (ii) Speed versus time at rated voltage and minimum starting voltage.
 - (iii) Torque versus speed at rated voltage and minimum voltage. For the motors with solid coupling the above curve i), ii), & iii) to be furnished for the motors coupled with driven equipment. In case motors with flexible coupling, above curves to be furnished with and without coupling. The torque speed curve of driven equipment to be shown with torque speed curve of motor.



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(iv) Thermal withstand curve at hot and cold conditions.

(v) Power factor, efficiency, current, slip versus load curves.

f) O & M manual

12.0 INSTALLATION AND MAINTENANCE MANUAL

12.1 The installation and maintenance manual of motor shall contain the following:

- a) Application of motor
- b) Technical Data
- c) Salient constructional features
- d) Instruction to be followed on receipt of motors at site
- e) Handling and slinging
- f) Storage and reconservation
- g) Instructions for foundation
- h) Erection procedure and check
- i) Earthing
- j) Drying out
- k) Commissioning procedures and site tests
- l) Routine, periodic and preventive inspection and maintenance procedures
- m) Assembly and disassembly of terminal box, rotor, stator, coolers, bearings, RTD etc.
- n) Safety rules
- o) Possible faults, their causes and remedies
- p) Routine and type test reports
- q) Catalogs, literatures and drawings

13.0 SPARES

13.1 Recommended list of spares for commissioning and for operation and maintenance of the motors for a period of three (3) years shall be furnished.



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13.2

A minimum of the following commissioning and O & M spares are to be included in the offer:

a) Commissioning Spares:

(1) One set of driving end (DE) and nondriving end (NDE) bearings for each type of frame size of motor.

b) Operation and maintenance (O & M) spares.

(1) One set of driving end (DE) and nondriving end (NDE) bearings for each type of frame size of motor.

(11) One number bearing oil temperature indicator.

(111) One number cooling air temp. indicator.

13.3

Bidder shall also quote for any other spares not listed above but necessary for commissioning or for operation and maintenance.



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ANNEXURE-I

LIST OF APPLICABLE CODES & STANDARDS

1.	INDUCTION MOTOR - THREE PHASE	[] IS325	[] BS4999
		[] IEC34-1	
2.	DESIGNATION FOR TYPE OF CONSTRUCTION & MOUNTING ARRANGEMENT OF ROTATING ELECTRICAL MACHINES	[] IS2253	[] BS4999-107
		[] IEC34-7	
3.	TERMINAL MARKING FOR ROTATING ELECTRICAL MACHINERY	[] IS4728	[] BS4999-108
		[] IEC34-8	
4.	DESIGNATION OF METHODS OF COOLING FOR ROTATING ELECTRICAL MACHINES	[] IS6362	[] BS4999-106
		[] IEC34-6	
5.	DIMENSIONS OF SLIDE RAIL FOR ELECTRIC MOTORS	[] IS2968	[]
		[]	
6.	GUIDE FOR TESTING THREE PHASE INDUCTION MOTORS	[] IS4029	[] BS4999-143
		[]	
7.	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES FOR ROTATING ELECTRICAL MACHINES	[] IS4691	[] BS4999-105
		[] IEC34-5	
8.	CODE OF PRACTICE FOR CLIMATE PROOFING	[] IS3202	[] BSCP1014
		[]	
9.	MEASUREMENT AND EVALUATION OF VIBRATION OF ROTATING ELECTRICAL MACHINES	[] IS12075	[] BS4999-142
		[] IEC34-14	
10.	CLASSIFICATION OF HAZARDOUS AREAS FOR ELECTRICAL INSTALLATION	[] IS5572	[]
		[] IEC79	
11.	NOISE MEASUREMENT	[] IS6098	[] BS4999-51
		[] IEC34-9	
12.	STANDARDISATION OF MOTOR FOR AUXILIARIES	[] CBIP-40	[] BS5000-40
		[]	
13.	PREFERRED NUMBERS	[] IS1076	[]
		[]	

NOTES:

- EQUIPMENT, ASSOCIATED ACCESSORIES, COMPONENTS/PARTS, RAW MATERIAL AND TESTS SHALL IN GENERAL CONFORM TO
[] IS [] BS [] IEC
- OFFERS CONFORMING TO OTHER AUTHORITATIVE STANDARDS
[] MAY ALSO BE CONSIDERED
[] MAY NOT BE CONSIDERED



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DATA SHEET - A

MV MOTORS

SPECIFIC TECHNICAL REQUIREMENTS

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PE-TS-179-

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- 1.0 Design ambient temperature : 50 °C
- 2.0 Driven equipment :
(as specified in specification)
- 3.0 Minimum kW rating of MV motors : > 160 kW
- 4.0 Details of Supply system
- Rated voltage : 6600 V, + 10 %
 - Rated frequency : 50 Hz, + 5 %
 - Combined Voltage and frequency variation (sum of absolutes) : 10 %
 - System fault level at rated voltage : 40 kA
 - Short time rating of MV switchgear : 40 kA for 3 sec.
 - Short time rating for terminal boxes : 40 kA for 0.25 sec.
 - MV system grounding : ~~Isolated / high resistance /~~
low resistance
- 5.0 Applicable standard : As per annexure-I enclosed
- 6.0 Minimum voltage for starting
- Mill Motor : _____ % of rated voltage
 - Other Motors : 80 % of rated voltage
- 7.0 Locked Rotor current
- Excluding tolerance
 - BFP motor : 4.5 times rated current
 - Other motors : 6.0 times rated current
 - Including tolerance : ± 20 % on all motors
- 8.0 Type of power cables
- Insulation : ~~PVC~~ / XLPE
 - Sheathing : ~~PVC~~ / FRLS PVC
 - Voltage grade : 6.6 K V ~~Earthed~~ / Unearthed
 - Armouring : Armoured / ~~unarmoured~~

PE-6666-6



P E M

DATA SHEET - A

MV MOTORS

SPECIFIC TECHNICAL REQUIREMENTS

SPECIFICATION No.

PE-15-179-

VOLUME IIB

SECTION D

REV. No. 0

DATE 20-8-96

SHEET 2

OF 2

- e) Conductor : Copper / ~~aluminium stranded~~
- f) Screening : ☒ Conductor screened /
☒ Insulation screened
- 9.0 Cable sizes :
- a) power cable for motor : Later sq. mm
- b) power cable for space heater : minimum 2.5 sq. mm PVC armoured Cu
- c) Control cable for RTD : 2 pair 0.5 sq. mm Cu
- d) Control cable for BTD : 2 pair 0.5 sq. mm Cu
- 10.0 Grounding
- a) Conductor size : 50X6 mm
- b) Material : GS FLAT
- 11.0 Space heater supply : 240 V, single phase
- 12.0 Painting : As per clause No. 7.0
- 13.0 Location of main phase terminal boxes :
- 14.0 Cooling water specification :
- 15.0 Additional tests :
- 16.0 Axial thrust in case of vertical motors (as specified by driven equipment vendor) :
- 17.0 Direction of rotation when viewed from non-driving end : Anti-clockwise / Clockwise
- 18.0 Insulation : CLASS F (ALL INSULATED WINDING) SHALL BE OF COPPER

DATA SHEET - C

SPECIFICATION No.

MV MOTORS

VOLUME IIB

SECTION D

SHEET

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OF 11

INSTRUCTIONS
TO VENDOR

1. This data sheet shall be filled up on the basis of finally agreed points of Data Sheet B, Bid Clarifications and MOM with the bidder.
2. This data sheet shall be submitted by successful bidder after award of contract.

- 1.0 Manufacturer :
- 2.0 Type and frame size & design code no. :
- 3.0 Nos. required :
- 4.0 Application :
- 5.0 Specification & codes :
- 6.0 Capacity :
- a) for specified climatic conditions :
- b) at 40 °C ambient temp. :
- 7.0 Location of installation : Indoor / Outdoor
- 8.0 Type of enclosure & ventilation:
- 9.0 Degree of protection :
- 10.0 Type of duty :
- 11.0 a) Rated voltage : V
- b) No. of phases :
- c) Frequency : Hz
- 12.0 Permissible variations in :
- a) Voltage : %
- b) Frequency : %
- c) Combined voltage & frequency (sum of absolute values) : %
- 13.0 At rated voltage & frequency :
- a) Full load current : A
- b) Full load speed : rpm

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DATA SHEET - C

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MV MOTORS

VOLUME IIB

SECTION D

SHEET 2

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- c) No load current : A
- 14.0 Minimum permissible voltage : _____ % of rated
during starting to bring the voltage
driven equipment up to rated
speed
- 15.0 Maximum permissible time at : _____ minutes
minimum permissible voltage running at _____ % of
during running at full load rated voltage
- 16.0 Maximum permissible time at 75% : min.
of rated voltage during running
at full load
- 17.0 Whether motor stalls at 70% of :
rated voltage (refer clause
3.5.2)
- 18.0 Efficiency & power factor at : Efficiency P.F.
a) Full load :
b) 50% of full load :
c) 25% of full load :
d) No load :
e) At start :
- 19.0 Stator winding
a) Connection :
b) Type & nos. of terminals :
brought out
c) Resistance between : ohms
terminals at 20 °C
d) Resistance per phase at : ohms
20 °C
- 20.0 Starting current as percentage
of full load current
a) with IS tolerance : %
b) without IS tolerance : %

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MV MOTORS

VOLUME IIB

SECTION D

SHEET 3

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- 21.0 Torque at full load : kg.m
- 22.0 Break away torque as percentage:
of full load torque %
- 23.0 Pull up torque as percentage :
of full load torque %
- 24.0 Pull out torque as percentage :
of full load torque %
- 25.0 Starting time in sec. without
mechanism coupled or mechanism
coupled through hydraulic
coupling when it may be presumed
that load is transferred to
motor shaft only after attaining
almost full speed
- a) with rated voltage : sec.
- b) with 80% of rated voltage: sec.
- c) with 110% of rated voltage: sec.
- 26.0 Starting time in sec. with
mechanism coupled through
flexible coupling
- a) with rated voltage : sec.
- b) with 80% rated voltage : sec.
- c) with 110% rated voltage : sec.
- 27.0 Safe stall time (Hot motor)
- a) at rated voltage : sec.
- b) at 80% rated voltage : sec.
- c) at 110% rated voltage : sec.
- 28.0 Safe stall time (Cold motor)
- a) at rated voltage : sec.
- b) at 80% rated voltage : sec.
- c) at 110% rated voltage : sec.

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DATA SHEET - C				SPECIFICATION No.	
HV MOTORS				VOLUME IIB	SECTION D
				SHEET 4	OF 11
29.0	Whether speed switch is provided, if required	:	YES / NO		
30.0	Limiting rotor temp. to determine safe stall time	:			
31.0	Permissible maximum accelerating: time (hot motor) at full load	:			
	a) at rated voltage	:		sec.	
	b) at 80% rated voltage	:		sec.	
	c) at 110% rated voltage	:		sec.	
32.0	Permissible maximum accelerating: time (cold motor) at full load	:			
	a) at rated voltage	:		sec.	
	b) at 80% rated voltage	:		sec.	
	c) at 110% rated voltage	:		sec.	
33.0	Insulation	:			
	a) Class of insulation	:			
	b) Tropical and fungicidal treatment (mention treatment) given	:			
34.0	Whether insulation is suitable for 6.6 kV earthed system	:			
35.0	Temp. rise under normal and abnormal conditions over 50 °C ambient temperature	:			
	a) By resistance method	:	<div style="display: flex; justify-content: space-between;"> _____ °C over cooling water temp. of _____ °C </div>		
		:	<div style="display: flex; justify-content: space-between;"> _____ °C over cooling air temp. of _____ °C </div>		
	b) By thermometer method	:	<div style="display: flex; justify-content: space-between;"> _____ °C over cooling water temp. of _____ °C </div>		
		:	<div style="display: flex; justify-content: space-between;"> _____ °C over cooling air temp. of _____ °C </div>		
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MV MOTORS

VOLUME IIB

SECTION D

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- 36.0 Method of starting :
- 37.0 Permissible starting duty cycles :
- 38.0 Stator thermal time constant :
- 39.0 Maximum permissible voltage during high speed bus transfer & its duration (describe special design feature) : _____ % of rated voltage for _____ duration
- 40.0 Time required for voltage to decay down to following values when driving voltage is removed
- a) 50% : sec.
- b) 40% : sec.
- c) 25% : sec.
- d) 0% : sec.
- 41.0 Method of cooling :
- 42.0 Details of water cooling system
- a) No. of coolers :
- b) Water requirement per cooler : LPM
- c) Losses removed by cooler :
- d) Max. permissible temp. of cooling water at inlet : °C
- e) Maximum permissible temp. of cooling water at outlet : °C
- f) Maximum permissible pressure at water outlet : kg/sq.cm
- g) Water pressure drop through the cooler :

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HV MOTORS

VOLUME IIB

SECTION D

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- h) Temp. of cold air coming:
out & entering the machine
for permissible cooling
water temperature °C
- i) Temp. rise of air passing:
through machine at full
load °C
- j) Air pressure drop through:
the cooler
- k) Temp. rise of water : °C
through cooler
- l) Protection against :
leakage of water
- m) Arrangement to ensure the:
water flow

43.0 Bearings

- a) Number :
- b) Type :
- c) Lubrication System :
- d) Quantity of lubricant :
required for both the
bearings
- e) Life at rated speed : hrs.
- f) Recommended lubricant :
- g) Bearing end play :
- h) Inlet oil pressure :
- i) Temp. rise of oil through:
bearing °C
- j) Max. permissible temp : °C
of oil
- k) Max. permissible temp. : °C
of bearing

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MV MOTORS

VOLUME IIB

SECTION D

SHEET 7

OF 11

l) Permissible running time :
without forced oil at full
load & full speed

m) Whether bearings are : YES / NO
provided with 3 wire,
platinum RTD having 100
ohm resistance at 0°C
for remote temp.
indication

n) Whether bearings are :
provided with local
temp. indicator having
two adjustable contacts
rated for 2A at 240V
AC or 0.2A at 220V DC

o) If forced lube oil system
provided

i. Qty. of lubricant :
required for
initial filling

ii. Recommended period :
after which
lubricant should
be replaced

iii. Bearing cooling :
water requirement

iv. Max. permissible : °C
bearing cooling
water inlet temp.

v. Max. permissible : °C
bearing cooling
water outlet temp.

44.0 Terminal designation corres- :
ponding to direction of
rotation (facing driving end)

45.0 Whether separate terminal
boxes provided for

a) Main terminals : YES / NO

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DATA SHEET - C

SPECIFICATION No.

MV MOTORS

VOLUME IIB

SECTION D

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- b) Space heaters : YES / NO
- c) Winding temp. detectors : YES / NO
- d) Bearing temp. detectors : YES / NO
- e) Moisture detectors : YES / NO
- f) Neutral terminals : YES / NO
- 46.0 Main terminal box details
- a) Type & Nos. :
- b) Fault level permissible for 0.25 sec. : MVA
- c) Rating of each :
- d) Total power requirement :
- e) Voltage : V
- 47.0 Details of 3 wire, platinum RTD having 100 ohm resistance at 0°C for winding temp. & bearing temp. detectors
- a) Type :
- b) Nos. provided :
- c) Location :
- 48.0 Whether differential protection provided. If yes, :
- a) no. of CTs supplied along with motors :
- b) CT details :
- i. CT ratio :
- ii. Knee point voltage :
- iii. Short ckt. withstand capacity :
- 49.0 Type of mounting :

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DATA SHEET - C				SPECIFICATION No.	
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50.0	Shaft orientation	:			
51.0	Shaft extension	:			
52.0	Grounding pads, sizes, nos. & location	:			
53.0	Method of coupling to driven mechanism	:			
54.0	GD sq. value				
	a) of the motor	:			
	b) of the mechanism referred to the motor shaft	:			
55.0	Thermal inertia of the motor	:			
56.0	Whether the speed switch provided	:	YES / NO		
57.0	Details of speed switch, if provided	:			
58.0	Compliance with testing requirements	:	YES / NO		
59.0	Lifting Device	:			
60.0	Weight				
	a) Weight of stator (wound)	:			
	b) Weight of rotor (wound)	:			
	c) Weight of base plate	:			
	d) Weight of Copper	:			
	e) Net weight of motor	:			
61.0	Shipping details				
	a) Shipping dimensions	:			
	b) Shipping weight	:			
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MV MOTORS

VOLUME IIB

SECTION D

SHEET 10

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62.0 Whether dial type capillary :
thermometers with temperature
switch provided

- a) In cold air / water path :
- b) In hot air / water path :
- c) For measurement of oil :
temp. for bearings

63.0 Characteristic curves attached

- a) Speed vs current at : YES / NO
rated voltage
- b) Speed vs torque at 110%, : YES / NO
100%, 90% and 80% of
rated voltage
- c) Thermal withstand curve : YES / NO
for hot & cold conditions
- d) Efficiency vs load : YES / NO
- e) p.f. vs load : YES / NO
- f) Current vs time : YES / NO
- g) Negative phase sequence : YES / NO
curve

64.0 Drawings attached

- a) General arrangement of : YES / NO
motor
- b) Main terminal box showing : YES / NO
Boards's incoming cables
- c) Instruction manuals : YES / NO

65.0 Other Documents Attached

- a) Final Quality Plan : YES / NO
- b) Final Field Quality Plan : YES / NO

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