

1x370 MW YELAHANKA COMBINED CYCLE POWER PLANT

KARNATAKA POWER CORPORATION LIMITED

TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM

SPECIFICATION NO. : PE-TS-409-555-A001



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA (INDIA)



**370 MW (109 FB) CAPP YELAHANKA
COMPRESSED AIR SYSTEM**

INDEX

SPECIFICATION NO: PE-TS-409-555-A001

VOLUME: II B & III

REV : 00

DATE:20.01.2016

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COMPRESSED AIR SYSTEM**

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VOLUME II B

SECTION-A

INTENT OF SPECIFICATION



370 MW (109 FB) CCPP YELAHANKA

**COMPRESSED AIR SYSTEM
INTENT OF SPECIFICATION**

SPECIFICATION NO: PE-TS-409-555-A001

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1.0 INTENT OF SPECIFICATION

- 1.1** The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, proper packing and shipment and delivery at site, as required on FOR site basis, supervision of erection and commissioning, final painting & carrying out acceptance tests at site of compressed air system of as per details in different sections / volumes of this specification and various pre award agreements for **370 MW (109 FB) CCPP YELAHANKA**.
- 1.2** The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply Lube oil pumps within quoted price.
- 1.3** It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4** The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5** The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6** While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL 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



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per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

- 1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section - C shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser / Employer, consultant, please referred relevant clause(s) of GCC.

SECTION: B

**PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN
CRITERIA**

Yelahanka 1x350 MW CCPP Plant details

1	Topographical Details of site	
	a Latitude	:13 Deg 7 Min
	b longitude	:77 Deg 35Min
	c Elevation	: 900 Mtr (Please Refer the Contour Map)
2	Highest Flood level	: Not applicable and can be finalized by studying the Plant Topography
3	Elevation	: 900 Mtr (Please Refer the Contour Map)
4	Annual Mean of Daily Max Temp	37.Deg.cent
5	Annual Mean of Daily Min Temp	11.5 Deg cent
6	Highest Temp Recorded	39.Deg Cent
7	LowestTemp Recorded	9.9 Deg Cent
8	Desigen Temperature	28.0 Deg Cent.
9	Relative Humidity	at 830hrs 79%
		at 1730 hrs 52%
10	Annula total Rain Fall (Max rain fall during July to Oct)	970 mm
11	Design Wind Speed	33M/sec (As per IS: 875)
12	Earthquake Zone	Seismic Zone II As per IS 1893

SECTION: C

TECHNICAL SPECIFICATIONS

SECTION: C1

SPECIFIC TECHNICAL REQUIREMENT

VOLUME - II B

SECTION: C1A

**SCOPE OF SUPPLY, TERMINAL POINTS
AND EXCLUSIONS**

1. SCOPE OF SUPPLY AND SERVICES:

The scope of work under this specification shall be as below.

Items not specifically mentioned but deemed necessary by the Tenderer for making the system completely reliable and efficient shall also be considered as if included.

- 1.1 Total lump sum firm prices for Equipment & Services as specified, comprising of design & engineering, manufacture, inspection & testing at manufacturer's works, painting at manufacturer's works, duly packed for transportation, delivery to site, unloading storage & handling at site, erection & commissioning, carrying out performance/acceptance tests at site & final painting of complete Compressed Air System consisting of following equipment's:
 - 1.1.1 Two (2) nos. (1 working + 1 standby) identical air compressors (common for service air and instrument air) each of minimum 10 NM³/Min (14.2 m³/min FAD) capacity at 8.0 Kg/sqcm (min) discharge pressure with electric motor drive, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.2 Two (2) Nos. Air Drying Plants Heat of compression (HOC) Rotary type(*)/Dual Tower Type of min. 15 NM³/min. capacity connected to above IA compressors with all instruments, control panels and other accessories as specified.
 - 1.1.3 Two (2) Nos. Air Receivers of minimum ten (10) Cu.M capacity each and one (1) DM plant air receiver of 2 M³ capacity with instruments, relief valve, drain connection with automatic trap stations and other accessories as specified.
 - 1.1.4 Two (2) Nos. Electronic Dew point meters.
 - 1.1.5 Pipes for compressed air line & interconnecting airline shall be galvanized as per IS-4736 and shall conform to IS-1239 Part-1 Heavy Grade Size up to 150 NB and IS-3589 for sizes greater than 150 mm NB. Fittings for air piping shall be conforming to IS-1239 Part-II, cooling water piping will be M.S. conforming to IS: 1239 (Part-I) (Heavy Grade)/IS:3589 Gr 410e. Fittings for cooling water line ASTM A-234 Gr. WPB for sizing including 65 mm NB and above and ASTM A 105 or as compatible with IS 1239 for size up to 50 NB. including hanger/supports, auxiliary structural members etc. inclusive of all cu-tubing for control air piping, fittings, valves, Counter flanges, bolts, nuts, gaskets etc. at all piping terminals, base plates, support plates, anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts etc and other accessories as required including drain piping - Lot .
 - 1.1.6 All airline valves shall be ball valve type. Valves for airline shall be Cast Steel body (ASTM A216 WCB) above 50 NB and Forged Steel Body (ASTM A 105) up to 50 NB with SS internals. Valve size 65 Nb and above with flanged end, valve size 50 Nb and below with screwed. For water service, cast iron valves with GM internals as per relevant IS/equivalent and other applicable standards above 50 mm size. Gunmetal valves as per IS-778/equivalent up to size 50mm– Lot
 - 1.1.7 Field instruments as specified, all instruments necessary for performance testing of compressors as well as air drying plants.

- 1.1.8 Individual compressor control shall be through microprocessor based control system as per OEM .Further, start /stop of compressor shall be hard wired to DCS and other signals shall be monitored in DCS through soft link connectivity.
- 1.1.9 One number sequencing panel to be provided to ensure equal running hours for both the compressors in order to have equal wear and tear. In case of failure of this sequencing panel each compressor load/unload shall be from individual Compressor controller based on discharge pressure transducer located inside compressor skid. Any other instrument required for ensuring the above operation to be considered & provided by bidder without any price implication to BHEL.
- 1.1.10 Start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – Lot
- 1.1.11 Any other item not included above or in specification but required for Compressed Air System.
- 1.1.12 The maximum velocity to be considered in compressed air shall be 15.0 m/s.
- 1.1.13 Online Vibration monitoring System as specified-Lot
- 1.1.14 Any other item not indicated above, but required to complete Compressed Air package as per system requirements.

2. TERMINAL POINTS :

- 2.1 Bidder will terminate compressed air piping for common IA header and common SA header downstream of air receiver as per enclosed tender drawing no PE-DG-409-555-A501 & as indicated in the compressor house layout PE-DG-409-555-SK002.
- 2.2 Cooling water supply will be provided by the purchaser outside the compressor house as per enclosed tender drawing no PE-DG-409-555-A501 and as indicated in the compressor house layout PE-DG-409-555-SK002.The return hot water shall be terminated by the contractor at the same location.

Further interconnection from these terminal points shall be in bidder's scope.

3. EXCLUSIONS :

- 3.1 MCC/Switchgear for power supply to Air Compressors and other drives and panels :
- 3.2 Civil works including construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe / cable trenches. However, minor dressings of foundation blocks, if necessary; equipment grouting; supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by the contractor of this specification.
The necessary input drawings for the preparation of the civil drawings shall be provided by the bidder.
- 3.3 Lighting and ventilation of compressor house.
- 3.4 Monorail hoists/Cranes as necessary for handling of equipment after erection.

3.5 Compressed Air Distribution Piping running from common IA/SA headers after the air receivers outside the compressor house.

SUB-VENDOR ITEMS

The tentative make of Sub-vendor items shall be generally as per annexure-I of section E enclosed which is subject to customer approval during detail engineering. Make of any unlisted items shall be subject to customer approval during detail engineering. For such items, bidder to furnish list of sub-vendors during detail engineering stage for BHEL's review and approval. Bidder shall furnish along with his offer the following supporting documentation within 1 month of placement of LOI. Thereafter no request for additional sub-vendor shall be entertained.

- Documentation to show that the equipment /system has been supplied for a plant of similar or higher capacity.
- Documentation in the form of certificate that the equipment/system has been operating satisfactorily for two years as on the scheduled date of bid opening.
- The successful bidder will get the makes of all items approved from Customer/ Consultant during detail engineering within two months of placement of LOI. The complete list will be necessarily be submitted within one month of placement of LOI to ensure timely placement of order for BOIs

Bidder to assess the capability of their proposed sub-vendors in terms of preparation of drawings, calculations, documents, quality assurance, supply of material etc. as per project schedule before placing the order on them.

4. DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

The drawings and documents to be submitted with the bid shall strictly be as per Volume III-section-1. Any documents other than those indicated in Volume III-section 1 will not be reviewed and will not form part of contract.

5. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

Tentative list of drawing / document required during detail engineering is attached in section E -Annexure –VIII. Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no commercial implication shall be entertained by BHEL.

6. DRAWINGS DISTRIBUTION SCHEDULE

Vendor needs to submit 10 sets of hard copies of each drawing/document during detail engineering along with editable soft copy of the same. However, exact no. of drawings / documents and submission/distribution procedure for the same shall be intimated to the successful bidder after award of contract and the same shall be complied by the successful bidder without any commercial implication.

7. DRAWINGS ENCLOSED WITH THE SPECIFICATION

Following drawings enclosed will form part of the specification.

- 1) Plot plan
- 2) P&I Diagram for compressed air system with rotary HOC type air drier
- 3) P&I diagram for compressed air system with conventional twin tower type HOC drier
- 4) Compressor House Layout

The P&I diagrams are indicative and show the minimum requirement to be followed including minimum requirement of instruments. Any other item and instruments required (within the terminal points) to make the system complete in all respect and for satisfactory operation of the system shall also deemed to have been included by the bidder in their scope. The detailed P&I diagrams for compressed air system in line with specification requirement shall be developed by the vendor during detail engineering for customer's approval and without any commercial implication to customer. Bidder to note that the while preparing PIDs after placement of order, successful bidder shall incorporate line numbers Instrument tag nos., KKS Numbering, equipment no, Line Spec, Line MOCs, legend / symbol chart , equipment capacity , relief valve capacity and set pressure, control valve capacity, range, fail position etc. in these drawing and same are subject to the customer approval.

8. Mandatory Spares

General requirement of mandatory spares will be as per the list enclosed under Section E-annexure-II. The successful bidder immediately after approval of PID, Layout & equipment/instrument data sheets /GA will prepare detailed list of mandatory spares with regard to their exact quantities, applicability/ non applicability; supply of alternate items against non-applicable items etc. This list will be submitted to customer for getting their approval. The successful bidder will proceed for ordering only after approval of the list.

9. OTHER REQUIREMENTS

- Detailed erection manual for each of the equipment as well as complete system supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- The O&M Manual to be submitted by the successful bidder will necessarily address the following:
 - a. Complete System Description along with PIDs, write up on electrical philosophy and safety/process interlocks etc.
 - b. Instructions for plant operation
 - c. Commissioning procedure of the system
 - d. Chapter on precautions to be taken during:
 - Operation
 - Idle time
 - Long shutdown
 - e. Chapter on trouble shooting during plant operation covering:
 - Safely aspects
 - Do's and do not's
 - Maintenance schedule
 - Schedule of lubricants & consumables
 - f. O & M instruction for all individual equipment which shall invariably contain but not necessarily limited to the following:
 - Equipment description/interdiction
 - Data sheet, Equipment GA & Cross Section Drawing

- Catalogue of each equipment
 - DO's & DON'T's
 - Duty Conditions
 - Installation & Safety Recommendation
 - Start-up & shut down procedure
 - Instructions for testing and adjustment of system parameters
 - Disassembly & Assembly Instructions giving sequence no. of each component
 - List of Replacement/ Spare parts along with their drawing and catalogues and procedure for ordering spares.
 - Reason & Remedy Chart for any problem
 - Maintenance Schedules- Daily, Weekly, Monthly, Half Yearly and Annual indicating clearly the spares part and man-hour requirement for each stage.
 - Detailed specification/ Schedule of all the consumables including lubricant oils, greases, chemicals etc. required for the complete system
 - Commission procedure for equipment.
- Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
 - In case vendor submits revised drawing/doc after approval of the corresponding drawing/doc, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion. However, in case changes are necessitated due to any constraints at customer end, delay in review/ approval of such revised drawing beyond one month will be to customer's account.
 - Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per dwg/ document distribution schedule. 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>)”

DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.

For quick access bidder may refer the link

<http://bhelpem.com/DMSManuals/DMSManuals.html>

- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
- Wherever CIVIL works is excluded from the bidder's scope, successful bidder shall furnish civil assignment drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the successful bidder for concurrence. In case any modification is required in the civil work already carried out based on final civil inputs given by vendor, BHEL reserves the right to debit cost of such rework to vendor”.
- If any deviation is there then same to be indicated separately under the heading “Schedule of Technical Deviation” enclosed as per Volume III-Section 4 of the Technical Specification along with Cost of Withdrawal. Incase nothing is mentioned under the column Cost of withdrawal then during bid evaluation no price implication will be admissible for withdrawal of deviations. Bidders shall also note that the deviation in any other form except above is not acceptable (i.e. in data sheet or other Annexure or elsewhere in the offer) and same shall not be considered for review/evaluation purpose/comments and it would be assumed that the system/material/equipment has been offered strictly in line with specifications/requirements.

10. Bidder to note the following information :

- 5.1 Bidders to indicate offered model in their offer and to submit backup document (e.g. performance test, etc.) matching FAD calculation along with the catalogue of the offered model to justify selection.
- 5.2 Compressor and air dryer shall be designed for cooling water (Station Aux. Cooling Water) with inlet temp of 34 deg C with terminal pressure 03 kg/sqcm(g) and rise in temp shall be limited to 10 deg C and pressure drop across Compressed Air System within terminal point shall be limited to 10 mwc. Qty of cooling water shall be provided by bidder considering working equipment only.
- 5.3 Design Inlet conditions for Compressor
 - a) Temp : 50.0 Deg C
 - b) Relative humidity : 95%
 - c) Altitude : 900 m above MSL
- 5.4 Bidder to confirm that there is no deviation from the tech specification and furnish signed Compliance cum Confirmation Certificate enclosed as volume-III-Section-2 of the Technical Specification .

VOLUME - II B

SECTION: C1B

SPECIFIC TECHNICAL REQUIREMENT

07.01.16	00				
Date	Rev	Description	PREPARED	CHECKED	APPROVED
PROJECT		370 MW (109 FB) CCPP YELAHANKA, BANGALORE			
 KARNATAKA POWER CORPORATION LTD		CUSTOMER KARNATAKA POWER CORPORATION LIMITED			
 BHEL		BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301			
JOB No.	409	BHEL Doc. No: PE-DC-409-555-A001			Rev: 00
STATUS	CONTRACT				
PACKAGE		COMPRESSED AIR SYSTEM			
TITLE		DESIGN PHILOSOPHY OF COMPRESSED AIR SYSTEM			
PREPARED BY	MAUSAM KUMAR/AMITKUMAR GARG	-SD-	04/01/2016		
CHECKED BY	SAYAN ROY/HARISH KUMAR	-SD-	04/01/2016		
APPROVED BY	PRAVEEN KISHORE	-SD-	04/01/2016		

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DESIGN PHILOSOPHY COMPRESSED AIR SYSTEM			

1.

INTENT

1.0.1

The purpose of this document is to bring out clarity with regard to the following:

a)

System description and Basic operation & Control Philosophy

b)

Major technical requirements of various items covered under this package

c)

Scope, terminal points (if any), exclusion (if any).

1.0.2

Approved copy of this document shall form the basis for subsequent approval of Compressed Air System vendor documents (by Client /their consultant or by BHEL)

1.0.3

In case of any contradictory requirement indicated in this document and those in the tender documents, details given in approved copy of this document (Design Memorandum) shall prevail.

2.

GENERAL DESCRIPTION

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

3.

DESIGN CRITERIA

3.1

SYSTEM DESIGN CRITERIA

Compressed air system includes the following:

3.1.1

Two (2) nos. (1 working + 1 standby) identical air compressors (common for service air and instrument air), including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.

3.1.2

Two (2) nos. (1 working + 1 standby) air-drying plants (ADP) each suitable for connecting to individual air compressor.

3.1.3

Intake air filters.

3.1.4

Two (2) nos. air receiver of 10 M3 capacity, i.e., one no. for each compressor near compressor house.

3.1.5

Heat of Compression (HOC) i.e. Rotary Drum type or Conventional Twin tower type.

3.1.6

All interconnecting piping, valves, fittings, supports/hangers, complete with valves and fittings between air receiver, compressor and local panel for each compressor, cooling water piping & valves for safe and satisfactory operation of air compressors.

3.1.7

Controls & interlocks of each compressor shall be from OEM based microprocessor controller.

3.1.8

All instruments including the electronic on line dew point meter with suitable sampling connection.

3.1.9

EOT Crane of 3T capacity (Electrically operated pendent controlled, underslung type).

3.2

EQUIPMENT DESIGN CRITERIA

3.2.1

AIR COMPRESSORS

3.2.1.1.

The capacity of each air compressor shall be 10 NM³/min. Delivery pressure will be 8 Kg/cm² (g) at outlet of compressors & 7.5 kg/ cm² (g) at ADP outlet. Each

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DESIGN PHILOSOPHY COMPRESSED AIR SYSTEM			

compressor will be designed to deliver the nominal capacity at the required delivery pressure.

3.2.1.2. Air compressors will be multi stage oil free, screw type.

3.2.1.3. The compressors' capacity will be designed for 45⁰ C DBT and 95% RH at atmospheric pressure at site & at MSL of 900m.

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

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

3.2.1.6. The continuous motor rating (at 50⁰ C ambient) will be at least ten percent (10%) above the maximum load demand of the driven equipment under the entire operating range.

3.2.1.7. Noise level shall not exceed 85 dBA plus tolerances when measured at a distance of 1.5 meter above the floor and 1 meter from the equipment in free field condition.

3.2.1.8. Material of Construction (MOC) of compressor shall be as per reputed manufacturer standard.

3.2.1.9. Compressed air velocity shall be 15 m/s.

3.2.2 ROTORS

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

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

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

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

3.2.2.5. Rotors shall be dynamically balanced.

3.2.3 AIR DRYING PLANT

3.2.3.1. Air-drying plant shall be of heat of compression desiccant type (conventional or rotary drum type), drying by adsorption process through a desiccant medium.

3.2.3.2. Quality of outlet air from ADP shall be in accordance to ISO 8573-1 as follows.

a) Dew point at outlet of the air drying plant will be minus (-) 40⁰ C at atmospheric pressure.

b) Dust particle size in instrument air shall be less than Three (3) micron & max, particle conc. limited to 1mg/m³.

c) Oil content of Instrument air shall be less than 0.10 mg/m³.

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

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

3.2.4 INTER COOLER, AFTER COOLER & OIL COOLERS

3.2.4.1 Inter cooler, after cooler & oil cooler shall be of water cooled with shell & tube type with water on the tube side. Inter cooler & after cooler shall be designed in accordance with sec. VIII, Div 1 of ASME code or equivalent.

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3.2.4.2	The coolers shall be designed for the max. heat load & at least 10 % design margin shall be provided in the tubes.
3.2.4.3	Adequately sized safety valve shall be provided for both inter cooler & after cooler.
3.2.4.4	Each intercooler & after cooler shall be provided with moisture separator unit with suitable baffling. Electrically operated automatic drain trap station with bypass valve & isolation valves shall be provided for moisture separator for automatic draining of condensed moisture. Manual draining facility shall also be provided.
3.2.5	INTAKE FILTER
3.2.5.1	Heavy duty dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the cylinders.
3.2.5.2	The filtering efficiency shall not be less than 99% for particles 3 micron & higher. Sound suppressing characteristics will be considered in the filter design.
3.2.6	AIR RECEIVER
3.2.6.1.	The capacity of each air receiver shall be 10 M ³ (nominal).
3.2.6.2.	The air receivers will be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.
3.2.6.3.	Design Pressure for the air receiver shall be 12 kg/cm ² (g) and 50degC respectively.
3.2.6.4.	The material of construction of shell, dished ends, flanges etc of the air receivers shall be of carbon steel as per IS: 2002 or SA 516 Gr B or equivalent.
3.2.6.5.	Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, temperature gauge, minimum 500 mm dia. manhole for inspection.
3.2.6.6.	Minimum corrosion allowance shall be 3.0 mm.
3.2.7	PIPING & VALVES (WITHIN COMPRESSOR HOUSE)
3.2.7.1.	All interconnecting compressed air piping shall conform to IS 1239 heavy grade/IS 3589 Gr 410 galvanised to IS- 4736 or equivalent. The fitting shall either be same as the parent material or malleable iron to IS-1879(galvanised). Compressed air piping from air compressor to after cooler and other lines handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg. C. The pipe joints will be screwed coupling type for sizes up to 50 NB and above 50 NB the same will be flanged.
3.2.7.2.	Water Piping shall be IS-1239 Heavy grade.
3.2.7.3.	VALVES
	a) Compressed Air Services:
	♦ All airline valves shall be ball valve type. For compressed air application, valve material shall be FCS/CCS with SS internals .
	b) Water Service:
	♦ Cast iron valves with GM internals as per IS-780/equivalent and other applicable standards above 50 mm size. Gunmetal valves as per IS-778/equivalent up to size 50mm.
	c) Auto drain trap for each air receiver shall be provided.

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4.

LAYOUT CONSIDERATIONS

4.1.1

Air compressors will be located indoor in a separate compressor room and EOT crane arrangement will be provided so that the heaviest component can be handled during maintenance.

4.1.2

The air receivers will be located outdoors adjacent to the compressor room. Other receiver necessary maintenance access will be provided in the layout.

4.1.3

Complete ADP equipment shall be preferably mounted on a skid and located indoor.

5.

OPERATION, CONTROL & INSTRUMENTATION

5.1.1

The necessary instrumentation and control has been provided for safe and trouble free operation of compressed air system.

5.1.2

Individual compressor control shall be through microprocessor based control system as per OEM .Further, start /stop of compressor shall be hard wired to DCS and other signals shall be monitored in DCS through soft link connectivity.

5.1.3

Depending upon operational requirement each compressor can be selected and operated in following mode

5.1.3.1.

Local Mode: Individual compressor is operated from Local Integral Control System as per sequence.

5.1.3.2.

Remote Mode: Individual compressor is operated (start/stop) through DDCMIS OWS.

5.1.4

All the process inputs (digital or analog), other than specific to compressors are taken directly to DDCMIS for monitoring as per OEM.

5.1.5

On tripping of the working compressor, the standby compressor shall come into operation automatically in case of very low pressure in the system.

6.

POWER SUPPLY ARRANGEMENT

6.1.1

The power supply (rated voltage, frequency, phase) of the equipments will be 415 V +/- 10%, 3ph, 50 Hz +5% to -5%. 10% combined variation of voltage and frequency.

7.

REFERENCE DRAWINGS/DOCUMENTS

P & I Diagram for Compressed Air system.

Compressor sizing calculation.

Compressor house layout drawing

**PERFORMANCE REQUIREMENTS AND SPECIFIC
GUARANTEES**

At Shop:

1. Capacity and discharge pressure of each air compressor.
2. Power consumption of each air compressor at its rated duty point with its own motor.

The tests shall be demonstrated at manufacturer's work.

At Site:

1. Parallel operations of air compressors.
 2. Capacity & dew point of air at the outlet of air drying plants of instrument air compressors.
 3. Pressure drop across the air drying plants of air compressors.
 4. Vibration & noise level of air compressors, blowers of air drying plant (if applicable).
- Vibration limits shall be as per VDI 3836 applicable for the oil-free screw compressors.
 - All machines / components / system shall be acoustically designed for a surface sound pressure level of $L_p < 85$ dB (A), measured in accordance with ISO 3746 respectively at a distance of 1.0 m from equipment surface and at a height of 1.5m above ground level. The surface sound pressure level (L_p) shall be averaged over the measurement surface and corrected for effect of background noise and the influence of reflected sound at measurement surface (environmental correction). With sound pressure levels of 85 dB (A) or less according ISO it shall be ensured that maximum surface noise levels of any item of plant of less than 85 dB (A) at 1.0 m from outline and a height of 1.5m from the floor shall be met during normal operating conditions.
 - 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 ninety (90) days or a reasonable period allowed by BHEL, after the tests have been completed, 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 BHEL.
 - The bidder will prepare a document titled "HANDLING OVER PROTOCOL" successful consisting various activities to be demonstrated by them for handing over of the package.

SECTION: C-2

CUSTOMER SPECIFICATIONS

COMPRESSED AIR SYSTEM

1. SYSTEM DESCRIPTION

The purpose of this system is the supply of plant air and instrument air through the distribution system to the power plant. The compressed air system is comprised of the common system for instrument air and plant air. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while plant air is required for general plant services. Compressed air system for the plant includes the following:

- 1.1 The plant is provided with compressed air for both pneumatic controls and for general services requirement. Two (2) Nos. identical air compressors (1W+1S) common for instrument air compressors and plant air compressors of capacity 10 Nm³/min. at discharge pressure of 8.0 Kg/cm² (g).
- 1.2 The compressors are oil free, screw compressors and water-cooled type, driven by electric motor including intercoolers, after coolers, step up gearbox, silencer and other accessories. Compressors, after coolers and intercoolers shall be of water-cooled type and shall utilize passivated DM water for cooling purpose. Material of construction within compressor skid shall be as per manufacturer standard.
- 1.3 The intake air filter and silencer, necessary gauges and all accessories and Instruments & controls required for a complete compressed air plant are provided to operate satisfactorily for the service intended. Material of construction within compressor skid shall be as per manufacturer standard.
- 1.4 Two (2) nos. (1W + 1S) Air Drying Plant at a working pressure of 8.0 Kg/Cm² (g) shall also be provided to supply moisture free air to instruments. Air Drying Plant shall be Heat of Compression type (Twin tower type OR Rotary drum type). Dew point of air after ADP shall be suitable for instruments air. Material of construction within air dryer skid shall be as per manufacturer standard.
- 1.5 Two (2) nos. Air receivers near compressor house of 10 M³ capacity each (one for each compressor outside compressor house) shall be provided, designed and constructed in accordance with the requirement of the ASME unfired pressure vessel code. Material of construction of receivers shall be as per IS 2002 / SA 516 Gr.B.
- 1.6 All cooling water piping, control air and interconnecting air piping, valves, supports etc, instruments as required shall be provided for smooth, reliable and efficient functioning of the system.
- 1.7 Air Piping shall be M.S. Galvanized Conforming to IS-1239 Part -1 ERW heavy grade. Pipes 50 NB and below shall have screwed ends, while pipes above 50 NB shall have flanged ends. All the distribution valves shall be ball valve type of FCS / CCS material body with SS internals. Necessary auto drain shall also be provided at strategic points.
- 1.8 Water Piping shall be M.S. Conforming to IS-1239 Part -1 ERW heavy grade.

2. CONTROL PHILOSOPHY

- 2.1 Product integrated control (Micro-processor based) for Air compressor as per manufacturer standard is provided for compressor pack. Overall control of compressor system shall be from DDCMIS.

- 2.2 Instruments within the compressor & dryer skid for control & operation shall be as per manufacturer standard.
- 2.3 The alarms and shutdown shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor.

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SECTION: C-3
TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

<u>S.NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	415 V Switchgear	BHEL	BHEL	415 V AC (3 ph 4 wire)/240 V AC (supply feeder) 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. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motors.
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	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system. 100/50 mm cable trays/Conduits/Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs as per approved layout drawing during contract stage.
7	Cable glands, lugs & bimetallic strip for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
8	Conduit and conduit accessories for cabling between equipments supplied by vendor.	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	--
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	--
12	Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification

15	Any other equipment/material/service required for completeness of system based on the system offered by vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	--
16	a. Input cable schedules (C & I) b. Cable interconnection detail for the above c. Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Cabling layout drawings	BHEL/ Vendor	-	a. In case of Compressor are HT motors, cable tray/trench layout inside compressed air building shall be prepared by BHEL. Vendor to furnish drawing (both in print form as well as in AUTOCAD) of compressor room layout clearly indicating all motors, panels, JB's etc. which require cabling along with their terminal box/location/ Foundation etc. b. In case of Compressor are LT motors, for ensuring cabling requirements are met, vendor shall prepare & submit cable tray/trench & equipment layout (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling for BHEL review & approval.
18	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. In case the requirement of junction box arises on account of power cable size mismatch due to vendor engineering at later stage, vendor shall supply the junction box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their civil assignment drawing.

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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
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1.0

INTENT OF SPECIFIATION

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 machnines
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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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.		
3.3.3 The following frequency of starts shall apply i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature. 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) 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		
3.4 Running Requirements		
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.		
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.		
3.5 Stress During bus Transfer		
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.		
3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.		
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.		
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.		
4.0 CONSTRUCTIONAL FEATURES		
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		
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.		
Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled		
4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.		

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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 bar 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	

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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 shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall 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 materials, components and equipments covered 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 more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted 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 equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling. iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.		



SPEC. NO.CEGSW/
BIDADI/EPC/001

KARNATAKA POWER CORPORATION LIMITED

TITLE

ELECTRICAL SYSTEMS - CABLING SYSTEM

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16.0 **CABLING SYSTEM**

16.1 **Cable Types**

16.1.1 For 6.6 kV services, XLPE cables with following specification shall be provided.

6600 volts unearthed grade single or multi core, stranded aluminium conductor, screened by triple extruded semi conducting compound gas cured, gas cooled, tree retardant, cross linked polyethylene insulated, cores screened with semi conducting compound is combination with copper tape, laid up, inner sheathed with extruded PVC compound type ST2, armoured with galvanised wire or strips for multi core cables and aluminium wire armoured for single core cables and overall sheathed with extruded FRLS PVC type ST2 cable complying with IS : 7098 part-2.

16.1.2 For 415 V power supply services, space heating, outdoor lighting, lighting in the hazardous areas, power supplies to lighting panels etc., XLPE power cables with the following specifications shall be provided.

1100 volt grade, single or multi core, stranded aluminium conductor, extruded XLPE insulated, cores laid up, inner sheathed with extruded PVC compound, armoured with galvanised steel wire or strip for multicore cables and aluminium wire or strip armoured for single core cables, outer sheathed with extruded FRLS PVC compound type ST2 complying with IS:7098 pt-1.

16.1.3 For control, protection, CT/PT connections and interlocks, metering, solenoids, and for digital signals from the field devices/junction boxes/switchgears to terminal cabinets of the control system etc., with signal voltages more than 60 volts, PVC control cables with the following specifications shall be provided. 1100 volt grade, multi core, stranded annealed high conductivity copper conductor (class 2 as per IS 8130), extruded PVC compound type A insulated, cores identified by numerals, cores laid up, inner sheathed with extruded PVC compound type ST1, armoured with galvanised steel wire/strip and outer sheathed with extruded FRLS PVC compound type ST1 cable complying with IS:1554, Pt-1.

16.1.4 For low voltage digital signals to instrumentation and control system and for the analog signals, instrumentation cables with following specification shall be provided :

Single pair, multi pair or triplets or quadruplets as required, stranded tinned, annealed, high conductivity copper conductor (class 2 as per IS

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8130), extruded PVC compound type-A insulated, cores identified by colour and coding, individual pair/triplet/quadruplets twisted, cores wrapped by non hygroscopic material by taping or extrusion, non metallic rip cord under wrapping, individual pair/triplet/quadruplet screened with aluminium mylar tape of 0.04 mm thick or copper tape of 0.04 mm thick or copper laminated plastic tape with 30% overlap, provided with 0.5 sq mm tinned copper drain wire for each cabling element, cabling elements suitably grouped, colour coded, cables overall screened with tinned copper wire braids of 0.15 mm dia with minimum coverage of 85% or aluminium mylar tape of 0.04 mm thick with overlap of 30%, inner sheathed with extruded PVC compound type ST1, armoured with GI wire strips/wires and outer sheathed with extruded FRLS PVC compound type ST1 complying with IEC.189-Part 1&2.

16.2 The HT & LT power cables shall be selected on the basis of current carrying capacity , short circuit rating and permissible voltage drop.

16.2.1 **Current carrying capacity**

The cable shall be able to carry the full load current of the circuit continuously under the specified ambient temperature and other conditions of installation. For this purpose, suitable derating factors shall be considered due to:

- (a) Thermal resistivity of soil
- (b) Ambient ground / Air temperature
- (c) Derating factor for grouping of cables over the current ratings at normal conditions given in standards. The design ambient air temperature and ground temperature for this plant shall be considered as 50 deg.C and 30 deg.C respectively.

16.2.2 **Short circuit rating :**

The cables for circuit breaker controlled circuits shall withstand the fault currents for the following fault clearing times.

- (a) Motor, service transformer (Protected by instantaneous over current protection) - 0.16 seconds
- (b) Tie feeders (with no IDMT relays on downstream) - 0.5 seconds
- (c) Others - 1 second

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For circuits which are protected by fuse short circuit rating capability need not be checked.

16.2.3 Permissible voltage dip normal running :

415V System: Voltage drop in cables between the transformer and the switchgear (PCC) or between PCC and MCC for full load current shall be limited to 2%. Further, the voltage drop in cables between PCC/MCC to the motor terminals for full load motor current shall be limited to 3% . However, these voltage drops may be adjusted in specific cases so that total voltage drop is within 5%.

16.2.4 Permissible voltage dip during starting :

- (a) 415V system : The voltage drop during starting of individual 415V motors shall be limited to less than 15% of the full load voltage.
- (b) 6.6kV system : The voltage drop during starting of BFP motors shall be limited to less than 20% of the full load voltage, for all other motors it shall be 15%.

16.2.5 Minimum conductor cross section for the power cables shall be 4.0 sq.mm aluminium or 2.5 sq. mm copper.

16.2.6 All D.C. power supply cables shall be single core cables.

16.3 Control cables

16.3.1 The minimum cross sectional area for control cables shall be 2.5 sq mm. However for Wiring of field device contacts (flow/level/pressure/temperature switches) to low burden circuits in annunciator relay panels, interlock relay panels, local cabinets etc., if the annunciator/ control/interlock relays are electro magnetic type, 1.5 sq.mm copper conductor can be used.

16.3.2 Current transformer leads shall be checked for lead burden, VA capacity and knee point voltage. In case 2.5 sq.mm Copper Conductor is not adequate, higher cross section cables shall be used.

16.4 Instrumentation Cables

16.4.1 The cross sectional area shall be 0.8 sq.mm or 0.5 sq.mm based on the requirement of I&C system employed. The minimum cross section however shall not be less than 0.5 sq mm.

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16.4.2 The instrumentation cables carrying digital signals shall have overall screening and analog signal carrying cables shall have each pair screening and overall screening. 16.5 <u>Specific Requirements of Cables</u> The following aspects are applicable for all types of cables : 16.5.1 <u>Core Identification</u> Colour coding shall be acceptable for all cables upto 5 cores. Cables with more than 5 cores shall have printed numerals on each core. 16.5.2 Core numbers with a minimum letter size of 3 mm shall be printed serially on each core of the control cable at intervals of not more than 200 mm. 16.5.3 Core numbers with a minimum letter size of 2 mm shall be printed serially on each core of the Instrumentation cable at intervals of not more than 200 mm and each core shall be colour coded as per IEC-189 Part-2 16.5.4 FRLS PVC compound for outer sheaths of all the cables shall meet the following performance requirements and cables shall pass these tests. (a) The critical oxygen index value shall be minimum 29 at room temperature and the temperature index value shall be minimum 250°C at oxygen index of 21 when tested as per ASTM-D-2863-77. (b) The maximum total acid gas generation as determined by titration shall be less than 20% by weight, when tested as per IEC 754-1. (c) The maximum smoke density rating expressed in percentage light absorption at any point on the curve during testing period shall not exceed 60 % when tested as per ASTM-D-2843-77. (d) The cables shall pass the hydrolytic stability and ultraviolet test as per DIN 53387. The measured values of ultimate tensile strength and elongation after the test shall not be less than 60% of that measured before the test. 16.5.5 The finished cables shall pass the flammability test as per IEC-332-1 and IEC-383. In addition it shall also pass flammability test as per class F3 of Swedish Standard S5-424-1475.		
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16.6 Tests

16.6.1 The Bidder shall conduct the routine tests on each drum length, acceptance and type test on the cables as per applicable standards. Also special tests for critical oxygen index, temperature index values, acid gas generation, smoke generation, flammability test, effects of light and water test as specified shall be conducted on specimen, from different batches. Routine tests shall include but not limited to the following for instrumentation cables.

16.6.2 Test for dielectric strength for one minute (as per IEC-189-1)

16.6.3 Insulation resistance test (as per IEC-189-1)

16.6.4 The vendor shall carry out following type tests as per IEC.189-1 for instrumentation cables :

- (a) Tensile test
- (b) Test for stripping properties of insulation
- (c) Accelerated ageing test
- (d) Pressure test
- (e) Insulation shrinkable test
- (f) Solder test on conductor
- (g) Test for resistance of conductor
- (h) Mutual capacitance test
- (i) Capacitance unbalance test
- (j) Measurement of dimensions
- (k) Test for insulation resistance at 70°C
- (l) Cold bend test
- (m) Heat shock test.

16.6.5 Cable carrier system

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

- (i) Control room building :
 - Cable vault : Cable trays
 - False floor : Cables to be laid on the cable support arm
- (ii) Switchyard relay room
 - Cable vault : Cable trays
 - : Cables to be laid on the cable support arms

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- (iii) GTG building : Cable trays / conduits
- (iv) STG building : Cable trays / conduits
- (v) Switchyard and transformer yard : Cable trench
- (vi) Boiler area : Cable rack
- (vii) Boiler platforms : Cable trays
- (viii) Road / Rail crossings : Hume or steel pipes
- (ix) Cable carrier system connecting outlying areas : Cable rack or cable trenches
- (x) Off-side buildings and utilities : Cable trays
- (b) Cable tunnels shall have minimum head room of 1.8 m considering the obstruction due to light fittings, sprinkler piping, etc.
- (c) **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

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(d) Cable trays

- (i) Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 14 gauge (2.0 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge (1.70 mm thick) MS sheets.
- (ii) Cable trays and covers shall be hot dip galvanised.
- (iii) In battery rooms and water treatment plant, the cable trays, accessories and covers shall be epoxy painted.
- (iv) The spacing of rungs for ladder type of trays shall be not more than 250 mm.
- (v) Vertical raceways shall be formed by either structural members and slotted angles or by running the prefabricated trays vertically.

(e) Conduits & Pipes

- (i) The galvanised steel conduits shall be used for sizes upto 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 80mm 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.

(f) 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.

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(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 aluminium alkyd paint.
- For outdoor & corrosive areas like battery room, R.O plant - Hot dip galvanised.

(g) Cable Carrier Installation practice

- (i) Minimum level difference between two tiers of horizontal cable trays in building, trenches, shall be 275 mm. In vertical race ways with multi-tiers the tiers shall be located atleast with 400 mm intervals.
- (ii) In trenches & tunnels the width of the cable tray shall be limited to 600 mm. In case of horizontal trays it shall be limited to 800 mm.
- (iii) Separate cable trays/tiers shall be provided for different voltage grade cable viz., 6.6 kV power, 415V/240V power, control cables and instrumentation & communication cables.
- (iv) Cable trays shall be supported at every 1000 mm interval. Cable trenches around the transformer shall be filled with sand.
- (v) Cable trays shall be welded to the mounting/carrier structures.
- (vi) Vertical trays (raceways) and all outdoor cable trays shall be provided with removable 16 guage galvanised MS sheet covers.
- (vii) Each continuous laid out length of cable tray shall be earthed at minimum two places by MS flats of minimum size 25mm x 3mm, the distance between earthing points shall not exceed 10 metres.
- (viii) When cables are taken in vertical raceways /trays and they pass from one floor & other floor pipe sleeves in concrete shall be provided.

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16.7 Cable Installation

16.7.1 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.

16.7.2 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 3mm 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.

16.7.3 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) 1100V grade power cables of 120 mm² size and above shall normally be laid in single layer in trays/on racks.
- (d) Smaller 1100V grade power cables below 120 mm² may be run in double layers, where required, due to space restrictions.

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- (e) Control and instrumentation cables can be laid upto 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.

16.7.4 Bending radii for cables

The bending radii for various types of cables shall not be less than those values specified by the cable manufacturer.

16.7.5 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 crimping type lug. Cable terminations shall be done with double compression type brass cable glands.
- (d) 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.

16.7.6 H.T.cable termination shall be of heat shrinkable type.

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16.7.7 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.

16.7.8 Earthing

- (a) Metallic sheaths, screens and armour of all multicore 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.

16.7.9 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, ANSI-IEEE-383, IEC-331& IEC-332

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(d) 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.

(e) 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.

(f) 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 fire break 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.

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(g) 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

- Fire breaks 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.

16.7.10 Contractor shall furnish the test certificates for the fire stops and fire breaks after award of contract for Owner / Owner'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 Owner / Owner's Representative approval.

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16.7.11 Performance Tests: Tests on Fire Stops

- (a) The fire stops shall be subjected to the following type tests :
- (i) Fire Rating Test
 - (ii) 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
- Before conducting the fire rating and hose stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.
- (d) 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.
- (e) Tests on fire breaks
- Fire breaks shall undergo the following tests as per ANSI-IEEE-383 :
- (i) Ampacity test
 - (ii) Flame test

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QUALITY PLAN			TITLE			NUMBER :		
BIDDER/ VENDOR			QUALITY PLAN			SPECIFICATION :		
SYSTEM			NUMBER PED-506-00-Q-007, REV-03			TITLE		
CAT.			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		
CHARACTERISTIC			REFERENCE			AGENCY		
CHECK			DOCUMENT			REMARKS		
EXTENT OF CHECK			NORM			P W V		
TYPE/ METHOD OF CHECK			FORMAT OF RECORD			VOLUME III		
CAT.			8			10		
3			7			11		
2			6			9		
1			5			4		
1.0			4			3		
1.1			3			2		
1.2			2			1		
1.3			1			0		
1.4			0			0		
BHEL			BHEL			BHEL		
PARTICULARS			BIDDER/VENDOR			BIDDER/VENDORS COMPANY SEAL		
NAME			NAME			NAME		
SIGNATURE			SIGNATURE			SIGNATURE		
DATE			DATE			DATE		

BHEL		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :					
				BIDDER/ VENDOR		TITLE		NUMBER :					
				SYSTEM		QUALITY PLAN		SPECIFICATION :					
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SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION	AGENCY	VOLUME III REMARKS		
									P	W	V		
1	2	3	4	5	6	7	8	9	10				11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED	
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2		
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE	
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2		
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2		
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2		
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2		
BHEL													
PARTICULARS				BIDDER/VENDOR									
NAME													
SIGNATURE													
DATE													
				BIDDER'S/VENDORS COMPANY SEAL									

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :					
				BIDDER/ VENDOR		TITLE		NUMBER :					
				SYSTEM		QUALITY PLAN		SPECIFICATION :					
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									AGENCY	P	W		V
1	2	3	4	5	6	7	8	9	10			11	
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	MANF'S DRG./ APPROVED DATASHEET	-DO-	Log Book	3	-	2	
		1.MAKE & TYPE	MA	VISUAL	100%	MANF'S DRG./ APPROVED DATASHEET	BHEL DATA SHEET	-DO-	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG/ SPECS.	-DO-	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	-DO-	3	-	-	
		BHEL											
PARTICULARS										BIDDER/VENDOR			
NAME													
SIGNATURE													
DATE													
										BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :	
				BIDDER/ VENDOR		TITLE		NUMBER :	
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				BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-Q-007, REV-03		SPECIFICATION : TITLE											
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SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	3	4	5	6	7	8	9	10		11		P		W		I	
1	2																		
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUF'R'S SPEC.	MANUF'R'S SPEC.	MANUF'R'S SPEC.	Log Book	2	-	-							
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	-DO-	Log Book	2	-	-							
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	-DO-	Log Book	2	1*	1							
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUF'R'S SPEC./BHEL SPEC.	MANUF'R'S SPEC./BHEL SPEC.	MANUF'R'S SPEC./BHEL SPEC.	Log Book	2	-	-							(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-							
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1							
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1							
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-							
		6.SURGE WITH STAND AND TAN.DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1							FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	-DO-	Log Book	2	-	-							
		2.TEMP. PRESSURE VACCUUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	-DO-	Log Book	2	-	-							
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1							THREE DIPS TO BE GIVEN
BHEL		PARTICULARS		BIDDER/VENDOR															
		NAME																	
		SIGNATURE																	
		DATE																	
		BIDDER'S/VENDORS COMPANY SEAL																	

		CUSTOMER :		PROJECT		SPECIFICATION :					
QUALITY PLAN		BIDDER/ VENDOR		TITLE		NUMBER :					
SHEET 7 OF 9		SYSTEM		QUALITY PLAN		TITLE					
COMPONENT/OPERATION		CAT.		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION					
SL. NO.	CHARACTERISTIC CHECK	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				
							P	W	V	REMARKS	
1	2	3	4	5	6	7	8	9	10	11	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1
		1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2	-	1
2.9	COMPLETE ROTOR ASSEMBLY	3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1
		1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2	-	1
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2	-	1
		1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	1
BHEL		PARTICULARS			BIDDER/VENDOR						
		NAME									
		SIGNATURE									
		DATE									
					BIDDER'S/VENDORS COMPANY SEAL						

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :	
				BIDDER/ VENDOR		TITLE		NUMBER :	
				SYSTEM		QUALITY PLAN		SPECIFICATION :	
						NUMBER PED-506-00-Q-007_REV-03		TITLE	
						ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION	
						REFERENCE DOCUMENT		AGENCY	
						ACCEPTANCE NORM		VOLUME III	
						FORMAT OF RECORD		REMARKS	

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	SHEET 9 OF 9	SYSTEM CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION	
										AGENCY	VOLUME III
										P	W
										V	
1	2	3		4	5	6	7	8	9	10	11
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY											
BHEL				PARTICULARS		BIDDER/VENDOR					
				NAME							
				SIGNATURE							
				DATE							
BIDDER'S/VENDORS COMPANY SEAL											

SL. NO.		COMPONENT/OPERATION		QUALITY PLAN SHEET 1 OF 2		CUSTOMER :		PROJECT		SPECIFICATION :					
						TITLE		NUMBER :							
						BIDDER/ VENDOR		SPECIFICATION		TITLE		SECTION		REMARKS	
						CAT. SYSTEM	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	
1	2	3	4	5	6	7	8	9	10	11					
1.0	ASSEMBLY	1.WORKMANSHIP 2.DIMENSIONS 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE 1.SHADE	MA MA MA MA	VISUAL -DO- VISUAL	100% -DO- 100%	MANUF'S SPEC MFG. DRG./ MFG. SPEC. MFG.SPEC./ RELEVANT IS	MANUF'S SPEC MFG. DRG./ MFG. SPEC. MFG.SPEC. RELEVANT IS	-DO- -DO- -DO-	2 2 2	- - -					
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUF'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-					
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC. 2.OVERALL DIMENSIONS & ORIENTATION	MA MA	-DO- MEASUREMENT & VISUAL	100% 100%	IS-325/ BHEL SPEC./ DATA SHEET APPROVED DRG/DATA SHEET	SAME AS COL.7 APPROVED DRG/DATA SHEET & RELEVANT IS	TEST REPORT INSPN. REPORT	2 2	1 1	NOTE -1 & NOTE-3 NOTE -1 & NOTE-3				
BHEL		PARTICULARS		BIDDER/VENDOR											
		NAME													
		SIGNATURE													

	QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
			BIDDER/ VENDOR		QUALITY PLAN		SPECIFICATION : TITLE :					
	SHEET 2 OF 2		SYSTEM CAT.		ITEM AC ELECT. MOTORS BELOW 55KW (LV)		VOLUME III					
	SL. NO.	COMPONENT/OPERATION CHARACTERISTICS CHECK	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.												
<u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
BIDDER'S/VENDORS COMPANY SEAL												

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 1 OF 2		BIDDER/ VENDOR :		STANDARD QP NO. : PE-OP-989-507-E005, REV. 0		SPECIFICATION TITLE:			
		COMPONENT/OPERATION		SYSTEM CABLING		ITEM : CABLE TRAYS & ACCESSORIES		DOC. NO. :			
SL. NO.	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
								P	W	V	
1	2	3	4	5	6	7	8	10			11
1.0	RAW MATERIAL										
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAL/TISCO/RINJ/BHUSAN/JINDAL ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS-1079	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	QC RECORD	3/2	-	1/2	
2.0	IN-PROCESS										
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	QC RECORD	2	-	1	
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPD to be reviewed during inspection.
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	QC RECORD	2	-	-	
BHEL											
PARTICULARS											
NAME											
SIGNATURE											
DATE											
BIDDER/VENDOR											
BIDDER'S/VENDORS COMPANY SEAL											
LEGEND : 1 - BHEL/CUSTOMER 2 - VENDOR 3 - SUB-VENDOR P - PERFORM W - WITNESS V - VERIFICATION											

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 2 OF 2		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-989-507-E005, REV. 0		SPECIFICATION TITLE:			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
			4	5	6	7	8	9	10	11	
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH 2.DROSS 3.RATE OF IMMERSION 4.SURFACE QUALITY	MA MA MA MA	TEMPERATURE INDICATOR VISUAL VISUAL VISUAL	CONTINUOUS PERIODIC 100% 100%	IS-2629 IS 2629 IS 2629/ MFR'S PRACTICE IS 2629	IS-2629 IS 2629 IS2629/ MFR'S PRACTICE FREE FROM BURRS, ROUGHNESS, SLAG FLUX, STAIN, ETC.	QC RECORD QC RECORD QC RECORD QC RECORD	2/3 2/3 2/3 2/3	- - 2 -	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
3.0	FINISHED ITEMS										
3.1	(CABLE TRAY, ACCESSORIES & HARDWARES)	1.DIMENSIONS 2.SURFACE FINISH	MA MA	MEASUREMENT VISUAL	IS-2500 (PART 1) LEVEL S-4 IS-2500 (PART 1) LEVEL S-4	APPD. DRG APPD. DRG	APPD. DRG FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP.REPORT INSP. REPORT	2 2	1 1	Fasteners shall be of reputed make. Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet. Following shall be engraved/ punched on each standard length of cable tray at the center of both sides of runner: 'PEW' (length of letter 90mm & height 30mm).
		3.RIGIDITY (FOR TRAYS) 4.MASS OF ZINC COATING 5.UNIFORMITY OF ZINC COATING 6.THICKNESS OF ZINC COATING 7.ADHESION	MA MA MA MA MA	DEFLECTION TEST CHEM. TEST CHEM. TEST ELCOMETER MECH.TEST	2 No./ LOT/TYPE IS-4759 IS-4759 IS-4759	APPD. DRG IS-6745/ APPD. DATASHEET IS-2633 APPD. DATASHEET IS-2629	APPD. DRG APPD. DATASHEET IS-2633 APPD. DATASHEET	INSP. REPORT INSP.REPORT INSP. REPORT INSP. REPORT INSP. REPORT	2 2 2 2 2	1 1 1 1 1	600MM wide cable tray to be tested. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND :		1 - BHEL/CUSTOMER	2 - VENDOR	3 - SUB- VENDOR	P - PERFORM	W - WITNESS	BIDDERS/VENDORS COMPANY SEAL				
										V - VERIFICATION	

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	200 KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz + 3 % to - 5%
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	o 110 kW and above (Breaker Controlled)	:	50 KA for 0.2 sec.
	o Below 110 kW (Contactor Controlled)	:	50 KA protected by fuse
	f) LV System grounding	:	Solidly
5.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
6.0	Minimum voltage for starting (As percentage of rated voltage)	:	(a) 85% of rated voltage
7.0	Power cables data	:	Shall be given during detailed engg.
8.0	Earth Conductor Size & Material	:	As per attached Datasheet of Earthing.
9.0	Space heater supply	:	240 V, 1 ϕ , 50 Hz
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
11.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS 12615*
12.0	Flame-proof motor		
	a) Enclosure suitable (As per IS: 2148)	:	As per requirement
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
13.0	Paint shade	:	Shall be given during detailed engg.
14.0	Degree Of protection for motor/ terminal box	:	IP 54/ IP 55

15.0 * Continuous duty LT motors up to 200 KW Output rating (at 50 deg.C ambient temperature), shall be Premium efficiency (IE3) as per IEC: 60034-30/ IS: 12615

16.0 TESTING

16.1 Type Tests

For LT Motors above 55kW, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years from the date of bid opening shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

16.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c)	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB)		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

ANNEXURE-II

[illegible]

ANNEXURE III

[illegible]

SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)



Technical specification for
Compressed Air System
 1X370 MW CCPP AT YELHANKA

REV. NO. 00 DATE : 16.01.2016

Table of Contents

Sheet No.

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Section D

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	Specific Technical Requirement For Compressed Air System	1X370 MW CCPP YELHANKA
1. Complete C&I system for Compressed Air System is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder. 2. Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor & Service Air Compressor. All PT, DPT, TE, and other instruments outside the compressor skid shall also be hooked-up to this system. Critical signals shall be hardwired otherwise through redundant bus soft link (MODBUS) from these systems to DCS for status monitoring. Protocol MODBUS for connectivity to DCS shall be applicable. In addition to the soft link, provision for hardwired START, STOP and LOAD & UNLOAD commands from DCS to all the compressors & their status feedbacks to DCS shall also be provided. Bidder to furnish the configuration diagram of control system of compressor showing communication with DCS along with the bid. 3. The requirements given are to be read in conjunction with detailed Technical specification enclosed. 4. The scope of cable shall be referred in Electrical scope split sheet in Electrical portion of the specification. 5. Compressors operation and bearing temperature / vibration monitoring in main DCS shall be through redundant bus serial link interface between Compressor control system and DCS, however Compressor Start/ Stop signals shall be hardwired with DCS. 6. All transmitters shall be smart type and shall have 4-20mA DC signal with superimposed digital communication (HART) on 24V DC powering. 7. Plant schematic for monitoring & operation shall be available on all the OWS. Bidder to further submit list of signals along with applicable schematic for monitoring in DCS. 8. Bidder to include all the instruments (PG, PS, LS, TS, Dew Point meter etc.) required for the package along with fittings, accessories and valve manifold. 9. The solenoid operated valves shall have limit switches for open/ close feedback. 10. All motor operated valves/electric actuators shall be envisaged with integral starter. Typical Hook Up diagram of all types of drives is attached for use (subject to Customer approval). 11. All pneumatic operated regulating control valves shall be envisaged with smart positioner. 12. The junction boxes for termination of instruments /actuator limit switches/solenoid valve limit switches etc. are in bidder's scope.		

	Specific Technical Requirement For Compressed Air System	1X370 MW CCPP YELHANKA
13. Bidder to provide RTDs (PT-100) for bearing & winding temperature measurements of Fans, Pumps, H.T. motors & other equipment. 14. 415V, 3ϕ AC supply shall be provided by BHEL at a single point, further distribution to various instruments/equipments of the CAS shall be in Bidder's scope. Bidder to include the necessary power distribution board in his scope. Any power supply other than the above, if required for any instrument/equipment has to be derived from the above supply & all the necessary hardware for the same shall be in Bidder's scope. 15. Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered. 16. Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no instruments / analyzers & JB's/Racks should be protruding on the walkway. 17. Instrument installation and accessories required and same shall be in Bidder's scope and shall be subject to customer/BHEL approval during detailed engineering. 18. Bidder to provide erection hardware including junction boxes, canopies, structural steel as required. 19. Bidder shall provide Cable Schedule in BHEL excel format which shall be provided during detailed engineering. Also, Cable Interconnections for Complete System shall be in Bidders' scope. DCS side details for hardwired signals shall be furnished by BHEL during detailed engineering. 20. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with. In case of any contradiction most stringent clause/condition shall prevail. 21. Typical Drive Control Philosophy is provided in section D, 1.1. Same shall be used by bidder for deciding signal interface between Microprocessor panel & MCC/SWGR and between DCS & Solenoid valve/Actuator/Analog drive. 22. Drawings/Documents and data to be furnished after award of the contract: 1. Control & operational write-up for the system 2. System Configuration Diagram 3. Recommended control scheme/ block logic diagram 4. Process manuscript for implementation in DCS 5. Drive List and I/O list 6. Power requirement and grounding scheme		

	Specific Technical Requirement For Compressed Air System	1X370 MW CCPP YELHANKA
7. Field instruments quality plan 8. Electrical Wiring Diagram for Compressor LCP 9. Instruments data sheet 10. JB/LIE/LIR Grouping document 11. Cable schedule(BHEL format) and cable interconnection drawing 12. Instrument schedule 13. Any other document decided during detailed engineering. Notes: 1. All equipment items shall be of latest design with proven on track record. 2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL. 3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication. 4. In case of any discrepancy in Section-C and Section-D of the specification, Section-C shall prevail.		



Technical specification for
CONTROL & INSTRUMENTATION
1X370 MW CCPP AT YELHANKA

SECTION D

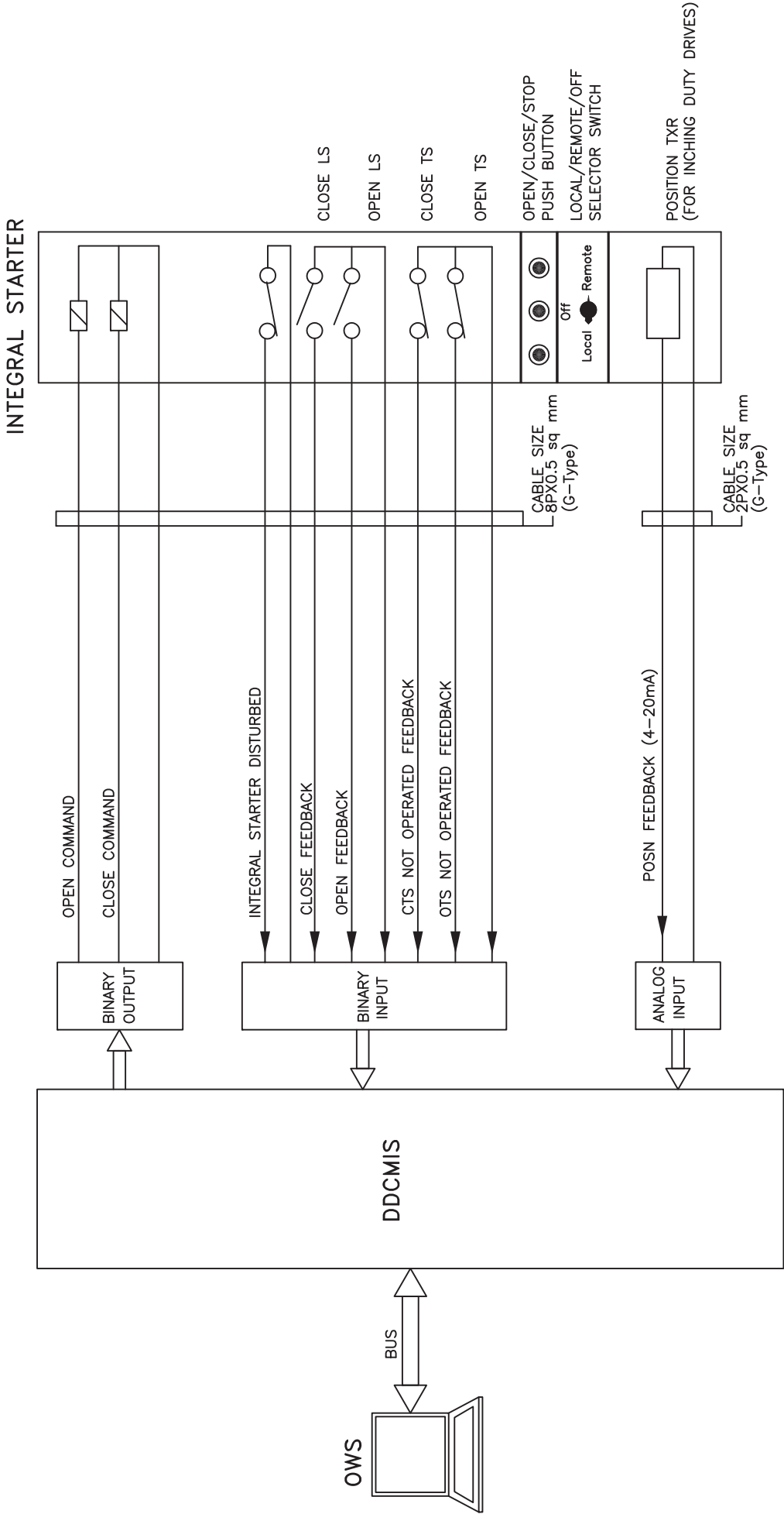
REV. NO. 00

DATE : 16.01.2016

SECTION - D

DRIVE CONTROL PHILOSOPHY

DCS INTERFACE FOR BIDIRECTIONAL DRIVE (WITH INTEGRAL STARTER)



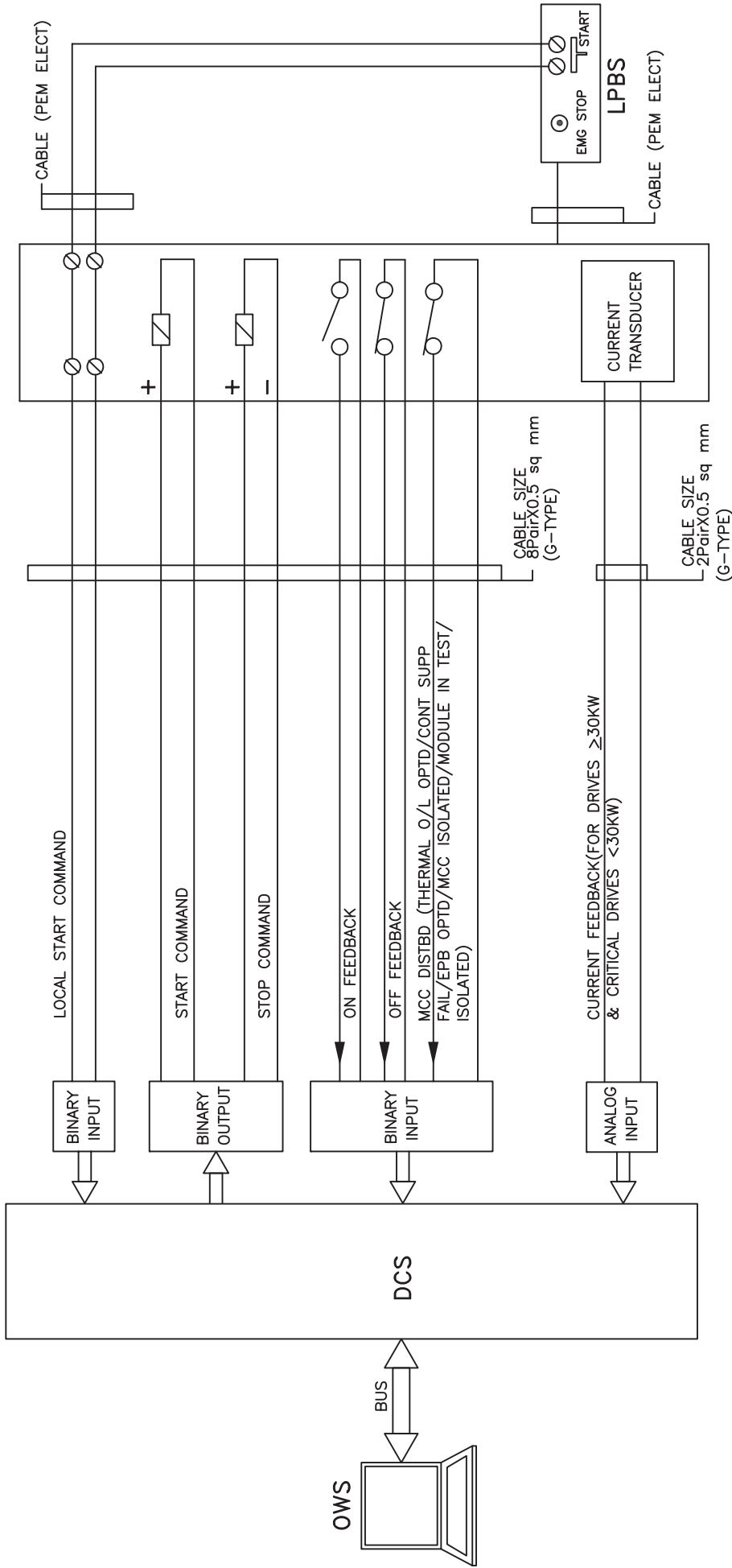
NOTE:

1. DISTURBED= Loss of Power supply (1 Phase/3 Phase),
Loss of control supply, Motor thermostate trip,
Thermal over load relay trip etc.

	PROJECT: KARNATAKA POWER CORPORATION LIMITED 1x370 MW YELAHANKA COMBINED CYCLE POWER PLANT		DRG.NO.	PE-DM-409-145-I002
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE		DATE	19.01.2016
			REV.NO.	00
			SHT	8 OF 13 77

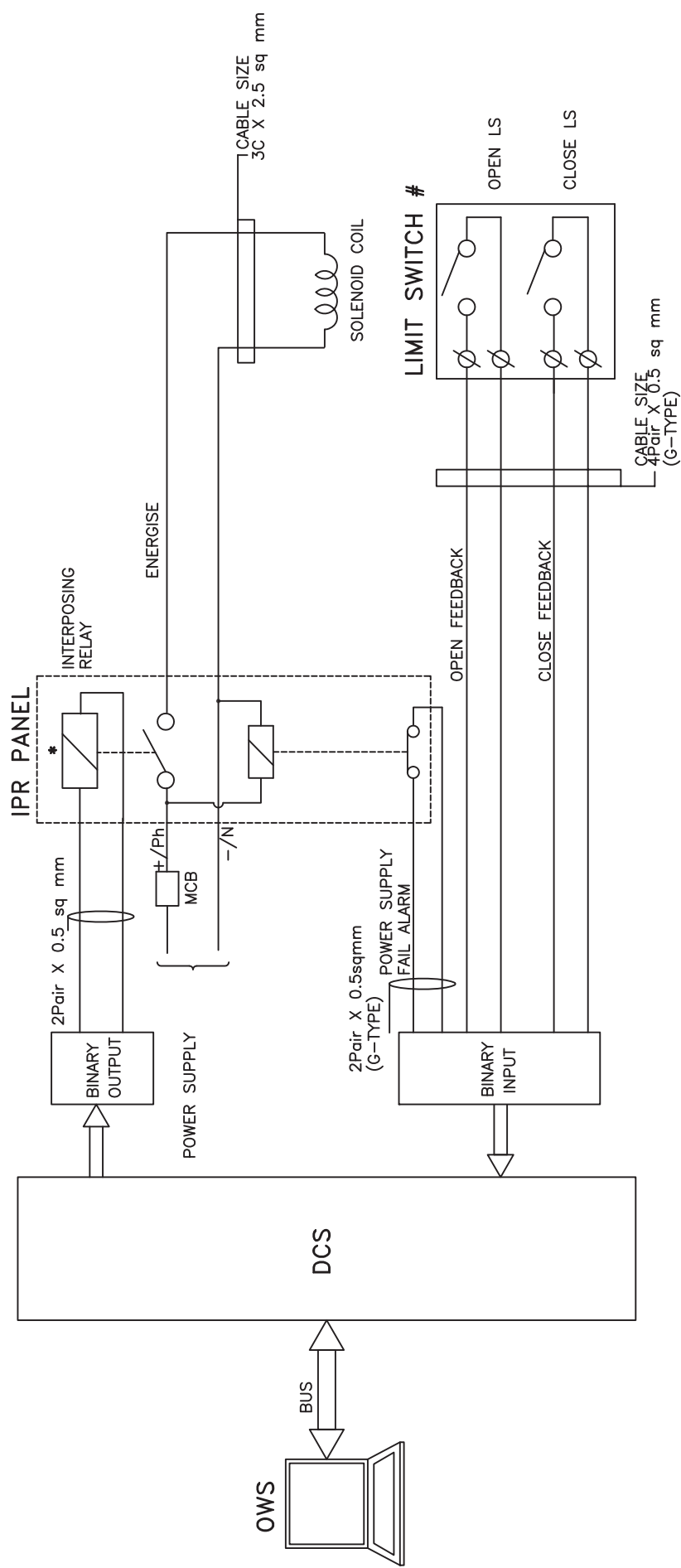
DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE-CONTACTOR OPERATED

MCC



	PROJECT: KARNATAKA POWER CORPORATION LIMITED 1x370 MW YELAHANKA COMBINED CYCLE POWER PLANT		DRG.NO.	PE-DW-409-145-I002
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE-CONTACTOR OPERATED		DATE	19.01.2016
			REV.NO.	00
			SHT	9 OF 13 78

DCS INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS)



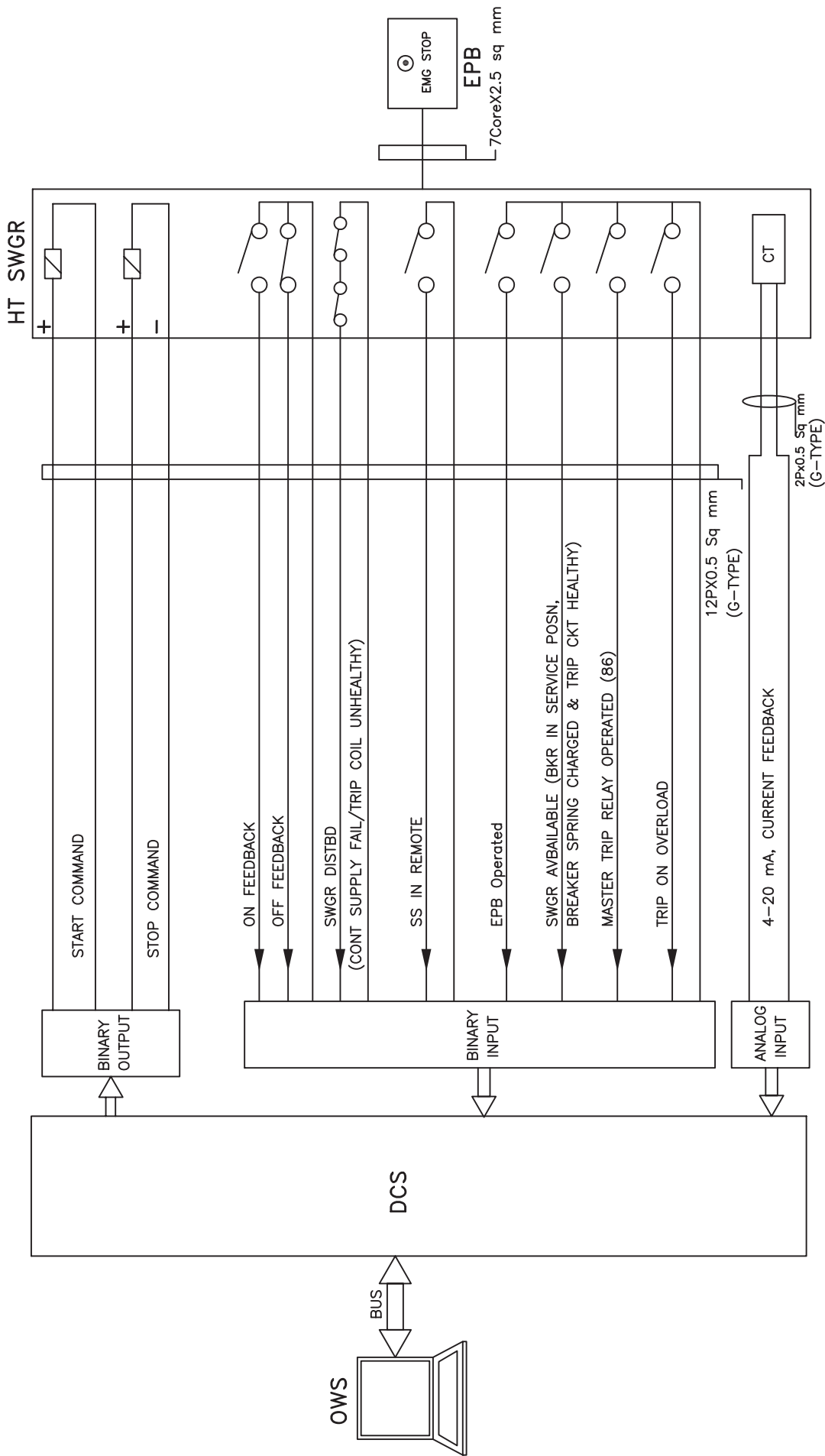
NOTES:

* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

	PROJECT: KARNATAKA POWER CORPORATION LIMITED 1x370 MW YELAHANKA COMBINED CYCLE POWER PLANT			DRG.NO.	PE-DM-409-145-1002		
	TITLE DDCMIS INTERFACE FOR SOLENOID DRIVE			DATE	19.01.2016		
				REV.NO.	00		
				SHT	10	OF	13 79

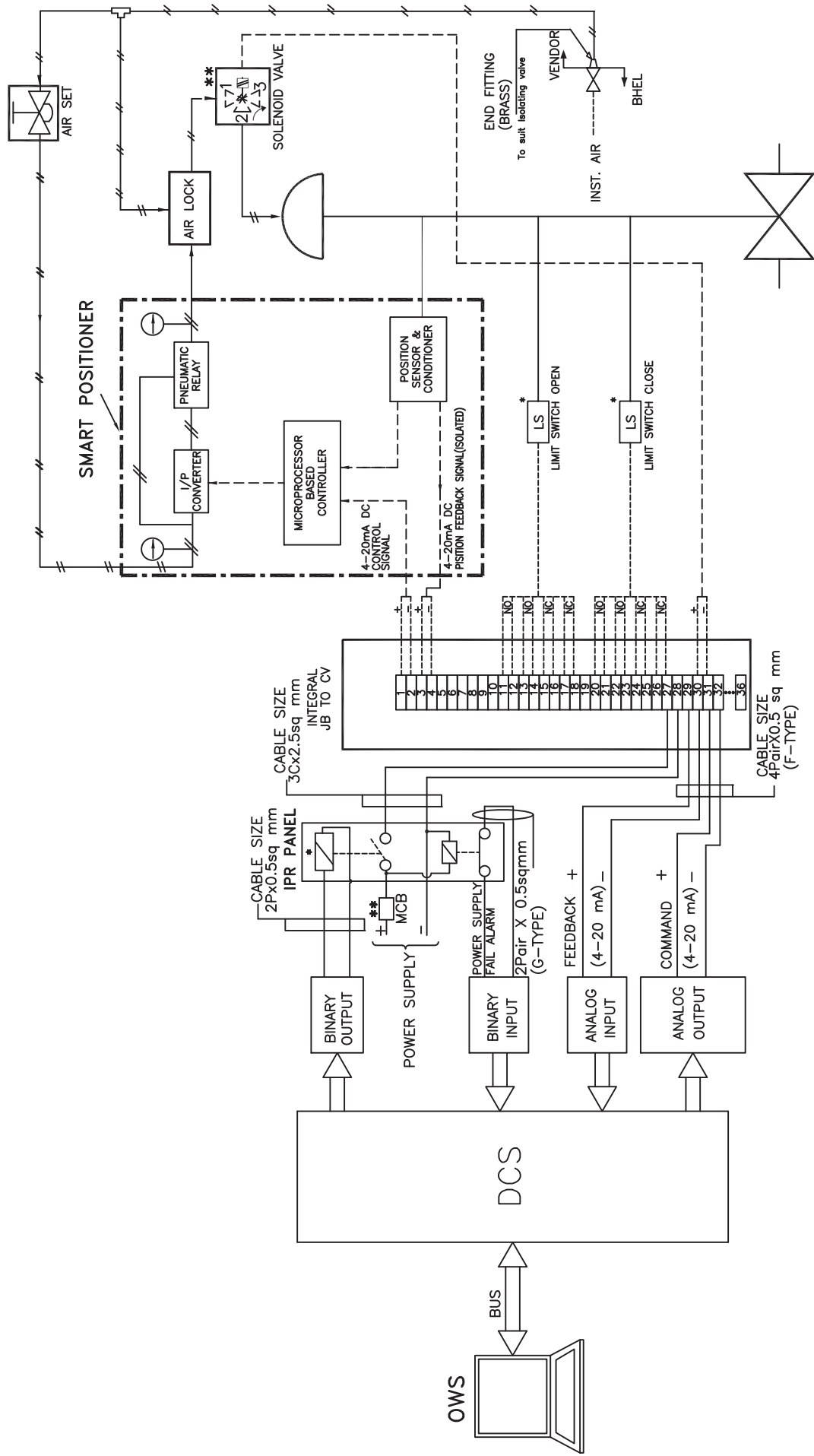
DCS INTERFACE FOR UNIDIRECTIONAL HT/LT DRIVE-BREAKER OPERATED



PROJECT: KARNATAKA POWER CORPORATION LIMITED
1x370 MW YELAHANKA COMBINED CYCLE POWER PLANT
TITLE DDCMIS INTERFACE FOR
UNIDIRECTIONAL HT/LT DRIVE-BREAKER OPERATED

DRG.NO.	PE-DM-409-145-1002
DATE	19.01.2016
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DCS INTERFACE FOR ANALOG DRIVE



NOTE:-

- ** WHEREVER REQUIRED
- * WHEREVER REQUIRED LIMIT SWITCHES SHALL BE WIRED TO DCS FOR INTERLOCK (RECIRCULATION VALVES, ON/OFF DUTY CONTROL VALVES & WHEREVER REQUIRED FOR INTERLOCK).



PROJECT: KARNATAKA POWER CORPORATION LIMITED
1x370 MW YELAHANKA COMBINED CYCLE POWER PLANT

TITLE TYPICAL HOOK-UP DIAGRAM
ANALOG DRIVE

DRG.NO.	PE-DM-409-145-1002
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Technical specification for
CONTROL & INSTRUMENTATION
1X370 MW CCPP AT YELHANKA

SECTION D

REV. NO. 00

DATE : 16.01.2016

INSTRUMENTS SPECIFICATIONS

- Storage and comparative analysis of vibrations.
- Generation/analysis of Bode plot/orbit plot and time waveform/ Nyquist plot etc.

All the vibration parameters as well as turbine supervisory parameters shall also be fed to the DDC MIS through software link so that all these parameters are suitably displayed on the TG control Monitor. All required I/O cards and software interface modules shall be provided for this purpose. The signals required for interlocking and protection shall be hardwired to DDC MIS.

BFP TURBINE SUPERVISORY INSTRUMENTS

The turbine supervisory equipment for Boiler Feed Pumps shall be complete including sensors, transmitters, measuring and amplifier modules, power supplies etc. along with required accessories.

Following measurements shall be provided as a minimum:

Shaft eccentricity, (both in horizontal & vertical direction) Axial shift
Differential expansion, Overall expansion, Speed (triple pick ups), Bearing metal temperature for all bearings, Stop valve metal temperature. (Also refer TD BFP TG equipment specification)

The vibration monitoring system shall acquire inputs from GTGs, STG and major 6.6 kV auxiliaries like HP/IP HRSG feed pumps.

2.16 General Guidelines for Provision of Instruments

FIELD INSTRUMENTS SHALL BE SUPPLIED AS PER AGREED PID :

- PRESSURE TRANSMITTERS
- DIFF. PRESSURE TRANSMITTERS
- DISPLACEMENT TYPE LEVEL TRANSMITTERS
- THERMOCOUPLES WITH THERMOWELLS
- RESISTANCE TEMPERATURE DETECTORS (PT 100)
- PRESSURE GAUGES
- DIFFERENTIAL PRESSURE GAUGES
- TEMPERATURE GAUGES
- LEVEL GAUGES
- PRESSURE SWITCHES
- DIFFERENTIAL PRESSURE SWITCHES
- LEVEL SWITCHES
- SIGHT FLOW INDICATOR
- OIL FLOW METER
- ROTAMETERS
- FLOW SWITCH
- ANUBAR

TECHNICAL SPECIFICATIONS FOR FIELD INSTRUMENTS, PLC, VMS, CCTV AND OTHER EQUIPMENT/SYSTEMS

- All instruments offered by the Contractor shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven as mentioned in design criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications.
- The Contractor shall furnish all Instrumentation/ Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Employer during detailed engineering. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/ erection of these transmitters shall be furnished, even if not specifically asked for, on as required basis. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm

Smart Electronic Transmitters for Measurement of Pressure, Differential Pressure(DP) & Flow/Level(DP Type):

- Micro-processor based indicating type (LCD display), rack mounted with accuracy of $\pm 0.1\%$ of span, Repeatability $\pm 0.05\%$ of FSR or better, Linearity $\pm 0.1\%$ of FSR or better. Hysteresis: $\pm 0.1\%$ of FSR or better. external zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4- 20 mA DC. IP 65 or equivalent degree of protection with epoxy coating, 316 SS/ Hastelloy/ other suitable sensing element. Accessories like snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armoured capillary for corrosive and oil services, etc. Material for accessories will be SS. HART protocol output shall be available in each transmitter. In case it becomes necessary to use a DP transmitter for pressure measurement then a 3-valve manifold should be used in place of 2-valve manifold. LVDT type is not acceptable.
- Wherever, 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

In Detail Technical Specification:

- 1) Type of Transmitter: Microprocessor based 2 wire type HART protocol compatible,
- 2) Accuracy : $\pm 0.1\%$ of span

- 3) Output Signal Range: 4-20 mA DC(Analog) Super imposed digital on HART protocol
- 4) Turn Down Ratio : 10:1 for vacuum/very low pressure applications
30:1/100:1 for other applications
- 5) Stability: +/-0.1% of calibrated span for 6 months up to 70 KSC & +/- 0.25% for range more than 70 KSC(g).
- 6) Zero and Span Drift: +/- 0.015% per Deg.C at max. span and 0.11% per Deg.C at Minimum Span
- 7) Load Impedance: 500 ohm (Min)
- 8) Housing: Weather proof as per IP-65 with durable corrosion resistant coating
- 9) Over Pressure - 150 % of Max. operating pressure
- 10) Connection(Electrical)- Plug and socket type
- 11) Process Connection - 1/2 inch NPT (F)
- 12) Span and Zero: Continuous, tamper proof, Remote Adjustability as well as manual from instrument with zero suppression and elevation facility.
- 13) Accessories
 - a) Diaphragm seal, pulsation dampeners syphon etc. as required by service and operating condition.
 - b) 2/3/5 Valve manifold as applicable
- 14) Diagnostics: Self Indicating Feature
- 15) Power Supply: 24 V DC +/- 10%
- 16) Adjustment : Calibration facility via Centralized PC based HART management system

In addition to the transmitters 6 Nos. of hand held calibrators for configuration shall be provided for maintenance of units

2.16.1 **Pressure indicators** shall be provided for

Suction and discharge lines of pumps including on header section if two or more pumps are employed for the same service and transmitters.

2.16.2 **Pressure switches** shall be provided for

- (a) On all process lines / equipment where parameter abnormality / status including pre-trips alarms to be communicated to the operator in control room.
- (b) For all permissives and protection conditions governed by safety operation of the equipment e.g., pressure adequate, pressure very high / low conditions.
- (c) For all interlock conditions which governs starting of standby equipment or subsequent equipment for safety operation of the system.

- (d) 3 switches shall be employed for protection in case of critical applications.

Inlet and outlet of filters / strainers.

2.16.3 **Differential Pressure Switches** shall be provided

- (a) Across filters / strainers for remote monitoring
- (b) Across condenser CW line for remote monitoring and interlocks.

2.16.4 **Differential pressure indicators** shall be provided

- (a) Across filters / strainers for local monitoring.
- (b) Across condenser CW line for local monitoring

2.16.5 **Pressure Transmitters** shall be provided

- (a) At suction and discharge of all major pumps.
- (b) For all control applications as demanded by the process. It shall be noted that for all critical control applications, 3 transmitters shall be provided.
- (c) Pressure conditions of all major vessels / tanks like deaerator, hotwell, HP / IP / LP drums, etc.
- (d) All inputs for equipment / unit performance calculation.

2.16.6 **Differential pressure transmitters** shall be provided for

- (a) all the requirements of differential pressure, flow and level measurements.
- (b) control applications.

All inputs for equipment / unit performance calculation.

2.16.7 **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 equipment such as heaters, desuperheaters, Heat exchangers and coolers for both the fluid media.

2.16.8 **Temperature switches** shall be provided

- (a) On all process lines where parameter abnormality is to be communicated to the operator in control room.
- (b) For all permissive, interlock and protection conditions governed by the safety operation of the equipment. For all critical services 3 nos., shall be provided for protection application.

2.16.9 **Resistance temperature detectors (RTD's)** shall be provided for all services where maximum temperature does not exceed 150 degree centigrade. RTD shall be 3 wire type, duplex with thermowell.

E.g., Suction / Discharge of pumps, inlet / outlet of heat exchangers, pump / motor bearings, motor windings, etc. RTD is employed for remote display, for control applications and density correction for flow measurement.

2.16.10 **Thermocouple**: Shall be provided for all services where normal operating temperature exceeds 150⁰C.

- (a) The element shall be duplexed integral with thermowell, K-type for temperature upto 600⁰C and R-type for temperature above 600⁰C.
- (b) The thermocouple is employed for remote display, for control applications and density correction for flow measurements.
- (c) Compensating cable shall be provided with all thermocouples as required to make the system complete.

2.16.11 **Temperature transmitters**: Shall be provided where thermocouples / RTD are used for control application. For bearing temperature, winding temperature and metal temperature, field located remote multiplexing units with digital communication to control room electronics can be considered. Otherwise, thermocouples with compensating cable to control room also can be run.

Temperature transmitters shall be mounted in marshalling cabinets in electronic cubicle room, compensating cables shall be run from the temperature element to the temperature transmitters.

2.16.12 **Level gauges:** Shall be provided on all tanks and the maximum length of one gauge glass shall not exceed 1 metre. The gauge glasses shall be stacked to cover the complete height of the tanks including over flow level. All high pressure vessel shall be provided with level gauges on either end as per Boiler statutory requirement.

2.16.13 **Level switches** : The instrument shall be provided on all equipment (storage vessel) where parameter abnormality / status to be communicated to the operator in the control room.

All permissive, interlock and protection conditions governed by the safety operation of the equipment. For all critical services, 3 switches shall be provided for protection application.

The instrument shall be external cage type with SW connection with isolation facility for surface mounted tanks and top mounted with still pipe for all sumps.

2.16.14 **Level transmitters** shall be provided on process equipment where continuous remote monitoring and/or control of level is envisaged.

The instrument shall be differential pressure type or displacement type.

2.16.15 **Flow Glasses** shall be provided at the outlet of the pipe line shall be employed under the following conditions:

Coolant from the equipment (coolers).

The instrument shall be rotary type with glass mounted for indication.

Upto 4 inch on-line flow glasses shall be supplied and above 4 inch bypass type flow glasses shall be provided.

2.16.16 **Flow Switches** shall be provided at different outlet header of identical equipment to alarm in the event of inadequate coolant requirement. (or) lub oil.

2.16.17 **Flow elements** shall be provided as mentioned below.

Orifice plate shall be provided for spray water, condensate, makeup water, LP steam/feed water. Flow nozzle shall be provided for HP/IP Feedwater, HP/IP steam, HP / LP Bypass system. The flow element connection shall be Butt welded except for DM water application where flanged connection shall be used.

2.16.18 **Control valves** shall be provided for all control application as required and in line with the system requirement. If the process

demands any other control, then control valves shall be provided for those applications also. Where a single control valve can not meet the turned down ratio as dictated by the process, control valves with split range application shall be provided. All bypass valves of control valves shall be suitable for inching operation and provided with position transmitters. Critical controls like feedwater control shall be provided with 100% standby control valve.

2.16.19 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.

2.16.20 **Valve / Damper Actuator**

All pneumatic actuators (valves / dampers) for ON/OFF and regulating services shall be complete with all accessories including the following:

- (a) Hand wheel with lock.
- (b) Air filter regulator.
- (c) Air lock relay
- (d) Pneumatic tubing from nearest air header to the actuator complete with all necessary fittings.
- (e) Smart positioner for regulating services
- (f) End position (open / close) limit switches.
- (g) Local position indicator and non-contact type position transmitter with 2 wire, 4-20 mA DC output for regulating services.

- (h) Necessary solenoid valves required for open / close operation and interlock functions.
 - (i) Smart position converters for the regulating services, suitable for accepting 4-20mA DC signal.
 - (j) Junction box near the valve for terminating the limit switch / position transmitter / E-P converter signals.
- 2.16.21 Smart Position transmitters shall be provided for all control valves, control damper and bypass valves / dampers, where modulating / inching operation is required.
- 2.16.22 Smart Positions shall be provided for all pneumatically operated control valves, control dampers, power cylinders, etc., for converting controller output of 4-20mA to 3-15 psi or interfacing with pneumatic actuators. For the service in heat proven area conventional positions shall be provided.
- 2.16.23 **Air filter regulators shall be provided in the :**
 - (a) Air supply line to valve positioners / power cylinders
 - (b) Air supply line to electric to pneumatic converters.
 - (c) Air supply line to pneumatic interlocked block valves.
 - (d) For each instrument rack, field instruments enclosure for purging.
- 2.16.24 **Analytical Instruments**
 - (a) **Steam and water quality measurement**

The various analytical instruments complete with their sampling system and sampling racks shall be provided for continuous monitoring of the quality of the process fluid as per Table – 1

These analysers shall be kept in an air conditioned sampling room near HRSG area.

(b) **Gas analysers**

The following gas analysers shall be provided at the location indicated below:

- HRSG stack for each HRSG: SO₂, NO_x, SPM.

2.16.25 **Transmitter racks**

All the pressure, flow and level transmitters shall be grouped depending the geographical locations and mounted on transmitter racks.

2.16.26 **Junction boxes shall be provided for :**

- (a) Termination of all sensors and transmitters located area-wise.
- (b) Termination of transmitters mounted on the transmitter racks.
- (c) Termination of both the contacts of switches and duplex elements of temperature measurement.

2.17 **Instrumentation and Control Cables**

Instrumentation and control cables and power cables shall be supplied to :

- (a) Connect field instruments to marshalling cabinets in the control room through field junction boxes.
- (b) Connect limit switches, torque switches, proximity switches, and position transmitters to their respective motor control centres / switchgears and marshalling cabinets through field junction boxes.
- (c) Connect interposing relay contacts from relay cabinet in the control room, the motor control centres / switchgears and solenoid valves through power supply distribution board.
- (d) Control desk cabling, annunciation/SER system cabling, power supply cables from distribution board to system cabinet.

Specification for cables is covered in Electrical Section.

2.18 **Impulse Pipes and Fittings**

Impulse pipes, tubes, fittings and air supply and signal piping / tubing shall be supplied for all the instruments under the scope of this specification as per Table 1 in this section.

2.19 **Selection of Ranges for Instruments**

The ranges of the instruments shall be selected based on the philosophy indicated below:

- (a) For pressure and draft measurements, the maximum operating pressure shall be within 70 to 80% of the maximum scale range. All pump suction measurement will cover the negative pressure range also and all draft gauges will cover the negative pressure as well as the positive pressure as the case may be.
- (b) For temperature measurement, the maximum operating temperature will be within 80 to 90% of the maximum scale range.
- (c) For pressure switches and temperature switches, the set points shall fall within 40% to 70% of the scale range selected.
- (d) For level measurement, the maximum of the range will cover the overflow point or six inches from the top of the vessel and the minimum of the range will be stacked with overlap to cover permissive, alarm and trip levels.

2.20 **Performance Test Points**

- (a) Pressure, temperature and flow test points shall be provided in line with performance test code requirements
- (b) Pressure test points shall be complete with root valves and shall terminate with a nipple
- (c) Temperature test points shall be provided with thermowell.
- (d) All instruments required for performance testing to prove the performance of the Instrumentation and Control Equipment shall be provided by the Contractor for the duration of the performance test. These test instruments shall have test certificates from reputed test house valid for the duration of the performance test.

- 2.22.3.6 Tables suitable for dot matrix/laser/inkjet printers shall be provided. The exact details shall be finalised & approved during detailed engineering.

2.23 **Specifications for Instruments**

2.23.1 **Pressure Indicators**

Direct reading, pipe mounted Pressure gauges of aluminium casing with 150 mm inch phenolic dial (white dial with black numerals), 316 SS Bourdon tube, nylon movements and micrometer type adjustable pointer, accuracy of $\pm 0.5\%$ of span including accessories like syphons for steam services, snubbers for pump discharge applications and chemical diaphragm for corrosive and oil services and name plate. Material of accessories will be SS. IP65 or equivalent degree of protection for enclosure. Over range protection will be 25% above maximum pressure. Armoured capillary of 15m shall be provided. Bourdon tube shall be drawn tube for pressure < 70 bar (g) and bored tube for > 70 bar (g).

2.23.2 **Pressure Switches**

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 syphons for steam services, snubbers for pump discharge applications and chemical diaphragm for corrosive and oil services, name plate and 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 repeatability shall be $\pm 0.5\%$ of full scale range.

2.23.3 **Pressure Transmitters**

Micro-processor based **Smart Electronic Transmitters**, rack mounted with accuracy of $\pm 0.1\%$ of span, field zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4-20 mA DC and digital signal with HART protocol. Two nos. HART communicator with pre-loaded device program shall be provided for smart pressure / differential pressure transmitters. 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 armoured capillary for corrosive and oil services. Material for accessories will be SS.

2.23.4 **Differential Pressure Indicators**

Direct reading type, pipe mounted, bellows or diaphragm operated differential pressure indicators; aluminium casing (epoxy coated) with 150 mm dial, 316 SS pressure element; 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 3 way manifold. Material of accessories will be SS. IP 65 or equivalent degree of protection. Over range protection will be 50% above maximum pressure.

2.23.5 **Differential Pressure Switches**

Bellows or diaphragm operated non-indicating field mounted type; aluminium casing (epoxy coated); 316 SS pressure element nylon movement; accuracy of $\pm 1\%$ of span with an 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 3 way manifold. 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 50% above maximum pressure. Repeatability shall be $\pm 0.5\%$ FSR.

2.23.6 **Smart Electronic Transmitters for Measurement of Pressure, Differential Pressure(DP) & Flow/Level(DP Type):**

Micro-processor based indicating type (LCD display), rack mounted with accuracy of $\pm 0.1\%$ of span, Repeatability $\pm 0.05\%$ of FSR or better, Linearity $\pm 0.1\%$ of FSR or better. Hysteresis: $\pm 0.1\%$ of FSR or better external zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4- 20 mA DC. IP 65 or equivalent degree of protection with epoxy coating, 316 SS/ Hastelloy/ other suitable sensing element. Accessories like snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armoured capillary for corrosive and oil services, etc. Material for accessories will be SS. HART protocol output shall be available in each transmitter.

In case it becomes necessary to use a DP transmitter for pressure measurement then a 3-valve manifold should be used in place of 2-valve manifold. LVDT type is not acceptable.

Wherever, 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.

2.23.7 **Thermometers**

Indicating type, field mounted, filled system with ten (10) metres capillary and six (6) inch white dial with black numerals with micrometer pointer housed in aluminium 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 316 SS thermowell having a process connection of M33 x 2 thread. Material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure. Thermowell with Hex head of fabricated assembly for air and flue gas system for rest of the services bar stock assembly. The thermowell construction shall meet the ANSI 19.3 (latest) requirements.

2.23.8 **Thermowells**

Pipe/equipment mounted temperature test wells of 316 SS (SS 446 for flue gas services) with a process connection of M33x2 thread. Material of accessories will be SS. Thermowell with hex head of fabricated assembly for air and flue gas system, for rest of the services 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. (latest) requirements.

2.23.9 **Temperature Switch**

Non-indicating type, field mounted, filled system with ten (10) metre capillary housed in Aluminium casing (epoxy coated) with an accuracy of $\pm 1\%$ span, auto temperature calibration, linear calibration over the range and 316 SS thermowell having a process connection of M33x2 thread. Micro switch with reset type with adjustable set values with 2 SPDT contacts rated for 0.2 A, 220 V DC. IP 54 or equivalent degree of protection for enclosure. Thermowell with hex head of fabricated assembly for air and flue gas system, for rest of the services bar stock assembly. Material of accessories will be SS. The thermowell construction shall meet the ANSI 19.3 (latest) requirements. Scale shall be provided for setting. Repeatability shall be $\pm 0.5\%$ of full scale. For ambient temperature applications switches designed for cross ambient operation shall be used.

2.23.10 **Thermocouple Assembly**

Duplex type with accuracy of $\pm 0.5\%$ of span, response time of 2 to 6 sec, Spring loaded mineral insulated thermocouple assembly with 316 SS thermowell housed in aluminium casing (epoxy coated) having a process connection of M33 x 2 thread. Material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure. Thermowell with hex head of fabricated assembly for air and flue gas system, for rest of the services bar stock assembly with ungrounded junction. For metal temperature measurement weldable thermocouple pads shall be provided with thermocouple extension wires of required length. Element size shall be 18 AWG. Insulation resistance at 540°C shall not be less than 5 M Ω . Temperature devices provided with thermowells shall be calibrated with the associated thermowell as an assembly construction and shall meet the ANSI 19.3 (latest) requirements.

2.23.11 **Resistance Temperature Detectors (RTD)**

Duplex type with accuracy of $\pm 0.5\%$ of span, response time 1-2 seconds; Spring loaded mineral insulated three (3) wire RTD assembly with 316 SS Thermowell housed in aluminium casing (epoxy coated) having a process connection of M33 x 2 thread. IP 54 or equivalent degree of protection for enclosure. Material of accessories will be SS.

2.23.12 **Temperature Transmitters Smart Electronic Transmitters:**

Temperature transmitters shall be provided where thermocouples/RTD'S are used for control application.

Indicating type, control room mounted temperature transmitters with an accuracy of $\pm 0.25\%$, ref. junction compensation, span/zero adjustment, burn out protection upscale, input/output isolation, circuit ungrounded, ambient temperature error 0.1%/10°C to provide linear output of 4-20 mA DC (2 wire system). Nema 4 or equivalent degree of protection for enclosure. Material of accessories will be SS.

2.23.13 **Level Gauges**

Reflex / tubular type with automatic ball check valves, illuminator, pyrex / borosilicate glass, guard rods and Holders. Material of accessories will be SS.

2.23.14 **Level Switches**

External magnetic float operated level switches for tanks and vessels and top mounted level switches for sumps and underground tanks. Micro switch with 2 SPDT contacts rated for 0.2 A, 220 V DC. Material of float will be 316 SS and the material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure.

2.23.15 **Displacement Type Level TransmittersSmart Electronic Transmitters:**

Displacement type level transmitters of float length of 14 inches or 32 inches with an accuracy of $\pm 0.5\%$ of span, 4-20 mA DC output (2 wire system), +24 V DC supply, isolated and ungrounded electrical circuits, zero adjustment (100% of sensing element) for control application and measurement purposes. IP 54 or equivalent degree of protection for enclosure. Displacer / float material of 316SS. The material of accessories will be SS.

2.23.16 **Flow Glasses**

Online flow glasses for pipe size up to 80 mm with a rotary wheel (not a flapper type) suitable for installation on vertical or horizontal pipe lines, material pyrex tempered glass. The material of accessories will be SS.

2.23.17 **Flow Elements**

316 SS long radius, weld in flow nozzles with D and D/2 pressure tappings; 316SS flow orifice plate assembly with flange tap connections; β ratio of 0.5 to 0.7. Element material of SS 316. The material of accessories will be SS. End connections for flow elements will be butt welded except orifice plate on condensate return line to CST which will be flanged. The flow elements shall be designed in accordance with ISO 5167 / BS 1042. The accuracy of the flow element for steam flow / feed water flow measurement shall be $\pm 2\%$ or better. Unit of measurement shall be metric tonnes / hour.

2.23.18 **Air Filter Regulator (AFR)**

Constant bleed type AFR with an accuracy of $\pm 0.1\%$, inlet pressure range of 5-8 kg/ cm² and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS.

2.23.19 **Electro-Pneumatic Convertors (E/P)**

Two wire type E/P convertors with an accuracy of $\pm 0.5\%$ accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm² air pressure to operate valve positioner of all final control elements; Housed in cast aluminium casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS.

2.23.20 **Pressure and Differential Pressure Transmitter Racks**

Open type transmitter racks to mount all pressure, differential pressure and flow transmitters with vibration damper (Keldur); air supply lines and header will be provided with bulk head fittings to receive impulse lines; Also provided with blow down/drain header. The material of accessories will be SS.

2.23.21 **Junction Boxes**

Wall/column mounted junction boxes having screwed terminals and cable entry only at the bottom and sealed with fire proof compound; The material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure. Separate terminal blocks shall be used for analog and digital signals and also for signals with different voltages.

2.23.22 **Interposing Relays (IPR)**

Electro magnetic type IPRs with plug-in type connections, suitable for channel/rail mounting in cabinets; coil rating 24V D.C; 2 set of change over contacts rated for 0.2A 220 V DC. Free wheeling diode across relay coil and self reset type status indicator flag (electronic) shall be provided.

2.23.23 **System Cabinets**

Indoor located, free standing vertical type system cabinets with 3 mm thick sheet metal of cold rolled steel; double doors; antivibration pads of 15 mm thick; Fluorescent lighting; cooling fans in each cabinet fire proof compound for sealing cable entry; fire detector for each cabinet; space heater for each cabinet (strip type). Door locking facility shall be provided. Beacon lamp shall be provided in each row of cabinet to indicate the cabinet having fault condition. The racks in system cabinets shall have provision along with plug in sockets / back plane to house atleast 10% additional cards, to accommodate for engineering flexibility or future expansion.

2.23.39 **Control Valves**

Balanced, modulating, globe type cage guided, diaphragm type of actuator, provision for hand wheel operation with accessories viz. Air filter regulator, air lock device, solenoid valve, position transmitters, limit switches. Valves shall be sized to have an opening of 15% at minimum flow condition and 85% maximum flow condition. Trim exit velocity shall be limited as per ISA standard. Anti – cavitation trims shall be used to limit trim velocity for all critical applications where flashing or cavitation is expected. Noise level shall not exceed 85 dBA at distance of about 1.5 M from the valve. In case of predicted noise level above 85 dBA, suitable low noise trim shall be provided. Noise abatement shall be obtained by valve body and trim design, and not by use of silencer.

Leakage class for double seated valve shall not exceed 0.05% and single seated valve shall not exceed 0.01%.

Either extended type bonnet or cooling fin type bonnet shall be provided for service above 200⁰C and for other service the bonnet type shall be standard.

The end connections shall be socket welded for sizes below 50 NB and butt welded for sizes 50 NB and above. Flanged connection shall be provided for DM services.

Water seal shall be provided for valves that could be subjected to below atmospheric conditions.

Material of trim shall be minimum 316 SS with guide bushings of hardened SS such as 17-4 pH, 440C or 316SS Stellite faced. Valve stem shall preferably be of chrome plated 316 SS.

The body material for control valves shall generally be as follows:

HP/IP steam services	-	WC9
HP/IP Feed water services	-	WCC
DM water services	-	SS 316
Condensate, Spray water	-	WCB



Technical specification for
CONTROL & INSTRUMENTATION
1X370 MW CCPP AT YELHANKA

SECTION D

REV. NO. 00

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INSTRUMENTS CHECK LIST