NEW NEYVELI TPP

2 X 500 MW

OF

NEYVELI LIGNITE CORPORATION LTD.

TECHNICAL SPECIFICATION

FOR

COMPRESSED AIR SYSTEM

SPECIFICATION NO.: - PE-TS-400-555-A001

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
PPEI BUILDING, NOIDA (U.P.)
INDIA

	INDEX	SPECIFICATION NO. PE-TS-400-555-A001
बी एच ई एल BHEL	COMPRESSED AIR SYSTEM 2 X 500 MW NNTPS, NEYVELI	VOLUME II B & III
		REV. 0

VOLUME – II B
SECTION – A
INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 This specification covers the design, manufacturing, inspection and testing at manufacturer's work, proper packing, delivery to site, and erection and commissioning, final painting & carrying out demonstration tests at site for COMPRESSED AIR SYSTEM as mentioned in the different sections of this specification for 2 X 500 MW NEW NEYVELI TPP (2 X 500 MW).

1.2 The bidder 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 responsibility of providing such facilities to complete the supply, erection and commissioning of the Compressed air system.

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

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

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

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. 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 in the enclosed schedule; otherwise, it will be presumed that the bidder's offer is strictly in line with NIT specification.

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

1.10 Unless specified otherwise, all through the specification, the word bidder shall have same meaning as successful bidder / vendor.

1.11 The standard quality plan is included in this specification to enable the bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the quality plan as minimum requirement during manufacturing and testing.

1.12 Other requirements

Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 2 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

Document approval by customer under Approval category or information category shall not absolve the bidder of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the bidder in writing and require written approval. Unless any change in specified requirement has been brought out by the bidder 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 bidder submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to bidder's account and shall not be used as a reason for extension in contract completion.

VOLUME – II B
SECTION – B
PROJECT INFORMATION

SALIENT FEATURES OF THE SITE & GENERAL PROJECT INFORMATION

1.1 Introduction

The project site at Neyveli has distinct location advantages, being at pit-head distance from the source of lignite supply from Mines, making it convenient for transportation of lignite by belt conveyor. Water source is readily available from the nearby mines lake. Besides, other infrastructure such as access road, railway connection etc, already exist.

1.2 Power Plant Site

The power plant site is located at Neyveli, opposite to the now defunct Fertilizer and Briquetting & Carbonization Plant, near TPS-1 Expansion and TPS-II.

1.3 Project & Site Information

(i).	Owner / Purchaser	:	Neyveli Lignite Corporation Limited (NLC Ltd), Neyveli, Cuddalore District, Tamil Nadu State, India
(ii).	Consultant	:	Lahmeyer International (India) Pvt. Ltd (LII), Gurgaon, NCR, India.
(iii).	Project Title	:	2x500 MW Neyveli New Thermal Power Project (NNTPP)
(iv).	Location	:	200 kms south of Chennai and 50 kms south-west of Cuddalore
(v).	Latitude	:	11° 34' 00" N to 11° 35' 00" N
(vi).	Longitude	:	79° 26' 00" E to 79° 27' 00" E
(vii).	Elevation above MSL	:	(+) 67 m
(viii).	Nearest Railway Station	:	Neyveli,
(ix).	Nearest Sea Port	:	Chennai, at a distance of 200 km
(x).	Nearest Airport	:	Chennai, at a distance of 200 km
(xi).	Road Access/Approach to Site	:	Connected by Chennai-Thanjavur NH 45C road and state highway connecting Cuddalore – Virudhachalam via Neyveli. Both NH and state high way roads are well connected to NLC township roads. The approach road is approximately 15 kms from Chennai–Thanjavur NH – 45C road
(xii).	**Site Meteorological Data**		
	• Max ambient temperature	:	42.8° C
	• Min Ambient Temperature	:	26.9° C
	• Wet bulb temp	:	29° C
	• Max. Relative Humidity	:	92 % in the month of September
	• Min. Relative Humidity		23 % in the month of May

• Rainfall	About 1265.7 mm annually (average)
• Wind direction	South West to North East direction
• Wind Speed	97.2 km/hr (maximum recorded) 4.3 km/hr (average wind speed)
• Seismicity	As per IS: 1893 (part 4) (Zone-II) Importance factor: 1.75.

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VOLUME - II B

SECTION C.1

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.

1.1.1 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 demonstration/acceptance tests at site & final painting of complete Compressed Air System consisting of following equipment's:

1.1.2 Three (3) Nos. Instrument Air Compressors (Oil Free Screw type) each of minimum 36 NM3/Min capacity at 9.0 Kg/cm2 (g) discharge pressure with electric motor drive, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.

1.1.3 Three (3) Nos. Air Drying Plants Heat of compression (HOC) Rotary type / Dual Tower Type of min. 36 NM3/min. capacity connected to above IA compressors with all instruments, control panels and other accessories as specified.

1.1.4 Two (2) Nos. Service Air Compressors (Oil Free Screw type) each of minimum 36 NM3/Min capacity at 9.0 Kg/cm2 (g) (min) discharge pressure with electric motor drive, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.

1.1.5 Seven (7) Nos. Air Receivers of minimum Ten (10) Cu.M capacity each with instruments, relief valve, drain connection with automatic trap stations and other accessories as specified.

1.1.6 Three (3) No. online Electronic Dew point meters.

1.1.7 Pipes & fittings for compressed air line, cooling water & drain line 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 - 1 Lot .

1.1.8 All airline valves & cooling water valves – 1 Lot

1.1.9 Instruments including all instruments necessary for demonstration testing of compressors as well as air drying plants – 1 Lot.

1.1.10 Maintenance tools and tackles, start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – 1 Lot

1.1.11 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-400-555-A001 (Sheet 1 & Sheet 2).

2.2 Cooling water supply will be provided by the purchaser outside the compressor house as per enclosed tender drawing no PE-DG-400-555-A001 A001 (Sheet 1 & Sheet 2). The return hot water shall be terminated by the contractor at the same location.

3. EXCLUSIONS :

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

3.2 Civil works like construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe/cable trenches. However, civil works such as opening in wall, grouting of equipment's & structural material and inserts plates for pipes supports is in the bidder scope of supply.

3.3 Lighting and ventilation of compressor house.

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

4. SUB-VENDOR ITEMS

The tentative make of Sub-vendor items shall be generally as per Section-C.5 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.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

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

6. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

Tentative list of drawing / document required during detail engineering is attached in Volume-III. 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.

7. 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 intimidated to the successful bidder after award of contract and the same shall be complied by the successful bidder without any commercial implication.

8. 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.

9. Mandatory Spares

General requirement of mandatory spares will be as per the list enclosed under Section C.6. 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.

Note: All the spares required for three years normal operation of the equipment/systems shall be supplied over and above the items indicated in the mandatory spares list under Section C.6. The list of such spares shall be clearly included in the mandatory spares list by the bidder. Any such spares found applicable at a later stage shall be supplied without any additional price implication to BHEL.

10. 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 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-II 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.

11. 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 Bidder to confirm that there is no deviation from the technical specification and furnish signed Compliance cum Confirmation Certificate enclosed under Volume-III of the Technical Specification.

5.3 Bidder to submit minimum 10 set of hard prints of drawing & docs. for approval. Also, 10 set of approved documents & O&M Manual to be submitted along with 5 CD's after completion of engg.

VOLUME – II B
SECTION – C.2
SPECIFIC TECHNICAL REQURIEMENTS (MECHANICAL)

1.00.00 FUNCTION

The purpose of this system is to supply the Instrument air for the control of various pneumatically operated instruments & Service air for general plant to the different areas of NNTP, Neyveli (2 x 500 MW) Power Plant as per details specified below.

2.00.00 SYSTEM DESCRIPTION

2.01.01 Compressed air system shall include the following: **Three (3)** numbers (2W + 1S) Instrument air (IA) compressors and **Two (2)** numbers Service air compressor (1W + 1S), including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.
In addition, the service air (SA) compressor may be used for instrument air system connecting ADP with service air compressor in case of failure of instrument air compressor.
Refer P & I diagram attached for detailed arrangement.

2.01.02 **Three (3)** numbers (2W+1S) Heat of Compression (HOC) type air-drying plants (ADP) (Conventional Twin Tower type / single rotary drum type) suitable for connecting to individual instrument air compressor, heater of suitable capacity to be provided with each ADP, if required, to meet the design inlet air temperature for ADP.

2.01.03 Intake air filters, as per details mentioned in clause no. 3.02.08 below.

2.01.04 **10m3** capacity air receivers, total **Seven (7)** numbers (i.e. one for each instrument air & service air compressor, air receivers located outside compressor house & two nos. unit air receiver, one for each unit, located in TG bldg. in B-C bay).

2.01.05 All interconnecting piping, valves, fittings, supports, control air tubing (complete with valves and fittings between air receiver, compressor and local control panel inbuilt for each air compressor), cooling water piping & valves for safe and satisfactory operation of air compressors & compressed air system as a whole.

2.01.06 All instruments including the electronic online dew point meter with suitable sampling connection.

3.00.00 EQUIPMENT DESIGN CRITERIA

The minimum requirements of design and construction features of various components of Compressed air system (oil free, rotary screw type air compressor, HOC air dryer & air receiver etc.) as described below.

3.01.00 Equipment Description & its Performance requirements:

3.01.01 The capacity of Instrument air compressor shall be **36 NM3/min.** Delivery pressure will be **9.0 Kg/cm2 (g)** at outlet of IA compressor & **8.5 kg/ cm2 (g)** at ADP outlet. Each compressor will be designed to deliver the nominal capacity at the designed delivery pressure.

3.01.02 The capacity of Service air compressor shall be **36 NM3/Min.** Delivery pressure will be **9.0 Kg/cm2 (g)** at outlet of SA compressor.

3.01.03 The compressors' capacity will be designed for **45 deg. C DBT and 75% RH** at atmospheric pressure at site & at MSL of **67.0 M.**

3.01.04 The power rating of the driver will be selected such that a margin of 15% is available over the power required to deliver rated capacity against rated pressure.

3.02.00 Screw Air Compressors

3.02.01 CODES AND STANDARDS

3.02.01.01 The design, manufacture, testing and performance of the various components of the Oil free, Rotary Screw type Air Compressors shall comply with the requirements of one or more of the following codes, as applicable :

IS-5456: Code of Practice for testing of positive displacement type air compressors and exhausters.

IS-10431 [part -1]: Measurement of Air Flow of Compressors and Exhausters.

ISO 1217:2009 – Displacement compressors – Acceptance test.

IS-6206: Guide for selection, installation and maintenance of Air compressors with operating pressure up to 10 bars.

Other International Standards like American/BS/DIN etc. equivalent or superior to above mentioned standards are acceptable.

3.02.01.02 The materials of the various components shall conform to the applicable IS/ISO/BS/ASTM/DIN Standards.

3.02.02 PERFORMANCE REQUIREMENT

3.02.02.01 Air Compressors shall be designed for continuous operation with high efficiency to satisfy the performance requirement of design codes & also describe herein as minimum.

3.02.02.02 Noise level shall not exceed **90 dBA** plus tolerances as per IS/ISO standard when measured at a distance of 1.0 meter from the source & at 1.5 meter above the floor. Required acoustic enclosures shall be provided to meet the above condition. The discharge blow off silencer and intake silencers shall be designed to meet the above noise limitation level.

3.02.02.03 As more than one compressor with drive is specified, satisfactory operation in parallel to be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room.

3.02.02.04 In addition to this, pl. refer demonstration guaranteed annexure, mentioned in Section-D of technical specification.

3.02.03 DESIGN AND CONSTRUCTION

3.02.03.01 The design shall be such as to ensure trouble free operation with least vibration and noise. Different parts of the compressor and accessories shall be arranged neatly in a compact manner. Due consideration shall be given for easy accessibility and maintenance of the compressors.

3.02.03.02 The compressor shall be oil free multistage, horizontal, water cooled, rotary screw type, heavy duty, rugged construction.

3.02.03.03 Rotors shall be supported on both sides by suitable antifriction bearings type IS- 25 Grade 84 / equivalent. The rotors shall not touch each other so that there shall be no metal to metal contact between them. The rotors shall have profile that keeps leakage losses to a minimum to ensure high efficiency.

3.02.03.04 The rotor and shaft shall be of single piece construction, made of forged steel (AISI C1141 or equivalent) with suitable corrosion resistant coated material to minimize leakage and wear. The stator (casing) shall be of Cast-Iron (IS-210 grade) with corrosion resistant

material and with integral jacket cooling. The rotors shall be dynamically balanced to reduce vibration.

3.02.03.05 The seal rings and retainers shall be of stainless steel construction and be free for radial self adjustment along the rotor shafts. The seals shall prevent air and oil leakage along the shaft. Air vented from second stage discharge end seals shall provide buffer air to the other seals to prevent migration of oil towards the compression chamber under all operating conditions.

3.02.03.06 The gaskets shall be of asbestos free material & Use of Oil lubricated anti friction type bearings to be at least 8000 running hours.

3.02.04 Lubrication system

3.02.04.01 The compressor package shall include a lubricant management system which shall lubricate the compressor rotors, bearings and seal and also cool the air as per OEM proven & tested designs, however minimum below requirement shall be met.

3.02.04.02 A thermostatically controlled valve shall modulate lubricant around and through the cooler to maintain a constant oil temperature.

3.02.04.03 The lubricant pump shall be shaft driven. An auxiliary motor driven pump shall be provided if required by the manufacturer to supply pre-start and shut down system. All lube oil pumps shall be of rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system will be protected by a relief valve.

3.02.04.04 All tapered roller – type antifriction bearing shall have a L10 rated life of at least 50,000 hours with continuous operation at rated conditions.

3.02.04.05 The lubrication system shall be designed to prevent oil leakage or discharge of oil mist to the compressed air chamber.

3.02.04.06 The lube oil cooler shall be designed for a heat duty corresponding to the peak power demand of the compressors.

3.02.04.07 All instrumentation and accessories in the lubrication circuit shall be as per OEM standard, subjected to safe & trouble-free operation of the compressors meeting customer requriements.

3.02.05 Gear Box

Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position. Gears shall have a rating of AGMA-12 or equivalent.

3.02.06 Moisture Separator

Moisture separator shall be of high efficiency design and provided with vent nozzle and auto drain trap system.

3.02.07 Inter cooler, After cooler& Oil Coolers

3.02.07.01 Inter coolers, After coolers and Oil coolers shall be of water cooled & shell-and-tube type with water on the tube side. Intercoolers & after coolers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.

3.02.07.02 Outlet temperature of air from intercooler shall be suitable to suit the equipment and outlet temperature of air from the compressor house outlet header shall be limited to 45 deg.C. However, the instruments or the pneumatic devices requires air temperature less than 45 deg.C., the same shall be achieved at the outlet header.

3.02.07.03 Coolers shall be provided with removable tube bundle design in accordance with design code TEMA Class C and shall be constructed with removable shell cover.

3.02.07.04 The coolers shall be constructed and arranged to allow removal of tube bundles without dismantling piping or compressor components.

3.02.07.05 Oil Coolers shall be equipped with vent & drain connections on oil and water sides. Oil temperature automatic control valve or bypass construction shall be provided to maintain constant temperature. Vent & drain connections for intercoolers and after coolers shall be provided.

3.02.07.06 Design pressure shall be 12 Kg/cm2 (g) based on shut-off head of cooling water pumps.

3.02.07.07 The coolers shall be designed for maximum heat load and at least 10 percent design margin shall be provided in the number of tubes.

3.02.07.08 Adequately sized safety valves shall be provided for both intercoolers and after coolers.

3.02.07.09 Each intercooler and after cooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.

3.02.07.10 Electrically operated automatic drain trap stations with bypass and isolating valves shall be provided for moisture separators for automatically draining of condensed moisture. The drain trap may be of full bore ball valve operated by capacitance type level switch. Manual draining facility shall also be provided in the drain trap.

3.02.07.11 Cooler shells, channels and covers shall be of carbon steel (SA 285 Gr C or equivalent).Tube sheet shall be of SS and the tubes shall be of SS 304.

3.02.07.12 For the instrument air compressors offered with "Heat of compression" type air drying plants, the after coolers shall also be provided at downstream of Air Drying Plant & also after cooler may be part of ADP assembly.

3.02.08 INTAKE AIR FILTER AND SILENCER

3.02.08.01 Filters with multiple elements quick removal type for easy cleaning shall be provided at suction of each air compressor and also be of heavy-duty dry type.

3.02.08.02 The filters shall be complete with integral silencers. The filtering elements shall be easily removable for cleaning.

3.02.08.03 The filters shall be designed for an efficiency of not less than 95% for particles 3 microns and larger.

3.02.08.04 The silencer shall be of very high efficiency type to adequately dampen the operating noise as per the requirements.

3.02.08.05 Pulsation dampener of approved design shall be provided on the compressor suction and discharge manifold.

3.03.00 AIR DRYING PLANTS

3.03.01 One number Air drying plant shall be provided for each Instrument air compressor. Drying shall be by adsorption process through a desiccant medium.

3.03.02 Capacity of ADP shall be so as to match the free air delivery of the Instrument air compressor.

3.03.03 Air Drying Plant (ADP) shall be of "Heat of Compression (HOC) type" – Rotary drum type / Twin tower type.

3.03.04 Access platforms to approach instruments & others valves for operation & maintenance to be provided.

3.03.03.01 Twin tower type HOC air dryer.

a. Regeneration of desiccant shall be achieved by "Heat of compression" method without any air purge loss.

b. Each ADP shall be provided with two absorber towers each sized for design drying cycle of minimum 8 hours. After this period, the absorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.

c. The reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the absorber tower. The moist air shall be cooled in dehumidifier and passed through the second absorber for final drying.

The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.

d. Each ADP shall be provided with 2 numbers of 100 percent capacity pre-filters and 2 numbers of 100 percent capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand at least 50% of static pressure as differential pressure. The pre-filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.

e. The absorber tower (for Twin tower ADP) shall be designed with sufficient cross sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in absorber vessels. Absorber vessels to be provided with suitable number of inspection/sight windows for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the absorber vessels.

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

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

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

i. Absorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.

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

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

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

(i) Absorber vessel Carbon steel

(ii) All internals of absorber vessels SS 304

(iii) Cooler shells, channels and covers, same as that in intercoolers/Cooler Tube sheet & tubes after coolers

(iv) Blower casing Carbon steel

(v) Blower blades & shaft Stainless steel

(vi) Relief valves Brass or SS

(vii) Desiccant Silica gel or Activated Alumina

(viii) Air piping Galvanized steel

(ix) Valves in Air Line Cast steel or forged steel body with stainless steel trim

(x) Valves in water pipelines SS.

3.03.03.02 Rotary drum type HOC air dryer.

a. This type of HOC dryer is provided with single rotating drum, desiccant packed with in-built regeneration and adsorption compartments.

b. The ADP shall be provided with regeneration line after cooler, electronic drain valves, electric motor etc. shall be provided. The instrumentation for the dryer within the dryer skid, shall be as per OEM proven design ensuring complete safety of the equipment & its performance.

3.04.00 Air Receivers

3.04.01 One air receiver (of 10M3 capacity) for each compressor outside compressor house & one Unit Instrument air receiver for each unit in TG bldg. in B-C bay shall be provided. Also, one receiver for DM plant (2 M3) capacity near DM plant shall be provided.

3.04.02 Receivers (other than unit air receivers) shall be outdoor located and vertical cylindrical vessel with dished ends.

3.04.03 The design pressure and temperature shall be minimum 10 Kg/cm_2 (g) and 50 deg.C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent.

3.04.04 Air receivers are to be provided with gasketted inspection manhole of minimum 500 mm diameter with cover plate, lifting handle, davit cap etc. Opening shall not pierce any seam &shall be as far as possible away from any welded seam.

3.04.05 Receivers shall be of welded construction with minimum number of joints. Longitudinal seam in adjacent sections shall not be in same line. Welding shall be as per relevant codes. Filler material to have composition & structure as that of material welded. Welding electrodes to be approved by Employer. Electrodes to be dried before use.

3.04.06 Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be at least 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure.

3.04.07 Each receiver shall be provided with drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves.

3.04.08 The material of construction of shell, dished ends, flanges, etc of the air receivers shall be of **carbon steel as per SA516 Gr.B** or equivalent.

3.04.09 The corrosion allowance of 2.5 mm shall be considered while deciding the plate thickness.

3.04.10 Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, temperature gauge & with minimum 500 mm dia. manhole for inspection.

3.04.11 Access platforms to approach instruments & others valves for operation & maintenance to be provided.

3.05.00 INTERCONNECTING PIPING, FITTING AND VALVES

3.05.01 All interconnecting compressed air piping shall conform to IS: 1239 (Heavy Grade) or IS: 3589 Gr. 410 and galvanised as per IS: 4736.

3.05.02 Fittings for air piping shall be conforming to IS: 1239/IS: 1879 and Grade equivalent that of parent pipe Grade.

3.05.03 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 60deg.C. The pipe joints will be screwed coupling type for sizes upto 50 NB and above 50 NB the same will be flanged.

3.05.04 All cooling water piping will be M.S. conforming to IS: 1239 (Part-I) (Heavy Grade).

3.05.05 Air pipe sizing shall be done by considering compressed air velocity not exceeding 10 m/s.

3.05.06 Water pipe sizing shall be done by considering water velocity in pipes 2.0 m/s.

3.05.07 VALVES

Compressed Air Services:
Valves for Compressed air system shall be as specified in Appendix - I.

Water Service:
All water line valves shall be gate valve type. 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.

4.00.00 CONTROL PHILOSPHY

4.01.00 GENERAL

4.01.01 The controls, protection, interlock and instrumentation has been provided for safe and trouble free operation of compressed air system.

4.01.02 Individual compressor control shall be through microprocessor based control system (inbuilt in each compressor) as per OEM standard and remote start/stop control operation of compressor shall be through Plant DCS (Note: Plant DCS of Customer (NLC) scope).

The connectivity of Integral compressor control system with Plant DCS shall be provided through Hardwired / Soft link as below:

The hard wired connection of the individual compressors to the Plant DCS is for the purpose of "Remote start-stop control operation". In addition to this dew point monitoring at Plant DCS shall be hard wired from electronic dew point meter to Plant DCS.

The softlink connection (via Modbus) shall be provided for the following general status of the individual compressor / dryer, to be made available at the Plant DCS.

Status of each compressor

Instrument air pressure low/high

Service air pressure low/high

Status of each ADP

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

4.01.04 Compressor Operation Mode

Depending upon the operational requirements, each compressor can be selected & operated in two modes i.e. LOCAL MODE and REMOTE MODE. The different mode selection can be carried from individual compressor microprocessor panel.

LOCAL MODE:
This mode of operation shall be selected from individual compressor microprocessor panel. During this mode, the individual compressor START / STOP commands shall be executed by the respective compressor microprocessor through facia MMI.

Required application / operational software with logic for start permissive / Start / Stop / Run etc. are pre-loaded in the individual compressor microprocessor panel, which will in turn control the compressor.

Further, Loading & Unloading of the compressor shall be as per the operating pressure band setting in the individual compressor microprocessor panel.

REMOTE MODE:
This mode of operation is selected, when individual compressor operation is foreseen from Plant DCS.

Selection of this mode is through the individual compressor microprocessor panel.
However during this mode, individual compressor START - STOP shall be executed from the Plant DCS.

As same as in Local mode, individual compressor microprocessor panel, with preloaded application / operational software consists of Logic for start permissive / Start / Stop / Run etc. will control the individual compressor.

During this mode also Loading & Unloading of the compressor shall be as per the operating pressure band setting in the individual compressor microprocessor panel.

4.01.05 All abnormal conditions used for tripping the compressor or any other equipment shall be provided with pre-trip audio-visual indication/annunciation in the control panel.

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

4.01.07 Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.

4.02.00 Screw Compressors – Operational & Safety interlocks

4.02.01 Each compressor shall have in-built microprocessor panel to operate either in Base duty (Auto Load-Unload) or Standby duty (Auto On-Off) mode in case of Screw compressor.

4.02.02 In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure (for this operation pressure transducer shall be within compressor skid), throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system

pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve.

4.02.03 In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor shall be started in unloaded condition and the compressor shall be fully loaded.

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

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

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

a) Air temperature high at inlet to last stage: Alarm & trip

b) Low lube oil pressure: Alarm & trip

c) High Lube oil supply temperature: Alarm & trip

d) High inlet air filter differential pressure: Alarm & trip

e) High oil filter differential pressure: Alarm

f) Low lube oil level in lube oil sump: Alarm

g) Low cooling water flow to air compressor: Alarm

4.03.00 Air Drying Plant

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

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

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

4.03.04 For rotary drum type Air drying plant, control philosophy as per OEM standard and proven practice to be provided.

5.00.00 PAINTING

5.01.01 The painting within the compressor & dryer skid shall be as per OEM standard.

5.01.02 The piping being galvanized shall not be applied with any painting.

5.01.03 The painting for valves & air receiver shall be as below

(a) For all the steel surfaces exposed to atmosphere (outdoor installation), a coat of chlorinated rubber based zinc phosphate primer of minimum thickness DFT of 50 microns followed up with undercoat of chlorinated rubber paint of minimum DFT of 50 microns shall be applied. Then, intermediate coat consisting of one coat of chlorinated rubber based paint pigmented with Titanium di-oxide with minimum DFT of 50 microns and top coat consisting of two coats of chlorinated rubber paint of approved shade and color with glossy finish and DFT of 100 microns shall be provided. Total DFT of paint system shall not be less than 200 microns.

(b) For all the steel surfaces inside the building (indoor installation), a coat of red oxide primer of minimum thickness of 50 microns followed up with undercoat of synthetic enamel paint of minimum thickness of 50 microns shall be applied. The top coat shall consist of two coats each of minimum thickness of 50 microns of synthetic enamel paint and thus total thickness shall be minimum 200 microns.

(c) Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard.

(d) Paint shade for air receiver shall be sky blue.

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

6.00.00 POWER SUPPLY ARRANGEMENT

The power supply (rated voltage, frequency, phase) of the equipments will be 3.3 KV +/- 10% , 415 V +/- 10%, 3ph, 50 Hz +3% to -5%.

7.00.00 GENERAL POINTS TO BE NOTED BY BIDDER

7.00.01 Compressed Air system shall be offered as turnkey basis meeting specification requirements.

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

7.00.03 All drawings and documents shall be computer based.

7.00.04 All commissioning spares & consumables for trouble free operation shall be provided, with minimum to what specified elsewhere in the specification.

7.00.05 Bidder to clearly note that the instruments, valves etc as shown in the P&I Diagram is the bare minimum and any additional instruments/valves required to complete the system in terms of safety, trouble free operation of equipment's & system as a whole and isolation of individual equipment for maintenance, then same shall be supplied by the bidder without any commercial implication to BHEL.

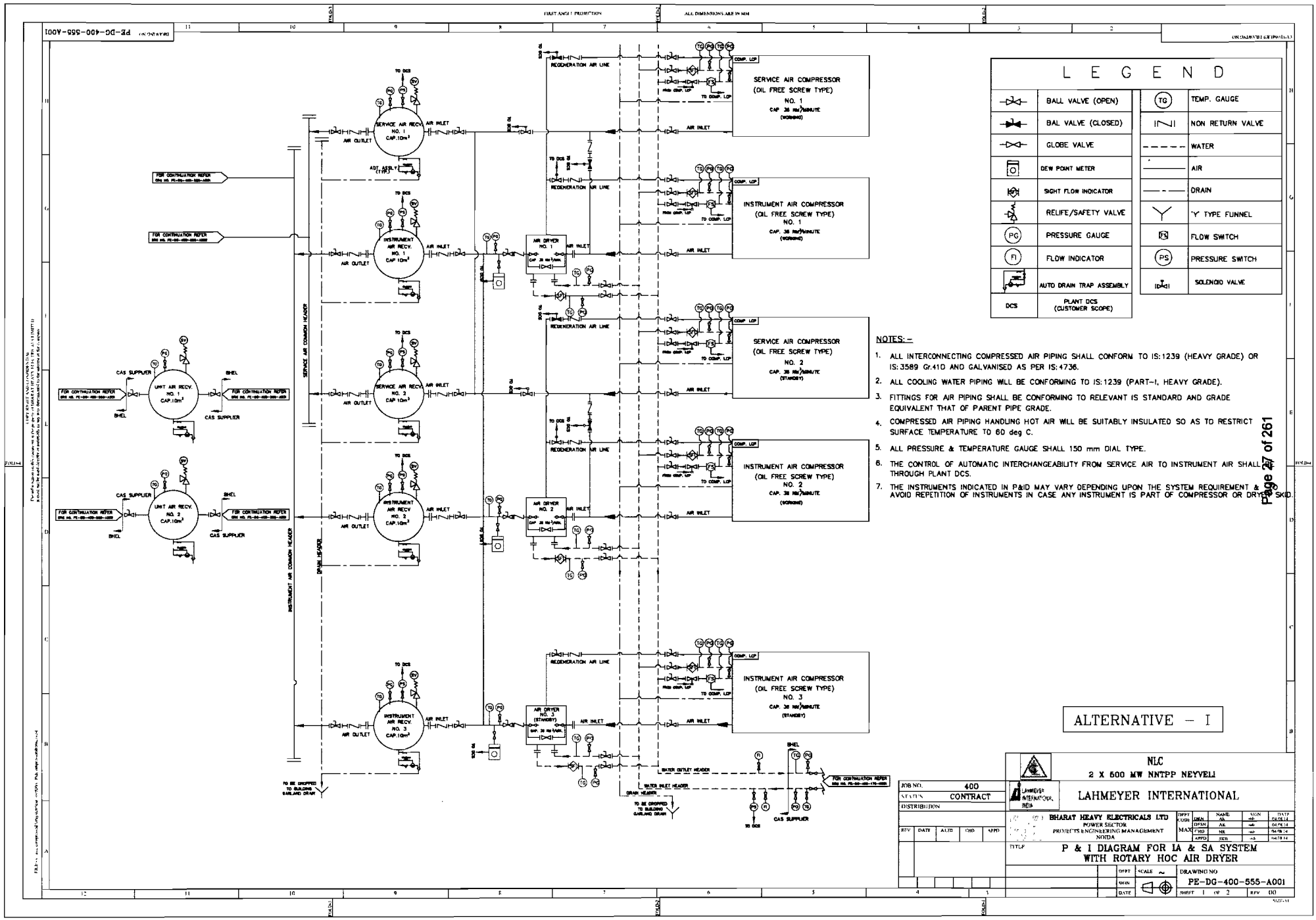
7.00.06 Grouting of equipment's, like Air receiver, Air dryer & foundation bolts etc. are in the scope of the bidder. GP2 grouting is to be provided.

7.00.07 Performance test for compressors shall be carried out at shops with job motor only.

7.00.08 All the instruments as required for demonstration testing shall be arrange by bidder. Instrument for testing shall be calibrated from government certified labs & this is in the bidder scope. Bidder to ensure validity of such reports before the demonstration tests.

7.00.09 Compressor and air dryer shall be designed for cooling water (passivated DM water) with inlet temp of thermal 38 deg C & mechanical 50 deg C with terminal pressure 06 kg/sqcm(g) and rise in temp shall be limited to 8 deg C and pressure drop across Compressed Air System within terminal point shall be limited to 10 mwc. However, Compressors and dryers coolers shall be designed to withstand 12 kg/cm^2 i.e., shutoff head of BHEL DM cooling water pumps.

7.00.10 Height of Air receivers shall be limited to 4M.



L E G E N D

	BALL VALVE (OPEN)	TG	TEMP. GAUGE
	BAL VALVE (CLOSED)		NON RETURN VALVE
	GLOBE VALVE		WATER
DP	DEW POINT METER		AIR
	SIGHT FLOW INDICATOR		DRAIN
	RELIFE/SAFETY VALVE		'Y' TYPE FUNNEL
PG	PRESSURE GAUGE	FS	FLOW SWITCH
FI	FLOW INDICATOR	PS	PRESSURE SWITCH
	AUTO DRAIN TRAP ASSEMBLY		SOLENOID VALVE
DCS	PLANT DCS (CUSTOMER SCOPE)		

NOTES:-

1. ALL INTERCONNECTING COMPRESSED AIR PIPING SHALL CONFORM TO IS:1239 (HEAVY GRADE) OR IS:3589 Gr.410 AND GALVANISED AS PER IS:4736.
2. ALL COOLING WATER PIPING WILL BE CONFORMING TO IS:1239 (PART-I, HEAVY GRADE).
3. FITTINGS FOR AIR PIPING SHALL BE CONFORMING TO RELEVANT IS STANDARD AND GRADE EQUIVALENT THAT OF PARENT PIPE GRADE.
4. COMPRESSED AIR PIPING HANDLING HOT AIR WILL BE SUITABLY INSULATED SO AS TO RESTRICT SURFACE TEMPERATURE TO 60 deg C.
5. ALL PRESSURE & TEMPERATURE GAUGE SHALL 150 mm DIAL TYPE.
6. THE CONTROL OF AUTOMATIC INTERCHANGEABILITY FROM SERVICE AIR TO INSTRUMENT AIR SHALL BE THROUGH PLANT DCS.
7. THE INSTRUMENTS INDICATED IN P&ID MAY VARY DEPENDING UPON THE SYSTEM REQUIREMENT & AVOID REPETITION OF INSTRUMENTS IN CASE ANY INSTRUMENT IS PART OF COMPRESSOR OR DRYER SKID.

ALTERNATIVE – I

JOB NO.	400
STATUS	CONTRACT
DISTRIBUTION	

REV	DATE	AUTH	CHD	APPD

NLC
2 X 600 MW NNTPP NEYVELI

LAHMEYER INTERNATIONAL

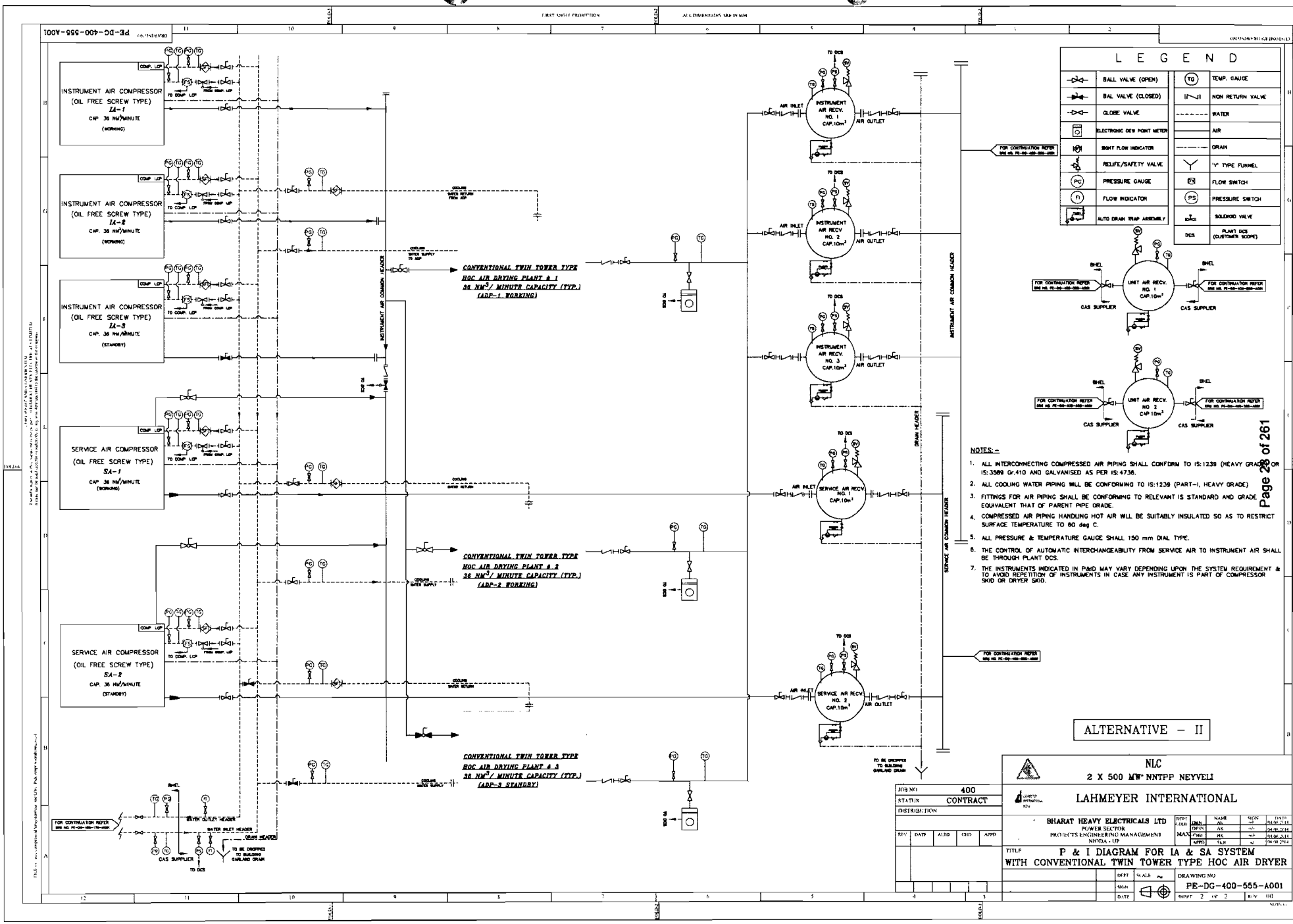
BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NOIDA

DSGN	DRN	AK		
	DSGN	AK		
MAX	CHD	NK		
	APPD	SDS		

TITLE: P & I DIAGRAM FOR IA & SA SYSTEM WITH ROTARY HOC AIR DRYER

DRAWING NO: PE-DG-400-555-A001

SHEET 1 OF 2 REV (0)



L E G E N D

	BALL VALVE (OPEN)	TG	TEMP. GAUGE
	BAL VALVE (CLOSED)		NON RETURN VALVE
	GLOBE VALVE		WATER
	ELECTRONIC DEW POINT METER		AIR
	SIGHT FLOW INDICATOR		DRAIN
	RELIEF/SAFETY VALVE		'Y' TYPE FUNNEL
PG	PRESSURE GAUGE	FS	FLOW SWITCH
FI	FLOW INDICATOR	PS	PRESSURE SWITCH
	AUTO DRAIN TRAP ASSEMBLY	SOLENOID	SOLENOID VALVE
		DCS	PLANT DCS (CUSTOMER'S SCOPE)

NOTES:-

1. ALL INTERCONNECTING COMPRESSED AIR PIPING SHALL CONFORM TO IS:1239 (HEAVY GRADE) OR IS:3589 Gr.410 AND GALVANISED AS PER IS:4736.
2. ALL COOLING WATER PIPING WILL BE CONFORMING TO IS:1239 (PART-I, HEAVY GRADE)
3. FITTINGS FOR AIR PIPING SHALL BE CONFORMING TO RELEVANT IS STANDARD AND GRADE EQUIVALENT THAT OF PARENT PIPE GRADE.
4. COMPRESSED AIR PIPING HANDLING HOT AIR WILL BE SUITABLY INSULATED SO AS TO RESTRICT SURFACE TEMPERATURE TO 60 deg C.
5. ALL PRESSURE & TEMPERATURE GAUGE SHALL 150 mm DIAL TYPE.
6. THE CONTROL OF AUTOMATIC INTERCHANGEABILITY FROM SERVICE AIR TO INSTRUMENT AIR SHALL BE THROUGH PLANT DCS.
7. THE INSTRUMENTS INDICATED IN P&ID MAY VARY DEPENDING UPON THE SYSTEM REQUIREMENT & TO AVOID REPETITION OF INSTRUMENTS IN CASE ANY INSTRUMENT IS PART OF COMPRESSOR SKID OR DRYER SKID.

ALTERNATIVE – II

JOB NO	400
STATUS	CONTRACT
DISTRIBUTION	

REV	DATE	ALTD	CHD	APPD

NLC
2 X 500 MW NNTPP NEYVELI

LAHMEYER INTERNATIONAL

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NOIDA - UP

DEPT CHD		NAME	SIGN	DATE
MAN	DRN	AK		04.06.2014
	DES	AK		04.06.2014
	CHD	HK		04.06.2014
	APPD	SKR		04.06.2014

TITLE: P & I DIAGRAM FOR IA & SA SYSTEM WITH CONVENTIONAL TWIN TOWER TYPE HOC AIR DRYER

DEPT	SCALE	DRAWING NO
SIGN		PE-DG-400-555-A001
DATE		SHEET 2 OF 2 REV 00

8.1 General

The Compressed Air System will meet the requirement of Instrument Air (IA) for the control of various pneumatically operated instruments and the Service Air (SA) for general plant services for (2 x 500) MW units. The system will be common and unitized for both 500 MW units and will be located in the compressor house Ground Floor.

Air drying plants of Heat of Compression (HOC) type will be provided to ensure dry moisture free Instrument quality air. The compressors will be non lubricated, oil free, horizontal, multi-stage water cooled, electric motor driven screw type, heavy duty, rugged construction. Compressors, after coolers and intercoolers will be of water cooled type and will utilize DM quality water for cooling purposes.

a). Compressed air facilities will be a centralized facility common for meeting the compressed air requirement (instrument air & service air) of the entire power plant i.e for the various facilities and systems / units covered under this specification as well as the requirements of other facilities and systems / units being arranged by the Owner.

b). Contractor will provide compressed air system complete in all respect and will include compressors with drives, air driers, air receivers, headers, compressed air distribution pipe work along with supports, valves, fittings, specialties, accessories and other auxiliaries as further described below.

c). Contractor will also provide a separate compressed air station building for housing the compressors,, air drying units, headers, valves etc. Air receivers will be placed just outside the compressor house.

d). Layout of the plant and equipment will be planned to ensure easy accessibility, maximum space utilisation and convenience of maintenance. The layout of integral piping for the compressed air station will ensure that all valves are located at conveniently accessible positions.

e). Suitable handling & hoisting equipment will be provided in the compressor house. An electrically operated, pendant controlled, underslung crane will be provided by the Contractor for compressor building. Lifting capacity will be 7.5 tonnes (minimum) or 120% of the weight of the heaviest part to be lifted. A complete set of new tools and tackles, required for the routine as well as major maintenance of plant and equipments will be provided. The Contractor will submit a list of such tools offered by them.

f). Quality of compressed air will be as follows:

Instrument air	
Quality	Oil and dust free

8.2 Codes and Standards

The equipment to be provided under this section will specifically conform to the following codes, standards, specifications and regulations as applicable, including all its latest amendments subsequent to the year of publication as mentioned below:

S.No	Code	Description
1.	IS-2825/1969	Code for unfired pressure vessels
2.	IS-4503/1967	Shell and Tube Type Heat Exchanger
3.	IS-5456/1985	Code of Practice for testing of positive displacement type air compressors and exhausters
4.	IS-5727/1981	Glossary of terms relating to compressors and exhausters
5.	IS-1239 part-1/1990	Mild Steel tubes, tubulars and other wrought steel pipes
6.	IS-1239 Part-2/1992	Mild steel tubes, tubular and other wrought steel fittings
7.	IS-6206/1985	Guide for selection, installation and maintenance of air compressors/plants with operating pressure up to 10 bars
8.	ANSI-B16.5(1988)	Steel Pipes Flanges and Fittings
9.	IS-7938/1976	Air Receivers for Compressed Air Installations
10.	IS-10431 Part-1/1983	Measurement of Air Flow of Compressor and Exhausters by nozzles
11.	ASME PTC-9	Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers
12.	ISO-7183	Compressed Air Dryers - Specification and Testing
13.	(part2)	Compressed Air Dryers Performance rating

In case of any contradiction with the aforesaid standards and the stipulations as per this Section and Attachments/Annexures of this section, the stipulations of this Section and its Annexures will prevail.

8.3 Scope of Supply and Works

The detailed scope of supply under this section will be as below and as indicated in relevant tender drawings. Items not specifically mentioned but deemed

necessary to make the system completely reliable and efficient will also be included.

1. 3x100% IA compressors and 2x100% SA compressors each of 36 Nm^3/min capacity for 2x500 MW units. There will be one (1) Air Receiver for each IA compressor and one (1) Air receiver for each SA compressor. Additionally, two (2) nos. of Air receivers, one number for each unit. Each Air Receiver will be of capacity 10 m^3.
2. Each Air Compressor will be complete with Intake Air filter cum Silencer, Intercooler, after cooler, Moisture Separator, interconnecting piping, valves, drive motors, instruments and all other accessories.
3. In addition, any additional air receiver(s) required by the Contractor's system at any consumer point within battery limit of this package will also be provided by the Contractor along with all accessories, supports, instruments, etc.
4. One (1) no. PLC-based control panel in built with each IA and SA compressors and one (1) local control panel for each Air Drying Plant will be provided. Each built-in control panel for the compressors will be complete with necessary PLC Hardware and Software, push buttons, annunciations as needed to make the system completely reliable and efficient. Necessary anti-vibration pads for free standing in case of vertical control panels are to be provided.
5. All Cooling water piping, control air and interconnecting air piping, valves, supports and hangers, instruments as indicated in tender drawings and as required for smooth, reliable and efficient functioning of the system.
6. One (1) no. air drying plant for each IA compressor will be provided by the Contractor. Each air drying plant will be complete with the following accessories:
   a) Air Ejector.
   b) Moisture separator with auto drain trap.
   c) Rotor drum loaded with desiccant and drive motor
   d) Dryer container.
   e) Regeneration line control valve
   f) Regeneration air cooler.
   g) All inter-connecting/integral piping, valves trap stations with by-pass valves at drains, fittings, flanges, gaskets, etc.
   h) Instrument and controls.
   i) Interconnecting wiring.
   j) Differential pressure indicator.
   k) One (1) dew point indicator.

7. Supporting structures, base plates, support plates, foundation/ anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts, etc. as needed for efficient installation and handling of equipment.

8.4 Specific Design Criteria

The Compressed Air System will ensure a reliable supply of adequate quantity and quality of oil free air on continuous and intermittent basis for the (2 x 500) MW Units. It consists of two sub systems, namely.

1. Instrument Air (iA) for Instrumentation and Control purposes for the station.
2. Service Air (SA) for usage in boiler, turbine and electrical equipment area general house cleaning and other miscellaneous usage
3. The normal pressure of Instrument Air supply at the outlet of Air Dryer will be 8.5 kg/sq.cm(g) and will not be lower than 8.0 Kg/sq.cm(g) under any circumstances. Corresponding to the normal pressure at the outlet of dryer, the rated discharge pressure of IA compressor will be worked out by the Contractor, allowing for pressure drops in system piping, equipment and all other accessories. The rated discharge pressure of IA compressor will be computed as per guidelines specified above or 8.0 kg/sq.cm(g), whichever is higher. Each Service Air compressor will be designed to deliver service air at a rated discharge pressure equal to the rated discharge pressure of each Instrument Air Compressor.
4. The maximum expected pressure in the system will be computed by considering 10% overpressure over and above the rated discharge pressure of each air compressor.
5. Compressed air system will comprise of one (1) IA group and one (1) SA group of compressors to cater for 2 x 500 MW units. The capacity of each air compressor will be 36 Nm^3/min, minimum.
6. IA group for two units will consist of 3 x 100% (i.e one (1) working for each unit and one (1) common standby for both units) compressors with necessary intercoolers, after coolers, piping, valves, instruments and other accessories with built-in control panel and supplemented by an Air Drying plant for each IA compressor. There will be one (1) Air Receiver for each IA compressor.
7. SA group for two units will consist of 2 x 100% (i.e one (1) common working for both units and one (1) common standby for both units) compressors common for both units with necessary intercoolers, after coolers, piping, valves, instruments and other accessories with built-in control panel. There will be one (1) Air Receiver for each SA compressor
8. Suitable interconnections will be kept between SA and IA headers before Air Dryers for each unit with normally closed motorized isolation valves.

Interconnections for SA headers and IA headers between Unit 1&2 will also be provided with suitable isolation

9. The temperature of compressor air at the outlet of air drying plant will be limited to 45°C.

10. The delivered compressed air will not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air will not exceed 3 Microns

11. Compressed air system equipment requiring cooling water will be capable of operation at design capacity with cooling water inlet temperature subject to a maximum of 39°C in DM cooling water (DMCW) system. The above equipment will also be capable to withstand a pressure not less than the shut off head of each DMCW pump

12. The temperature of air at outlet from after cooler will not exceed 10°C above the cooling water inlet temperature.

13. Air Compressors will be identical and will be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Annexure-A enclosed with this section

14. The power rating of the driver will be selected such that a minimum margin of 15% is available over the power required to deliver rated capacity against rated discharge pressure. When the driver is not directly coupled to the compressor, due account should be made for losses in power transmission, in addition to the above margin

15. As more than one (1) compressor with drive is specified, satisfactory operation in parallel will be ensured without any uneven load sharing, undue vibration, Keeping noise level within permissible limits for a number of compressors working simultaneously

16. Each Air Receiver will be so sized that even in the event of total stoppage of air inflow to the same, the pressure in the Air Receiver will not fall below 5.5 kg/cm2 (g) within two (2) minutes of such stoppage, while maintaining an out flow of air at a rate equal to the rated capacity of a single compressor, during the aforesaid period. In no case, the size of each Air Receiver will be less than that arrived from IS 7938.

The capacity of each Air Receiver will be determined in accordance with the following guidelines:

$$V_{AR} = \frac{T \times C \times P_A}{P_{MAX} - P_{MIN}} \times E$$, where

V_{AR} = Volume of each Air Receiver in M^3.

T = Bleed down time in minutes, will be taken as 2 minutes (minimum)

P_A = Atmospheric pressure, will be taken as 1 Kg/Sq.cm (absolute).

P_{MAX} = Maximum system pressure in Kg/Sq.cm absolute, will be taken as 110 percent of rated compressor delivery pressure.

P_{MIN} = Minimum system pressure in Kg/Sq.cm absolute, will be taken as 6.5 Kg/Sq.cm absolute.

C = Free air delivery capacity of each Air compressor for IA system or free air delivery capacity of each SA compressor for SA system, M^3.

E = 1.15, considering 15 percent minimum margin to account for peak requirements

The water filled volume of each Air Receiver will be calculated in accordance with the guidelines specified above or $10M^3$, whichever is higher.

17. The drying capacity of each Air Drying Plant (ADP) will be provided to match the corresponding capacity of each IA compressor
18. The air drying plants receiving compressed air saturated with moisture will be capable of operating continuously to provide reliable moisture free compressed air. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet will be taken as 100% and 40°C respectively.
19. The drying process will employ the Heat of compression (Twin tower type/ Rotary drum type) drying by adsorption method to remove moisture from air.
20. Driers will be suitable for part load operation while maintaining the outlet air dew point as specified above. Necessary instruments and controls will be provided to ensure that the specified dew point is maintained irrespective of input variations.

8.5 Design and Construction

1. The design will be such as to ensure trouble free operation with least vibration and noise. Suitable acoustical treatment will be provided to ensure the noise level within permissible limits as specified. Different parts of the compressor and accessories will be arranged neatly in a compact manner. Due consideration will be given for easy accessibility and maintenance of the compressors.
2. The compressors will be non lubricated, oil free, horizontal, multi-stage water cooled, electric motor driven screw type, heavy duty, rugged construction. Their speed will be so selected as to result in low maintenance and trouble-free operation under specified conditions.
3. Unless inconsistent with this section, equipment from the standard range of manufacture of the Contractor will be preferred.
4. Compressor components will be interchangeable as far as possible. Material of construction will be suitable for the service.

5. Compressor casing, rotor and shaft

a) Compression chamber wall thickness will be such that to withstand maximum design pressure.

b) During maintenance of compressor suitable arrangement for cleaning of the cooling water jackets will be provided.

c) Dynamically balanced, one-piece Rotor construction with a symmetric profile to keep leakage loss to a minimum and ensure high efficiency.

d) Rotor shaft mounted, highly precise timing gears will be designed to counter the axial forces incurred in compression.

e) The rotor and shaft will be of single piece construction, made of forged steel with suitable corrosion resistant coated material to minimize leakage and wear (AISI C1141 or equivalent). The stator (casing) will be of Cast-Iron Construction with corrosion resistant material and with integral jacket cooling.

f) The seal rings and retainers will be of stainless steel construction. The seals will prevent air and oil leakage along the shaft. Air vented from second stage discharge end seals will provide buffer air to the other seals to prevent migration of oil towards the compression chamber under all operating conditions.

g) The gaskets will be of asbestos free material & Use of Oil lubricated anti friction type bearings to be at least 8000 running hours.

6. Lubrication system

a) The compressor package will include a lubricant management system which will lubricate the bearings and seal. By the design, the compressor chamber (screw rotor housing) is totally separated from bearing / gear chamber.

b) The lubricant pump will be shaft driven. An auxiliary motor driven pump will be provided if required by the manufacturer to supply pre-start and shut down system. All lube oil pumps will be of rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system will be protected by a relief valve.

c) The fouling factor will be considered as per the recommendation of TEMA

d) The lube oil cooler will be designed for a heat duty corresponding to the peak power demand of the compressors.

e) The cooler will be designed in accordance with the requirement of IS-2825.

f) Due consideration for the differential expansion of shell and tube will be given in the design of the coolers.

7. Gear Box

Speed increasing gears between the motor and compressor stages will consist of a common helical gear driving the pinion of each stage. Helical timing gears will be mounted on the rotor shafts to maintain accurate relative rotor position. Gears will have a rating of AGMA-12 or equivalent.

8. Inter Cooler, After Cooler and Moisture Separator

   a) Inter-cooler will be located between the low and high-pressure stages, if required, to reduce overall power consumption. Design performance will be in accordance with Manufacturer`s Standard and wall thickness of tubes and expansion joints will ensure maximum trouble-free service for long period.

   b) After-cooler at each compressor discharge will be water cooled and supplied by the Contractor. It will be located after compressor discharge to bring the outlet temperature of the compressed air within 10°C, of the cooling water inlet temperature. The moisture separator to be provided on after cooler air outlet will have suitable internal baffling for removal of moisture and oil. Necessary safety valves will be provided on inter coolers and after coolers.

   c) Inter-cooler, After-cooler and Moisture Separator will be provided with Auto trap stations including strainer, bypass and double isolating valves for the traps. A level gauge glass with isolating cock will be provided near the bottom of moisture separator. Automatic traps will be of reputed make and will be of float type suitable for intended services. Y-strainer of 20 mesh screen of stainless steel will be placed before each trap.

   d) The after coolers and water cooled intercoolers will be shell and tube type. The intercooler will have air in shell side and water in tube side to add surge volume for reducing air pulsation before the second stage.

   e) The shell, tubes, tube sheets and expansion joints with tube sheets particularly at flange portion etc. of the heat exchangers will be designed to withstand the maximum working pressures encountered. Necessary allowance for corrosion will be provided.

   f) Intercoolers/After coolers will be provided with supports, which are designed to avoid undue stress or deflection in support or body of the equipment.

   g) Necessary drain and vent nozzles will be provided for intercooler and after cooler.

9. Air Receiver

   a) Air receiver(s) will be in accordance with IS-2825 or ASME Volumes-VIII Div.I and IS-7938.

   b) The air receiver will be vertical self-supporting cylindrical vessel with torispherical dished ends and with supporting stand for resting on the Civil foundation.

c) Receivers will be of welded construction with minimum number of joints. Longitudinal seams in adjacent sections of shell will not be in the same line.

d) All welding will be performed in accordance with relevant codes. Filler material that will deposit weld metal with a composition and structure as near as that of the material being welded will be used. The electrodes will be dried in oven immediately before use to ensure freedom from porosity.

e) Receivers will be provided with required number of nozzles, the orientations of which will be subject to approval by the Owner. At least two gasketted inspection holes will be provided for receivers up to 600 mm diameter. For larger diameter manhole of minimum 450 mm diameter will be provided. All openings will be placed as far as possible from welded seams and in no instance will pierce the seam.

f) Receivers will be provided with one or more safety relief valves of proper capacity so that the maximum working pressure of the system is not exceeded under any circumstance. Unless otherwise mentioned, each receiver will be provided with at least one pressure gauge and one temperature gauge of proper range and required number of pressure switches for compressor control purposes.

g) Receiver will be heat-treated in accordance with BS-5169.

10. Intake Air Filter and Silencer

a) Filters with multiple elements and quick removal type for easy cleaning to be provided at suction of each air compressor and will also be of heavy-duty dry type. Oil bath type will not be acceptable for non-lubricated compressors

b) The filters will be complete with integral silencers and all other accessories. The filtering elements will be easily removable for cleaning or for replacement.

c) The filters will be designed for an efficiency of not less than 95% for particles 3 microns and larger.

d) The silencer will be of very high efficiency type to adequately dampen the operating noise as per the requirements.

e) Pulsation dampener of approved design will be provided on the compressor suction and discharge manifold.

f) If filter after receiver is specified in Attachments/Annexures, the same will be provided to remove the bulk of moisture and other contaminants entrained in the air stream

11. Drive Unit

a) The compressors will be driven by constant speed squirrel cage induction motor unless otherwise specified.

b) The power rating of the driver will be selected such that a minimum margin of 15% is available over the power required to deliver rated capacity against rated discharge pressure. When the driver is not directly coupled to the compressor, due account should be made for losses in power transmission, in addition to the above margin.

c) For other types of connection between drive unit and compressor, suitable flexible coupling will be provided.

d) Necessary guard will cover all exposed moving parts.

e) Motor will be suitable for eight (8) equally spreaded starts per hour.

12. Moisture Separator

Moisture separator will be of high efficiency design and provided with vent nozzle and auto drain trap system.

13. Air Drying Plant

a) Air-drying plant will be of heat of compression desiccant type (rotary drum type), drying by adsorption method.

b) Reactivation will be by Heat of compression method without any air purge loss. Hot unsaturated compressed air will be used for regeneration of exhausted desiccant in ADP.

c) In the rotary drum dryer, since the drum is continuously rotating, the regeneration and drying are continuously occurring cycles.

d) Air dryer will be Indoor located.

e) The air dryer rotary drum motor should start automatically on compressor load command and stop the moment compressor unloads.

f) All pressure vessels will be designed as per IS: 2825 or equivalent code.

g) All vessels will be included with required manholes/hand holes

h) All hot vessels & pipelines to be insulated to restrict the outside temperature within 60 deg. C with mineral wool (or equivalent).

i) Quantity of desiccant to be calculated taking into account residual moisture content at the end of regeneration cycle.

j) Complete ADP equipments will be preferably mounted on a skid.

14. Pressure Vessels

a) All pressure vessels will be designed as per IS : 2825 or approved equal

b) The vessels will be of self supporting construction. All welding materials and procedures will be as per IS: 2825 or approved equal.

c) Relief valves of adequate capacity will be provided for each vessel. Relief valves will be provided with hand lever. The valves will be of stainless steel construction.

d) Internal surfaces of all the vessels will be suitably protected against corrosion and rusting. Corrosion allowance of 2.5 mm will also be provided on shell and dished end thickness.

e) Draining trap station complete with Auto drain trap, isolation and by-pass valves and Y-strainer will be provided for the moisture separator.

15. Solenoid Valves and Multiway Valves

a) The solenoid valve will be of approved make. The solenoid valves will have heavy duty, double impregnated tropicalised coils (Single or double solenoid as required) and will be suitable for the operating temperature and for operation continuously energized, in a tropical climate.

b) The solenoid valves will be of bronze body with stainless steel trim. The coil will be of continuous duty and of epoxy moulded type, Class-F. The enclosure will be watertight, dust tight, weather proof and will conform to NEMA-4X standard. The valves will be suitable for mounting in any position. Solenoid coils will be Class-H high temperature construction and will be suitable for continuous operation.

16. Interconnecting Piping, Valves and Fittings

a) MS pipe as per IS 1239/ IS 3589; medium grade, galvanized as per IS 4736 will be used. Piping in airlines and cooling water lines up to 50 NB will be socket welded and 65 NB and above will be butt-welded and flanged type. All interconnected air piping and cooling water piping etc., as indicated in tender drawings will be furnished by the Contractor, complete with valves, fittings, pipe supports as necessary.

b) The air discharge piping will be full size of compressor outlet or larger, short and direct with minimum number of fittings. Only long radius elbows will be used where bends are unavoidable. The velocity of compressed air in pipe will be limited to 7 to 10 m/sec for headers and 11 to 15 m/sec for piping network.

c) Long runs of vertical piping at compressor discharge will not be acceptable.

d) The layout will be such as to prevent resonance. Provision of thermal expansion of hot pipes will be made.

e) All pipe connections with equipment will be flanged type. All pressure gauges/switches will be complete with root valves and all temperature elements will be mounted in a proper thermowell.

f) For water cooled compressors, cooling water will normally be piped through the intercooler and after cooler in parallel. From the intercooler, the water will be taken to cylinder jackets. A solenoid valve will be provided on the water inlet line for interlocked starting of compressors. Where provision for automatic water flow regulation by thermostatic

valve has been made, a suitable bypass arrangement to the valve will be made so that flow to the cylinder is ensured under all circumstances.

g) The velocity in water pipes will be limited to 2.0 Metres/Sec.

h) Sight flow indicators will be provided on water discharge from each cylinder, intercooler and after cooler.

i) All traps will be float operated. All traps will be of auto drain type to drain out moisture at regular intervals. The body and cover will be of cast iron/solid steel construction and internals will be of SS. Isolating valves will be of stainless steel.

17. Dew Point Indicator

Dew point indicator will be digital type for spot measurement of dew point of air. The specification of the meter will be as follows:

a) Range : (-) 40 °C to (+) 20 °C

b) Accuracy : ± 0.2 °C

Dew point monitoring facility will also be provided in local Control Panel as well as in unit DCS operator work station

18. E.O.T. Crane

a) The crane will be of electrically operated, pendant controlled, overhead travelling type. The Span and runway length will suit the compressor house building.

b) The design and construction of crane will be as elaborated in relevant Sub-Section of technical specification.

19. Painting

a) All the Equipments will be protected against external corrosion by providing suitable painting.

b) The surfaces of stainless steel, Galvanised steel, Gunmetal, brass, bronze and non-metallic components will not be applied with any painting.

c) The steel surface to be applied with painting will be thoroughly cleaned before applying painting by brushing, shot blasting etc as per the agreed procedure.

d) For all the steel surfaces exposed to atmosphere (outdoor installation), a coat of chlorinated rubber based zinc phosphate primer of minimum thickness DFT of 50 microns followed up with undercoat of chlorinated rubber paint of minimum DFT of 50 microns will be applied. Then, intermediate coat consisting of one coat of chlorinated rubber based paint pigmented with Titanium di-oxide with minimum DFT of 50 microns and top coat consisting of two coats of chlorinated rubber paint of approved shade and color with glossy finish and DFT of 100

microns will be provided. Total DFT of paint system will not be less than 200 microns.

e) For all the steel surfaces inside the building (indoor installation), a coat of red oxide primer of minimum thickness of 50 microns followed up with undercoat of synthetic enamel paint of minimum thickness of 50 microns will be applied. The top coat will consist of two coats each of minimum thickness of 50 microns of synthetic enamel paint and thus total thickness will be minimum 200 microns.

f) Also refer the Section-XI for painting system.

8.6 Inspection & Testing

1. The Contractor will carry out the following specific tests and inspections to ensure that the equipment furnished will conform to the requirements of this section and in accordance with relevant codes and standards.
2. Material identification of compression chambers, rotor, rotor staff, suction and delivery valves constituting the compressors and all parts of intercoolers, aftercoolers, moisture separators, air receivers, strainers, filters, all interconnecting air and water piping with valves and all other parts and accessories that could not spelt out in this clause.
3. Hydrostatic testing of compressor, intercoolers, aftercoolers, moisture separators, air receivers, strainers, filters, all interconnecting air and water piping with valves and all other applicable pressure parts that could not be spelt out in this clause will be carried out. Hydrostatic testing will be carried out at 150% of the design pressure for at least one (1) hour, unless contradicted by the relevant test code.
4. Specific tests to be carried out for each compressor
5. Non-destructive testing of rotors, rotor shaft and all other applicable parts.
6. Type test/Routine tests for all the air compressors as per ISO-1217. All performance tests for compressors will be carried out with actual motor being furnished. Routine tests will include the following tests and measurements:
   a) Capacity (Free Air delivery)
   b) Speed
   c) Specific power consumption
   d) Volumetric and overall efficiency of machine
   e) Test of loading and unloading mechanism
   f) Any other test deemed necessary for the system
7. In addition to the above tests, the following tests will be conducted at shop and site.

   At shop

   a) Capacity and discharge pressure of each air compressor.

b) Power consumption of each air compressor at its rated duty point with its own motor.

At site

a) Parallel operations of air compressors.

b) Dew point of air at the outlet of air drying plants of instrument air compressors.

c) Pressure drop across the air drying plants of air compressors.

8. Dynamic balancing of all rotating components and assembly of each air compressor including all drive motors in the compressed air system.

9. Tests for capacity, pressure drop and efficiency of each Intake Air Filter with silencer will be as Manufacturer's standard. These tests will be conducted along with performance testing of each compressor.

10. Testing of all drive motors and control panels in the compressed air system.

11. Dew Point tests to be carried out on each Air Drying Plant.

12. Any other test deemed necessary for the system.

Note : Contractor means the successful bidder / vendor.

4.18.2 Specific Requirement for Valves

Service	Size	Body/ bonnet	Disc	Stem	Hand wheel	Valve ends
Steam lines (temp > 400°C) except for main steam and hot-reheat	≥ 65NB ≤ 50 NB	ASTM A217 WC-6/WC-9 ASTM A182 Gr.F-11/Gr.F-22	ASTM A217 WC-6/WC-9 ASTM A182 Gr.F-11/Gr.F-22	ASTM A182 Gr. F6a ASTM A182 Gr.F6a.	ASTM A47 G Gr. 32510 ASTM A97 Gr.32510	Butt welded Socket Weld
Steam lines (temp < 400 °C), feed water, Condensate blow down, steam tracing	≥65NB ≤ 50 NB	ASTM A216 Gr WCB ASTMA105	ASTM A216 Gr WCB ASTM A182 Gr F6a	ASTM A182 Gr F6a ASTM A182 Gr F6a	ASTM A47 Gr 32510 ASTM A47 Gr 32510	Butt welded Socket welded
HFO, LDO, lube oil, oily water drain	≥65NB ≤ 50 NB	ASTM A216 Gr WCB ASTMA105	ASTM A216 Gr WCB ASTM A182 Gr F6a	ASTM A182 Gr F6a ASTM A182 Gr F6a	ASTM A47 Gr 32510 ASTM A47 Gr 32510	Butt welded Socket welded
Boiler feed system	65NB	ASTM A216 Gr WCB/WCC	ASTM A 216 Gr. WCB/WCC	ASTM A 182 Gr. F6a	ASTM 417 Gr. 32510	BW
	≤50NB	A105	ASTM A 182 Gr.F6a	ASTM A 182 Gr.F6a	ASTM 417 Gr. 32510	SW
Cooling water system	BFV	AWWA C-504; flanged or long body wafer type; Body A 216 WCB;SHAFT A 182 304; seal & O ring: EPT/ BUNA – N / Neoprene				FL

Service	Size	Body/ bonnet	Disc	Stem	Hand Wheel	Valve ends
Instrument air system, potable water system (ball valves)	≥65N B ≤ 50 NB	ASTM A216 Gr WCB ASTMB62 / IS31 Gr.2	ASTM A216 Gr WCB ASTM B62 / IS:318 Gr.2	ASTM A182 Gr F6a ASTM B312 Gr A / IS320 HT2	ASTM A47 Gr 32510 ASTM A47 Gr 32510	Flanged Screw type
Service air system, (ball valves)	≥65N B ≤ 50 NB	ASTM A216 Gr WCB ASTM A105	ASTM A216 Gr WCB ASTM A182 Gr F6a	ASTM A182 Gr F6a ASTM A182 Gr F6a	ASTM A47 Gr 32510 ASTM A47 Gr 32510	Butt welded Socket welded

Bharat Heavy Electricals Limited Power Sector Marketing New Delhi-110049

NLC LTD. NEYVELI

VOLUME – II B
SECTION – C.3
SPECIFIC TECHNICAL REQURIEMENTS (ELECTRICAL)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

c) Supply of mandatory spares as specified in the specifications of Mechanical/Electrical equipment.

d) Erection and commissioning spares.

e) Erection & Maintenance tools & tackles.

f) Electrical load requirement for Compressed Air System.

g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL.

i) Various drawings, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer /BHEL approval without any commercial implications to BHEL.

j) Motor shall meet minimum requirement of specification AC/DC motors.

k) Technical requirements shall be as per specifications listed in Clause 4.1 to 4.11. In case of any discrepancy between **Basic technical features for HT or LT motors** and BHEL standard specification, Basic technical features for HT or LT motors shall prevail.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:

a) A copy of this sheet "Electrical Equipment Specification for Compressed Air System" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.

b) List of Erection and Commissioning spares.

c) List of Erection & Maintenance tools & tackles.

d) Electrical load requirement.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

1. Electrical scope between BHEL & vendor.- 2 sheets
2. Std. Technical specification for LV motors.- 5 sheets
3. Std. Technical specification for HT motors.- 28 sheets
4. General Technical requirements for Cabling installation.- 6 sheets.
5. Basic technical Features for HT/ LT motors for 2x500 MW NEW NEYVELI TPP (SG & TG PACKAGE): - 7 Sheets
6. Data Sheets (A) for 415V Electric Motors.- 2 sheets.
7. Data Sheets (C) for 415V Electric Motors- 2 sheets.
8. Quality plan for motor below 55kW.- 2 sheets

9. Quality plan for motor above 55kW.- 9 sheets
10. Load data format.- 1 sheet
11. Approved sub-vendor list for HT and LT motors

Scope sheet for Scope between BHEL & Vendor

PROJECT: 2x500 MW NEYVELI NEW THERMAL POWER STATION (NNTPS)

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

Scope sheet for Scope between BHEL & Vendor

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

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. For skid mounted system, 2 nos. (1W+1S) supply feeders of 415 V, 3 phase, 4 wire AC shall be provided by BHEL. Complete skid including changeover between feeders/starters/LCP/ inter-locks/protection devices /any other supply etc. shall be in bidder's scope only

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ELECTRICAL FEEDER LIST FORMAT																		

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	400	ORIGINATING AGENCY		PEM (ELECTRICAL)	
		PROJECT TITLE	2 X 500 MW NNTPS	NAME		DATA FILLED UP ON	
		SYSTEM	COMPRESSED AIR SYSTEM	SIGN.		DATA ENTERED ON	
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

1.0 This document covers the basic technical features of high tension (HT) and low tension (LT) squirrel cage induction AC motors employed for driving auxiliaries of BHEL-PEM scope packages in 2x500 MW New Neyveli Thermal Power project.

2.0 CODES AND STANDARDS

The motors shall generally conform to IS 325/IEC-60034. LT motors of continuous duty (S1) shall be energy efficient IE2 conforming to IS-12615.

3.0 DESIGN REQUIREMENTS

3.1 General Requirements

The design ambient temperature shall be 50 deg C.

3.2 Supply system and rated voltage of motors

KW rating	Supply system	Rated voltage of motor
Above 750 kW	11 KV	11 KV
Above 160 kW up to & including 750 kW	3.3 KV	3.3 KV
From 220W up to & including 160 kW	415 V	415 V
Below 220W	240V	240V

3.2.1 Supply voltage & variations shall be as follows:-

Voltage variation (AC Supply) (+/-) 10%
Frequency variation (+) 3% to (-) 5%
Combined V & F variation 10% (sum of absolute values)

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

3.3 Motor Rating

Motor ratings shall be adequate to m eet the requirements of the drive equipm ent. Motors shall be continuously rated at the design am bient temperature of 50 degree C and relative humidity of 85%. Maximum continuous motor ratings shall have at least a 15% margin above the maximum load demand of the driven equipment under entire operating range including voltage & frequency variation.

3.4 Starting Requirements

3.4.1 Motor shall start smoothly and rapidly. 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% of the motor's full load torque.

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

For motors rated up to 1500 KW, 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 of 85 (eighty five) percent rated voltage at motor terminals.

3.4.3 The locked rotor current of the 11 kV motors (except MDBFP motors & CWP motors) shall not exceed six times full load current inclusive of tolerance as per IS:325 and for 3.3 kV motors locked rotor current shall not exceed six times full load current subject to IS tolerance as per IS:325. For LT motors of continuous duty (S1) type motors, starting current shall be as per IS: 12615.

3.4.4 The following frequency of starts shall apply

i) Three nos. consecutive cold starts in succession with the motor being initially at a temperature not exceeding the ambient temperature.

ii) Two nos. consecutive hot starts in succession with the motor being initially at a temperature not exceeding the rated load operating temperature.

iii) 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)

iv) In case of multiple start motors like conveyor motors three starts shall be allowable from hot condition with maximum 20 starts per day & minimum 20,000 starts during life time of motors.

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

For HT Motors

a) For motors more than starting time by at least 3 sec or 15% of the accelerating time whichever is greater.

For LT Motors

a) For motors with starting time up to 20 sec.

- at least 2.5 sec. more than starting time.

b) For motor with starting time above 20 secs but not exceeding 45 secs.

- at least 5.0 sec. more than starting time.

c) For motors with starting time above 45 secs.

- at least 10%. more than starting time.

The starting time of the motor referred above is at minimum permissible voltage. For motors and in cases where the above requirements are not complied with, speed switches of approved make & type shall be provided to bypass the locked rotor protection for a pre-selected time during starting of motors. The speed switches shall have one NO & one NC contacts having maximum interrupting capacity of 5 Amps at 240V AC and 0.25 amps at 220 V DC.

3.5 Running Requirements

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

3.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

3.6 Stress during bus Transfer

3.6.1 Motors shall withstand the voltage and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vect or difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.6.2 Motor windings shall be adequately braced to satis factorily withstand the mech. Stresses during above condition.

3.6.3 Motors shall be capable of withstanding heavy in-rush transient current caused by bus transfer without damage.

3.6.4 Motor and driven eqpt. Shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.7 Noise level

Maximum noise level measured at distance of 1.5 metres from the outline of motor shall not exceed 85 db(A) in line with IS 12065.

3.8 Vibration

The maximum vibration velocity or double am plitude of m otors vibration as m easured at m otor bearings shall be within the limits specified in IS: 12075.

4.0 CONSTRUCTIONAL FEATURES

4.1 Degree of Protection

4.1.1 Indoor motors shall conform to degree of protec tion IP: 54 as per IS: 4691. Outdoor or sem i-indoor motors shall conform to degree of protection IP : 55 as per IS: 4691 and shall be of weather-proof construction. The degree of protection for term inal boxes shall be IP 55 for outdoor area & IP 54 for indoor area as per IS 4691.

4.1.2 The stator lam inations shall m ade from suitable silicon steel/m agnetic steel sheet varnished on both sides and pressed to form a rigid core.

4.1.3 The rotor shall be of rigid cage construction with di e cast aluminium / copper alloy / copper bars firmly wedged in bar slots and brazed to the end rings. The rotor cage shall be designed to operate satisfactorily under respective starting and load duty cycle.

4.2 Enclosure and Cooling

4.2.1 Motors shall generally have totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362. Motors may

have Closed Air circuit Air (CACA) method of cooling conforming to IC-0161 of IS: 6362 for motor rated 3000kW & above.

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

4.2.3 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.3 Class of Insulation

HT/LT motors shall have class F insulation. The temperature rise of all motors shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits, 10deg C rise above the temperature limits specified in IS: 325 shall be permissible.

4.4 Bearings

4.4.1 Horizontally mounted motors shall have grease lubricated ball/roller or sleeve bearings. For MV motors, the bearings shall be regreasable type and for LV motors, these bearings can be either sealed life lubricated type or regreasable type as per manufacturer's standard.

4.4.2 The vertical motors shall have a combined thrust and guide bearing on top and guide bearing at bottom. If the ball or roller bearings can take vertical thrust, thrust and guide bearing need not be provided.

4.4.3 After taking all motor driven equipment loads and thrust (if any) into account, the bearings shall be suitable for min. 40,000 working hours. Re-greasable bearings shall be provided with grease nipples and relief holes for on-line re-greasing and shall be suitable for 8000 working hours without changing of the grease.

4.4.4 The bearings of solidly coupled motors shall be of the same type as those of the driven equipment.

4.4.5 For motors upto 2 kW, double sealed type bearings shall be provided.

4.4.6 Motors rated above 1000kW shall be provided with insulated end shield on non-driving end to prevent flow of shaft current.

4.5 Terminals and Terminal Boxes

4.5.1 Motors of rating 90 kW and up to 160kW will be controlled by air circuit breaker & shall be provided with comprehensive numerical motor protection relays. For all motors of rating 45 kW & above but less than 90kW shall be provided with MCCBs with CT operated electronic over load relays. Motors of rating above 18.5 kW & below 45 kW shall be provided with MCCBs and motors of rating up to 18.5 kW shall be provided with MPCBs. The terminal box of motors shall be designed for the fault current of 44 kA, 0.25 secs and 50 kA, 0.25 secs for HT & LT motors respectively.

4.5.2 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.

4.5.3 For MV motors, the main terminal box shall be of phase-segregated type with clamping arrangement for the terminals.

4.5.4 Connections shall be such that when the supply leads R, Y & B are connected to m otor terminals A B & C or U, V & W respectively , motor shall rotate in an anticlockwise direc tion when viewed from the non-driving end. Where such m otors require clockw ise rotation, the supply leads R, Y, B will be connected to motor terminals A,C,B or V, W & U respectively.

4.5.5 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside term inal box cover giving the connection di agram for the desired direction of rotation and reverse rotation.

4.5.6 Motor terminals and terminal leads shall be fully insulated with no bar live parts.

4.5.7 Separate terminal boxes shall be provided for space h eaters and temp. Indicators. If this is not possible in case of LT motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression tinned brass glands shall be provided in terminal boxes.

4.5.8 Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree.

4.5.9 Cable glands and cable lugs as per selected cable sizes shall be provided in line with cable erection philosophy. For single core cable termination, gland plates shall be of non-magnetic material.

4.6 Grounding

Two separate earthing term inals suitable for connec ting G.I. or MS strip grounding conductor shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.7 General

4.7.1 Motors provided for similar drives shall be interchangeable.

4.7.2 An arrow block shall be screwed on the body of the motors on the non-driving end to indicate the direction of rotation of the motors.

4.7.3 Motors for Fuel oil unloading and drain oil pum ps located in hazardous areas shall be with flam e-proof enclosures in accordance with IS 2148 / IEC 60079.

5.0 ACCESSORIES

5.1 SPACE HEATERS

All motors rated 30KW and above sh all be provided with space heaters to maintain the m otor internal air temperature above the dew point. Space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

The leads from space heaters of each m otor shall be brought out to a separate terminal Box. Space heaters shall be m ounted inside the m otor in accessi ble places so that their rem oval and replacement is simple.

5.2 RESISTANCE TEMPERATURE DETECTORS (RTDs)

5.2.1 HT motors stator windings shall be provided with 12 nos. (4 per phase) Simplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for rem ote monitoring of winding tem perature. The leads from RTDs of each motor shall be brought out to a separate terminal Box.

5.2.2 For HT m otors, each bearing shall be provided with 1 no. Duplex 3 wire Platinum RTDs with 100 ohms resistance at 0 deg C for remote monitoring of bearing temperature. The leads from these RTDs shall be brought out to a separate terminal Box or the terminal box same as for winding RTDs.

5.3 DIAL TYPE TEMP. INDICATORS

5.3.1 For HT m otors, each bearing shall be provided w ith 1 no. Mercury -in-steel Dial type temperature indicator for local indication of bearing temperature. The indicators shall have 2 nos. NO contacts rated for 5A, 240 V AC and 0.5 A, 220 V DC for alarm/trip purpose.

5.4 Vibration monitoring pads

5.4.1 Provision shall be made in all HT motors for mounting vibration detectors.

6.0 NAME PLATE

Motors shall have stainless steel nam e plate with all particulars as per IS: 325 / NEMA-MG-1. In addition, the following information shall be shown on motor rating plates:

i) Type of bearing & recommended lubricants along with location of insulated bearing.
ii) Temperature rise in deg.C under normal/abnormal conditions.
iii) Year of manufacturing.

7.0 PAINTING

The paint shall be corrosion proof epoxy based of approved class and paint thickness shall be within 100 to 150micron.

8.0 TESTING

8.1 Ty pe Tests

For HT & LT Motors above 50kW, ty pe test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplie d and carried out within last five y ears from the date of bid opening viz. February 2012 shall be subm itted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

8.2 Routine Tests

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

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

1.0 INTENT OF SPECIFIATION

The specification covers the design, m aterials, c onstructional features, m anufacture, inspection and testing at m anufacturer's work, and packing of Low voltage (LV) squirrel cage induction m otors 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 com ply with latest edition, including all am endments 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 m otors 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 m aximum 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 tor que, break away torque and starting tim e shall be properly co-ordinated with the requirem ents of dr iven equipm ent. The accelerating torque at any speed with the m inimum 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.

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 mimimum 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: 4691and 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.

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**

4.9.1 Motors provided for similar drives shall be interchangeable.

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

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

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

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

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

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

5.0 INSPECTION AND TESTING

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

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

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

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

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipm ent. In case motor is coupled with m echanical equipment by fluid coupling, the above cu rves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

GENERAL TECHNICAL REQUIREMENTS

OF

MV MOTORS

SPECIFICATION No.

1.0 GENERAL

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

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

2.0 CODES AND STANDARDS

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

3.0 DESIGN REQUIREMENTS

3.1 General Requirements

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

3.2 Supply Voltage and Frequency

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

Voltage variations	± 10 %
Frequency variations	± 5 %
Combined voltage and frequency variation (sum of absolutes)	10 %

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

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

3.3 Motor Rating

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

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

3.4 Starting Requirements

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

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

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

3.4.4 The following frequency of starts shall apply:

a) Two starts in succession with the motor initially at temperature not exceeding the rated load operating temperature.

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

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

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

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

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

3.5 Running Requirements

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

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

3.6 Stress During Bus Transfer

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

3.7 Noise Level

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

3.8 Vibration

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

4.0 CONSTRUCTIONAL FEATURES

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

4.2 Enclosure and Cooling

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

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

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

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

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

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

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

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

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

a) Suitable visual indication for detecting the tube failures.

b) Visual indication for observing flow of water.

c) Flow switch for initiating alarm under no flow conditions. The switch shall be provided with two contacts.

d) Cooling materials of the cooler tube and tube plates shall be suitable for the cooling water specified in Data Sheet-A.

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

a) Temperature gauge for inlet and outlet water temperature and air temperature.

b) Cooling water pressure switch with two contacts.

The above are not in the scope of motor supplier.

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

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

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

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

4.3 Class of Insulation

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

4.4 Bearings

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

4.4.1 Anti Friction Bearings

4.4.1.1 Anti-friction type bearings shall be of ball/roller type. These shall be pressure grease gun lubricated and fitted with grease nipple and grease relief devices. Bearings shall be so constructed that the loss of grease and its creeping along the shaft into the motor housing is prevented. Dirt and water getting into the motors shall also be prevented.

4.4.1.2 The minimum life of ball/roller bearings shall not be less than 30,000 working hours.

4.4.1.3 For the motors equipped with ball/roller bearings adequate means shall be provided during stand-still period to prevent the brinelling effect. During transport and shipping such motors shall receive a special bearing insert or a suitable arrangement to block the movement of rotor.

4.4.2 Sleeve Bearings

4.4.2.1 Sleeve bearings shall be of the split type, readily accessible and replaceable. These shall be either ring-oil lubricated type or forced-oil lubricated type. If forced- oil lubrication is used, the lubricating oil system shall be common to both motor and the driven equipment. The forced - oil lubricating system comprising oil pump, oil tank, piping, oil coolers, valves, etc. shall not be supplied along with motors. These shall be arranged separately by the purchaser.

4.4.2.2 Motors with sleeve bearings shall be fitted with a sight gauge marked with the proper oil level and shall be supplied with the oil fill and oil drain plugs. Proper means shall also be provided for observing oil-ring rotation when the motors are running.

4.4.2.3 When the forced-oil lubrication is provided for the bearings, ring-oil lubrication shall also be provided for starting and emergency shut down which shall be adequate for starting the motors and allowing continuous operation for at least 10 minutes without the forced-oil lubrication system in operation and without damage to the bearing.

4.4.3 **Combined Thrust and Guide Bearings**

4.4.3.1 For vertical motor combined thrust and guide bearings shall be provided to withstand the normal downward thrust due to operating loads and rotor weight as well as the maximum anticipated upward thrust. The guide bearings shall be of sleeve type. Both thrust and guide bearings shall be housed in a common upper bracket and a guide bearing in lower bracket. In upper bracket, the oil for thrust and guide bearings shall be common.

4.4.4 **General requirements for Bearing**

4.4.4.1 Except in the case of totally enclosed motors, means of access shall be provided to the rotor air gap, without disturbing the bearing housings, to permit the use of air gap gauges to check bearing wear.

4.4.4.2 In case of independently supported bearings, motor and bearing pedestals shall be fitted on a common base plate.

4.4.4.3 Flow of shaft currents through bearings shall be positively blocked in all motors rated above 1000 kW as also in smaller motors where considered necessary by the manufacturer. In the case of pedestal mounted bearings, both bearing shall be insulated, and an earth bonding link shall be provided at the driving end, the link shall be removable for insulation testing. Where the bearings are mounted directly in the motor end frames, the non-driving end shall be permanently insulated. It shall be possible to carry out maintenance without damaging the insulation. All oil and water pipes, direct-driven oil pumps etc., shall be insulated where necessary to prevent flow of any shaft current. The insulation provided to avoid shaft currents, shall be meggered at 500 volts at manufacturer's work.

In case of water cooled oil bearings, proper insulation shall be provided at the connecting point of water pipe to bearing bodies to prevent the bearings leakage current through the water pipes.

4.4.4.4 Sleeve and thrust bearings shall be provided with temperature gauges of mercury in-steel type with micro-switch with a minimum of one meter flexible capillary and having alarm and trip contacts. The contacts rating shall be 2 Amps at 240 V AC or 0.5 Amp at 220 V DC.

4.4.4.5 Sleeve and thrust bearings shall be provided with duplex platinum resistance temperature detectors (RTD) for remote indication of bearing temperature. The DC resistance of the RTDs shall be 100 Ohms at $0^{o}C$. The RTDs shall be of three wire type. The terminals of the RTDs shall be brought out to the winding RTDs terminal box or in a separate terminal box. The bearing RTDs terminals shall be marked as B1, B2, etc.

4.5 **Winding Resistance Temperature Detectors(RTDs)**

Motors shall be provided with a minimum of six Nos. RTDs of platinum resistance duplex type or 12 Nos. simplex type having a DC resistance of 100 Ohms at 0 deg C. The RTDs shall be embedded in the stator windings at locations where highest temperature are expected. The RTDs shall be of three wire type . The terminal box, shall be complete with removable front and cable gland plate. RTD leads shall be marked as 1,2,3 etc.

4.6 Terminals and Terminal Boxes

4.6.1 Terminal, terminal leads, terminal boxes, windings details and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet - A for a duration of atleast 0.25 second.

The test reports for terminal boxes shall be furnished for approval.

4.6.2 Unless otherwise specified or approved, main phase terminal boxes shall be positioned on the left hand side of the motor when viewed from the non-driving end. The main terminal box location shall be subject to purchaser's approval.

4.6.3 Motors with rating of 2000 kW and above shall be star connected and six leads shall be brought out. Line and neutral terminals of these motors shall be located in separate terminal boxes having provision for mounting differential protection current transformers.

4.6.4 Power terminal boxes shall have a phase separated (not phase segregated) construction. However, for motors which would have single core cables, three separate terminals boxes, one for each phase would also be acceptable. A minimum clearance of 100 mm between the lugs/bare live parts of different phases and 90 mm between lugs/bare live parts and earth shall be provided in the terminal boxes for 6.6 kV motors. For high voltages the clearances shall be subject to purchaser's approval.

The distance between gland plate and the terminal studs shall not be less than 500 mm. The terminal boxes shall be capable of withstanding a system fault level specified in Data Sheet-A for at least 0.25 seconds. A suitable provision of releasing the pressure developed during faults shall be made.Terminal boxes shall be suitable for top and bottom entry of cables.

4.6.5 Connections shall be such that when the supply leads R,Y & B are connected to motor terminals A, B & C OR U, V & W respectively, motors shall rotate in desired direction when viewed from the non-driving end as specified in data sheet-A.

4.6.6 Motor, terminals and terminal leads shall be fully insulated with no bare live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.6.7 Degree of protection for terminal boxes shall be same as that of motors as specified in Clause 4.1.

4.6.8 Dessicator shall be fitted inside the terminal box and shall have an indicating head visible from outside the box.

4.6.9 Detachable cable box shall be fitted on the main phase terminal box and the design of cable box shall be suitable for terminating the cables specified in Data Sheet - A.

Details of cable boxes shall be submitted for approval. Cable boxes shall be mounted in such a way that the incoming cable does not foul with the foundation block. Double compression nickel plated brass cable glands for all terminal boxes and copper cable lugs for main terminals shall be included in bidder's scope.

4.6.10 Separate terminal boxes shall be provided for RTDs, CTs and space heaters. Detachable gland plates with double compression glands shall be provided in terminal boxes.

4.6.11 Main phase terminal boxes shall be suitable for 180 deg. rotation.

4.7 Earth Terminals

Two separate earth terminals suitable for connecting copper or MS strip grounding conductor of size given in Data Sheet - A shall be provided on the motor frame.

4.8 General

4.8.1 Motor provided for similar drives shall be inter-changeable.

4.8.2 Motors and their enclosures shall be constructed to permit easy dismantling and reassembly at site. All heavy parts should have means for attaching the lift tackle.

4.8.3 Rotors shall be dynamically balanced.

4.8.4 An arrow block shall be screwed on the body of the motors on the non-driving end to indicate the normal direction of rotation of the motors.

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

4.8.6 Motors shall be provided with eye bolts, lugs or other means to facilitate safe lifting.

4.8.7 The CTs for differential protection for motors shall be arranged by purchaser but the mounting and connections are to be done by the motor supplier.

5.0 SPACE HEATERS

All motors shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be connected to a supply of 240 V AC, single phase 50 Hz.

The leads from space heaters of each motor shall be brought out to a separate terminal box. Space heaters shall be mounted inside the motor in accessible place so that their removal and replacement is simple.

6.0 NAME PLATE

Motors shall have anodized brass/stainless steel name plate with all particulars as per IS: 325. The rating plate shall also indicate the following additional information :

a) Maximum continuous rating in kW and corresponding temperature rise, as applicable for cooling medium temperature specified in Data Sheet -A.

b) Bearing identification numbers (In case of ball/roller bearing and recommended lubricant)

7.0 PAINTING

a) Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 as per IS:5. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions. Motors frame shall also be painted to withstand corrosion.

b) All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

8.0 SHOP INSPECTION AND TESTS

8.1 Stage Inspection and Tests

All materials, components and equipment covered in this specification shall be procured, manufactured as per approved standard quality plan and shall be complied with.

8.2 Type tests

First motor of each type and rating shall be subject to tests as per IS:325. In addition to this,the following tests shall also be done on first motor of each type and

a) Over speed test at 20% overspeed for 2 minutes.

b) Polarization index test. The test value shall not than 2 when determined as per IS:7816

c) Degree of protection as per IS 4691. Type test for D.O.P. of similar enclosure design can also be subject to purchaser's approval.

(B)

d) Measurement of noise level as per BS:4999 Part 51.

e) Tan delta and dielectric loss measurement on each phase of motor stator winding.

8.3 Routine Tests

All motors shall be subjected to routine tests as per IS:325. All motors except the one which has been subjected to type test shall be subjected to the following tests in addition to the routine tests:

a) Measurement of stator resistance.

b) Verification for direction of rotation relative to phase sequence of the supply.

c) Measurement of vibration as per IS: 12075.

d) Axial play for the rotor having sleeve bearing.

8.4 The following additional Special Tests shall also be conducted:

a) Surge withstand test on the sample coils at (4u+5) kV and with at least five impulses of 1.2/50 micro sec. wave where u is the line to line voltage in kV.

b) Surge withstand test at 25.5 kV (PEAK) with 0.3/3 micro sec wave on 6.6 kV motor sample coils with at least five such impulses. For 11 kV motor sample coils,the test voltage value shall be mutually agreed between purchaser & manufacturer.

9.0 SITE TESTS

9.1 Site checks/tests shall be done at site by the equipment supplier (by purchaser in case of supply contract) to ascertain the compliance of the motor with specification and the test specification and the test certificates as per relevant standards and other tests as agreed with BHEL site.

a) Measurements of insulation resistance.

b) Measurements for starting current.

c) Check on motor vibration.

d) Polarization index.

e) Correctness for phase sequence.

10.0 PERFORMANCE GUARANTEES

Bidders shall guarantee that motors offered shall meet the rating and performance requirements as stipulated in this specification and as confirmed by them in technical data sheets and motor characteristics curves. In case the performance of motors at site is not as per the performance guarantee, the bidders have to replace the motors at site free of cost. Regarding performance guarantee refer section 'C' of specification also.

11.0 DRAWINGS

11.1 Drawings to be submitted with offer:

a) Data Sheet B

b) Dimensional outline drawing.

c) Standard Quality Plan (Enclosed in Vol. III) after putting signature and seal of acceptance.

d) Field Quality Plan for quality checks to be observed at site during erection, testing and commissioning, as per standard BHEL format.

e) Test certificates for equipment of similar rating and design.

f) Clause wise deviations, if any.

11.2 Drawings/Data to be submitted after award of contract

a) Data Sheet C

b) Final Quality Plan & Field Quality Plan

c) OGA drawing showing the position of terminal boxes, earthing connections, temperature sensing devices, etc.

d) Arrangement drawing of terminal boxes.

e) Characteristic Curves

(i) Current versus time at rated voltage and minimum starting voltage.

(ii) Speed versus time at rated voltage and minimum starting voltage.

(iii) Torque versus speed at rated voltage and minimum voltage. For the motors with solid coupling the above curve i), ii), & iii) to be furnished for the motors coupled with driven equipment. In case motors with flexible coupling, above curves to be furnished with and without coupling. The torque speed curve of driven equipment to be shown with torque speed curve of motor.

(iv) Thermal withstand curve at hot and cold conditions.

(v) Power factor, efficiency, current, slip versus load curves.

f) O & M manual

12.0 INSTALLATION AND MAINTENANCE MANUAL

12.1 The installation and maintenance manual of motor shall contain the following:

a) Application of motor

b) Technical Data

c) Salient constructional features

d) Instruction to be followed on receipt of motors at site

e) Handling and slinging

f) Storage and reconservation

g) Instructions for foundation

h) Erection procedure and check

i) Earthing

j) Drying out

k) Commissioning procedures and site tests

l) Routine, periodic and preventive inspection and maintenance procedures

m) Assembly and disassembly of terminal box, rotor, stator, coolers, bearings, RTD etc.

n) Safety rules

o) Possible faults,their causes and remedies

p) Routine and type test reports

q) Catalogs, literatures and drawings

13.0 SPARES

13.1 Recommended list of spares for commissioning and for operation and maintenance of the motors for a period of three (3) years shall be furnished.

13.2 A minimum of the following commissioning and O & M spares are to be included in the offer:

a) Commissioning Spares:

(i) One set of driving end (DE) and nondriving end (NDE) bearings for each type of frame size of motor.

b) Operation and maintenance (O & M) spares.

(i) One set of driving end (DE) and nondriving end (NDE) bearings for each type of frame size of motor.

(ii) One number bearing oil temperature indicator.

(iii) One number cooling air temp. indicator.

13.3 Bidder shall also quote for any other spares not listed above but necessary for commissioning or for operation and maintenance.

ANNEXURE-I

LIST OF APPLICABLE CODES & STANDARDS

1.	INDUCTION MOTOR - THREE PHASE	[ ]IS325 [ ]IEC34-1	[ ]BS4999
2.	DESIGNATION FOR TYPE OF CONSTRUCTION & MOUNTING ARRANGEMENT OF ROTATING ELECTRICAL MACHINES	[ ]IS2253 [ ]IEC34-7	[ ]BS4999-107
3.	TERMINAL MARKING FOR ROTATING ELECTRICAL MACHINERY	[ ]IS4728 [ ]IEC34-8	[ ]BS4999-108
4.	DESIGNATION OF METHODS OF COOLING FOR ROTATING ELECTRICAL MACHINES	[ ]IS6362 [ ]IEC34-6	[ ]BS4999-106
5.	DIMENSIONS OF SLIDE RAIL FOR ELECTRIC MOTORS	[ ]IS2968 [ ]	[ ]
6.	GUIDE FOR TESTING THREE PHASE INDUCTION MOTORS	[ ]IS4029 [ ]	[ ]BS4999-143
7.	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES FOR ROTATING ELECTRICAL MACHINES	[ ]IS4691 [ ]IEC34-5	[ ]BS4999-105
8.	CODE OF PRACTICE FOR CLIMATE PROOFING	[ ]IS3202 [ ]	[ ]BSCP1014
9.	MEASUREMENT AND EVALUATION OF VIBRATION OF ROTATING ELECTRICAL MACHINES	[ ]IS12075 [ ]IEC34-14	[ ]BS4999-142
10.	CLASSIFICATION OF HAZARDOUS AREAS FOR ELECTRICAL INSTALLATION	[ ]IS5572 [ ]IEC79	[ ]
11.	NOISE MEASUREMENT	[ ]IS6098 [ ]IEC34-9	[ ]BS4999-51
12.	STANDARDISATION OF MOTOR FOR AUXILIARIES	[ ]CBIP-40 [ ]	[ ]BS5000-40
13.	PREFERRED NUMBERS	[ ]IS1076 [ ]	[ ]

NOTES:

1. EQUIPMENT, ASSOCIATED ACCESSORIES, COMPONENTS/PARTS, RAW MATERIAL AND TESTS SHALL IN GENERAL CONFORM TO
   [ ]IS [ ]BS [ ]IEC

2. OFFERS CONFORMING TO OTHER AUTHORITATIVE STANDARDS
   [ ] MAY ALSO BE CONSIDERED
   [ ] MAY NOT BE CONSIDERED

1.0	Design ambient temperature		:	50 °C
2.0	Driven equipment (as specified in specification)		:	
3.0	Minimum kW rating of MV motors		:	>160 kW
4.0	Details of Supply system			
	a)	Rated voltage	:	6600 V, ± 10 %
	b)	Rated frequency	:	50 Hz, ± 5 %
	c)	Combined Voltage and frequency variation (sum of absolutes)	:	10 %
	d)	System fault level at rated voltage	:	40 kA
	e)	Short time rating of MV switchgear	:	40 kA for 3 sec.
	f)	Short time rating for terminal boxes	:	40 kA for 0.25 sec.
	g)	MV system grounding	:	~~Isolated~~ / ~~high resistance~~ / low resistance
5.0	Applicable standard		:	As per annexure-I enclosed
6.0	Minimum voltage for starting			
	a)	Mill Motor	:	____ % of rated voltage
	b)	Other Motors	:	80 % of rated voltage
7.0	Locked Rotor current			
	a)	Excluding tolerance		
		i. BFP motor	:	4.5 times rated current
		ii. Other motors	:	6.0 times rated current
	b)	Including tolerance	:	± 20 % on all motors
8.0	Type of power cables			
	a)	Insulation	:	~~PVC~~ / XLPE
	b)	Sheathing	:	~~PVC~~ / FRLS PVC
	c)	Voltage grade	:	6.6 KV ~~Earthed~~ / Unearthed
	d)	Armouring	:	Armoured / ~~unarmoured~~

	e)	Conductor	:	Copper / ~~aluminium stranded~~
	f)	Screening	:	✓Conductor screened / ✓Insulation screened
9.0	Cable sizes		:	
	a)	power cable for motor	:	later sq. mm
	b)	power cable for space heater	:	minimum 2.5 sq.mm PVC armoured Cu
	c)	Control cable for RTD	:	2pair 0.5sq. mm Cu
	d)	Control cable for BTD	:	2pair 0.5 sq. mm Cu
10.0	Grounding			
	a)	Conductor size	:	50X6 mm
	b)	Material	:	GS FLAT
11.0	Space heater supply		:	240 V, single phase
12.0	Painting		:	As per clause No. 7.0
13.0	Location of main phase terminal boxes		:	
14.0	Cooling water specification		:	
15.0	Additional tests		:	
16.0	Axial thrust in case of vertical motors (as specified by driven equipment vendor)		:	
17.0	Direction of rotation when viewed from non-driving end		:	Anti-clockwise / Clockwise
18.0	Insulation		:	CLASS F (ALL INSULATED WINDING SHALL BE OF COPPER)

INSTRUCTIONS TO VENDOR
1. This data sheet shall be filled up on the basis of finally agreed points of Data Sheet B, Bid Clarifications and MOM with the bidder.
2. This data sheet shall be submitted by successful bidder after award of contract.

1.0	Manufacturer	:		
2.0	Type and frame size & design code no.	:		
3.0	Nos. required	:		
4.0	Application	:		
5.0	Specification & codes	:		
6.0	Capacity			
	a) for specified climatic conditions	:		
	b) at 40 ^{o}C ambient temp.	:		
7.0	Location of installation	:	Indoor / Outdoor	
8.0	Type of enclosure & ventilation	:		
9.0	Degree of protection	:		
10.0	Type of duty	:		
11.0	a) Rated voltage	:		V
	b) No. of phases	:		
	c) Frequency	:		Hz
12.0	Permissible variations in			
	a) Voltage	:		%
	b) Frequency	:		%
	c) Combined voltage & frequency (sum of absolute values)	:		%
13.0	At rated voltage & frequency			
	a) Full load current	:		A
	b) Full load speed	:		rpm

	c) No load current	:	A
14.0	Minimum permissible voltage during starting to bring the driven equipment up to rated speed	:	_____ % of rated voltage
15.0	Maximum permissible time at minimum permissible voltage during running at full load	:	_____ minutes running at _____ % of rated voltage
16.0	Maximum permissible time at 75%: of rated voltage during running at full load		min.
17.0	Whether motor stalls at 70% of rated voltage (refer clause 3.5.2)	:	
18.0	Efficiency & power factor at	:	Efficiency P.F.
	a) Full load	:	
	b) 50% of full load	:	
	c) 25% of full load	:	
	d) No load	:	
	e) At start	:	
19.0	Stator winding		
	a) Connection	:	
	b) Type & nos. of terminals brought out	:	
	c) Resistance between terminals at 20 °C	:	ohms
	d) Resistance per phase at 20 °C	:	ohms
20.0	Starting current as percentage of full load current		
	a) with IS tolerance	:	%
	b) without IS tolerance	:	%

21.0	Torque at full load	:	kg.m
22.0	Break away torque as percentage of full load torque	:	%
23.0	Pull up torque as percentage of full load torque	:	%
24.0	Pull out torque as percentage of full load torque	:	%
25.0	Starting time in sec. without mechanism coupled or mechanism coupled through hydraulic coupling when it may be presumed that load is transferred to motor shaft only after attaining almost full speed		
	a) with rated voltage	:	sec.
	b) with 80% of rated voltage	:	sec.
	c) with 110% of rated voltage	:	sec.
26.0	Starting time in sec. with mechanism coupled through flexible coupling		
	a) with rated voltage	:	sec.
	b) with 80% rated voltage	:	sec.
	c) with 110% rated voltage	:	sec.
27.0	Safe stall time (Hot motor)		
	a) at rated voltage	:	sec.
	b) at 80% rated voltage	:	sec.
	c) at 110% rated voltage	:	sec.
28.0	Safe stall time (Cold motor)		
	a) at rated voltage	:	sec.
	b) at 80% rated voltage	:	sec.
	c) at 110% rated voltage	:	sec.

29.0	Whether speed switch is provided, if required	:	YES / NO
30.0	Limiting rotor temp. to determine safe stall time	:	
31.0	Permissible maximum accelerating time (hot motor) at full load		
	a) at rated voltage	:	sec.
	b) at 80% rated voltage	:	sec.
	c) at 110% rated voltage	:	sec.
32.0	Permissible maximum accelerating time (cold motor) at full load		
	a) at rated voltage	:	sec.
	b) at 80% rated voltage	:	sec.
	c) at 110% rated voltage	:	sec.
33.0	Insulation		
	a) Class of insulation	:	
	b) Tropical and fungicidal treatment (mention treatment) given	:	
34.0	Whether insulation is suitable for 6.6 kV earthed system		
35.0	Temp. rise under normal and abnormal conditions over 50 ^{o}C ambient temperature	:	
	a) By resistance method	:	____^{o}C over cooling water temp. of ____^{o}C
		:	____^{o}C over cooling air temp. of____^{o}C
	b) By thermometer method	:	____^{o}C over cooling water temp. of ____^{o}C
		:	____ ^{o}C over cooling air temp. of____^{o}C

36.0	Method of starting	:		
37.0	Permissible starting duty cycles	:		
38.0	Stator thermal time constant	:		
39.0	Maximum permissible voltage during high speed bus transfer & its duration (describe special design feature)	:	_____ % of rated voltage for _____ duration	
40.0	Time required for voltage to decay down to following values when driving voltage is removed			
	a) 50%	:		sec.
	b) 40%	:		sec.
	c) 25%	:		sec.
	d) 0%	:		sec.
41.0	Method of cooling	:		
42.0	Details of water cooling system			
	a) No. of coolers	:		
	b) Water requirement per cooler	:		LPM
	c) Losses removed by cooler	:		
	d) Max. permissible temp. of cooling water at inlet	:		^{o}C
	e) Maximum permissible temp. of cooling water at outlet	:		^{o}C
	f) Maximum permissible pressure at water outlet	:		kg/sq.cm
	g) Water pressure drop through the cooler	:		

h)	Temp. of cold air coming out & entering the machine for permissible cooling water temperature		°C
i)	Temp. rise of air passing through machine at full load		°C
j)	Air pressure drop through the cooler		
k)	Temp. rise of water through cooler	:	°C
l)	Protection against leakage of water	:	
m)	Arrangement to ensure the water flow	:	

43.0 Bearings

a)	Number	:	
b)	Type	:	
c)	Lubrication System	:	
d)	Quantity of lubricant required for both the bearings	:	
e)	Life at rated speed	:	hrs.
f)	Recommended lubricant	:	
g)	Bearing end play	:	
h)	Inlet oil pressure	:	
i)	Temp. rise of oil through bearing	:	°C
j)	Max. permissible temp of oil	:	°C
k)	Max. permissible temp. of bearing	:	°C

l) Permissible running time : without forced oil at full load & full speed

m) Whether bearings are : YES / NO
provided with 3 wire, platinum RTD having 100 ohm resistance at 0°C for remote temp. indication

n) Whether bearings are :
provided with local temp. indicator having two adjustable contacts rated for 2A at 240V AC or 0.2A at 220V DC

o) If forced lube oil system provided

i. Qty. of lubricant :
required for initial filling

ii. Recommended period :
after which lubricant should be replaced

iii. Bearing cooling :
water requirement

iv. Max. permissible : °C
bearing cooling water inlet temp.

v. Max. permissible : °C
bearing cooling water outlet temp.

44.0 Terminal designation corres- :
ponding to direction of rotation (facing driving end)

45.0 Whether separate terminal boxes provided for

a) Main terminals : YES / NO

b)	Space heaters	:	YES / NO
c)	Winding temp. detectors	:	YES / NO
d)	Bearing temp. detectors	:	YES / NO
e)	Moisture detectors	:	YES / NO
f)	Neutral terminals	:	YES / NO

46.0 Main terminal box details

a)	Type & Nos.	:	
b)	Fault level permissible for 0.25 sec.	:	MVA
c)	Rating of each	:	
d)	Total power requirement	:	
e)	Voltage	:	V

47.0 Details of 3 wire, platinum RTD having 100 ohm resistance at $0^{o}C$ for winding temp. & bearing temp. detectors

a)	Type	:	
b)	Nos. provided	:	
c)	Location	:	

48.0 Whether differential protection provided. If yes, :

a)	no. of CTs supplied along with motors	:	
b)	CT details	:	
	i. CT ratio	:	
	ii. Knee point voltage	:	
	iii. Short ckt. withstand capacity	:	

49.0 Type of mounting :

50.0	Shaft orientation	:	
51.0	Shaft extension	:	
52.0	Grounding pads, sizes, nos. & location	:	
53.0	Method of coupling to driven mechanism	:	
54.0	GD sq. value		
	a) of the motor	:	
	b) of the mechanism referred to the motor shaft	:	
55.0	Thermal inertia of the motor	:	
56.0	Whether the speed switch provided	:	YES / NO
57.0	Details of speed switch, if provided	:	
58.0	Compliance with testing requirements	:	YES / NO
59.0	Lifting Device	:	
60.0	Weight		
	a) Weight of stator (wound)	:	
	b) Weight of rotor (wound)	:	
	c) Weight of base plate	:	
	d) Weight of Copper	:	
	e) Net weight of motor	:	
61.0	Shipping details		
	a) Shipping dimensions	:	
	b) Shipping weight	:	

62.0	Whether dial type capillary thermometers with temperature switch provided	:	
	a) In cold air / water path	:	
	b) In hot air / water path	:	
	c) For measurement of oil temp. for bearings	:	
63.0	Characteristic curves attached		
	a) Speed vs current at rated voltage	:	YES /NO
	b) Speed vs torque at 110%, 100%, 90% and 80% of rated voltage	:	YES / NO
	c) Thermal withstand curve for hot & cold conditions	:	YES / NO
	d) Efficiency vs load	:	YES / NO
	e) p.f. vs load	:	YES / NO
	f) Current vs time	:	YES / NO
	g) Negative phase sequence curve	:	YES / NO
64.0	Drawings attached		
	a) General arrangement of motor	:	YES / NO
	b) Main terminal box showing Boards's incoming cables	:	YES / NO
	c) Instruction manuals	:	YES / NO
65.0	Other Documents Attached		
	a) Final Quality Plan	:	YES / NO
	b) Final Field Quality Plan	:	YES / NO

65.0 List of Spares Commissioning Spares O&M Spares

ELECTRICAL SUB-VENDOR LIST FOR MV and LV MOTORS (AS ON 16.08.14)						
SL NO.	**ITEM**	**VENDOR CODE**	**VENDOR NAME**	**ADDRESS**	**PHONE**	**REMARKS**
1	MOTORS LV	A24	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	0129-2567580, 09871799449	
2	MOTORS LV	E1027	BHARAT BIJLEE LTD.	Bharat Bijlee Limited, 1st Floor, 7-B, Rajindra Park, Pusa Road, New Delhi - 110 060.	Tel.: + 91 (11) 25816931-33, 35 & 36| DT: +91 25724318 Fax: + 91 (11) 25819640| M:+ 91 9818 121132	www.bharatbijlee.com
3	MOTORS LV	C02	CROMPTON GREAVES	3rd Floor, Express Building,9-10, Bahadur Shah Zafar Marg, Near ITO Crossing,New Delhi-110002, India	91 11 23460700 - 999	Sunil.Das@cgglobal.com
4	MOTORS LV	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	044-49681447	
5	MOTORS LV	K01	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055	Tel: +91-80-23374865	Fax: +91-80-23377706
6	MOTORS LV	L04	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	0217- 2357001-005	APPROVED UPTO 200KW
7	MOTORS LV	M01	MARATHON	Marathon Electric India Private Ltd.Sector - 11, Model Town, Faridabad - 121006	Ph: +91-129-2286421, 2265340, 4006601 to 4006610	
8	MOTORS LV	A35	NGEF	Pocket No.10, Flat No. 37 & 38, Expandable DDA Flats, Nasirpur Dwarka, Phase-I NEW DELHI-110 045	Ph: (011) 2539 7763	
9	MOTORS LV	E1115	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	91-22-26730823, 26730789	91)-(22)-267301S4
10	MOTORS LV	S01	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	0124-2842000, 9873424331	amit.bhadauria@siemens.com
11	MOTORS MV	E1031	BHEL (INDUSTRY SECTOR)	INTEGRATED OFFICE COMPLEX, LODHI ROAD , NEW DELHI	4634148,4636411	
12	MOTORS MV	C02	CROMPTON GREAVES	3rd Floor, Express Building,9-10, Bahadur Shah Zafar Marg, Near ITO Crossing,New Delhi-110002, India	91 11 23460700 - 999	Sunil.Das@cgglobal.com
13	MOTORS MV	K01	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 MALLESWARAM WEST,BANGALORE 560055	Tel: +91-80-23374865 Fax: +91-80-23377706	
14	MOTORS MV	A35	NGEF	Pocket No.10, Flat No. 37 & 38, Expandable DDA Flats, Nasirpur Dwarka, Phase-I NEW DELHI-110 045	Ph: (011) 2539 7763	
15	MOTORS MV	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	044-49681447	
16	MOTORS MV	M01	MARATHON	Marathon Electric India Private Ltd.Sector - 11, Model Town, Faridabad - 121006	Ph: +91-129-2286421, 2265340, 4006601 to 4006610	

	TITLE	SPECIFICATION NO. PE-TS-400-555-A001
	MOTOR	VOLUME III
		SECTION C.3
	DATA SHEET - C	REV NO. 00

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	

NAME OF VENDOR				REV.	
NAME	SIGNATURE	DATE	SEAL		

	TITLE	SPECIFICATION NO. PE-TS-400-555-A001
BHEL	MOTOR DATA SHEET - C	VOLUME III SECTION C.3 REV NO. 00

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR				REV.	
NAME	SIGNATURE	DATE	SEAL		

	QUALITY PLAN		CUSTOMER : NLC LTD.			PROJECT : 2 X 500 MW NNTPS, NEYVELI TITLE			SPECIFICATION : NUMBER : PE-TS-400-555-A001			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			TITLE			
	SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION : C.3			VOLUME IIB
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 2 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
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, CONNEC-TORS, 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 TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 3 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 4 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-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-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 6 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-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

	QUALITY PLAN	CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :					
		BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE					
	SHEET 7 OF 9	SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	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
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	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	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	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 TITLE	SPECIFICATION : NUMBER :								
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE								
	SHEET 8 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION			VOLUME III					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2
BHEL			PARTICULARS	BIDDER/VENDOR								
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
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.

Legends for Inspection agency

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 : NLC LTD.			PROJECT : 2 X 500 MW NNTPS, NEYVELI			SPECIFICATION : PE-TS-400-555-A001			
			BIDDER/ VENDOR :			TITLE			NUMBER :			
						QUALITY PLAN NUMBER PED-506-00-Q-003/01						
		SHEET	SYSTEM			ITEM ELECTRICAL IN-PROCESS			SECTION :C.3			VOLUME IIB
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	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
1.O	FABRICATION	1. DIMENTION	MA	MEASUREMENT	100%	APPD. DRG.	APPD. DRG.	INSPC.	2	-	-	
		2.ALIGNMENT	MA	MEASUREMENT & VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
		3. FINISH SURFACE DEFECT	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
.2.0	SURFACE PREPARATION & PRE-TREATMENT	1. PROCESS PARAMETERS SOLUTION STRENGTH TEMPERATURE DIPPING TIME ETC.	CR	PROCESS	PERIODIC	MFR.STD./ BHEL SPEC. RELV. IS	MFR. STD./ BHEL SPEC RELV. IS	LOG BOOK	2	-	-	
		2. SURFACE CONDITION	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
3.0	PRIMER & PAINTING (SPRAYED & STOVED)	1. SURFACE FINISH & COVERAGE	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
		2. FILM THICKNESS	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3. SHADE	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. ADHESION	MA	CROSSOUT TYPE	-DO-	-DO-	-DO-	-DO-	2	-	-	
	BHEL		PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN	CUSTOMER :			PROJECT			SPECIFICATION :			
			BIDDER/ VENDOR :			TITLE			NUMBER :			
		SHEET	SYSTEM			NUMBER PED-506-00-Q-003/01			SPECIFICATION :			
						ITEM ELECTRICAL IN-PROCESS			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	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
4.0	MOUNTING OF VARIOUS ITEMS	1. RIGIDITY	MA	VISUAL	100%	MANUFACTURE DRAWING	MANUFACTURE DRAWING	LOG BOOK				
		2.THICKNESS	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
		3. CORRECTNESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG.	APPD. DRG.	-DO-	2	-	-	
		4. ACCESSIBILITY	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
5.0	MARKING/LABELLING	1. CORRECTNESS	MA	VISUAL	100%	-DO-	-DO-					
		2. ADHESION/ FIXING	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
6.0	PRE-FINAL INSPECTION	1. ALIGNMENT	MA	VISUAL	100%	BHEL SPEC. & RELV. STD.	BHEL SPEC. & RELV. STD.	TEST CERT.	2	-	-	
		2. PERFORMANCE	MA	ELECTRICAL	100%	-DO-	-DO-	-DO-	2	-	-	
		3. IR & HV	MA	ELECTRICAL	100%	-DO-	-DO-	-DO-	2	-	-	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ : VENDOR	QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01	SPECIFICATION TITLE
	SHEET	SYSTEM	ITEM AC ELECT. MOTORS BELOW 55KW (LV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'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.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3

BHEL	PARTICULARS	BIDDER/VENDOR
	NAME	
	SIGNATURE	

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ : VENDOR	QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01	SPECIFICATION : TITLE :

SHEET		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY 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. TH 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.

Legends for Inspection agency

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

GENERAL TECHNICAL REQUIREMENTS

FOR

CABLING INSTALLATION

1.0 **INTENT OF SPECIFICATION**

1.1 This specification covers the activities mentioned below, as applicable to various areas of power station:

b) Laying and termination of cables.
c) Testing and charging of cables.
d) Supply and erection of miscellaneous items for completion of the cabling system.
e) All associated work for completion of cabling system.
f) Receipt of cables and cabling materials supplied by purchaser/others.
g) Site handling and storage of material.
h) Minor civil works.

1.2 The scope of supply of cabling materials as a part of cable installation work includes supply of all accessories including, but not limited to, cable clamps, ferrules, cable tags, nuts, bolts, and consumables like anti-corrosive paints, welding electrodes etc. required to complete the cabling system. All other sundry materials for minor civil work shall also be supplied by vendor.

1.3 WORKS EXCLUDED FROM VENDOR'S SCOPE

a) Major civil works like excavation and concreting of concrete trenches, plate embedments on cable trenches, ceiling and floors.
b) Civil works for ducting for crossing of roads & rail tracks.
c) Conduits and pipes embedded in walls, floors etc.

2.0 CODES AND STANDARDS

2.1 Installation of cabling work shall comply with the latest edition of following Indian standards rules, regulations and acts. However, if Specification specifies conformance to any other international standard, equivalent BS / IEC / ISO / any other standard shall be applicable.

a)	IS:1255	Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
b)	IS:732	Electrical wiring installation (system voltage not exceeding 650 V).
c)	IS:5216	Guide for safety procedures and practices in electrical works.
d)	IS:226	Structural steel (Standard Quality).
e)	IS:800	Code of practice for use of structural steel.
f)	IS:316	Code of practice for use of metal arc welding for general construction in mild steel.
g)	IS:1363	Hexagonal bolts, nuts and screws.
h)	IS:1572	Electroplated coatings of cadmium on iron and steel.
i)	IS:2629	Code of practice for hot dip galvanizing for iron and steel.
j)	IS:2633	Method of testing uniformity of coating on zinc coated articles.
k)		Indian Electricity Act.
l)		Indian Electricity Rules.
m)		Fire insurance regulations.
n)		Regulations laid down by the Chief Electrical Inspector of the State.
o)		Regulations laid down by the Factory Inspector of the State.
p)		Any other regulations laid down by the authorities.

2.2 In case any clause of contradictory nature arises between standards and this specification, the latter shall prevail.

3.0 CABLING MATERIALS TO BE PROVIDED

3.1 Trefoil Cable Clamps shall be provided for clamping single core cables carrying alternating current and shall be of aluminium alloy or nylon material as per Specification.

3.2 Omega Cable Clamps shall be provided to fasten the individual multi-core cable above 35mm outer diameter and shall be of aluminium alloy or mild steel.

3.3 Strip Cable Clamps shall be provided to fasten the group of multi-core cables up to 35mm diameter and shall be of mild steel or aluminium

3.4 Self Locking Clamps shall be shall be provided of nylon material with self locking feature when the cord is looped and shall provided with manual lock release.

3.4 Steel clamps shall be hot dip galvanized as per the requirements given in Specification.

3.5 Ferrules shall be provided for individual core of control cables and shall be of plastic material.

3.6 Cables shall be provided with cable number tags for identification Cable tags shall be of durable fibre, aluminium or stainless steel sheets as per Specification.

3.7 Miscellaneous items required for the buried cables such as cable markers, bricks, sand, protective slabs etc. shall be to provided by the vendor.

4.0 CABLING CONCEPT

4.1 In the plant building, substations, switchgear rooms, control rooms etc., power and control cables shall generally be laid on cable trays installed in concrete trenches, tunnels, cable basements, cable vaults, cable shafts or along building and technological structures as the case may be.

4.2 In case of multicore cables of diameter up to 30 mm where not more than 3 cables are taken in one run, these can be taken directly along structures, walkways, platforms, galleries, walls, ceiling etc. by proper clamping at regular intervals of 750 mm or less.

4.3 Power & control cables installed along buildings, structures, ceilings, walls, etc., which are required to be protected against mechanical damage, shall be taken in GI conduits.

4.4 GI Conduits shall also be used for flameproof installations, wherever required, with sealing at both ends.

4.5 Entry of cables from trenches/tunnels into buildings shall be by means method duly approved by purchaser approved, which shall be informed to successful bidder during detailed engg stage.

4.6 Cables laid exposed in racks/trays and routed from trenches/tunnels/basements etc to individual drive/ control devices etc shall be taken in embedded/exposed/surface-grouted rigid GI conduits and / or flexible conduits unless directly terminated to the equipment in the panels located above trenches, tunnels or basement.

4.7 All cables routed along walls or in equipment rooms shall be protected by means of laying them through G.I. pipes or by providing sheet metal covers up to a height of 2000 mm from

the working floor levels and platforms, for protection against mechanical damage. All vertical risers shall be enclosed type.

4.8 For 415 V power wiring in ancillary buildings, offices and laboratories, cables shall be taken through embedded/exposed GI conduits or rigid PVC pipes as applicable.

4.9 Wherever cables are to be laid below roads and railway tracks, the same shall be taken through ducts buried at a suitable depth.

4.10 At certain places where hazardous fumes/gases may cause fire to the cables, cable trenches after installation of cables shall be sand-filled.

4.11 In corrosive atmosphere, Epoxy painted G.I. conduits shall be used for cables.

4.12 Single core cables, when pulled individually, shall be taken through PVC pipes only.

4.13 Cables shall be avoided below oil pipes and in the vicinity of steam pipes.

4.14 Cable installation shall be properly coordinated at site with other services and wherever necessary suitable adjustment shall be made in the cable routings with a view to avoid interference with any part of the building, structures, equipment, utilities and services

4.15 All apparatus, connections and cable work shall be designed and arranged to minimise the risk of fire and ingress of water. All material required to achieve the same shall be included in the cost of installation of cables.

5.0 TRANSPORTATION & STORAGE OF CABLE DRUMS

5.1 Transportation and storage of cable drums shall generally conform to the requirements of IS:1255. The cable drums shall be transported on wheels to the place of work.

5.2 Transportation of all cables, which shall be provided by purchaser as free issue items, from purchaser's storage area to the work site shall be the responsibility of vendor. Empty cable drums shall be returned to purchaser.

6.0 LAYING OF CABLES

6.1 Laying and installation of power, control and special cables shall generally conform to IS:1255.

6.2 The cables shall be paid-out in proper direction from the cable drums (opposite to the normal direction of rotation for transportation).

6.3 In case of higher size cables, the paid out cables shall run over rollers placed at close intervals and finally transferred carefully on the racks/trays. Care shall be taken so that kinks and twists or any mechanical damage does not occur to cables. only approved cable pulling grips or other devices shall be used. Under no circumstances cables shall be dragged on ground or along structure while paying out from cable drums, carrying to site and straightening for laying purpose.

6.4 All possible care shall be given while handling un-armoured cables.

6.5 Additional length of power cables of one loop with permissible bending radius shall be provided. For control cables extra length of 1 - 1.5 metre shall be provided.

6.6 The bending radius of various types of cables shall not be less than those specified by cable manufacturers and that specified in IS:1255.

6.7 All cables shall be provided with identification tags indicating the cable numbers. Tags shall be fixed at both ends of cables, at each bend, and both sides of floor/wall crossings.

6.8 Single core cables for a. c. circuits shall form a complete circuit in trefoil formation supported by means of trefoil clamps of nonmagnetic material.

6.9 Multi-core cables above 1100 V grade shall be generally laid in ladder type trays in one layer with spacings not less than one cable diameter of bigger diameter cable.

6.10 All 1100 V grade multicore power cables and single core DC cables shall be placed in single layer, touching each other and clamped by means of single or multiple galvanized MS saddles/ aluminium strips/ nylon cable ties as specified in specification. Cables above 35mm outer diameter shall be clamped individually.

6.11 Control cables shall be laid touching each other and may not preferably be taken in more than two layers.

6.12 Segregation of the cables on the basis of their types and their functions shall be as under for horizontal formations:

a) HT cables shall be laid in the top tier(s).
b) LT power cables to be laid in the tray(s) below the HT cable trays.
c) LT control cables to be laid in the tray(s) next below to the LT power Cable tray(s).
d) Special control cables including screened control cables to be laid in the bottom most tray(s).

6.13 For vertical formations, the tray closest to the wall shall be considered as bottom most tray and the order indicated in clause just above shall be followed.

6.14 When it may not be possible to accommodate cables as per the criteria indicated in the clauses 6.12 & 6.13 above, the following rules In hierarchical order shall override the criteria:

a) Control cables are mixed up with the special control cables with clear minimum gap of 100mm between them.
b) LT power cables are mixed up with control cables with clear minimum gap of 150mm between them.
c) LT power cables are mixed up with HT power cables with clear minimum gap of 200mm between them.

However, under no circumstances HT power cables can be mixed up with control cables of any type.

6.15 For laying cables along building steel structures and technological structures, the cables shall be taken by clamping with MS saddles screwed to the MS flats welded to the structure. MS saddles and flats shall be galvanized.

6.16 For laying cables along concrete walls, ceilings etc., the cables shall be taken by clamping with MS saddles screwed to the MS flats welded on the inserts. Where inserts are not available the saddles shall be directly fixed to the walls using rawl plugs and MS flat spacers of minimum 6mm thickness.

6.17 To facilitate pulling of cables in GI conduits, powdered soft stone, plastic soap or other dry inert lubricant may be used but grease or other material harmful to the cable sheaths shall not be used.

6.18 No single core cable shall pass through a GI conduit or duct singly except DC single core cables. AC single core cables shall pass through GI conduits/pipes in trefoil formation only.

6.19 Entry of cables from underground trenches to the buildings or tunnels shall be by some approved method. Necessary precautions shall be taken to make the entry point fully water tight by properly sealing the pipe sleeves wherever they enter directly into the building at trench level. The sealing shall be by cold setting compound. Any alternative sealing arrangement may be suggested with the offer for purchaser's consideration.

7.0 CABLE TERMINATION AND JOINTING

7.1 All cable entries in the equipment shall be sealed by cable glands.

7.2 Power cable terminations shall be carried out in a manner such as to avoid strain on the terminals by providing suitable clamps near the terminals.

7.3 Control cable cores entering switchboard or control panels shall be neatly bunched and strapped with PVC perforated tapes/nylon ties and suitably supported to keep them in position at the terminal block. Spare cores shall be neatly dressed and suitably taped at both ends.

7.4 Cable joint, not more than one in a circuit, shall normally be made at an intermediate point in the straight run of the cable only when the length of the run is more than the standard drum length supplied by the cable manufacturer.

7.5 Junction boxes shall be used, wherever required, for jointing of control cables.

7.6 Termination and jointing shall generally conform to the requirements of IS:1255 and shall strictly conform to the recommendations of termination and jointing kit supplier.

7.3 Cable installation shall be properly coordinated at site with other services and wherever necessary suitable adjustment shall be made in the cable routings with a view to avoid interference with any part of the building, structures, equipment, utilities and services

7.8 All apparatus, connections and cable work shall be designed and arranged to minimise the risk of fire and ingress of water. All material required to achieve the same shall be included in the cost of installation of cables.

VOLUME – II B
SECTION – C.4
SPECIFIC TECHNICAL REQURIEMENTS (C&I)

Specific Technical Requirements (C&I):

1.0 Integrated microprocessor based control system along with suitable operator interface shall be provided for each Instrument Air Compressor & Service Air Compressor. Dual two way Ethernet connectivity to plant DCS shall be provided through MODBUS for information and overall control of air compressors. In addition to the soft link, provision for hardwired START, STOP, LOAD & UNLOAD commands from plant DCS to all the compressors & their status feedbacks to plant DCS shall also be provided. Bidder to furnish the configuration diagram of control system of compressor showing communication with plant DCS along with the bid.

2.0 Special cable if required, depending on the distance criteria, then same to be provided by bidder. Distance from DCS to Compressor House to be estimated by bidder from the reference dwgs . Ethernet to F.O. converter, L.I.U., patch cords & any hardware required at the compressor end for soft link to DCS shall be in bidder's scope (if applicable).

3.0 Group control is envisaged to clock more or less or equal number of running hours for each air compressor, hence the necessary logic/control scheme, write-up and HMI graphics for overall operation of the compressor from DCS is to be submitted by the bidder during detailed engineering.

4.0 Bidder to include all the instruments (PG, PS, LS, TS, FS, Dew Point meter, etc.) required for the package along with fittings, accessories and valve manifold.

5.0 The solenoid operated valves shall have limit switches for open/ close feedback

6.0 All motor operated valves/electric actuators shall be envisaged with non-integral starter.

7.0 All instruments/actuator limit switches/ solenoid valve limit switches etc. shall be suitably grouped based on physical locations & terminated on JBs in the field. JBs shall be in bidder scope.

8.0 Power supply required for instruments and compressor's control system shall be derived from 415 V, 3 phase, AC supply provided for the compressor. No other power supply shall be provided.

9.0 The Bidder to provide provision for sensor mounting for Vibration monitoring system on all HT motors.

10.0 Electronic Dew Point meter shall be hard wired to plant DCS for dew point monitoring from plant DCS.

11.0 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.

12.0 Drawings/Documents and data to be furnished after award of the contract for BHEL & NLC review as per MDL attached in Vol.III of technical specification.

13.0 All the instrument cables, control cables, fiber optic cables and any other cable between control system of compressor and plant DCS shall be as per Electrical Cable scope matrix in Electrical portion of specification.

14.0 The specifications outline the minimum requirements of the system. The Bidder is to supply any additional instruments and/or accessories required for ensuring safe and reliable operation of the system even if it may not be mentioned in the specifications.

15.0 The requirements given are to be read in conjunction with detailed technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.

16.0 C&I Mandatory spares (as applicable) to be provided as per list attached in Vol.III of technical specification.

18. C&I FOR STATION COMPRESSED AIR SYSTEM

18.1 General

1. The Control and Instrumentation System envisaged shall be complete in all respect and adequate for safe, reliable & efficient operation of the Compressed Air system under normal and worst service and environmental conditions. The scope of work shall include detailed design, supply, erection, testing and commissioning for the compressed air system.
2. The design of C&I system shall be such that isolation of any piece of defective equipment would be possible without shutting down the main equipment or disturbing the operation of associated instrument and accessories.
3. Contractor shall supply Compressed Air instrumentation system with all necessary instruments, actuators, interlocks and sequences, annunciator systems, automatic/manual controls, etc.
4. Complete instrumentation cables required for Compressed Air System i.e. from field sensors / actuators to JB's, JB's to PLC system and from MCC / switchgear to PLC system i.e. where one end or both ends equipments is in Contractor's scope, complete Supply, laying, termination, etc shall be as per electrical scope matrix attached in section - C.3.

18.2 Operation & Control Philosophy

1. The compressed air systems shall be provided with microprocessor-based control system for each compressor and shall be fully automated, using the manufacturer's standard control package, with single button system start/stop from the CCR and with status/alarm information provided to the CCR operator via the Plant DCS. Local control units with display shall be provided for the compressors to allow local operation & monitoring. In addition, local panel shall be provided for operation & monitoring of other equipments like dryers. Selection of duty operation shall be via the Plant DCS at the CCR. All common logics for compressors such as selection, auto change over, duty cycle etc. shall be implemented in Plant DCS. Contractor to provide necessary recommended control & protection schemes & coordinate with Plant DCS supplier for implementation of the logics in Plant DCS.
2. Isolation valves on instrument air distribution headers and sub-headers shall be provided with a pressure gauge, downstream of the valve, located at a suitable operational position.
3. Junction box / local panel shall be provided by the SG Contractor for terminating the On, Off commands from Plant DCS to each compressor and the On, Off & fault feedbacks from each compressor to Plant DCS. Supply, laying and termination of all cables from JB / local panel to the compressors shall be in the scope of SG Contractor.

4. The control equipment shall be interfaced (via Modbus) with the Plant DCS such that the CCR operator can monitor the operation of the compressors and be aware of problems as and when they occur.

5. A protection system shall be provided to shut down the compressed air systems in emergency situations. The protection system shall be independent of the Plant DCS and any proprietary control systems and shall be operational under all operational conditions. An interface to the Plant DCS from the protection system shall be provided to advise the operator that the protection has operated and the cause for its operation.

6. The control scheme shall be suitable for operating the compressors such that all the compressors shall be equally loaded and ensures power consumption is also optimized.

7. In case the Contractor's standard practice is to provide air compressor with individual microprocessor based control system, then the same shall be connected to the Plant DCS via modbus.

8. Any of the compressor and Air drying Plant may be selectable for "shut down ", "working " or "standby" duty.

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

10. All abnormal conditions used for tripping the compressor or any other equipment shall be provided with pre-trip audio-visual indication/annunciation in the control panel.

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

12. An electrically operated automatic valve shall be provided on cooling water supply line of each compressor & dryer (if applicable) which shall be automatically shut off the cooling water supply, in case any of the compressor/dryer is not running for more then set time duration. Suitable interlock shall also be provided for opening the valve before starting of any of the compressor.

13. All important and critical measurements required for protection of equipments shall be provided with adequate redundancy.

14. The following indications shall be made available in the control panels

    - Status of each compressor
    - Instrument air pressure low /high
    - Service air pressure low/high
    - Dew point of instrument air
    - Status of each ADP

18.3 Measurement Philosophy

Following is the list of minimum required measurements for Compressors & driers. However, additional measurements required, if any, for efficient operation of the offered system, shall also be included.

1. **Measurements at Local Panel for Compressors**

- Indication of suction pressure after suction air filters for each compressor.
- Indication of pressure of compressed air after 1st stage, after Inter cooler and after 2nd stage & after after- cooler.
- Indication of temperature of compressed air after 1st stage outlet and after after- cooler.
- Indication of pressure of compressed air in each air receiver.
- Indication of pressure of lube oil after oil filter.
- Indication of differential pressure across lube oil filter.
- Oil Level Indication of lube oil sump.
- Sight glass in common cooling water return line from each compressor.
- Indication of pressure at the supply & return line of common header of cooling water of compressor cooling circuit.
- Indication of Flow measurement at the common discharge airline.

2. **Measurements at Local Panel for Air Driers**

- Indication of pressure on each pressure vessel
- Local Indication of differential pressure at pre-filters and after-filters
- Indication of pressure on air line before adsorber
- Indication of pressure on dry compressed air line outlet
- Indication of temperature on return cooling water line after reactivation air cooler
- Indication of temperature on air line after reactivation air cooler
- Indication of temperature on adsorber.

3. **Measurements at CCR**

- Indication of Air pressure of individual compressor discharge header and on each air receiver.

18.4 Alarms & Interlocks Philosophy

Following is the list of minimum required alarms & interlocks for operation & monitoring of Compressors & driers. However, additional alarms & interlocks required, if any, for efficient operation of the offered system, shall also be included.

1. Alarms & Interlocks for Compressors

Following audiovisual alarms and interlocks shall be provided for each compressor.

Table 18.1

Alarms & Interlocks for Compressor

1	Suction pressure of air after suction filter low	Alarm
2	1st stage suction air pressure low	Alarm/Trip
3	Temperature of air after 1st stage very high	Alarm/Trip
4	Temperature of air after Inter cooler, after 2nd stage & after after-cooler high	Alarm/Trip
5	Pressure of air after after-cooler high	Alarm/Trip
6	Temperature of cooling water to each compressor high	Alarm
7	Temperature of cooling water to each compressor too high	Alarm/Trip
8	Flow of cooling water from each compressor low	Alarm
9	Flow of cooling water from each compressor too low	Alarm/Trip
10	Differential pressure across lube oil filter high	Alarm
11	Pressure of lube oil to compressor low	Alarm
12	Pressure of lube oil to compressor too low	Alarm/Trip
13	Temperature of lube oil to compressor high	Alarm
14	Motor winding temperature high	Alarm/Trip
15	Manual tripping	Alarm

2. Alarms & Interlocks for Air Driers

Following audiovisual alarms and interlocks shall be provided for each Air Drier.

Table 18.2

Alarms & Interlocks for Air Drier

[illegible]	[illegible]	[illegible]
1	Temperature of reactivation air high	Alarm
2	Cooling air flow low	Alarm
3	Cooling air pressure low	Alarm
4	Heater temperature high	Alarm/Trip
5	Temperature of cooling water from reactivation air cooler high	Alarm

Checklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	☐ Multidrop ☐ Peer to Peer ☐ N/w topology attached	
3	Protocol Mode (Device is a)	☐ Master ☐ Slave ☐ Master/Slave	
4	Protocol	☐ RTU ☐ ASCII ☐ Other ————	
5	Master	☐ System maxDNA ☐ Other ————	
6	Dist.bet.maxDNA System & Device*	☐ ———— Feet ☐ ———— Meters	

B Electrical Spcific :

1	Interface Type	☐ RS232 ☐ RS422 ☐ RS485	
2	Wiring at Device end	☐ 2 Wire ☐ 4 Wire	
3	Transmission Channel	☐ Half Duplex ☐ Full Duplex	
4	Baud Rates (bps)	☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200	
5	Databits	☐ 8 ☐ 7	
6	Stopbits	☐ 1 ☐ 2	
7	Parity	☐ None ☐ Odd ☐ Even	
8	H/w & Software Handshake	☐ Yes ☐ No	
9	Response Timeout time (Sec)	☐ ———— ☐ Configurable timeout	
10	Data Formats Supported	☐ Boolean ☐ Real ☐ Char ☐ Sn.Int ☐ UnSn.Int	
11	Transmission mode	☐ Asynchronous ☐ Synchronous	

C Application Specific : *

1	Primary Function*	☐ Data Acquisition ☐ Data Acquisition & Control	
		☐ Download parameter sets	
2	Analog Points to read	——Nos. ☐ Details attached ☐ Details not attached	
3	Analog Points to write	——Nos. ☐ Details attached ☐ Details not attached	
4	Digital Points to read	——Nos. ☐ Details attached ☐ Details not attached	
5	Digital Points to write	——Nos. ☐ Details attached ☐ Details not attached	
6	Memory / Flag Points to read	——Nos. ☐ Details attached ☐ Details not attached	
7	Memory / Flag Points to write	——Nos. ☐ Details attached ☐ Details not attached	

D Hardware Specific :

1	Cable type	☐ Boolean cable ☐ Twisted pair cable	
2	Cable Details Enclosed	☐ Yes ☐ No	
3	Any specific Converter required	☐ Yes ☐ No ☐ Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	☐ Tech., Spec. ☐ Operating Manual	

***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

Format for vendor to furnish signal
Exchange list between DCS-PLC

Tag Name	Tag Description	Modbus address	Point type	Range	Alarm Setpoint	Alarm priority	History reqd	Function code	

FORM NO. PEM-6666-0

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 3

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL*	* PROJECT		
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, DUST TIGHT, WEATHER PROOF, IP:67	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR REGULATING SERVICE - 150 STARTS/HR MINIMUM	
HANDWHEEL	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	IE1 TYPE AS PER IS: 12615, SQUIRREL CAGE INDUCTION MOTOR SUITABLE FOR DOL STARTING.	
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) ■ DRG. NO. 4-V-MISC-90271 R11	
	COLOUR SHADE	■ BLUE (RAL 5012), To be decided during detail engg.	
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ■ EPOXY ☐	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	600% OF FLC INCLUSIVE OF I.S. TOLERANCE	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC / DOL STARTER	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V	
	@ ENCLOSURE CLASS OF MOTOR	■ IP 67 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	

FORM NO. PEM-6666-0

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 3

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ _____	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	☐ REQUIRED ■ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS	
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	☐ REQUIRED	
	OPEN / CLOSE PB	☐ REQUIRED ☐ NOT REQUIRED	
	STOP PB	☐ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	☐ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	☐REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	☐ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER	
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	■1 No ☐2 Nos. : 2 Nos. (ADJ.) : ■1 No. ☐2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	

FORM NO. PEM-6666-0

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:	
		VOLUME	
		SECTION	
		REV. NO.	DATE:
		SHEET 3	OF 3

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING	FOR MOTORS WITH RATING >30 KW	
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@☐ IP 68 @☐.....	
	@ EARTHING TERMINAL	8 SWG GI WIRE	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ■ NOT REQUIRED☐ ☐ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:DDE	
	@ SPACE HEATER CABLE GLAND	SIZE:DDE	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE: 1no., 2.5 sq. mm	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

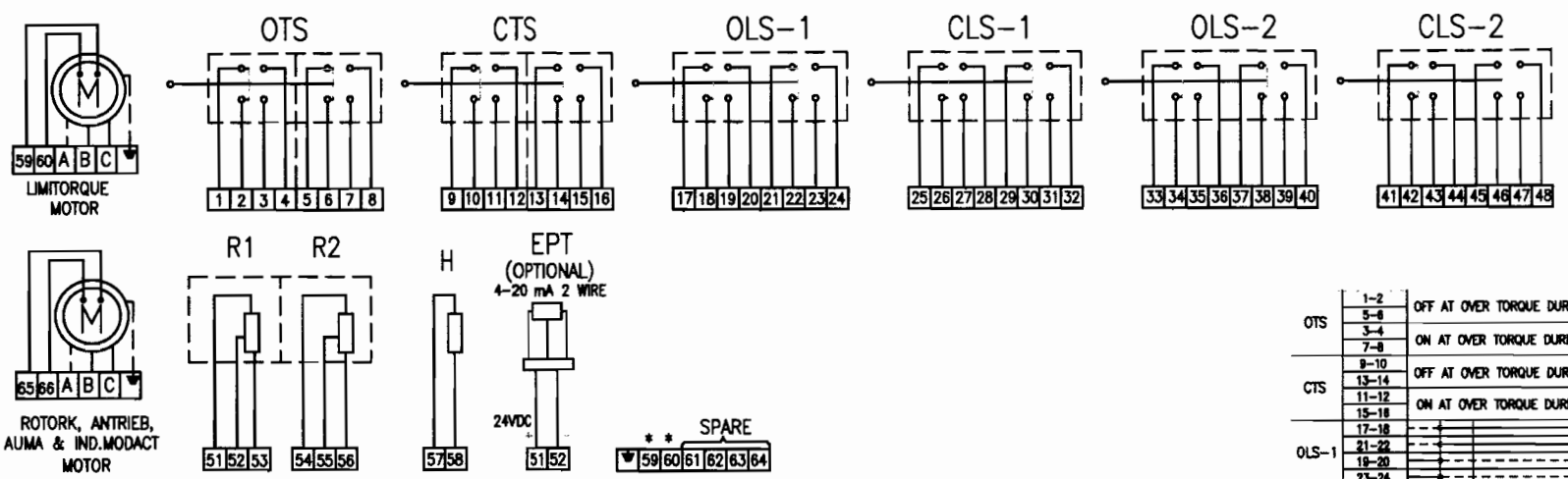
1. **SCOPE:** DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS:** DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS 12615 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL, WITH NICKEL COATING SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

$$ **TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.**

**EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.**

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES



OTS	1-2	OFF AT OVER TORQUE DURING OPENING TRAVEL
	5-6	
	3-4	ON AT OVER TORQUE DURING OPENING TRAVEL
	7-8	
CTS	9-10	OFF AT OVER TORQUE DURING CLOSING TRAVEL
	13-14	
	11-12	ON AT OVER TORQUE DURING CLOSING TRAVEL
	15-16	
OLS-1	17-18	
	21-22	
	19-20	
	23-24	
CLS-1	25-26	
	29-30	
	27-28	
	31-32	
OLS-2	33-34	
	37-38	
	35-36	
	39-40	
CLS-2	41-42	
	45-46	
	43-44	
	47-48	

SWITCH	TERMINAL NO.	FULL OPEN	a	INTERMEDIATE	b	FULL CLOSE

VALVE POSITION

——— INDICATES CONTACT CLOSED

------ INDICATES CONTACT OPEN

* – SPARE FOR ROTORK, AUMA, ANTRIEB & IND.MODACT

SWITCHES – ALL ARE POTENTIAL FREE AND TWO PAIR OF CONTACTS CAN BE USED FOR DIFFERENT SUPPLY

THERMOSTAT – 65–66 (ROTORK, AUMA, ANTRIEB & IND.MODACT), 59–60 (LIMITORQUE).

EPT – ELECTRONIC POSITION TRAMSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)

THERMOSTAT TERMINALS – TERMINATED IN MOTOR TB IN ANTRIEB & IND.MODACT AND IN MAIN TB IN OTHER MAKES

CTS – TORQUE SWITCHES FOR CW ROTATION (CLOSE) – 2 NO+2 NC

OTS – TORQUE SWITCHES FOR CCW ROTATION (OPEN) – 2 NO+2 NC

OLS–1, OLS–2 – LIMITSWITCHES FOR POSITION OPEN – 2 NO+2 NC

CLS–1, CLS–2 – LIMITSWITCHES FOR POSITION CLOSE – 2 NO+2 NC

OTS, CTS – TWO INDEPENDENT SWITCHS IN ANTRIEB & LIMITORQUE

OLS–2 & CLS–2 – CAM DISC IN ROTORK & ANTRIEB

R1–R2– POTENTIOMETER 2 x 100 OHMS

H – SPACE HEATER 1ø 240V AC SUPPLY

M – MOTOR 3ø 415V 50 Hz AC SUPPLY

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS	CTS	●

● – CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

NOTE:

1. BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)
2. CONNECT THERMOSTAT WITHOUT FAIL IN THE STARTER CIRCUIT

REV	DATE	CHED	APPD	DESCRIPTION
11	09.09 2000			CONTACT DEV. FIG.ADDED.

365-139

BHARAT HEAVY ELECTRICALS LTD.
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI 620014.

DRAWN	N.P.ESWAR
CHECKED	K.ARUNACHALAM
APPROVED	P.LOGANATHAN
DATE	09.09.2000

TITLE

INTERNAL WIRING DIAGRAM
FOR
ELECTRICAL VALVE ACTUATORS (AC)
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

DRAWING No.

REV 11

RETRACED WITH REVISION 11

9. FIELD INSTRUMENTS & FINAL CONTROL ELEMENTS

9.1 General Requirements

1. Measuring instruments/equipment and subsystems 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. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Owner's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, make/ numbers as approved by the Owner during detailed engineering.

2. Every panel mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

3. All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided.

4. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tappings where the pressure exceeds 40 kg/sq cm.

5. For protection purposes, transmitters can be considered in place of switches.

9.2 *Pressure / Differential Pressure / Flow / Level Transmitter*

Table 9.1

Specifications for Pressure / Differential Pressure / Flow / Level Transmitter

S.N	Features	Minimum Requirements
1	Type	Microprocessor based 2 wire type, HART protocol compatible
2	Sensor Type	Capacitive/ Piezo-electric
3	Output Signal	4-20 mA signals superimposed with HART signal.
4	Signal Processing Unit	Microprocessor based

S.N	Features	Minimum Requirements
5	Overpressure	150% of max. operating pressure. For vacuum service, the element shall have under – range protection to full vacuum
6	Turn-down Ratio	10:1 for vacuum / very low pressure applications. 100:1 for other applications.
7	Stability	± 0.1% of calibrated span for six months up to 70 Kg/cm² and ± 0.25% for range more than 70 Kg/cm²(g).
8	Span and Zero drift	± 0.015% per deg. C at max span & 0.11% per deg. C at min. span.
9	Enclosure Class	Weather proof as per IP 67 with corrosion resistance coating. For hazardous area explosion proof enclosure as described in NEC article 500
10	Zero & span adjustability	Continuous, tamper proof, remote as well as manual from instrument with zero suppression and elevation facility.
11	Local Indicator	To be provided
12	Display	Digital LCD Integral Display (minimum 5 digit) Engineering Unit
13	Process connection	½" NPT (F)
14	Electrical Connection	½ " NPT
15	MOC of Electrical Housing	Aluminum Alloy or better
16	Ambient Temperature	65 Deg. C
17	Operating Voltage	16 – 40 Volts DC
18	Load	600 Ohms (minimum) at 24 Volts DC
19	Accuracy	± 0.075% of span or better
20	Response Time	100 millisecond or better
21	Adjustment/ calibration/ maintenance	Port/provision for Centralised PC based system maintenance.

1. All transmitters shall be equipped with all necessary accessories like valve manifolds, mounting bracket etc. Pulsation dampeners shall be used where the process media is unstable for measurement such as at the discharge of a pump. For absolute pressure transmitter, 2 valve manifold; for gauge / vacuum pressure transmitter, 3 valve manifolds and for DP / level / flow transmitter, 5 valve manifold shall be provided. In case if it becomes necessary to use a DP transmitter for pressure measurement then a 3 valve manifold shall be used in place of 2 valve manifold.
2. Pressure transmitter shall have easily accessible span, zero and time constant adjustments. A range suppression / elevation device shall be provided wherever required.
3. For pressure / differential pressure transmitter, proof pressure shall be 200% of maximum static process pressure.
2. All transmitter cases shall be dust – tight and rugged. Weather – proof and explosion – proof cases shall be used in outdoor and hazardous areas respectively. Protection class shall be of IP 67 or better.

3. Transmitters for pressure / DP measurements of liquid and steam shall always be installed below the sampling point, preferably with the connection at the top.

4. Transmitters for pressure / DP measurements for gases and air shall always be installed above the sampling point, preferably with the connection at the bottom.

5. Transmitters with diaphragm seal system shall be considered when

   - The process temperature is outside of the normal operating ranges of the transmitter and cannot be brought into those limits with impulse piping or
   - The process is corrosive and would require frequent transmitter replacement or unusual materials of construction or
   - The process contains suspended solids or is viscous and may plug the impulse piping or
   - There is a need to make density or interface measurements or
   - The process medium may freeze or solidify in transmitter or impulse piping.

6. Diaphragm seal shall be either capillary type or direct mounted type depending upon the application. 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.

7. Differential pressure type level transmitters shall be used for range above 1219 mm, for services requiring purge or where liquid might boil in external portions.

8. Differential pressure type level transmitters for use on corrosive service shall generally be diaphragm wafer with extended filled capillary type. Flush or extended diaphragm type DP transmitter shall be considered for special application. Diaphragm material shall normally be stainless steel or any other special alloy.

9. Differential pressure type flow transmitters shall have in-built square-root extractors.

9.3 Temperature Transmitter

Table 9.2

Specifications for Temperature Transmitter

S.N	Features	Minimum Requirements
1	Type	2-Wire, Smart (HART)
2	Output Signal	4-20 mA signals superimposed with HART signal.
3	Signal Processing Unit	Microprocessor based
4	Accuracy	± 0.075 % of span or better
5	Local Indicator	To be provided (Not applicable for DIN Rail Mounted type)
6	Display	Digital LCD Integral Display (minimum 5 digit)

S.N	Features	Minimum Requirements
		Engineering Unit
7	Input	Ohm input from Pt-100 RTD/ mV signal from thermocouples
8	Stability	± 0.1 % of reading or 0.1° C, whichever is greater, for 24 months for RTDs. ± 0.1 % of reading or 0.1 °C, whichever is greater, for 12 months for thermocouples
9	Output	4-20 mA DC, linear
10	Load	600 Ohms (minimum) at 24 Volts DC
11	Power Supply	24 VDC, 2- Wire Loop Power
12	MOC of Electrical Housing	Aluminum Alloy or better
13	Enclosure Class	Weather proof as per IP 67 with corrosion resistance coating. For hazardous area explosion proof enclosure as described in NEC article 500

1. The temperature transmitter of following types (2-wire Loop Powered temperature transmitter) compatible with thermocouples shall be provided. Cold junction temperature compensation of the thermocouples shall be performed in the temperature transmitter itself. The Contractor shall use multiplexer philosophy to connect thermocouples to plant DCS. Metal thermocouples shall be terminated in Local JB and from there copper cables shall be connected upto the separate panel in the control room. For linking this panel to Plant DCS, the required communication protocol like TCP/IP, Modbus, OPC, Profibus shall be provided. The Contractor shall provide the complete system excluding the cabling between Local JBs and Control Panel and communication cable to Plant DCS.

   a. **Single/multiple Input DIN-rail mounted Temperature Transmitter (Only for Metal Temperature measurement)**

      These shall be suitable for mounting on DIN-rails in Panels/JBs. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

   b. **Field mounted Temperature Transmitter With Indicator**

      These shall be suitable for mounting on pipes/ supports. Indicator shall be provided with these transmitters. These transmitters shall have bump-less change over facility to second sensor in case first sensor fails .This changeover is to be alarmed. Protection class shall be IP67 minimum.

      The exact applications for which this type of transmitter is to be provided shall be finalized during detailed engineering.

2. Transmitters shall be provided with following features:

   - Sensor drifts alarm for sensor failure prediction

- Differential & average temperature measurement if required.
- Automatic switch-over to back-up sensor on primary sensor failure.
- Accepts any combination of two sensor types (RTDs, T/Cs, mV or ohms)
- Ambient temperature compensation
- Fault detection for electronics & sensors with fail-safe alarming.
- Provision of built-in CJC

3. Transmitters to be used for RTD sensors shall be provided with RTD EMF correction features so that it shall detect and eliminate EMF errors which are the result of small voltage produced by RTD sensing elements.

4. The product and make shall be selected so that with one make of transmitter all applications with respect to measuring range, temperature sensor (resistance thermometer / thermocouple) and connection type (2/3/4) wire connection of resistance thermometers) shall be covered.

5. Field mounted Transmitters shall be capable of communication with HART (Highway Addressable Remote Transducer) communicator. HART communicator shall be provided with transmitters for tuning / configuring / diagnosing / maintenance of the transmitters. It shall meet the intrinsic safety requirement if required depending upon the application.

6. All transmitters' cases shall be dust-tight and rugged. Weather-proof and explosion-proof cases shall be used in outer and hazardous areas respectively

9.4 Thermocouple

Table 9.3

Specifications for Thermocouple

S.N	Features	Minimum Requirements
1	Wire Gauge	16 AWG (for K type 24 AWG (for R type)
2	Protective tube	O.D. 8 mm Material SS 316 seamless Filling – Compacted Magnesium Oxide (Purity above 99.4)
3	Loading	Shall be spring loaded to ensure positive contact with the well. Prevention of rotation of the insert with respect to head and resultant twisting of leads shall be ensured.
4	Accuracy	As per ANSI MC 96.1 / IEC 751 / IS-2054 / 2055, 1974.
5	Characteristic	Linear with respect to temperature within +/- ½ per cent of top range value.

S.N	Features		Minimum Requirements	
6	Reference		For temperature vs. mV characteristics, following IS shall be applicable : Type K IS – 2054, 1974 Type R IS - 2055, 1974	
7	Head	Type	IP-65 universal screwed type (Explosion proof for NEC class-1, division-1 area)	
		Material	Die-cast aluminium or better material painted with black enamel paint.	
		Terminal Block	Brass screw type / silver plated on ceramic head.	
		Cable Connection	½ " NPT gland & grommet	
		Cover	Screwed cover with suitable gasket & SS Chain	
8	Instrument connection to Well		½" NPT	
9	Accessories		a)	Adjustable nipple-union-nipple {1/2" Sch. 80 X1/2" NPT (MI} with thermowell connection
			b)	Compression fittings/union
			c)	Flanges etc. (For flanged connection only)
			d)	SS 316 forged/barstock thermowell as per ASME PTC code. Process connection M33X2 (M)in general or 1½" Flanged for Flue gas/ Furnace air etc. application

1. The following types of sensors shall be used for the different temperature ranges:
   - For measurement of temperatures of up to max. 1100 °C, rapid-responded sheathed thermocouples with insulated tip, 16 AWG wire, as Chromel-Alumel (NiCr-NiAl, ISA type K) measuring element, with admissible deviation of thermo voltage of half the values stated in IS-2054, 1974 or DIN 43710.
   - For measurement of temperature between 1100°C and 1300°C, 24 AWG, Platinum Rhodium (13%) – Platinum (ISA type R) measuring elements, with admissible deviation of thermo voltage of half the values stated in IS-2055, 1974 or DIN-43710.
2. All thermocouples shall be duplex type with tip grounded. Thermoelectric properties and accuracy shall be as per ANSI MC 96.1 / IS-2054 / 2055: 1974.