

**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

GROUP I PROJECTS

- 1. 2x660 MW DVC Raghunathpur (528)**
- 2. 2x660 MW CPGCL Korba West (530)**
- 3. 1x800 MW GSECL Ukai (529)**
- 4. 2x660 MW MAHAGENCO Koradi (527)**

GROUP II PROJECT:

- 5. 1x800 MW HPGCL Yamunanagar (510)**

SPECIFICATION No. **PE-TS-510/ 527/ 528/ 529/ 530-555-A001**
REV. No. 0



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

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
INDEX		
S. NO.	DESCRIPTION	PAGE NO.
1	Project Information	3 - 8
2	Scope	9 - 10
3	General Technical Requirement	11 - 14
4	Specific Technical Requirement	15 - 119
a)	Annexure- A (Annual Maintenance Contract Services)	120 - 122
b)	Annexure - B (Instruction Manuals)	123 - 128
c)	Annexure - C (Hard Prints Requirement for Drgs/docs)	129 - 130
d)	Electrical Specification	131 - 256
e)	C&I Specification	257 - 403
5	Performance Guarantees for Compressed Air System	404 - 417
6	Quality Assurance & Quality Plan	418 - 443
7	Sub Vendor List	444 - 449
8	Painting Requirement	450 - 453
9	Packing Requirement	454 - 459
10	Bill of Quantity (BOQ)	460 - 483
11	Documentation Requirement a) Documents Required Along With Bid By Bidders b) Documents to be submitted by Successful Bidder after award of contract along with submission schedule	484 - 485
12	Compliance Certificate	486 - 488
13	Pre-Qualification Requirement (Technical)	489 - 501

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
PROJECT INFORMATION		

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
PROJECT INFORMATION 2x660 MW DVC Raghunathpur		
S. No.	DESCRIPTION	DETAILS
1	CUSTOMER	Damodar Valley Corporation
1.1	CONSULTANT	DCPL
2	LOCATION	Raghunathpur sub-division of Purulia District, West Bengal
3	METEOROLOGICAL DATA	
3.1	SUMMER OUTSIDE DBT	29.8 deg C
3.2	SUMMER OUTSIDE WBT	25.5 deg C
3.3	MONSOON OUTSIDE DBT	27.6 deg C
3.4	MONSOON OUTSIDE WBT	25.4 deg C
3.5	WINTER OUTSIDE DBT	16.4 deg C
3.6	WINTER OUTSIDE WBT	12.8 deg C
3.7	PEAK GROUND HORIZONTAL ACCELERATION (MCE), AS PER DVC SPEC	0.24*g
3.8	BASIC WIND SPEED	47 m/s
3.9	HEIGHT ABOVE MSL	255 m
4	ELECTRICAL DATA	
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
4.2	RATED FREQUENCY	50Hz
4.3	FREQUENCY VARIATION	(+)3% to (-)5%
4.4	AC VOLTAGE	415V, 3 Phase
4.5	AC VOLTAGE VARIATION	+/-10%
4.6	SYSTEM FAULT LEVEL AT RATED VOLTAGE	50KA for 1.0 sec
4.7	SHORT TIME RATING FOR TERMINAL BOXES	50KA for 0.25 sec
5	ANALYSIS OF EQUIPMENT COOLING WATER	
	CHARACTARISTICS	VALUE
i)	SILICA (Max.)	0.02 ppm as SiO2
ii)	IRON as Fe	NIL
iii)	TOTAL HARDNESS	NIL
iv)	pH VALUE	8.5 to 9.5
v)	CONDUCTIVITY	Not more than 0.1 micro mho/cm excluding the effects of free CO2
5.1	DESIGN DMCW INLET TEMP. TO VARIOUS COOLERS	38 deg C

	TECHNICAL SPECIFICATION		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM		Rev. No. 00
			Date: Dec 2025
PROJECT INFORMATION 2x660 MW CPGCL Korba West			
S. No.	DESCRIPTION	DETAILS	
1	CUSTOMER	Chhattisgarh State Power Generation Company Limited (CSPGCL)	
1.1	CONSULTANT	NTPC Ltd.	
2	LOCATION	The Hasdeo Thermal Power Station project is located at Korba Village in Korba District of Chhattisgarh. Access to the Project Site by Road is through State Highway No. 39 from Raipur and Bilaspur.	
3	METEOROLOGICAL DATA		
3.1	SUMMER OUTSIDE DBT	43.5 deg C	
3.2	SUMMER OUTSIDE WBT	25.5 deg C	
3.3	MONSOON OUTSIDE DBT	37.8 deg C	
3.4	MONSOON OUTSIDE WBT	27.3 deg C	
3.5	WINTER OUTSIDE DBT	15.0 deg C	
3.6	WINTER OUTSIDE WBT	10.0 deg C	
3.7	PEAK GROUND HORIZONTAL ACCELERATION (MCE)	0.24g	
3.8	BASIC WIND SPEED	44 m/s	
3.9	HEIGHT ABOVE MSL	305.50 m	
4	ELECTRICAL DATA		
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C	
4.2	RATED FREQUENCY	50Hz	
4.3	FREQUENCY VARIATION	(+)3% to (-)5%	
4.4	AC VOLTAGE	415V, 3 Phase	
4.5	AC VOLTAGE VARIATION	+/-10%	
4.6	SYSTEM FAULT LEVEL AT RATED VOLTAGE	50KA rms for 1.0 sec	
4.7	SHORT TIME RATING FOR TERMINAL BOXES	50KA for 0.25 sec	
5	ANALYSIS OF EQUIPMENT COOLING WATER		
	CHARACTARISTICS	VALUE	
i)	SILICA (Max.)	0.01 ppm as SiO2	
ii)	IRON as Fe	NIL	
iii)	TOTAL HARDNESS	NIL	
iv)	pH VALUE	8.5 to 9.5	
v)	CONDUCTIVITY	Not more than 0.1 micro mho/cm at 25 DegC.	
5.1	DESIGN DMCW INLET TEMP. TO VARIOUS COOLERS	38 deg C	

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
PROJECT INFORMATION 1x800 MW GSECL Ukai		
S. No.	DESCRIPTION	DETAILS
1	CUSTOMER	GUJARAT STATE ELECTRICITY COPRORATION LIMITED
1.1	CONSULTANT	STEAG
2	LOCATION	The project is located in Tapi district of Gujarat state in India. The site is located at a distance of about 10 km from Ukai - Songadh Railway Station and the site is also connected by roads from highway at a distance of 10 km from Songarh. The nearest Airport is Surat, which is about 93km from the site. Nearest port is Hazira Port, which approximately 120Km from the site
3	METEOROLOGICAL DATA	
3.1	SUMMER OUTSIDE DBT	40 deg C
3.2	SUMMER OUTSIDE WBT	15.0 deg C
3.3	MONSOON OUTSIDE DBT	30 deg C
3.4	MONSOON OUTSIDE WBT	27.2 deg C
3.5	WINTER OUTSIDE DBT	18 deg C
3.6	WINTER OUTSIDE WBT	11.1 deg C
3.7	PEAK GROUND HORIZONTAL ACCELERATION (MCE)	As per SEISMIC ZONE III (IS1893-2002)
3.8	BASIC WIND SPEED	44m/s as per IS:875 –Part3:1987.
3.9	HEIGHT ABOVE MSL	82.2 M
4	ELECTRICAL DATA	
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
4.2	RATED FREQUENCY	50Hz
4.3	FREQUENCY VARIATION	(+)3% to (-)5%
4.4	AC VOLTAGE	415V, 3 Phase
4.5	AC VOLTAGE VARIATION	+/-10%
4.6	SYSTEM FAULT LEVEL AT RATED VOLTAGE	50KA for 1.0 sec
4.7	SHORT TIME RATING FOR TERMINAL BOXES	50KA for 0.25 sec
5	ANALYSIS OF EQUIPMENT COOLING WATER	
	CHARACTERISTICS	VALUE
i)	SILICA (Max.)	0.01 ppm as SiO2
ii)	IRON as Fe	NIL
iii)	TOTAL HARDNESS	NIL
iv)	pH VALUE	8.5 to 9.5
v)	CONDUCTIVITY	Not more than 0.1 micro mho/cm at 25 DegC.
5.1	DESIGN DMCW INLET TEMP. TO VARIOUS COOLERS	38 deg C

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
PROJECT INFORMATION 2x660 MW MAHAGENCO Koradi		
S. No.	DESCRIPTION	DETAILS
1	CUSTOMER	MAHARASHTRA STATE POWER GENERATION CO. LTD.
1.1	CONSULTANT	STEAG
2	LOCATION	At Koradi Thermal Power Station, near Koradi village, which is situated at about 11Km from Nagpur city, in Maharashtra state, India.
3	METEOROLOGICAL DATA	
3.1	SUMMER OUTSIDE DBT	50 deg C
3.2	SUMMER OUTSIDE WBT	27 deg C
3.3	MONSOON OUTSIDE DBT	29.4 deg C
3.4	MONSOON OUTSIDE WBT	27.2 deg C
3.5	WINTER OUTSIDE DBT	15.6 deg C
3.6	WINTER OUTSIDE WBT	11.1 deg C
3.7		RH - 61% IN DRY SEASON & 85% IN MONSOON SEASON
3.8	PEAK GROUND HORIZONTAL ACCELERATION (MCE),	0.1*g
3.9	BASIC WIND SPEED	44 m/s
3.10	HEIGHT ABOVE MSL	304.75 m
4	ELECTRICAL DATA	
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
4.2	RATED FREQUENCY	50Hz
4.3	FREQUENCY VARIATION	(+)3% to (-)5%
4.4	AC VOLTAGE	415V, 3 Phase
4.5	AC VOLTAGE VARIATION	+/-10%
4.6	SYSTEM FAULT LEVEL AT RATED VOLTAGE	50KA for 1.0 sec
4.7	SHORT TIME RATING FOR TERMINAL BOXES	50KA for 0.25 sec
5	ANALYSIS OF EQUIPMENT COOLING WATER	
	CHARACTARISTICS	VALUE
i)	SILICA (Max.)	0.01 ppm as SiO2
ii)	IRON as Fe	NIL
iii)	TOTAL HARDNESS	NIL
iv)	pH VALUE	8.5 to 9.5
v)	CONDUCTIVITY	Not more than 0.1 micro mho/cm at 25 DegC.
5.1	DESIGN DMCW INLET TEMP. TO VARIOUS COOLERS	38 deg C

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
PROJECT INFORMATION 1x800 MW HPGCL Yamunanagar		
S. No.	DESCRIPTION	DETAILS
1	CUSTOMER	Haryana Power Generation Corporation Limited (HPGCL)
1.1	CONSULTANT	DESEIN and DCPL
2	LOCATION	The project site is located at Kalanaur town in Yamuna Nagar district of Haryana having latitude and longitude as 30°06'34"N and longitude 77°19'43" E respectively. The site is approachable from National Highway No. 344. Nearest railway station is at Kalanaur at about 2 Kms. The nearest commercial airport is Chandigarh at about 110 km by road.
3	METEOROLOGICAL DATA	
3.1	SUMMER OUTSIDE DBT	44 deg C
3.2	SUMMER OUTSIDE WBT	26 deg C
3.3	MONSOON OUTSIDE DBT	33 deg C
3.4	MONSOON OUTSIDE WBT	27 deg C
3.5	WINTER OUTSIDE DBT	23 deg C
3.6	WINTER OUTSIDE WBT	8 deg C
3.7	PEAK GROUND HORIZONTAL ACCELERATION (MCE)	0.24*g
3.8	BASIC WIND SPEED	47 m/s
3.9	HEIGHT ABOVE MSL	270M
4	ELECTRICAL DATA	
4.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
4.2	RATED FREQUENCY	50Hz
4.3	FREQUENCY VARIATION	(+)3% to (-)5%
4.4	AC VOLTAGE	415V, 3 Phase
4.5	AC VOLTAGE VARIATION	+/-10%
4.6	SYSTEM FAULT LEVEL AT RATED VOLTAGE	50KA for 1.0 sec
4.7	SHORT TIME RATING FOR TERMINAL BOXES	50KA for 0.25 sec
5	ANALYSIS OF EQUIPMENT COOLING WATER	
	CHARACTARISTICS	VALUE
i)	SILICA (Max.)	0.01 ppm as SiO ₂
ii)	IRON as Fe	NIL
iii)	TOTAL HARDNESS	NIL
iv)	pH VALUE	8.5 to 9.5
v)	CONDUCTIVITY	Not more than 0.1 micro mho/cm at 25 DegC.
5.1	DESIGN DMCW INLET TEMP. TO VARIOUS COOLERS	38 deg C

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
SCOPE		

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025

SCOPE

SCOPE OF THIS PACKAGE COVERS THE FOLLOWING:		
S. No.	PARAMETERS	REQUIREMENT
1	Supply Including Design, Engineering & Manufacturing of	
a)	Main Supply (For all projects)	YES
b)	Commissioning Spares (For all projects)	YES
c)	Consumables (For all projects)	YES
2	Painting (For all projects)	YES
3	Inspection & Testing (For all projects)	YES
4	Packing (For all projects)	YES
5	Transportation & Delivery to Site (For all projects)	YES
6	Transportation, Handling & Storage in the Plant (For all projects)	YES
7	Erection & Commissioning (For all projects)	YES
8	Supervision of Erection & Commissioning (For all projects)	NO
9	Performance Guarantee (PG) Test (For all projects)	YES
10	Training of BHEL/Customer personnel (For all projects)	YES
11.1	Mandatory Spares (For all projects)	YES
12	Annual Maintenance Contract (AMC) (For all projects)	YES
13	Operational Spares (For all projects)	YES
14	Handover of CAS system (For all projects)	YES

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
GENERAL TECHNICAL REQUIREMENTS		

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
GENERAL TECHNICAL REQUIREMENT - MECHANICAL		
1.0	It is not the intent to specify herein all the details of design and manufacturing. Bidder shall ensure that the offered equipment confirms in all respects to high standards of design, engineering and workmanship.	
2.0	The equipment shall comply with all applicable safety codes and statutory regulations of India as well as of the locality where the equipment is to be installed.	
3.0	In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.	
4.0	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.	
5.0	Drawing/document submission shall be through web based Document Management System (DMS). Bidder would be provided access to the DMS for drg/doc approval and training for the same. Bidder to ensure proper internet connectivity at their end.	
6.0	Transit Insurance & Insurance till receipt of MRC/ MDCC is in the scope of CAS supplier.	
7.0	Bidder shall carry out the inspection & testing as per the approved Quality Plan.	
8.0	Bidder shall submit stamped QP on compliance route in the event of order. In case, the bidder is supplying the item from outside India, the third party inspection shall be arranged and considered by the bidder in their offer.	
9.0	Sub vendor list is attached with the specification. Any additional sub - vendors proposed by bidder during contract stage shall be subject to BHEL & Customer approval in the event of order.	
10.0	Document approval by BHEL & Customer shall not absolve the supplier of their contractual obligations of completing the work as per specification requirement without any commercial and delivery impact.	
11.0	Void	
12.0	Void	
13.0	Instruments to be used for PG test shall be additionally supplied over and above the instruments shown in tender P&IDs. PG test Instruments being supplied, installed and commissioned for each unit, shall be retained by Customer after completion of PG test.	
14.0	Mandatory Spares: Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid. In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the mandatory spare list (Refer Price Format attached elsewhere in the NIT). All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary. Bidder shall not indicate "Not Applicable" against any of the spare (except for those items for which "if applicable" is specified). In case of not applicability, functionally equivalent spare to be mentioned with price in the relevant price schedules. Bidder shall not mention any remark other than price value in relevant price schedule.	
15.0	For each project, CAS supplier shall supply with the equipment one complete set of all special tools and tackles and other instruments required and other instruments for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software).	
16.0	No material brought to the Site shall be removed from the Site by the CAS supplier and/or his Sub-supplier without the prior written approval of the BHEL & Customer.	
17.0	The Contractor shall establish an Office at each Site and keep posted an authorised representative for the purpose of the Contract.	
18.0	The CAS Supplier shall have total responsibility for protecting his works till it is finally taken over by BHEL. No claim will be entertained by BHEL for any damage or loss to the CAS supplier works and the CAS supplier shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings.	
19.0	In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the CAS supplier, also will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.	
20.0	All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the CAS supplier's employees shall be the sole responsibility of the CAS supplier.	
21.0	The CAS supplier shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipments covered under the Contract.	
22.0	The CAS supplier shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site.	
23.0	The work procedures that are to be used during the erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at least once each day.	
24.0	Void	

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
25.0	All the Plant and equipments / Systems supplied under the contract shall be designed following "Fail Safe" concept. In case of failure of Power supply like Electric power, Hydraulic pressure, Pneumatic pressure, Vacuum etc. the system should be designed in such a way that the equipment/Valves/dampers etc. shall always move/remains (as applicable) to safest position as per system requirement to ensure safety of Man and Machinery.	
26.0	After Rev-0 comments, the drawing will be locked in the system. CAS supplier will review the Rev-0 comments within 7 days & furnish the Comment Reply Sheet (CRS) to Customer as an agenda point for TCM.	
27.0	It is responsibility of the CAS supplier to get all the drawings approved in the Category I/ IV/ A (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.	
28.0	All the first fill and for the period as specified elsewhere in spec., topping requirement of consumables such as greases, oils, lubricants, servo fluids / control fluids etc. which will be required to put the equipment covered under the scope of specification into successful commissioning/initial operation and to establish completion of facilities shall be supplied by the CAS supplier. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.	
29.0	All equipment name plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi/ regional script and another with English inscriptions may be provided.	
30.0	All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be.	
31.0	Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.	
32.0	CAS supplier shall submit Field Welding Schedule for field welding activities. The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before scheduled start of erection work at site.	
33.0	Void	
34.0	Void	
35.0	All the materials stored in the open or dusty location must be covered with suitable weatherproof and flame-proof covering material wherever applicable.	
36.0	The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.	
37.0	As the transit of compressor to project site and also the storage of Compressors at project site is in CAS supplier scope, CAS supplier shall ensure the protection of Compressors during transit and storage at site. A.) In order to prevent corrosion during shipping, following needs to be ensured and for this a note to be included in QAP's of Compressors. - Compressor to be tested with Oil (as per OEM recommendation), a film of which remains behind on shafts, gears and bearings. - Silica gel or equivalent adsorbent bags, to be placed inside compressor to absorb any traces of moisture. The compartments are closed off airtight as per OEM recommendation. - The vent holes are closed off with moisture repellent adhesive tape. - Instruments & Microprocessor panel is protected as per OEM recommendation. B.) Steps pre-installation - Periodically, renewing the silica gel bags/ equivalent material at least once in six months or as recommended by OEM, whichever is less. - Periodically, renewing the preservative oil-film by rotating the main drive coupling by hand during a few minutes in correct rotation direction, this will ensure re-distribution of oil film on bearings balls, rollers and drive gears. Same to be repeated at least once a month or as recommended by OEM, whichever is less. C.) Steps post-installation - Installation & commissioning of Sequential panel is must in order to avoid long idleness of compressors. - Automatic provision shall be provided to replace wet air inside compressor with the dry air as per OEM recommendation.	
38.0	Incase, any major fault/ failure occurs in Compressor & Dryer, CAS supplier shall visit project site and further course of action as specified in Annexure-A.	
39.0	The scope of service under training of Employer's engineers shall include a training module covering the areas of Operation & Maintenance. Training module shall enable these personnel to individually take the responsibility of operating and maintaining the system in a manner acceptable to the Employer. Training on Erection methodologies for all the Sub-packages, System and Equipment's associated with the EPC Package, including a visit to power plant construction site. The exact details, extent and schedule for training shall be as finalized during detailed engineering and shall be subject to Employer's approval. The scope of services under training shall also necessarily include training of Employer's Engineering personnel covering entire scope for the package. This shall cover all disciplines viz, Mechanical, Electrical, C&I , QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing erection, welding etc. In all the above cases, the lodging and boarding of the Employer's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same. For training purposes, 3 (three) working days (excluding all intervening holidays) per person shall be provided. Location of classroom training for engineering shall be at Design/Engineering office. Classroom training for erection/O&M shall be at location of Manufacturers' works.	
40.0	The bidder scope covers the Annual maintenance contract (AMC) for Preventive / Breakdown maintenance of Compressed air system (Refer Annexure-A).	

	TECHNICAL SPECIFICATION		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM		Rev. No. 00
			Date: Dec 2025
41.0	EXCLUSIONS		
	Compressor House – Civil Building		
	Pipe trench		
	EOT Crane		
	Power Cable, lugs & glands at BHEL end equipment		
	Ventilation		
	Fire Protection		

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
SPECIFIC TECHNICAL REQUIREMENTS Annexure I: 2x660 MW DVC Raghunathpur Annexure II: 2x660 MW CPGCL Korba West Annexure III: 1x800 MW GSECL Ukai Annexure IV: 2x660 MW MAHAGENCO Koradi Annexure V: 1x800 MW HPGCL Yamunanagar		

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
SPECIFIC TECHNICAL REQUIREMENTS Annexure I: 2x660 MW DVC Raghunathpur		

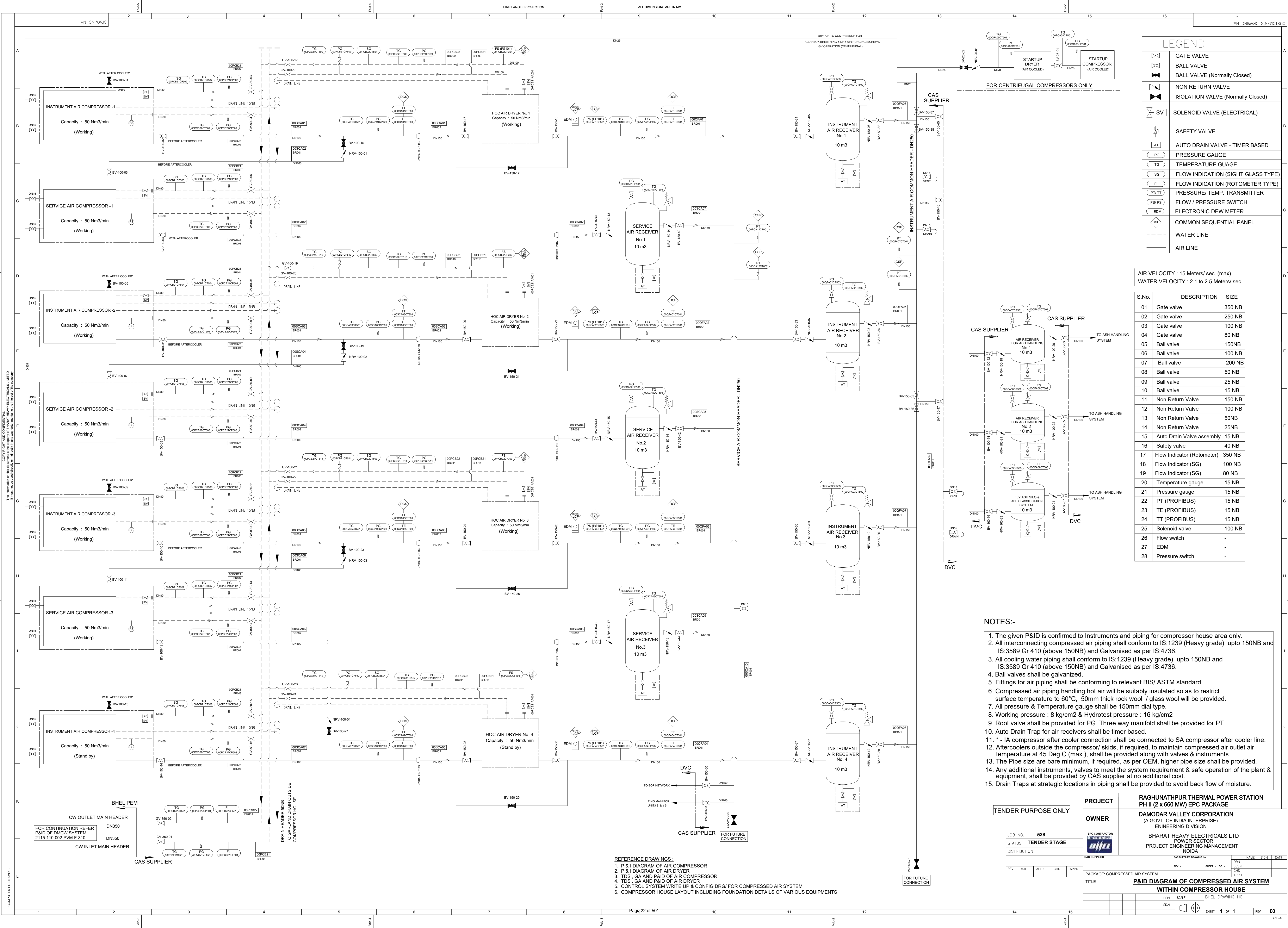
	SPECIFIC TECHNICAL REQUIREMENTS: Annexure I RAGHUNATHPUR TPS PH-II (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec. 2025
	SPECIFIC TECHNICAL REQUIREMENT - MECHANICAL	
1.0	The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants, Service Air compressors & their motor drives, air receivers, instrumentation and control, control panels and interconnecting compressed air piping in the compressor house.	
2.0	Four (04 numbers (3 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for instrument air duty for the complete plant each of 50 Nm³/min. capacity & 8.0 kg/cm²(g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works.	
3.0	Four (04) numbers (3 working+ 1 standby) Air Drying Plants (one for each instrument air compressor) of 50 Nm³/min. capacity with all interconnecting piping, valves, fittings, etc. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". Discharge pressure available at the outlet of Air drying Plant shall be minimum 7.5 Kg/cm ² (g).	
4.0	Three (03) numbers (3 working) oil free, rotary screw/centrifugal type air compressors for service air duty for the complete plant each of 50Nm³/min. capacity & 8.0 kg/cm²(g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issue by BHEL at compressor supplier works. 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.	
5.0	Air Receivers - The design pressure and temperature shall be minimum 10 Kg/cm² (g) and 50 deg. C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent. 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. Each receiver shall be provided with pressure indicator, temperature indicator and drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves. The drain trap shall be timer based. Manual draining facility shall also be provided in the drain trap. The material of construction of shell, dished ends, flanges, etc of the air receivers shall be of carbon steel as per IS:2062 or equivalent. Air receiver are to be provided with Gasketed inspection manhole of minimum 500mm diameter with cover plate, lifting handle, davit cap etc.	
5.1	One number of air receiver of minimum capacity 10 m ³ at the discharge of each air compressor (Total: 07 numbers).	
5.2	One number unit air receiver of minimum capacity 10 m ³ for each unit to be located near ESP Buffer Hopper Area for Ash Handling System. (Total: 02 numbers).	
5.3	One number of air receiver of minimum capacity 10 m ³ for Fly ash storage Silo area and Ash classification system to be located near Silo Utility building.	
6.0	All the equipment shall be designed for continuous duty as well as for intermittent operation. Frequent start/stop of the system shall neither result deterioration in performance nor damage to the equipment.	
7.0	The compressors and Air Drying plants shall operate under the following ambient conditions. i. Minimum temperature : 10 deg. C ii. Maximum temperature : 50 deg. C iii. Design condition (Temperature : 45 deg.C & 75% RH) iv. Height above MSL (m) : 255.0 M	
8.0	The compressor capacity & discharge pressure of instrument air system and service air system shall be identical.	
9.0	The heat exchangers are DMCW cooled and the maximum cooling water temperature at compressor coolers inlet shall be 38 deg. C. The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-10 deg C.	
10.0	Noise level shall not exceed 85 dBA to a reference level of 0.0002 microbar when measured at a distance of 1.5 meter above the floor and 1m horizontal distance. Required acoustic enclosures may 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. For eventual noise, from the discharge line, accessories and/or ancillary equipment which are not included, a correction factor of (+) 8 dBA maximum shall be allowed for background & ambient noise.	
11.0	Vibration level of screw compressor shall be as per VDI-3836. However, velocity vibration shall be limited to 10 mm/sec (rms). Vibration level of centrifugal compressor shall be as per manufacturer standard & proven practice.	
12.0	Air Compressors (Screw /Centrifugal type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement. As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room. Parallel operation of compressors shall be possible without any undue vibration and noise.	
13.0	The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors.	
14.0	All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover.	
15.0	The canopy shall be designed to cater the load of air filter with 100% choked condition.	
16.0	SCREW AIR COMPRESSORS	
16.1	CODES AND STANDARDS - The design, manufacture, testing and performance of the various components of the rotary screw type air compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727, ISO-1217 and CAGI).	

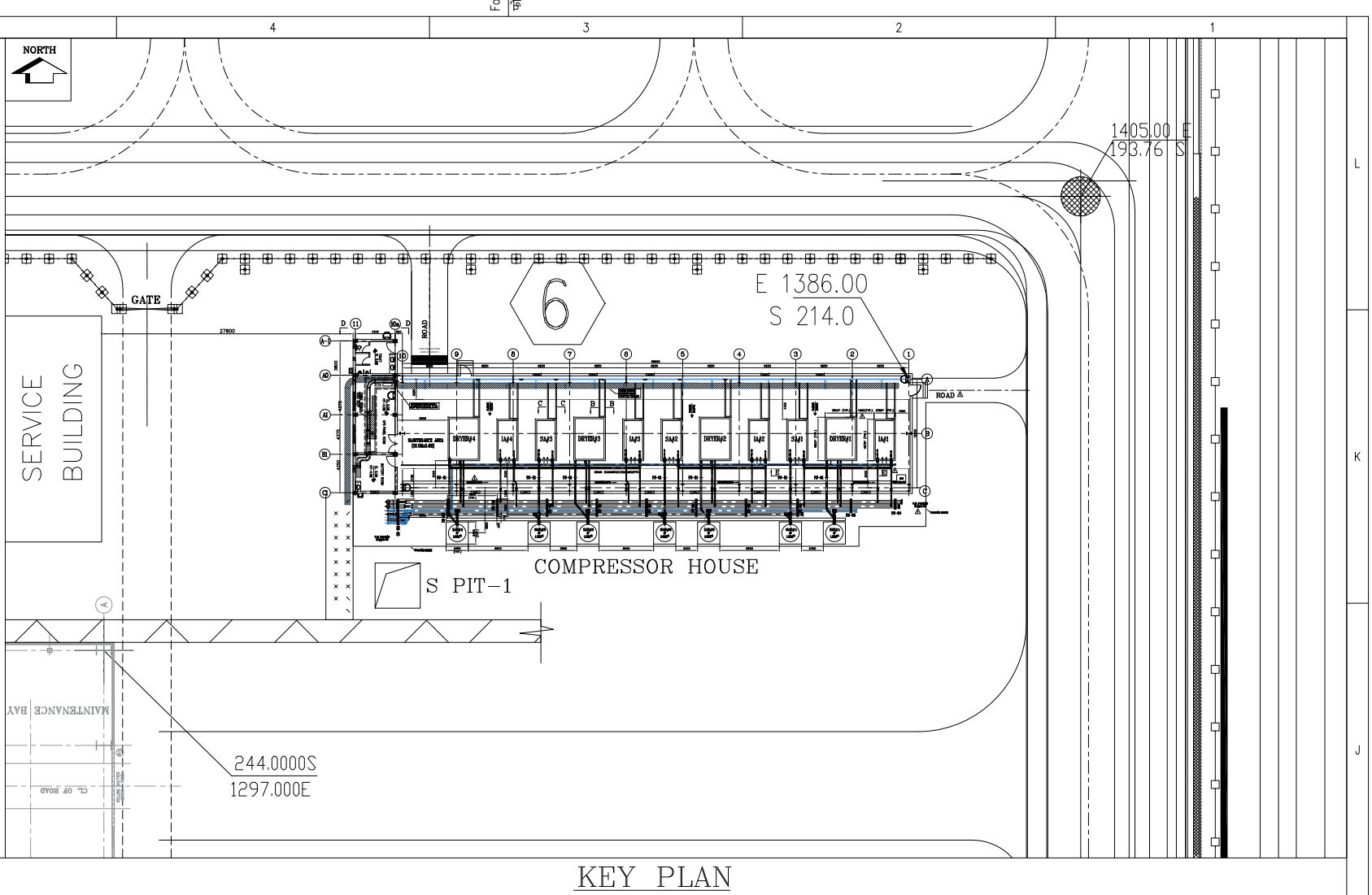
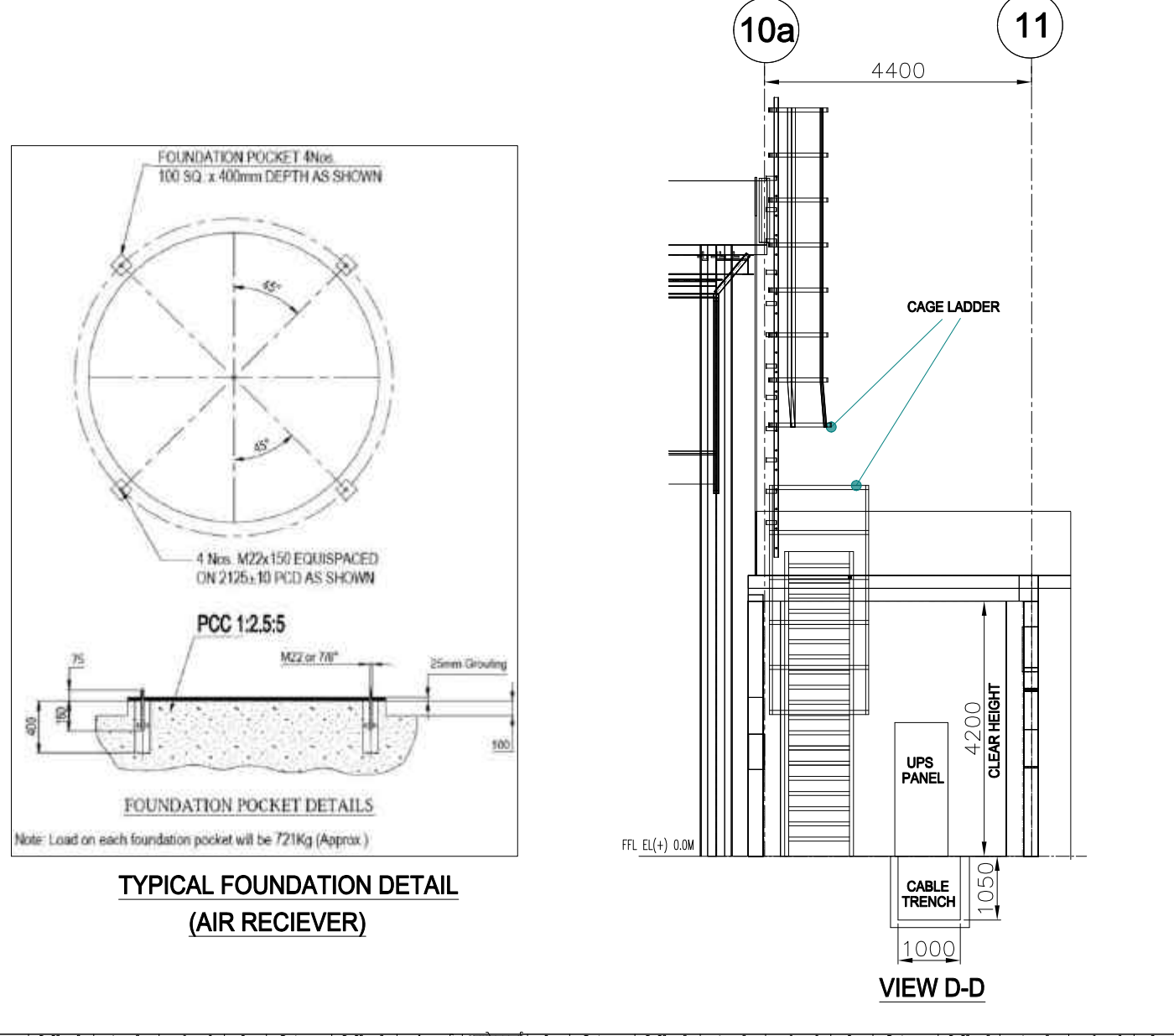
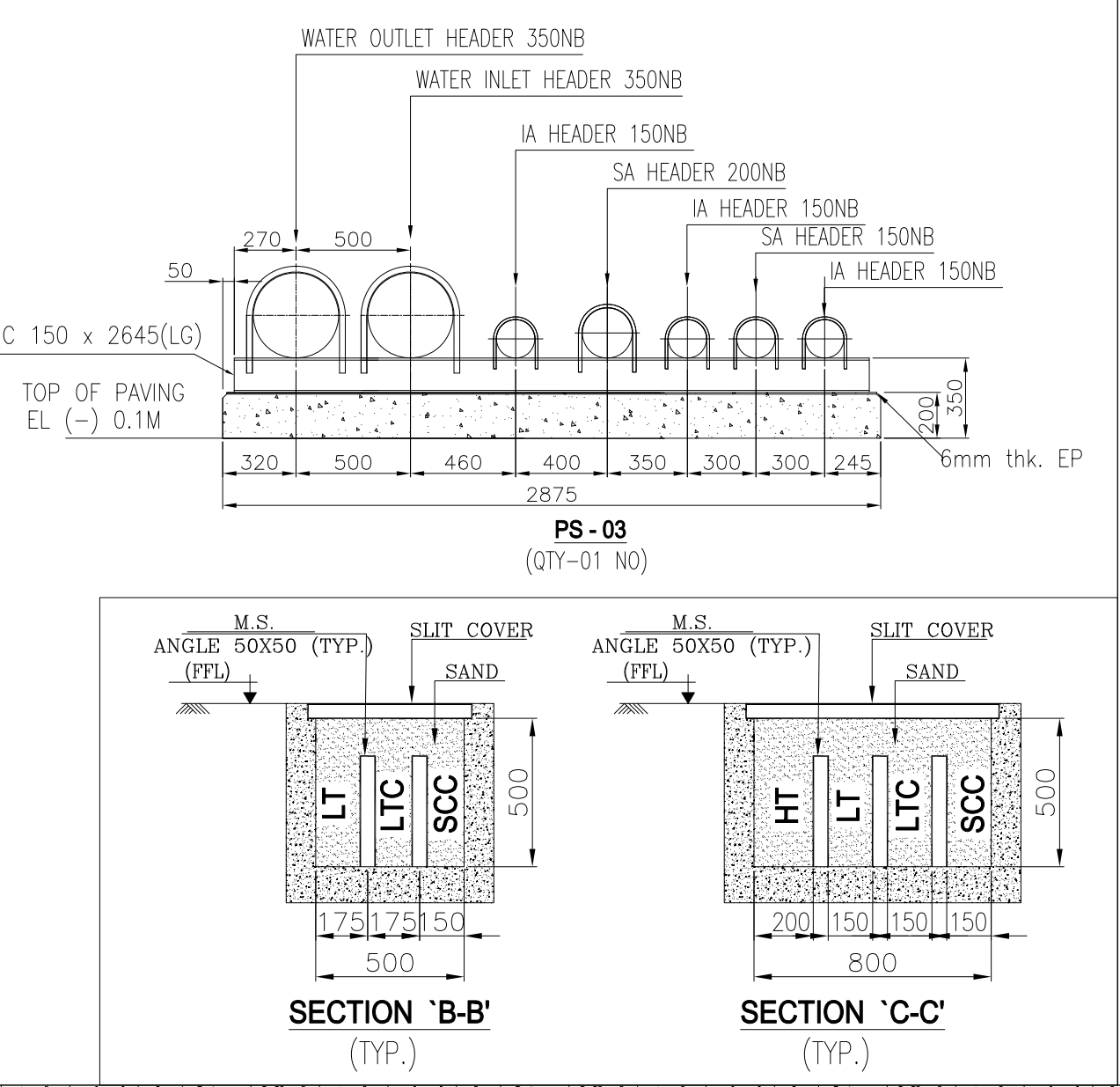
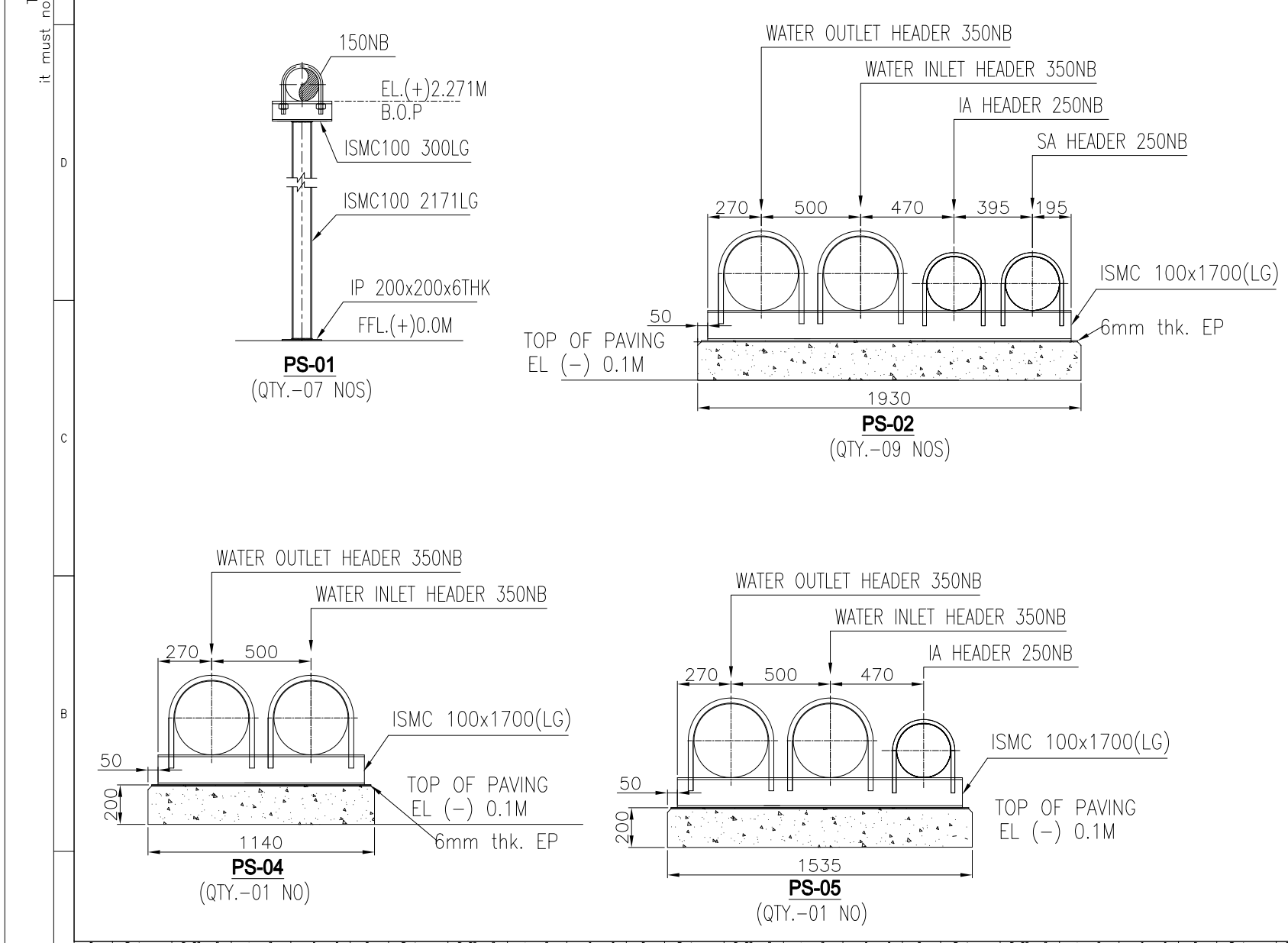
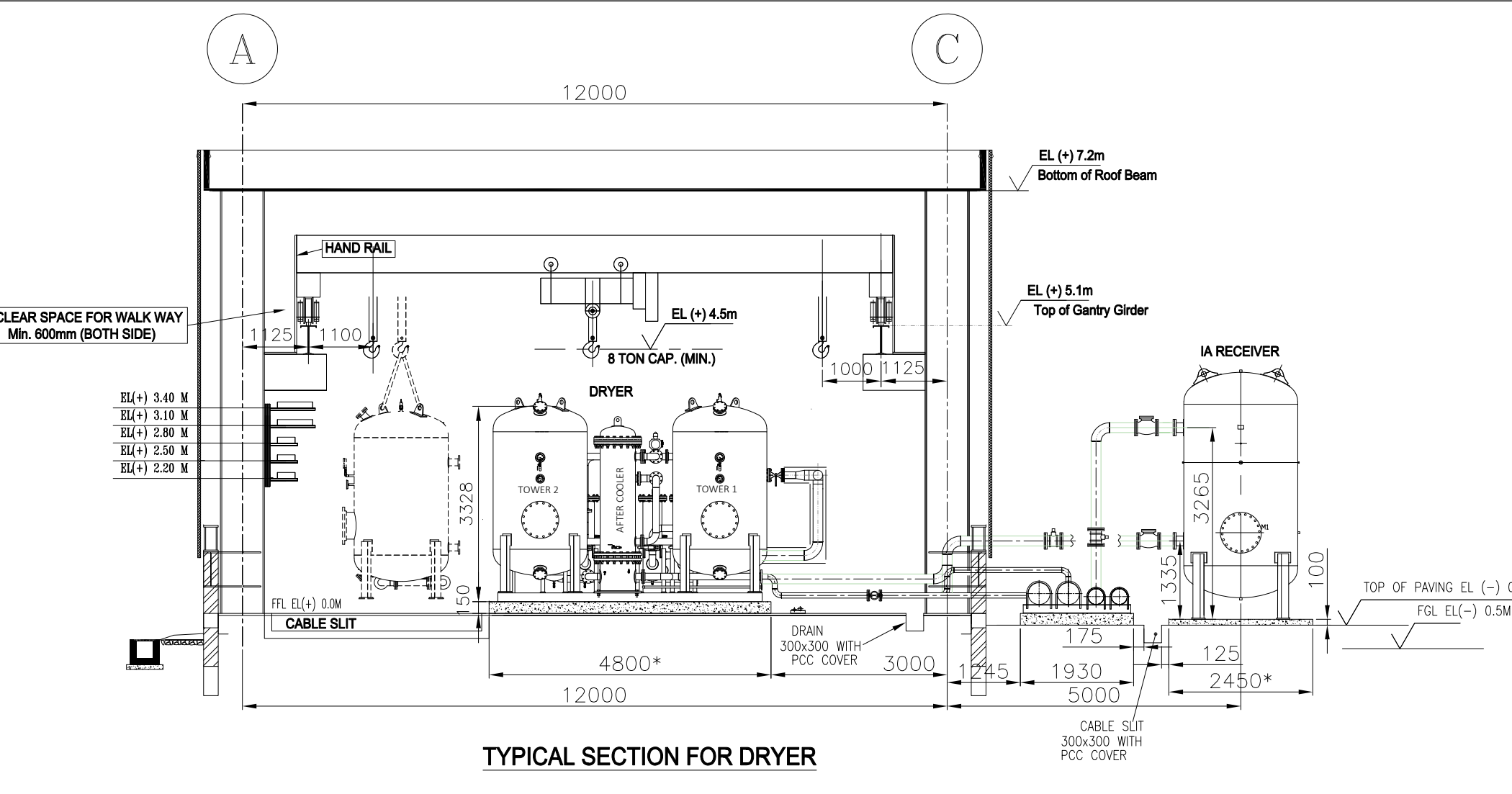
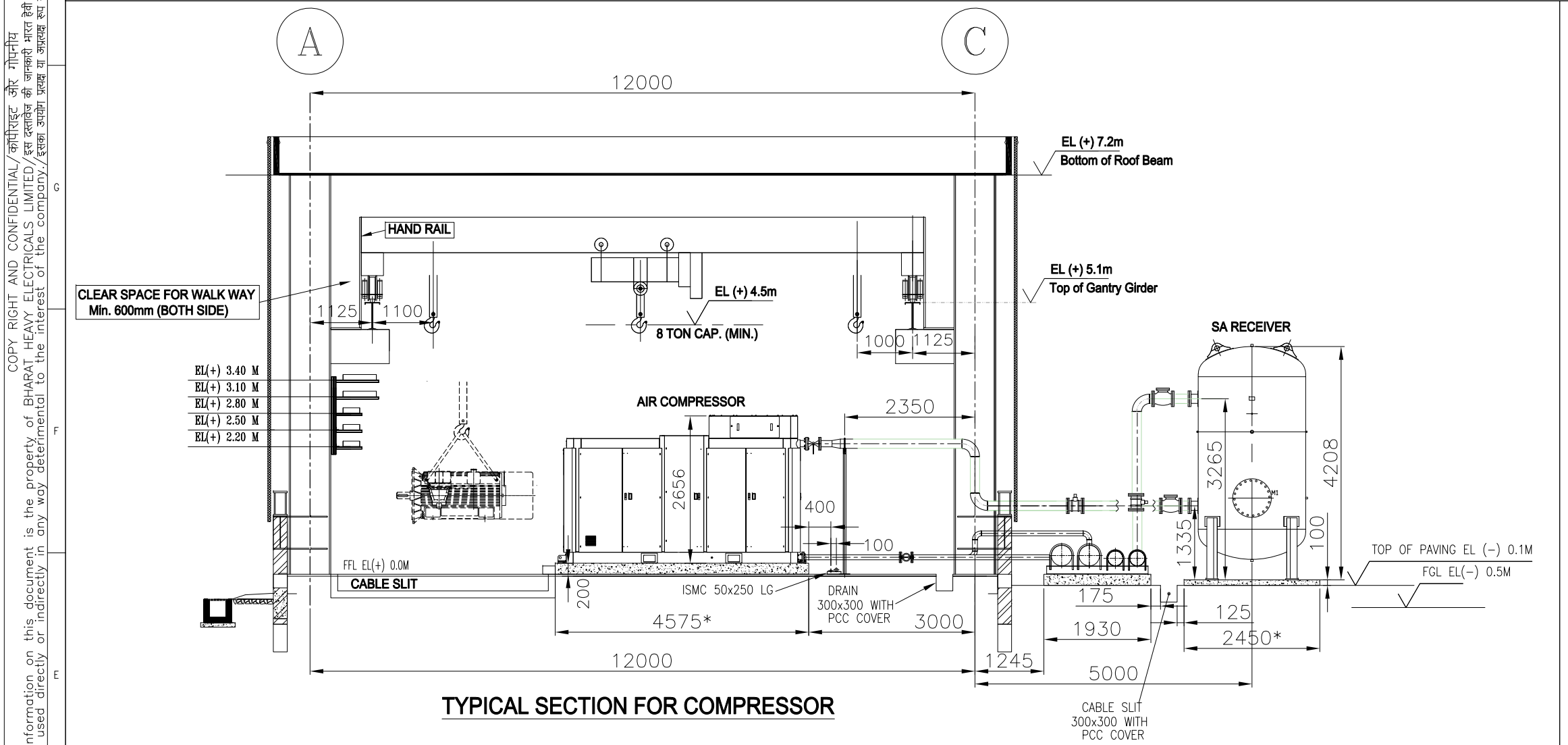
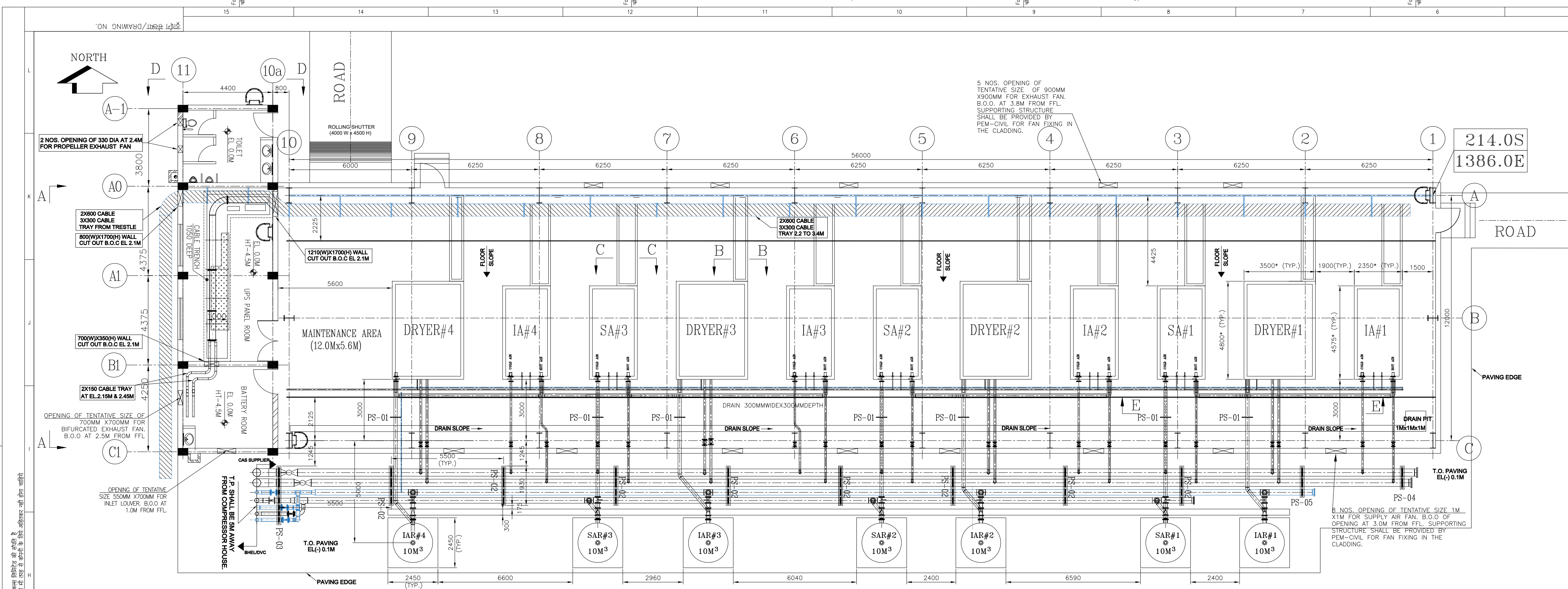
	SPECIFIC TECHNICAL REQUIREMENTS: Annexure I RAGHUNATHPUR TPS PH-II (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec. 2025
16.2	DESIGN AND CONSTRUCTION	
a.)	The compressor shall be oil free multistage, horizontal, water cooled, rotary screw type, heavy duty, rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.	
b.)	Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 110% of compressor rated BkW at rated conditions.	
c.)	The rotor and shaft shall be made of forged steel. The stator (casing) shall be of Cast-Iron (IS-210) construction with integral jacket cooling. The rotors shall be dynamically balanced to reduce vibration.	
d.)	The seal rings and retainers shall be of stainless steel construction and be free for radial self adjustment along the rotor shafts.	
e.)	Bearings shall be high precision antifriction type IS- 25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement.	
f.)	Lubrication system shall be as per manufacturer standard practices.	
g.)	Any superior material & type (as per proven practice and relevant standard) of various components of screw compressor is also acceptable.	
h.)	Gears shall have a rating of AGMA-12 or equivalent. Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position.	
17.0	CENTRIFUGAL AIR COMPRESSORS	
17.1	CODES AND STANDARDS - The design, manufacture, testing and performance of air compressors and accessories shall comply with the requirements of one or more of the relevant codes as applicable (IS-2825, IS-4503, CAGI, IS-5727, IS-6206, ASME-PTC-10, API 672 and IS-11727).	
17.2	DESIGN AND CONSTRUCTION	
a.)	Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 110% of compressor rated BkW at rated conditions or BkW at unthrottled minimum ambient temperature whichever is higher	
b.)	Air Compressors shall be oil free centrifugal air compressors with non-contact air/oil seals, each capable of delivering continuously rated volume flows at rated delivery pressure. Compressor components shall be interchangeable as far as possible.	
c.)	The rotor shaft shall be made of Stainless Steel. The rotors shall be dynamically balanced to reduce vibration. The gaskets shall be of asbestos free material. Any superior material & type (as per proven practice and relevant standard) of various components of screw compressor is also acceptable.	
d.)	Each compressor shall be provided with Inlet Guide Vane (IGV) control for suction air volume control.	
e.)	Each compressor shall be provided with coupling guard with fixing arrangement.	
f.)	Proper and robust supporting arrangement shall be provided from foundation/ floor for overhang casing, oil coolers, air piping, cooling water piping, oil piping, etc.	
g.)	Compressors shall be provided with adequate safety, protection control system including anti surge protection with bypass valve etc. and auto dual control (either; controlled for constant pressure or constant volume flow). The duty points shall be at least 15% away from the anti surge line.	
h.)	Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). Compressor shall be provided with IGV at the suction flange.	
18.0	INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW/CENTRIFUGAL)	
a.)	Intercoolers & after coolers shall be designed in accordance with Section-VIII, Division 1 of ASME Code or equivalent.	
b.)	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. Design pressure of coolers shall be 12 Kg/cm2 (g).	
c.)	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. However, plate type oil coolers as per OEM standard & proven design are also acceptable.	
d.)	The coolers shall be designed for maximum heat load and at least 10 percent design margin shall be provided in the number of tubes.	
e.)	Adequately sized safety valves shall be provided for both intercoolers and after coolers. However, in case of centrifugal compressors, safety provisions as per manufacturer's standard & proven design are also acceptable.	
f.)	Each intercooler and aftercooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.	
g.)	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 shall be timer based. Manual draining facility shall also be provided in the drain trap.	
h.)	Cooler shells, channels and covers shall be of carbon steel (SA 285 Gr C / SA 516 Gr 70). Tube sheet shall be of Brass or SS and the tubes shall be of Admiralty brass or Aluminium brass or Copper or SS 304. However, any superior material as per proven practice and relevant standard is also acceptable.	
19.0	INTAKE AIR FILTER AND SILENCER - 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. The filters shall be complete with integral silencers. Separate silencers, if specified, shall be provided. The filtering elements shall be easily removable for cleaning. The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure I RAGHUNATHPUR TPS PH-II (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec. 2025
20.0	AIR DRYING PLANT	
a)	Drying shall be by adsorption process through a desiccant medium. Air Drying (ADP) Plant may be of "Open Through type (Blower reactivated)" OR "Heat of (HOC) Compression type". Regeneration of desiccant shall be achieved by "open through" or "Heat of compression " method without any air purge loss.	
b.)	Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in Heat of compression type ADP and air from blower shall be used for regeneration after heating by electrical heater in case of "Open through type ADP".	
b.)	Each ADP shall be provided with two adsorber towers each sized for design drying cycle of minimum 8 hours. After this period, the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.	
c)	In "Open Through" type ADP ,for regeneration of desiccant, atmospheric air shall be filtered , heated through an electric heater and passed though the desiccant before exhausted to atmosphere. The reactivated desiccant shall be cooled through same atmospheric air without heater in operation .	
c.)	HOC type drier, the reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.	
d.)	Each ADP shall be provided with two (2) numbers of 100 percent capacity pre-filters and two (2) numbers of 100 percent capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand at least 50% of static pressure as differential pressure. However, as per manufacturer's standard & proven design, any superior material to the material specified is also acceptable. The prefilters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.	
e.)	The electric heaters (if required) (2x100% capacity for each ADP) shall be provided with thermostatic control for heater and relief valve for safety and shall be flanged type to facilitate easy replacement of element. Each electric motor driven blower (2x100% capacity for each ADP) shall be provided with individual dry type filters at inlet.	
f.)	The adsorber tower shall be designed with sufficient cross-sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Perplex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.	
g.)	The coolers/heat exchangers/ dehumidifiers of ADP shall be designed & constructed as per the requirements specified for "Intercoolers, After coolers & Oil coolers" above.	
h.)	All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers / coolers etc associated with ADP shall be designed in accordance with Section-VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight Gasketed manholes/handholes and relief valves.	
i)	Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.	
j.)	Desiccant shall be activated alumina only and adsorption capacity and density of the same shall not be more than 8% and 900 kg/m3 respectively.	
k.)	In case of Heat of compression type, adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period. Complete ADP equipments shall preferably be mounted on a skid. Required sample connections in piping be provided for sampling of air at desired locations.	
l.)	Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided. The material of Construction for various components of ADP shall be as per manufacturer's proven standard.	
m.)	HOC dryers of single rotating drum type design using packed desiccant with in-built regeneration and adsorption compartments are also acceptable in place of specified twin tower type dryers, if the design ensures specified performance guarantee. In case, the CAS supplier offers such a type, the same shall be of proven design. The control & instrumentation requirements specified is applicable for such design also.	
21.0	CONTROL PHILOSOPHY	
21.1	The minimum requirements are specified herein and the same shall be elaborated by CAS supplier. The CAS supplier shall include controls & instrumentation to facilitate safe, reliable and efficient operation for the system. The controls, protection, interlock and instrumentation system offered by the contractor shall be subjected to approval of the BHEL & Customer during post award engineering stage.	
21.2	Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.	
21.3	On tripping of working equipment, the standby equipment shall come into operation automatically in case of very low air pressure in the system. 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.	
21.4	An electrically operated automatic valve shall be provided on cooling water return 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.	
21.5	The following indications shall be made available in the control panels for repeating the same in main plant Control System / Panels. (a) Status of each compressor (b) Instrument air pressure low/high (c) Service air pressure low/high (d) Dew point of instrument air (e) Status of each ADP	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure I RAGHUNATHPUR TPS PH-II (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec. 2025
21.6	Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.	
21.7	Automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.	
21.8	Whenever the operation of an auxiliary equipment is interlocked with main motor running status, the actual feedback from HT switchgear needs to be considered instead of start/stop command. Proper logging of abnormal conditions should be ensured in compressor system itself with adequate alarms/annunciations on compressor local panel as well as plant DCS. The logged data should be easily retrievable at later stage for any analysis. Control of the compressors should be designed in such a manner it comes to fail safe condition during unhealthy conditions or malfunctioning of any input external to compressor. For example, to save the compressor from further damages, cooling water supplies should not be stopped/ air intake valve should not be closed, if the compressor is running under abnormal condition or proper status feedback from HT switch gear is not available.	
21.9	Screw /Centrifugal compressor	
a.)	Each compressor shall be in the control panel to operate either in Base duty (Auto Load- Unload) or Standby duty (Auto On-Off) mode in case of Screw and unload/module/energy optimization (Auto Dual Mode) in case of centrifugal. In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve. In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor should start in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by a timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a pre-set time.	
b.)	The control system shall provide warning to the operator that a hot-start condition exists for the motor driver and adequate cool-down period has not occurred after the motor was shut down.	
c.)	The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor: (a) "Air temperature high" at inlet to last stage - Alarm & trip (b) "Low lube oil pressure" - Alarm & trip (c) "High Lube oil supply temperature" - Alarm & trip (d) "High oil filter differential pressure" - Alarm (e) "Low lube oil level in lube oil sump" - Alarm (f) "High inlet air filter differential pressure" - Alarm & trip (g) "Low cooling water flow to air compressor" - Alarm	
22.0	Air Drying Plant	
a.)	Sequential operation of the adsorber towers & air compressors shall be controlled automatically with a provision for manual take over.	
b.)	Change over of tower from drying mode to regeneration mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor. Automatic operation during regeneration, starting and stopping of blowers, starting and stopping of heaters, etc shall be timer controlled. During the process, in case, operation is taken over manually from the panel through push button or selector switch, the sequential operation shall start with the manual initiation for each of the steps.	
c.)	The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air temperature", "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.	
d.)	For rotary drum type Air drying plant, control philosophy as per manufacture's standard and proven practice is also acceptable.	
23.0	For Centrifugal compressors, as per OEM recommendation, Start-up air compressor and air dryer along with piping, valves, instruments etc. shall be provided by CAS supplier. Additionally, tapping from instrument air main header shall also be taken and connected to the start-up compressor outlet piping along with valves and instruments and shall be used in case of outage of start-up compressor / dryer.	
24.0	CAS supplier to note that RTD/BTD of HT motor of air compressor shall be terminated to temperature scanner / microprocessor (one for each compressor to be provided by CAS Supplier) mounted on compressor itself. Interlocks and protection for RTD/BTD of compressor motor has to be provided from compressor panel itself.	
25.0	Control and Instrumentation – Individual compressor control shall be through compressor mounted microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR. Interface module for the overall control of compressed air system through DDCMIS shall be provided by CAS Supplier.	
26.0	Sequential panel for ensuring equal no. of running hours of each IA & SA set of compressors shall be provided by CAS Supplier.	
27.0	Junction Box for cable termination purpose shall be provided by CAS Supplier.	
28.0	HT motors for Instrument Air and Service Air Compressors, which are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder at its Works. HT motors shall be of BHEL make. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Also, once the motors are delivered at successful bidder's works / factory, any damage to motor shall be bidders' responsibility and rectification work shall be carried by bidder at its own cost. Further insurance of these motors after delivered at bidder's works shall be in bidder scope in line CAS package insurance, as per insurance terms & conditions defined under GCC.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure I RAGHUNATHPUR TPS PH-II (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec. 2025
29.0	Foot cum flange mounted motors shall be of 1500 RPM only. While foot mounted motors shall be 3000/ 1500 RPM.	
30.0	Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors.	
31.0	CAS supplier scope also includes - Pipe supporting structure over the insert plate for pedestal supported pipe, wall supported pipe, insert plate and supporting structure for floor supported pipe. All MS structures for cross overs, valve, instrument, equipment operating and maintenance platform; approach ladder for access to pit/ trench. All Equipment base plate, foundation anchor bolts.	
32.0	Paint required for painting of all items under the package for corrosion protection and to meet color coding required by customer.	
33.0	SCOPE OF SERVICES: Scope of services by CAS supplier shall include but not necessarily limited to the following: 1.) Erection & Commissioning of Compressed Air System (Refer Annexure-B). 2.) Unloading, Storage, handling and transportation at site. 3.) Pre commissioning & Commissioning activities for Compressed Air System. 4.) Trial operation, AMC for storage and Preventive / Breakdown maintenance , PG Test & handover of Compressed Air System.	
34.0	CAS supplier shall terminate compressed air piping at common IA header and common SA header downstream of air receiver closer to pipe rack/pedestal (around 5.0 m from compressor house building).	
35.0	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.	
36.0	Piping material - Compressed air (Instrument & service air) - ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.	
37.0	Piping material - Equipment cooling water - IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410 /IS-1239 Heavy.	
38.0	Valve material - Compressed air application - valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal / Forged carbon Steel for sizes 50 NB and below. Equipment cooling water shall be cast iron for sizes 65NB and above; gunmetal for sizes 50 NB and below.	
39.0	P&ID of CAS and Compressor house layout attached in this annexure to be read along with this specification and deemed to be included in scope of bidder.	
40.0	Void.	
41.0	Annual maintenance contract (AMC) for Preventive / Breakdown maintenance of Compressed air system (Refer Annexure-A) is in CAS supplier scope.	
42.0	Performance test for compressors shall be carried out at shops with job motor only.	

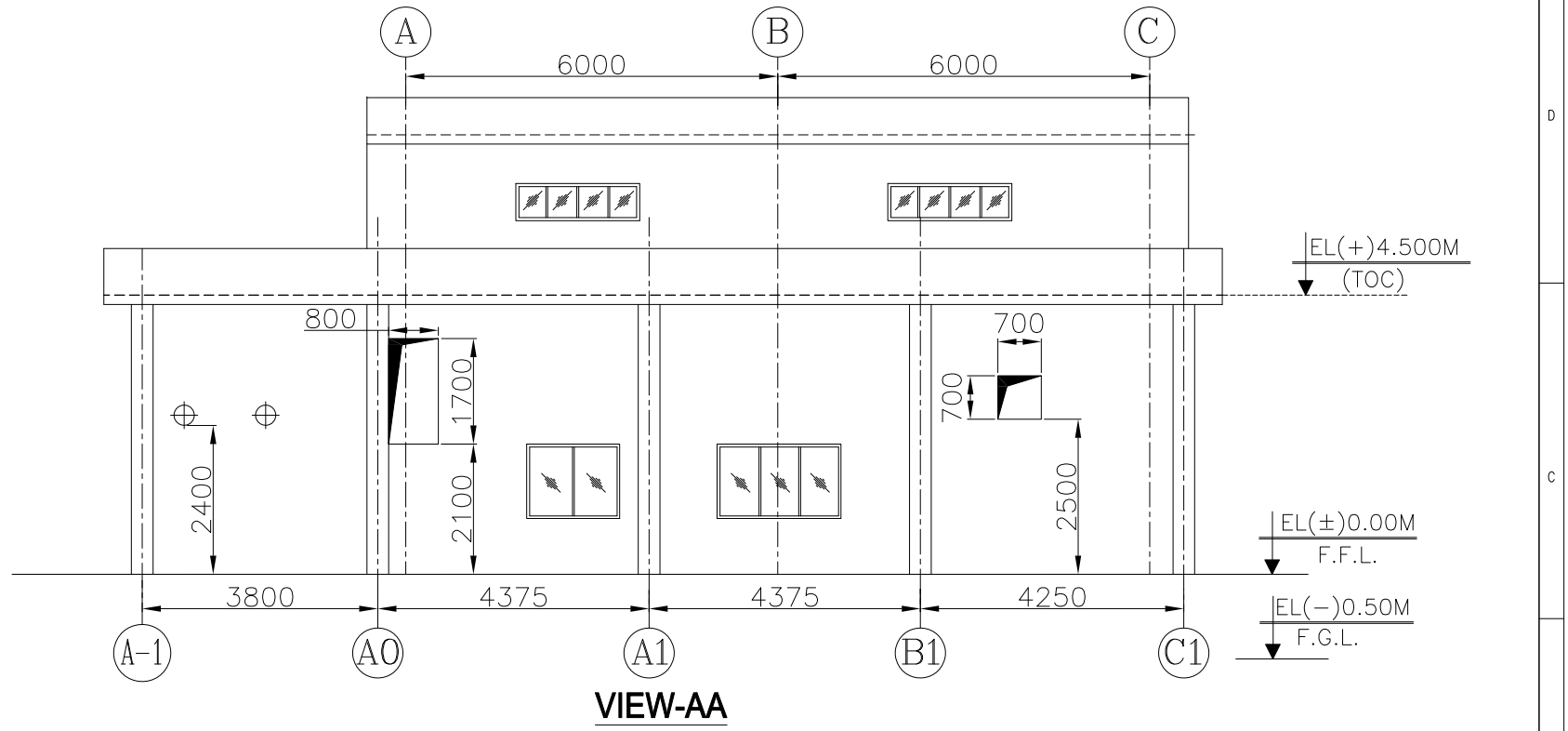
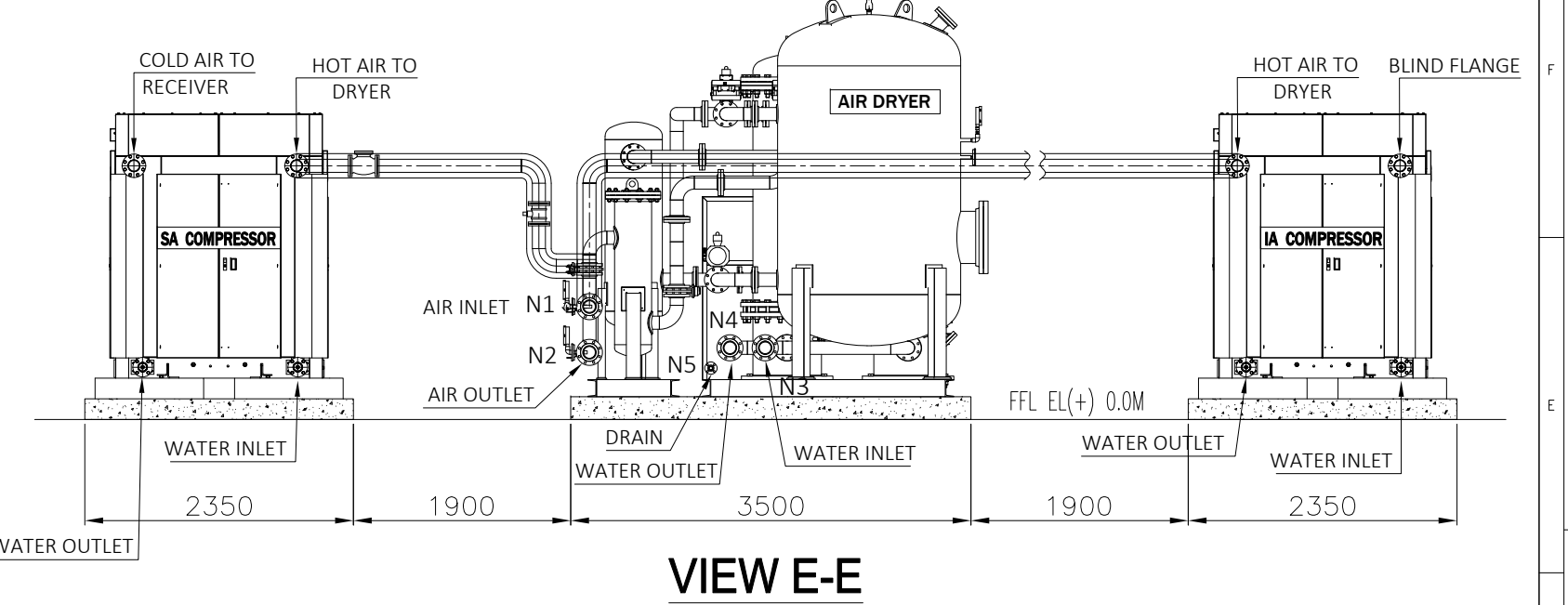




- NOTES :-
- 1) ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METERS.
 - 2) ALL ELEVATIONS ARE REFERRED TO THE FINISHED FLOOR LEVEL OF TG BUILDING AS EL.(+) 0.00 M WHICH CORRESPONDS TO RL (+)154.50 M.
 - 3) THE FINISHED FLOOR LEVEL OF COMPRESSOR BUILDING IS EL.(+) 0.00 M I.E. RL (+)154.50 M. AND F.G.L OUTSIDE THE BUILDING IS EL.(-) 0.500 M OR RL (+)154.00 M.
 - 4) SUITABLE ISMC CHANNEL SHALL BE PROVIDED ALL AROUND THE VENTILATION FAN OPENING BY BHFL-CIVIL FOR SUPPORTING OF THE FAN IN CLADDING STRUCTURE.
 - 5) GROUTING OF 25MM IN AIR RECEIVER FOUNDATION SHALL BE DONE BY CAS SUPPLIER.
 - 6) ALL HOT PIPELINES SHALL BE INSULATED TO RESTRICT THE OUTSIDE TEMPERATURE WITHIN 60 DEG. C. WITH MINERAL WOOL (OR) EQUIVALENT GI WIRE NETTING & ALUMINUM CLADDING/COVER.
 - 7) GRADE OF CONCRETE AND GROUTING SHALL BE AS PER TECHNICAL SPECIFICATION.
 - 8) DIMENSIONS FOR EQUIPMENT AS INDICATED '*' IN COMPRESSOR HOUSE HAVE BEEN CONSIDERED BASED ON PAST VENDOR DATA AND SAME SHALL BE REVALIDATED BY THE EQUIPMENT SUPPLIER.
 - 9) PIPE OPENINGS, EQUIPMENT LOAD & DETAILS, FOUNDATION DETAILS, PIPING WITH PEDESTALS, VALVES, PIPE AND CABLE SLIT DETAILS ARE INDICATIVE ONLY & SHALL BE VALIDATED AFTER THE FINALIZATION OF EQUIPMENT SUPPLIER.

REFERENCE DRAWINGS :-

1) PLOT PLAN ----- 2115-102-002-PVM-F-045



FOR TENDOR PURPOSE ONLY.

CUSTOMER DRG. NO.: 2115-102-002-PVM-F-044

PROJECT: 2X660MW DVC RAGHUNATHPUR TPS PH-II (SG PACKAGE)

DRG. NO.: 2X660MW DVC RAGHUNATHPUR TPS PH-II (SG PACKAGE)

DRG. TITLE: COMPRESSOR HOUSE LAYOUT

DRG. DATE: 2024-08-10

DRG. SCALE: 1:100

DRG. SHEET: 1 OF 1

DRG. NO.: 2X660MW DVC RAGHUNATHPUR TPS PH-II (SG PACKAGE)

DRG. TITLE: COMPRESSOR HOUSE LAYOUT

DRG. DATE: 2024-08-10

DRG. SCALE: 1:100

DRG. SHEET: 1 OF 1

INSTRUMENT AIR COMPRESSOR	490 kW	-----	S	3	1	C	U	N	C	Motor	15-20 Sec	*						Refer notes (i), (ii) and (iii)	
SERVICE AIR COMPRESSOR	490 kW	-----	S	3	0	C	U	N	C	Motor	15-20 Sec	*							
AIR DRYER (INCL. HEATER)	9.0 kW	-----	S	3	1	E	D	N	C	Panel	-----	*							
IA COMPRESSOR AUX. SUPPLY (INCLU. OIL PUMP)	7.5 kW	-----	S	3	1	D	S	Y	C	Panel	-----	*						DG SUPPLY	
SA COMPRESSOR AUX. SUPPLY (INCLU. OIL PUMP)	7.5 kW	-----	S	3	0	D	S	Y	C	Panel	-----	*							
UPS SUPPLY FOR MICROPROCESSOR PANELS & SEQUENTIAL PANEL	7.5 kW	-----	S	1	1	E	S	N	C	Panel	-----	*						230V AC UPS	By C&I
RECEIVER DRAIN ADT	0.5 kW	-----	S	10	0	E	S	N	I	ADT	-----	**						Qty. as (applicable)	
AFTER COOLER DRAIN ADT	0.5 kW	-----	S	-	-	E	S	N	I	ADT	-----	*							
UTILITY COMPRESSOR FOR CENTRIFUGAL COMPRESSOR	9.0 kW	-----	S	1	0	D	S	N	I	Motor	5 Sec	*							
UTILITY COMPRESSOR FOR CENTRIFUGAL COMPRESSOR	1.0 kW	-----	S	1	0	D	S	N	I	Panel	-----	*							

NOTES:

- 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) Suitable protection shall be included in the HT Switchgear logic to prevent frequent start stop of the compressor HT motors.
 - * - Compressor House
 - ** - 7 nos. air receivers outside compressor house; 2 No. near ESP buffer hopper area for Ash handling system and 1 No. in Fly ash silo area and Ash classification system near silo utility building.
- Bidder to comply the above mentioned “NOT TO EXCEED ELECTRICAL LOAD” during detailed engg. of the package.

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
SPECIFIC TECHNICAL REQUIREMENTS Annexure II: 2x660 MW CPGCL Korba West		

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure II CSPGCL KORBA WEST STAGE-IV (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
SPECIFIC TECHNICAL REQUIREMENT - MECHANICAL		
1.0	The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants, Service Air compressors& their motor drives , air receivers, instrumentation and control, control panels and interconnecting compressed air piping in the compressor house.	
2.0	Three (03) numbers (2 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for instrument air duty for the complete plant each of 50Nm³/min capacity & 8.0 kg/cm²(g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works.	
3.0	Three (03) numbers (2 working+ 1 standby) Air Drying Plants (one for each instrument air compressor) of 50 Nm ³ /min. capacity with all interconnecting piping, valves, fittings, etc. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". Discharge pressure available at the outlet of Air drying Plant shall be minimum 7.5 Kg/cm ² (g).	
4.0	Four (04) numbers (3 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for service air duty for the complete plant each of 50Nm ³ /min capacity & 8.0 kg/cm ² (g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issue by BHEL at compressor supplier works. 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.	
5.0	Air Receivers - 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. Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be atleast 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure. Each receiver shall be provided with pressure indicator, temperature indicator and drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves. The drain trap shall be timer based. Manual draining facility shall also be provided in the drain trap. The material of construction of shell, dished ends, flanges, etc of the air receivers shall be of carbon steel as per IS:2062 or equivalent. Air receiver are to be provided with gasketed inspection manhole of minimum 500mm diameter with cover plate, lifting handle ,davit cap etc.	
5.1	One(1) number of air receiver of minimum capacity 10 m ³ at the discharge of each air compressor (Total: 07 numbers).	
5.2	One number unit air receiver of minimum capacity 10 m ³ for each unit to be located in TG building. (Total: 02 numbers).	
5.3	One number (1) of air receiver of minimum capacity 02 m ³ for DM plant to be located in Water Treatment Area.	
6.0	All the equipments shall be designed for continuous duty as well as for intermittent operation. Frequent start/stop of the system shall neither result deterioration in performance nor damage to the equipment.	
7.0	The compressors and Air Drying plants shall operate under the following ambient conditions. i. Minimum temperature : 10 deg. C ii. Maximum temperature : 50 deg. C iii. Design condition (Temperature : 45 deg.C & 75% RH) iv. Height above MSL (m) : 305.5 M	
8.0	The compressor capacity & discharge pressure of instrument air system and service air system shall be identical.	
9.0	The heat exchangers are DMCW cooled and the maximum cooling water temperature at compressor coolers inlet shall be 38 deg. C. The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-10 deg C.	
10.0	Noise level shall not exceed 85 dBA to a reference level of 0.0002 microbar when measured at a distance of 1.5 meter above the floor and 1m horizontal distance. Required acoustic enclosures may 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. For eventual noise, from the discharge line, accessories and/or ancillary equipment which are not included, a correction factor of (+) 8 dBA maximum shall be allowed for background & ambient noise.	
11.0	Vibration level of screw compressor shall be as per VDI-3836. However, velocity vibration shall be limited to 10 mm/sec (rms). Vibration level of centrifugal compressor shall be as per manufacturer standard & proven practice.	
12.0	Air Compressors (Screw /Centrifugal type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement. As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room. Parallel operation of compressors shall be possible without any undue vibration and noise.	
13.0	The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors.	
14.0	All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover.	
15.0	The canopy shall be designed to cater the load of air filter with 100% choked condition.	
16.0	SCREW AIR COMPRESSORS	
16.1	CODES AND STANDARDS - The design, manufacture, testing and performance of the various components of the rotary screw type air compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727, ISO-1217 and CAGI).	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure II CSPGCL KORBA WEST STAGE-IV (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
16.2	DESIGN AND CONSTRUCTION	
a.)	The compressor shall be oil free multistage, horizontal, water cooled, rotary screw type, heavy duty, rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.	
b.)	Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 110% of compressor rated BKW at rated conditions.	
c.)	The rotor and shaft shall be made of forged steel. The stator (casing) shall be of Cast-Iron (IS-210) construction with integral jacket cooling. The rotors shall be dynamically balanced to reduce vibration.	
d.)	The seal rings and retainers shall be of stainless steel construction and be free for radial self adjustment along the rotor shafts.	
e.)	Bearings shall be high precision antifriction type IS- 25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement.	
f.)	Lubrication system shall be as per manufacturer standard practices.	
g.)	Any superior material & type (as per proven practice and relevant standard) of various components of screw compressor is also acceptable.	
h.)	Gears shall have a rating of AGMA-12 or equivalent. Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position.	
17.0	CENTRIFUGAL AIR COMPRESSORS	
17.1	CODES AND STANDARDS - The design, manufacture, testing and performance of air compressors and accessories shall comply with the requirements of one or more of the relevant codes as applicable (IS-2825, IS-4503, CAGI, IS-5727, IS-6206, ASME-PTC-10, API 672 and IS-11727).	
17.2	DESIGN AND CONSTRUCTION	
a.)	Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 110% of compressor rated BKW at rated conditions or BKW at unthrottled minimum ambient temperature whichever is higher	
b.)	Air Compressors shall be oil free centrifugal air compressors with non-contact air/oil seals, each capable of delivering continuously rated volume flows at rated delivery pressure. Compressor components shall be interchangeable as far as possible.	
c.)	The rotor shaft shall be made of Stainless Steel. The rotors shall be dynamically balanced to reduce vibration. The gaskets shall be of asbestos free material. Any superior material & type (as per proven practice and relevant standard) of various components of screw compressor is also acceptable.	
d.)	Each compressor shall be provided with Inlet Guide Vane (IGV) control for suction air volume control.	
e.)	Each compressor shall be provided with coupling guard with fixing arrangement.	
f.)	Proper and robust supporting arrangement shall be provided from foundation/ floor for overhang casing, oil coolers, air piping, cooling water piping, oil piping, etc.	
g.)	Compressors shall be provided with adequate safety, protection control system including anti surge protection with bypass valve etc. and auto dual control (either; controlled for constant pressure or constant volume flow). The duty points shall be at least 15% away from the anti surge line.	
h.)	Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). Compressor shall be provided with IGV at the suction flange.	
18.0	INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW/CENTRIFUGAL)	
a.)	Intercoolers & after coolers shall be designed in accordance with Section-VIII, Division 1 of ASME Code or equivalent.	
b.)	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. Design pressure of coolers shall be 12 Kg/cm2 (g).	
c.)	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. However, plate type oil coolers as per OEM standard & proven design are also acceptable.	
d.)	The coolers shall be designed for maximum heat load and atleast 10 percent design margin shall be provided in the number of tubes.	
e.)	Adequately sized safety valves shall be provided for both intercoolers and after coolers. However, in case of centrifugal compressors, safety provisions as per manufacturer's standard & proven design are also acceptable.	
f.)	Each intercooler and aftercooler shall be provided with moisture separator units with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.	
g.)	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 shall be timer based. Manual draining facility shall also be provided in the drain trap.	
h.)	Cooler shells, channels and covers shall be of carbon steel (SA 285 Gr C / SA 516 Gr 70). Tube sheet shall be of Brass or SS and the tubes shall be of Admiralty brass or Aluminium brass or Copper or SS 304. However, any superior material as per proven practice and relevant standard is also acceptable.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure II CSPGCL KORBA WEST STAGE-IV (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
19.0	INTAKE AIR FILTER AND SILENCER - 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. The filters shall be complete with integral silencers. Separate silencers, if specified, shall be provided. The filtering elements shall be easily removable for cleaning. The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.	
20.0	AIR DRYING PLANT	
a.)	Drying shall be by adsorption process through a desiccant medium. Air Drying (ADP) Plant may be of "Open Through type (Blower reactivated)" OR "Heat of (HOC) Compression type". Regeneration of desiccant shall be achieved by "open through" or "Heat of compression" method without any air purge loss.	
b.)	Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in Heat of compression type ADP and air from blower shall be used for regeneration after heating by electrical heater in case of "Open through type ADP".	
b.)	Each ADP shall be provided with two adsorber towers each sized for design drying cycle of minimum 8 hours. After this period, the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty. The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.	
c.)	In "Open Through" type ADP, for regeneration of desiccant, atmospheric air shall be filtered, heated through an electric heater and passed through the desiccant before exhausted to atmosphere. The reactivated desiccant shall be cooled through same atmospheric air without heater in operation.	
c.)	HOC type drier, the reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.	
d.)	Each ADP shall be provided with two (2) numbers of 100 percent capacity pre-filters and two (2) numbers of 100 percent capacity after-filters at the upstream & downstream of towers. The filtering media shall be of ceramic candle type elements designed to withstand at least 50% of static pressure as differential pressure. However, as per manufacturer's standard & proven design, any superior material to the material specified is also acceptable. The pre-filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.	
e.)	The electric heaters (if required) (2x100% capacity for each ADP) shall be provided with thermostatic control for heater and relief valve for safety and shall be flanged type to facilitate easy replacement of element. Each electric motor driven blower (2x100% capacity for each ADP) shall be provided with individual dry type filters at inlet.	
f.)	The adsorber tower shall be designed with sufficient cross-sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Perspex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.	
g.)	The coolers/heat exchangers/ dehumidifiers of ADP shall be designed & constructed as per the requirements specified for "Intercoolers, After coolers & Oil coolers" above.	
h.)	All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers / coolers etc associated with ADP shall be designed in accordance with Section-VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketed manholes/handholes and relief valves.	
i)	Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.	
j)	Desiccant shall be activated alumina only and adsorption capacity and density of the same shall not be more than 8% and 900 kg/m ³ respectively.	
k)	In case of Heat of compression type, adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period. Complete ADP equipments shall preferably be mounted on a skid. Required sample connections in piping be provided for sampling of air at desired locations.	
l)	Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided. The material of Construction for various components of ADP shall be as per manufacturer's proven standard.	
m)	HOC dryers of single rotating drum type design using packed desiccant with in-built regeneration and adsorption compartments are also acceptable in place of specified twintower type dryers, if the design ensures specified performance guarantee. In case, the CAS supplier offers such a type, the same shall be of proven design. The control & instrumentation requirements specified is applicable for such design also.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure II CSPGCL KORBA WEST STAGE-IV (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
21.0	CONTROL PHILOSOPHY	
21.1	The minimum requirements are specified herein and the same shall be elaborated by CAS supplier. The CAS supplier shall include controls & instrumentation to facilitate safe, reliable and efficient operation for the system. The controls, protection, interlock and instrumentation system offered by the contractor shall be subjected to approval of the BHEL & Customer during post award engineering stage.	
21.2	Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.	
21.3	On tripping of working equipment, the standby equipment shall come into operation automatically in case of very low air pressure in the system. 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.	
21.4	An electrically operated automatic valve shall be provided on cooling water return 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.	
21.5	The following indications shall be made available in the control panels for repeating the same in main plant Control System / Panels. (a) Status of each compressor (b) Instrument air pressure low/high (c) Service air pressure low/high (d) Dew point of instrument air (e) Status of each ADP	
21.6	Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.	
21.7	Automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.	
21.8	Whenever the operation of an auxiliary equipment is interlocked with main motor running status, the actual feedback from HT switchgear needs to be considered instead of start/stop command. Proper logging of abnormal conditions should be ensured in compressor system itself with adequate alarms/annunciations on compressor local panel as well as plant DCS. The logged data should be easily retrievable at later stage for any analysis. Control of the compressors should be designed in such a manner it comes to fail safe condition during unhealthy conditions or malfunctioning of any input external to compressor. For example, to save the compressor from further damages, cooling water supplies should not be stopped/ air intake valve should not be closed, if the compressor is running under abnormal condition or proper status feedback from HT switch gear is not available.	
21.9	Screw /Centrifugal compressor	
a.)	Each compressor shall be in the control panel to operate either in Base duty (Auto Load- Unload) or Standby duty (Auto On-Off) mode in case of Screw and unload/modulate/energy optimization (Auto Dual Mode) in case of centrifugal. In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve. In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor should start in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by a timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a pre-set time.	
b.)	The control system shall provide warning to the operator that a hot-start condition exists for the motor driver and adequate cool-down period has not occurred after the motor was shut down.	
c.)	The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor: (a) "Air temperature high" at inlet to last stage - Alarm & trip (b) "Low lube oil pressure" - Alarm & trip (c) "High Lube oil supply temperature" - Alarm & trip (d) "High oil filter differential pressure" - Alarm (e) "Low lube oil level in lube oil sump" - Alarm (f) "High inlet air filter differential pressure" - Alarm & trip (g) "Low cooling water flow to air compressor" - Alarm	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure II CSPGCL KORBA WEST STAGE-IV (2X660 MW) COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec 2025
22.0	Air Drying Plant	
a.)	Sequential operation of the adsorber towers & air compressors shall be controlled automatically with a provision for manual take over.	
b.)	Change over of tower from drying mode to regeneration mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor. Automatic operation during regeneration, starting and stopping of blowers, starting and stopping of heaters, etc shall be timer controlled. During the process, in case, operation is taken over manually from the panel through push button or selector switch, the sequential operation shall start with the manual initiation for each of the steps.	
c.)	The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air temperature", "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.	
d.)	For rotary drum type Air drying plant, control philosophy as per manufacture's standard and proven practice is also acceptable.	
23.0	For Centrifugal compressors, as per OEM recommendation, Start-up air compressor and air dryer along with piping, valves, instruments etc. shall be provided by CAS supplier. Additionally, tapping from instrument air main header shall also be taken and connected to the start-up compressor outlet piping along with valves and instruments and shall be used in case of outage of start-up compressor / dryer.	
24.0	CAS supplier to note that RTD/BTD of HT motor of air compressor shall be terminated to temperature scanner / microprocessor (one for each compressor to be provided by CAS Supplier) mounted on compressor itself. Interlocks and protection for RTD/BTD of compressor motor has to be provided from compressor panel itself.	
25.0	Control and Instrumentation – Individual compressor control shall be through compressor mounted microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR. Interface module for the overall control of compressed air system through DDCMIS shall be provided by CAS Supplier.	
26.0	Sequential panel for ensuring equal no. of running hours of each IA & SA set of compressors shall be provided by CAS Supplier.	
27.0	Junction Box for cable termination purpose shall be provided by CAS Supplier.	
28.0	HT motors for Instrument Air and Service Air Compressors, which are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder at its Works. HT motors shall be of BHEL make. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Also, once the motors are delivered at successful bidder's works / factory, any damage to motor shall be bidders' responsibility and rectification work shall be carried by bidder at its own cost. Further insurance of these motors after delivered at bidder's works shall be in bidder scope in line CAS package insurance, as per insurance terms & conditions defined under GCC.	
29.0	Foot cum flange mounted motors shall be of 1500 RPM only. While foot mounted motors shall be 3000/ 1500 RPM.	
30.0	Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors.	
31.0	CAS supplier scope also includes - Pipe supporting structure over the insert plate for pedestal supported pipe, wall supported pipe, insert plate and supporting structure for floor supported pipe. All MS structures for cross overs, valve, instrument, equipment operating and maintenance platform; approach ladder for access to pit/ trench. All Equipment base plate, foundation anchor bolts.	
32.0	Paint required for painting of all items under the package for corrosion protection and to meet color coding required by customer.	
33.0	SCOPE OF SERVICES: Scope of services by CAS supplier shall include but not necessarily limited to the following: 1.) Erection & Commissioning of Compressed Air System (Refer Annexure-B). 2.) Unloading, Storage, handling and transportation at site. 3.) Pre commissioning & Commissioning activities for Compressed Air System. 4.) Trial operation, AMC for storage and Preventive / Breakdown maintenance , PG Test & handover of Compressed Air System.	
34.0	CAS supplier shall terminate compressed air piping at common IA header and common SA header downstream of air receiver closer to pipe rack/pedestal (around 5.0 m from compressor house building).	
35.0	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.	
36.0	Piping material - Compressed air (Instrument & service air) - ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.	
37.0	Piping material - Equipment cooling water - IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410 /IS-1239 Heavy.	
38.0	Valve material - Compressed air application - valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal / Forged Steel for sizes 50 NB and below. Equipmnt cooling Water shall be cast iron for sizes 65NB and above; gunmetalfor sizes 50 Nb and below.	
39.0	P&ID of CAS and Compressor house layout attached in this annexure are to be read along with this specification and deemed to be included in scope of bidder.	
40.0	Void.	
41.0	Annual maintenance contract (AMC) for Preventive / Breakdown maintenance of Compressed air system (Refer Annexure-A) is in CAS supplier scope.	
42.0	Performance test for compressors shall be carried out at shops with job motor only.	

INSTRUMENT AIR COMPRESSOR	490KW	-----	S	2	1	C	U	N	C	Motor	15-20SEC	*						Refer notes	
SERVICE AIR COMPRESSOR	490KW	-----	S	3	1	C	U	N	C	Motor	15-20SEC	*						(i), (ii) and (iii).	
AIR DRYER (INCL. HEATER)	9KW	-----	S	2	1	E	D	N	C	Panel	-----	*							
IA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*						DG SUPPLY	
SA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	3	1	D	S	Y	C	Panel	-----	*							
UPS SUPPLY FOR MICROPROCESSOR PANELS & SEQUENTIAL PANEL	7.5KW	-----	S	1	1	D	S	N	C	Panel	-----	*						230VAC UPS	BY C&I
RECEIVER DRAIN ADT	0.5KW	-----	S	10	0	E	S	N	I	ADT	-----	**							
AFTER COOLER DRAIN ADT	0.5KW	-----	S	-	-	E	S	N	I	ADT	-----	*						(Qty. as applicable)	
UTILITY COMPRESSOR FOR CENTRIFUGAL COMPPRESSOR	9KW	-----	S	1	0	D	S	N	I	Motor	5 SEC	*							
UTILITY DRYER FOR CENTRIFUGAL COMPPRESSOR	1KW	-----	S	1	0	D	S	N	I	Panel	-----	*							

NOTES:

- 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) Suitable protection shall be included in the HT Switchgear logic to prevent frequent start stop of the compressor HT motors.**
- * - Compressor House.**
- ** - 7 nos. outside Compressor House, 2 nos. for TG (one for each Unit), 1 no. in DM plant Area.**

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
SPECIFIC TECHNICAL REQUIREMENTS Annexure III: 1x800 MW GSECL Ukai		

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure III 1X800 MW UNIT-07 UKAI TPS	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
	COMPRESSED AIR SYSTEM	Date: DEC 2025
SPECIFIC TECHNICAL REQUIREMENT - MECHANICAL		
1.0	The compressed air system shall consist of Instrument Air compressors, Air Drying Plants (ADPs), Service Air compressors, Air receivers, interconnecting compressed air piping, cooling water piping, drain piping, fittings, valves, instruments, compressor & dryer inbuilt microprocessor control panels, sequential panel in the compressor house.	
2.0	Three (03) numbers (2 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for instrument air duty for the complete plant each of 50 Nm³/min. capacity & 8.5 kg/cm ² (g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works.	
3.0	Three (03) numbers (2 working+ 1 standby) Air Drying Plants (one for each instrument air compressor) of 60 Nm³/min. capacity with all interconnecting piping, valves, fittings, etc. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". Discharge pressure available at the outlet of Air drying Plant shall be minimum 8.0 Kg/cm ² (g).	
4.0	Two (02) numbers (1 working+ 1 Standby*) oil free, rotary screw/centrifugal type air compressors for service air duty for the complete plant each of 50 Nm ³ /min. capacity & 8.5 kg/cm ² (g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works. 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. * During Startup Operations of Boiler, Both Service Air Compressors will be in working condition. Accordingly, all Service Air piping, Valves & Cooling Water piping for Service Air compressors shall be sized considering both Service Air compressors as working.	
5.0	Air Receivers a.) 12.5 m ³ capacity air receivers, total Five(5) numbers to be provided, one for each instrument air & service air compressor, located outside compressor house. b.) 10.0 M ³ capacity air receivers, total one (1) number to be provided, located in TG building in B-C bay. c.) 2.0 m ³ capacity air receiver, total One (1) number to be provided for Water treatment Plant area.	
6.0	All the equipments shall be designed for continuous duty as well as for intermittent operation. Frequent start/stop of the system shall neither result deterioration in performance nor damage to the equipment.	
7.0	The compressors and Air Drying plants shall operate under the following ambient conditions. i. Minimum temperature : 5 deg. C ii. Maximum temperature : 50 deg. C iii. Design condition (Temperature : 40 deg.C & 75% RH) iv. Height above MSL (m) : 82.2 M	
8.0	The condensate drainage system of air compressors & air drying plant must be designed to handle the maximum possible moisture load generated when ambient humidity reaches 85% during monsoon.	
9.0	The compressor capacity & discharge pressure of instrument air system and service air system shall be identical.	
10.0	The heat exchangers are DMCW cooled and the maximum cooling water temperature at compressor coolers inlet shall be 38 deg. C. The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-10 deg C.	
11.0	Noise level shall not exceed 85 dBA to a reference level of 0.0002 microbar when measured at a distance of 1.5 meter above the floor and 1m horizontal distance. Required acoustic enclosures may 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. For eventual noise, from the discharge line, accessories and/or ancillary equipment which are not included, a suitable correction factor may be allowed for background & ambient noise, backup calculation shall be submitted by bidder during detail engineering for approval.	
12.0	Vibration level of screw compressor shall be as per VDI-3836. However, velocity vibration shall be limited to 10 mm/sec (rms). Vibration level of centrifugal compressor shall be as per manufacturer standard & proven practice.	
13.0	Air Compressors (Screw /Centrifugal type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement. As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room. Parallel operation of compressors shall be possible without any undue vibration and noise.	
14.0	The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors/ dryers. Similarly, the flow in cooling water piping shall be designed for the design capacity of each compressor/dryer and the flow in header and ring mains to be designed for the total capacity of working compressors & dryers.	
15.0	All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover by bidder.	
16.0	The canopy shall be designed to cater the load of air filter with 100% choked condition.	
17.0	SCREW AIR COMPRESSORS	
17.1	CODES AND STANDARDS - The design, manufacture, testing and performance of the various components of the rotary screw type air compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727 , ISO-1217 and CAGI).	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure III 1X800 MW UNIT-07 UKAI TPS COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: DEC 2025
17.2	DESIGN AND CONSTRUCTION	
a.)	Design & construction of compressor shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	
18.0	CENTRIFUGAL AIR COMPRESSORS	
18.1	CODES AND STANDARDS - The design, manufacture, testing and performance of air compressors and accessories shall comply with the requirements of one or more of the relevant codes as applicable (IS-2825, IS-4503, CAGI, IS-5727, IS-6206, ASME-PTC-10, API 672 and IS-11727).	
18.2	DESIGN AND CONSTRUCTION	
a.)	Design & construction of compressor shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	
b.)	Each compressor shall be provided with Inlet Guide Vane (IGV) control for suction air volume control.	
c.)	Each compressor shall be provided with coupling guard with fixing arrangement.	
d.)	Proper and robust supporting arrangement shall be provided from foundation/ floor for overhang casing, oil coolers, air piping, cooling water piping, oil piping, etc.	
e.)	Compressors shall be provided with adequate safety, protection control system including anti surge protection with bypass valve etc. and auto dual control (either; controlled for constant pressure or constant volume flow). The duty points shall be at least 15% away from the anti surge line.	
f.)	Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). Compressor shall be provided with IGV at the suction flange.	
19.0	INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW/CENTRIFUGAL)	
19.1	Design & construction of inter cooler, after cooler & oil cooler of compressors, air dryers including external after cooler (as applicable) shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	
20.0	INTAKE AIR FILTER AND SILENCER shall meet the minimum requirement mentioned in the specification	
21.0	AIR DRYING PLANT	
21.1	Design & construction of dryer shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of dryer is also acceptable.	
22.0	CONTROL PHILOSOPHY	
22.1	The CAS supplier shall include controls & instrumentation to facilitate safe, reliable and efficient operation of air compressors, air drying plant & CAS as a whole. The controls, protection, interlock and instrumentation system shall meet the minimum requirements mentioned in the specification and shall be subjected to approval of the BHEL & Customer during post award engineering stage.	
22.2	Whenever the operation of an auxiliary equipment is interlocked with main motor running status, the actual feedback from HT switchgear needs to be considered instead of start/stop command. Proper logging of abnormal conditions should be ensured in compressor system itself with adequate alarms/annunciations on compressor local panel as well as plant DCS. The logged data should be easily retrievable at later stage for any analysis. Control of the compressors should be designed in such a manner it comes to fail safe condition during unhealthy conditions or malfunctioning of any input external to compressor. For example, to save the compressor from further damages, cooling water supplies should not be stopped/ air intake valve should not be closed, if the compressor is running under abnormal condition or proper status feedback from HT switch gear is not available.	
23.0	For Centrifugal compressors , as per OEM recommendation, Start-up air compressor and air dryer along with piping, valves, instruments etc. shall be provided by CAS supplier. Additionally, tapping from instrument air main header shall also be taken and connected to the start-up compressor outlet piping along with valves and instruments and shall be used in case of outage of start-up compressor / dryer.	
24.0	CAS supplier to note that RTD/BTD of HT motor of air compressor shall be terminated to temperature scanner / microprocessor (one for each compressor to be provided by CAS Supplier) mounted on compressor itself. Interlocks and protection for RTD/BTD of compressor motor has to be provided from compressor panel itself.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure III 1X800 MW UNIT-07 UKAI TPS COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: DEC 2025
25.0	Control and Instrumentation – Individual compressor control shall be through compressor mounted microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR. Interface module for the overall control of compressed air system through DDCMIS shall be provided by CAS Supplier.	
26.0	Sequential panel for ensuring equal no. of running hours of each IA & SA set of compressors shall be provided by CAS Supplier.	
27.0	Junction Box for cable termination purpose shall be provided by CAS Supplier.	
28.0	HT motors for Instrument Air and Service Air Compressors, which are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder at its Works. HT motors shall be of BHEL make. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Also, once the motors are delivered at successful bidder's works / factory, any damage to motor shall be bidders' responsibility and rectification work shall be carried by bidder at its own cost. Further insurance of these motors after delivered at bidder's works shall be in bidder scope in line CAS package insurance, as per insurance terms & conditions defined under GCC.	
29.0	Foot cum flange mounted motors shall be of 1500 RPM only. While foot mounted motors shall be 3000/ 1500 RPM.	
30.0	Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors.	
31.0	CAS supplier scope also includes - Pipe supporting structure over the insert plate for pedestal supported pipe, wall supported pipe, insert plate and supporting structure for floor supported pipe. All MS structures for cross overs, valve, instrument, equipment operating and maintenance platform; approach ladder for access to pit/ trench. All Equipment base plate, foundation anchor bolts.	
32.0	Paint required for painting of all items under the package for corrosion protection and to meet color coding required by customer.	
33.0	SCOPE OF SERVICES: Scope of services by CAS supplier shall include but not necessarily limited to the following: 1.) Erection & Commissioning of Compressed Air System (Refer Annexure-B). 2.) Unloading, Storage, handling and transportation at site. 3.) Pre commissioning & Commissioning activities for Compressed Air System. 4.) Trial operation, AMC for storage and Preventive / Breakdown maintenance , PG Test & handover of Compressed Air System.	
34.0	CAS supplier shall terminate compressed air piping at common IA header and common SA header downstream of air receiver closer to pipe rack/pedestal (around 5.0 m from compressor house building).	
35.0	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed socket or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized (in case of Service air pipe) before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.	
36.0	Piping material - For Instrument Air pipelines (including interconnections and fittings) - Stainless Steel pipes as per ASTM A-312 Gr. 304 for Sizes up to 50 NB as per schedule 40 ANSI B36.10 and above 50 NB as per Schedule 10S ANSI B36.10 shall be followed. For Service Air piping - ASTM A53 type E Grade B/ IS 1239 Gr heavy galvanized for sizes upto 150 NB/IS 3589 Gr 410 galvanized for sizes above 150 NB shall be followed. Galvanized shall be to IS- 4736 or equivalent.	
37.0	Piping material - Equipment cooling water: AWW C-200 / ANSI B 36.10 / ASTM A 53, TypeE, Gr. B /IS-1239Heavy /IS-3589 Gr. 410.	
38.0	Valve material - Compressed air application : Cast Carbon Steel body or Forged Carbon Steel valves with SS internals for sizes 65NB & above and Gun Metal valves for sizes upto 50NB. Ball valves shall be provided for compressed air application. Cooling water application : Cast iron valves with GM internals as per IS 780 / equivalent and above 50 mm size. Gunmetal valves as per IS 778 / equivalent up to size 50mm. Gate valves shall be provided for cooling water application.	
39.0	P&ID of CAS and Compressor house layout attached in this annexure are to be read along with this specification and deemed to be included in scope of bidder.	
40.0	Annual maintenance contract (AMC) for Preventive / Breakdown maintenance of Compressed air system (Refer Annexure-A) is in CAS supplier scope.	
41.0	Performance test for compressors shall be carried out at shops with job motor only.	



GUJARAT STATE ELECTRICITY CORPORATION LIMITED

VOLUME - III

**1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE
AREA AT UKAI TPS**

PART - A

BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01

SECTION - 9

TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM

REV. - B

1.00.00 GENERAL

1.01.00 This section covers minimum requirements for design, engineering, manufacture & assembly, inspection, supply, erection, testing commissioning and performance testing of complete COMPRESSED AIR SYSTEM for 1x800 MW pulverized fuel based thermal power plant; to meet well established engineering practices, safety codes and other relevant codes and standards. Plant Compressed Air System will cover the following:

1.01.01 Instrument Air System (IA),

1.01.02 Service Air System (SA)

2.00.00 SYSTEM DESCRIPTION

2.01.00 The plant compressed air system is mainly comprised of instrument air system and service air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while service air is required for general plant services like operation of pneumatic tools, cleaning etc.

2.02.00 Plant compressed air system shall consist of Air Compressors, Air-Drying Plants (ADP), Air Receivers & complete compressed air piping including distribution piping. Compressed air system would cater to the requirements of Instrument Air & Service Air for the complete plant, except as specified.

2.03.00 Instrument air is dehumidified & dried to requisite level before use. Oil free air is required from the compressors especially for instrument air service. The instrument air distribution will be through main header & it will be ensured that sudden leakage in any part of the instrument air lines will not affect instrument air supply to any of the other supply points.

~~2.04.00 Configuration of IA compressors shall be 'N_{IA}' working and one standby, with individual ADP and air receiver for each compressor.~~

2.05.00 The plant service air system will be designed & provided with suitable manifolds to allow adequate discharge points in all operation & maintenance areas.

~~2.06.00 Configuration of SA compressors shall be 'N_{SA}' working and one standby, with individual air receiver for each compressor.~~

2.07.00 Both IA and SA compressors shall be identical.

2.08.00 The compressors shall be so arranged such that each service air compressors shall be able to supply air upstream of each adjacent ADP through an isolation valve and a non-return valve and control valve; so that in the event of failure of instrument air compressor, Service air compressor shall be used as standby IA compressor.

2.09.00 Additional air receivers of adequate capacity shall be provided at different locations based on layout and process requirements.

~~2.09.01 Unit air receivers of min. 10 m³ shall be provided for SG & TG auxiliaries.~~

2.09.02 Dedicated air receiver of min. 2m³ shall be provided for water treatment plant.

~~2.09.03 Dedicated air receiver of min. 5m³ shall be provided for FGD area.~~

Deleted - 2.04.00,
2.06.00, 2.09.01 &
2.09.03



2.10.00 All other compressed air requirement of the plant may be catered from the plant compressed air system.

~~2.11.00 However, if due to layout constrains, additional compressors are required to meet the plant compressed air requirements, 2x100% compressors of adequate capacity with associated ADP (as required), receivers and piping shall be provided to meet the plant requirements.~~

Deleted - 2.11.00

3.00.00 CODES AND STANDARDS

3.01.00 All materials, design, fabrication, manufacture, testing, and installation shall be as per the stipulation of applicable approved International standards so far as they are equal to or more stringent than this specification. In addition to the codes and standard mentioned elsewhere in the specification, the latest edition of following standards and their amendments of any or their approved equivalent shall be followed:

Measurement of air flow for compressor	BS 726
Unfired pressure vessel	IS 2825
Specification for shell & tube type heat exchanger	IS 4503
Testing of Positive Displacement Type Air Compressors and Exhausters	IS 5456
Guide for selection, installation and maintenance of air compressor plants with operating pressure up to 10 bar	IS 6206
Air receivers for compressed air installation	IS 7938
Measurement of air flow of compressors and exhausters by nozzles	IS 10431
Code of practice for compressor safety	
Technical supply conditions for Dynamic compressors	IS 11563
Compressed air dryer	IS 11989
Technical supply condition for air screw compressor	IS 12258
Displacement compressors – Acceptance test	IS/ISO 1217
Turbo-compressors – Performance test code	IS/ISO 5389
Fusion Welded Steel Air Receiver	BS-5169/1975
Compressed Air Dryers – Specification and Testing	ISO-7183 (Part-I)
Compressed Air Dryers – Performance rating	ISO-7183 (Part-II)
Compressed air quality	IS/ISO 8573
Simplified Acceptance Test for Air Compressor and Exhausters	BS-1571
Quality Standard for Instrument air	ISA-S7.0.01
Pressure Vessels	ASME Sec VIII Div 1
Steel Pipes Flanges and Fittings	ANSI-B16.5
Butterfly Valves	BS 5155 / AWWA C 504



GUJARAT STATE ELECTRICITY CORPORATION LIMITED

VOLUME - III

**1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE
AREA AT UKAI TPS**

PART - A

BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01

SECTION - 9

TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM

REV. - B

Diaphragm Valves	BS 5156
Vibration	ISO 7919 / ISO 10816
American Society of Mechanical Engineers	ASME
Compressed Air & Gas Institute	CAGI
Occ. Safety Health Admin.	OSHA
Reputed manufacturers standard	RMS
Tubular Exchanger Manufacturer's Association	TEMA
Verein Deutscher Ingenieure	VDI

4.00.00 GENERAL TECHNICAL REQUIREMENTS

- 4.01.00 The plant shall be designed to meet the complete requirements for a 1x800 MW pulverized fuel based thermal power plant taking into consideration the plant location, environmental conditions, meteorological conditions, available input quality considerations to meet continuous, safe, efficient, economic and reliable working of the complete system for a period not less than 30 years.
- 4.02.00 All the equipment shall be protected against external corrosion by providing suitable painting. The steel surfaces to be supplied with painting shall be thoroughly cleaned before applying painting, by brushing, shot blasting etc. Galvanized surfaces shall not be applied with any painting
- 4.03.00 The system shall be designed for continuous and efficient operation to satisfy the system requirements.
- 4.04.00 Equipment operating on instrument and service air system shall be designed for a pressure of 120% of rated discharge pressure of each compressor.
- 4.05.00 Satisfactory operation in parallel shall be ensured, without any uneven load sharing, undue vibration and keeping noise level within permissible limits for the number of compressors working simultaneously in the same room.
- 4.06.00 Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH) - **Compressor turndown is applicable for Centrifugal compressor only.**
- 4.07.00 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 micron.
- 4.08.00 The instrument air quality shall confirm to ISO-8573, Class-1 purity standard
- 4.09.00 Minimum design requirements are specified herein.
- 4.10.00 **Air Compressors**
- 4.10.01 Type of air compressors shall be oil free, multistage rotary screw / **Oil free** Centrifugal type compressors .
- 4.10.02 Compressor speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.
- 4.10.03 The instrument air compressor should deliver air at 8.5 kg/cm² (minimum) at IA outlet and 8.0 kg/cm² (minimum) at ADP outlet.
- 4.10.04 The service air compressor should deliver air at 8.5 kg/cm² (minimum) at SA compressor outlet.

**Modified - 4.06.00 &
4.10.01**

	GUJARAT STATE ELECTRICITY COPORATION LIMITED	VOLUME - III
	1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE AREA AT UKAI TPS	PART - A
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01	SECTION - 9
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - B

- ~~4.10.05 The compressor sizing shall be duly selected considering, requirement of consumption points, margin for wear & tear losses (5%) & margin for leakages (10%), margin for contingency demand (10%).~~
- 4.10.06 The compressors' capacity will be designed for 40°C DBT and 75% RH at atmospheric pressure at site.
- 4.10.07 Testing of compressor will be as per ISO: 1217.
- 4.10.08 The plant service air compressors should deliver air at the same pressure as that of the instrument air compressors.
- 4.10.09 Service air compressors and instrument air compressors shall be interconnected for flexibility in operation.
- 4.10.10 The continuous motor rating (at 50°C ambient) will be at least ten percent (10%) above the maximum load demand of the driven equipment under the entire operating range. When the driver is not directly coupled to the compressor, due consideration will be made for losses in power transmission, in addition to the above margin.
- 4.10.11 System shall be designed for compressed air velocity of 15 m/sec.
- 4.10.12 Noise level should not exceed 85 dBA when measured at distance of 1.0 meter from compressor and at a height of 1.5 m above the floor. Acoustic enclosure as required shall be provided.
- 4.10.13 Each compressor shall be suitable for single compressor operation or parallel operation with other compressors. Further, the compressor would run either on loaded or unloaded condition depending upon the compressed air requirement without any instability in performance, vibration, noise, pressure fluctuations etc. Variable speed drive to control the loading of compressors is also acceptable, if the proneness of the same is established.
- ~~4.10.14 Compressors shall be sized for the following conditions:~~
- ~~i) Normal operation of unit~~
- ~~ii) Start of unit~~
- ~~4.10.15 Total air requirement shall be assessed as follows:~~
- ~~i) For instrument air requirement~~
- ~~$Z = \{[(A+B) + C + D] \times (1 + mw + ml)\} \times (1 + cd)$~~
- ~~Where;~~
- ~~A = Instrument air requirement of SG & Auxiliaries (including FGD, DeNOx & MRHS)~~
- ~~B = Instrument air requirement of TG & auxiliaries~~
- ~~C = Instrument air requirement of AHP, WTP and all other BoP facilities.~~
- ~~D = Station C&I requirement~~
- ~~mw = wear & tear losses (5%)~~
- ~~ml = margin for leakages (10%)~~

Deleted - 4.10.05,
4.10.14 & 4.10.15



~~cd = margin for contingency demand (10%)~~

~~Z = Total instrument air requirement~~

~~ii) For service air requirement~~

~~$Y = \{[(A+B) + C] \times (1 + mw + ml)\} \times (1 + cd)$~~

~~Where;~~

~~A = Service air requirement of SG & Auxiliaries (including FGD, ESP, DeNOx, & MRHS)~~

~~B = Service air requirement of TG & auxiliaries~~

~~C = Service air requirement of AHP, WTP and all other BoP facilities.~~

~~mw = wear & tear losses (5%)~~

~~ml = margin for leakages (10%)~~

~~cd = margin for contingency demand (10%)~~

~~Y = Total service air requirement~~

~~iii) All regulating/intermittent requirements shall be considered as continuous requirement for purpose of calculation. No diversity factor (i.e. Diversity factor = 1) needs to be considered as they are assumed to be simultaneous requirement.~~

~~iv) Atomising air for LDO firing during start-up shall be considered as continuous requirement.~~

4.10.16 Each compressor shall be selected to meet the higher of the above demand, taking into consideration that IA and SA compressors shall be identical; for interchange-ability and optimisation of spares inventory.

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

4.10.18 The stator (casing) shall be of CI IS 210 FG 260, with integral jacket cooling. Cleaning of jacket during maintenance should be easy.

4.10.19 ROTORS:

i) Rotor will be one-piece construction with a suitable forged carbon steel or stainless steel coated with corrosion resistant material to minimize leakage and wear.

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

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

iv) These gears will be designed to counteract and minimise the axial forces incurred in compression.

v) Rotors shall be dynamically balanced.



- vi) Bearings shall be high precision antifriction type. Minimum operating life of bearing shall be 40,000 hrs.
- 4.10.20 Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 110% of compressor rated BkW at rated conditions.
- 4.10.21 Drive shall be directly coupled, through flexible coupling to squirrel cage induction motor.
- 4.10.22 Safety valves to be provided on low pressure and high pressure stages.
- 4.10.23 CENTRIFUGAL COMPRESSORS (Additional requirements, If centrifugal compressors are being provided):
 - i) Air Compressors shall be oil free centrifugal air compressors with non-contact air/oil seals, each capable of delivering continuously rated volume flows at rated delivery pressure.
 - ii) The rotor shaft shall be made of Stainless Steel. The rotors shall be dynamically balanced to reduce vibration.
 - iii) Any superior material & type (as per proven practice and relevant standard) of various components of compressor is also acceptable.
 - iv) The gaskets shall be of asbestos free material.
 - v) Lubrication system shall be as per manufacturer standard practices.
 - vi) Each compressor shall be provided with Inlet Guide Vane (IGV) control for suction air volume control.
 - vii) Proper and robust supporting arrangement shall be provided from foundation/ floor for overhang casing, oil coolers, air piping, cooling water piping, oil piping, etc.
 - viii) Compressors shall be provided with adequate safety, protection control system including anti surge protection with bypass valve etc. and auto dual control (either; controlled for constant pressure or constant volume flow). The duty points shall be at least 15% away from the anti surge line.
- 4.10.24 INTAKE FILTERS:
 - i) Heavy duty dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the cylinders.
 - ii) Filtering efficiency should be minimum 99% for particles 2 micron or higher.
 - iii) Maximum pressure drop across filter at design flow rate in new condition be 250 mm of Water column.
 - iv) Design Airflow rate corresponding to compressor airflow.
 - v) To be made of densely packed, replaceable type paper as filtering media.
 - vi) Filter to be designed to have sound suppressing characteristics.
 - vii) Preferable filter & silencer should be combined type.
- 4.10.25 Closed circuit DM cooling water system of the plant will be used for cooling in the compressed air system.



4.10.26 INTER COOLER AND AFTER COOLER:

- i) Inter cooler, after cooler & oil cooler shall be of water cooled with shell & tube or plate type heat exchanger, with water on the tube side in case of shell & tube type heat cooler.
- ii) Inter cooler & after cooler shall be designed in accordance with sec. VIII, Div 1 of ASME code or equivalent & TEMA.
- iii) 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. However, plate type oil coolers as per OEM standard & proven design are also acceptable.
- iv) The coolers shall be designed for the maximum heat load & at least 10 % design margin shall be provided in the tubes/plates.
- v) Design pressure in waterside should not be less than shut off head of DM cooling water pump.
- vi) Compressors should be able to work effectively with maximum DMCW inlet temperature of 38°C ~~(indicative)~~.
- vii) Temperature of air at outlet of after cooler shall not exceed 8°C above the DMCW inlet temperature.
- viii) 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 °C. However, the instruments or the pneumatic devices requires air temperature less than 45 °C, the same shall be achieved at the outlet header.
- ix) Shall be designed for easy maintenance.
- x) Adequately sized safety valve shall be provided for both inter cooler & after cooler as per manufacturer practice.
- xi) In case of centrifugal compressors, safety provisions as per manufacturer's standard & proven design are also acceptable.
- xii) Each intercooler & after cooler shall be provided with moisture separator unit, with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.
- xiii) Cooler shells, channels and covers shall be of steel (SA 285Gr or equivalent). Tube sheet shall be of Brass or SS and the tubes shall be of admiralty brass or aluminium brass or copper or SS 304. In case of PHEs plates shall be of SS.

4.10.27 Electrically operated automatic drain trap station with bypass valve & isolation valves shall be provided for moisture separator for automatic draining of condensed moisture. Manual draining facility shall also be provided.

4.10.28 Pulsation damper of approved design shall be provided as required on the compressor suction and discharge manifold.

4.11.00 **Air Drying Plant (ADP)**

4.11.01 Air-drying plant shall be of 'Heat of Compression (HoC)' desiccant type (conventional or rotary drum type), drying by adsorption process through a desiccant medium. 'Open Through (Blower reactivated)' type is also acceptable.



- 4.11.02 Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant -
- In case of 'HoC' type ADP, the reactivation of desiccant will be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber.
 - In 'Open Through' type ADP, for regeneration of desiccant, atmospheric air shall be filtered, heated through an electric heater and passed through the desiccant before exhausted to atmosphere. The reactivated desiccant shall be cooled through same atmospheric air without heater in operation.
- 4.11.03 In case of twin tower dryers –
- The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying.
 - The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant for both the types of ADP.
 - After this period (reactivation cycle), the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty.
 - The change of drying mode to reactivation mode or vice-versa shall be automatic with provision for manual operation also. The change over from one mode to another shall be through automatic solenoid operated valves.
- 4.11.04 The adsorber tower shall be designed with sufficient cross-sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Persplex" for observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.
- 4.11.05 Air drying plant receiving compressed air saturated with moisture, shall be capable of operating continuously to provide reliable moisture free compressed air, without any air purge loss. For calculating moisture load, relative humidity and DBT at ADP inlet shall be taken as 100% & 50°C respectively.
- 4.11.06 Design temperature shall be 60°C.
- 4.11.07 Quality of outlet air from ADP shall be in accordance to ISO 8573-1, class 1 as follows:
- Dew point at outlet of the air drying plant will be minus (-) 40°C at atmospheric pressure.
 - Dust particle size in instrument air shall be less than One (1) micron & max, particle concentration limited to 1mg/m³.
 - Oil content of Instrument air shall be less than 0.01 mg/m³.
 - Contaminants – No corrosive hazardous, toxic or flammable materials.
- 4.11.08 Nominal flow rate shall be 1.2 times of compressor capacity
- 4.11.09 Desiccant shall be silica gel / activated alumina as per manufacturer's standard.

	GUJARAT STATE ELECTRICITY COPORATION LIMITED	VOLUME - III
	1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE AREA AT UKAI TPS	PART - A
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01	SECTION - 9
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - B

- 4.11.10 Desiccant shall be activated alumina only and adsorption capacity and density of the same shall not be more than 8% and 900 kg/m³ respectively.
- 4.11.11 Material of Construction (MOC) of rotary drum type HOC dryer shall be as per reputed manufacturer standard.
- 4.11.12 Thermal insulation should be provided for all hot pipelines and vessels
- 4.11.13 Prefilter and after filter (for twin tower type ADP)
- The 2x100% pre-filters shall remove dust, water, and oil drops and shall protect the air dryers. Pre-filters shall be of the coalescing type.
 - The 2x100% after-filters shall be dry type and shall remove particulates in the range of 1 to 5 microns.
 - The filtering media shall be of ceramic candle type elements, designed to withstand at least 50% of static pressure as differential pressure.
 - However, as per manufacturer's standard & proven design, any superior material to the material specified is also acceptable.
 - The pre- filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.
- Note: The requirement of pre-filter & after filter is applicable to conventional twin tower type of HOC dryer. Same is not applicable for Rotary drum type HOC dryer.
- 4.11.14 Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.
- 4.11.15 For HoC, Adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle time and quality of air (dew point) shall be maintained throughout the design cycle period.
- 4.11.16 Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided.
- 4.11.17 All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers / coolers etc associated with ADP shall be designed in accordance with Section VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketed manholes/handholes and relief valves.
- 4.11.18 Air drying pant shall be suitable for part load operation while maintaining the outlet air dew point as specified herein.
- 4.11.19 Dew point measurement shall be provided at each ADP outlet and also at IA header after receivers.
- 4.11.20 Required no. of sampling connections should be provided.
- 4.12.00 **Air Receiver**
- ~~4.12.01 The minimum capacity of each air receiver shall be 10 M³ (nominal), 5 M³ (nominal) & 2 M³ (nominal) as per requirement.~~

Deleted - 4.12.01



~~4.12.02 Each air receiver shall be so sized that even in the event of total stoppage of air flow from the compressors, the pressure in the receiver shall not fall below 5.5kg/cm² within two (2) minutes of such stoppage, while maintaining an outflow of air at a rate equal to the rated capacity of one compressor, during such period.~~

4.12.03 In no case, the size of each air receiver be less than that is arrived from IS 7938.

4.12.04 Air receivers shall be designed for outdoor service

4.12.05 Design code: ASME Sec. VIII Div I or IS 2825. Corrosion allowance of minimum 3mm shall be considered.

4.12.06 The air receivers will be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.

4.12.07 Air receivers shall be designed for minimum 1.5 times compressor discharge pressure {13 kg/cm² (g)} and 50°C respectively.

4.12.08 The material of construction of shell, dished ends, flanges etc of the air receivers shall be of carbon steel IS 2062 or equivalent.

4.12.09 Moisture trap & Auto drain for each air receiver shall be provided.

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

4.12.11 In addition to above, each air receiver shall be provided with –

- i) Drain connection with electrically/pneumatically operated auto drain trap arrangement,
- ii) Isolation valves at inlet and outlet,
- iii) Check valves at inlet and outlet,
- iv) Bypass valve.
- v) Safety valve

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

4.12.13 Adequate no. of air receivers shall be provided at various locations based on layout and system requirement. Capacity of these air receivers shall be adequate to meet to meet their intended requirement.

4.13.00 Piping and Valves

4.13.01 Compressed air piping shall be designed for the maximum anticipated flow requirements, with air velocity of 15 m/s.

4.13.02 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs. Compressor piping should have 1-2 degree slope in order for the pipe to drain condensation easily.

Deleted - 4.12.02



- 4.13.03 The pressure drop in the compressor pipeline up to air receiver should not exceed 5% of the preset pressure of the air compressor. Pipe diameters should be selected accordingly.
- 4.13.04 Branch connections must be top take-off type as far as possible.
- 4.13.05 Drain valve and globe valve should be installed at the end of the main pipeline / headers at the lowest point.
- 4.13.06 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation.
- 4.13.07 Moisture traps & Auto drains shall be provided at all strategic locations/points, including the distribution network. Y-strainer of min. 20 mesh screen of stainless steel shall be provided before each trap.
- 4.13.08 Ring header shall be provided around the plant.
- 4.13.09 (a) All interconnecting **Service** air piping shall conform to ASTM A 53 Type-E, Gr. B or IS-1239 heavy, galvanized / IS 3589 Gr 410; galvanized to IS- 4736 or equivalent. The fitting shall either be same as the parent material or malleable iron to IS-1879 (galvanized). In case thickness calculated is more than heavy grade, suitable schedule as per ANSI B 36.10 shall be followed.
- 4.13.10 Compressed air piping from air compressor to after cooler and other lines handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg. C.
- 4.13.11 The pipe joints will be screwed coupling type for sizes up to 50 NB and above 50 NB the same will be welded/flanged. All pipe lines shall have butt welded connections with minimum flange joint connections to valves, vessels and equipment.
- 4.13.12 All the distribution valves shall be ball valve type. Isolation valve with quick (hose) coupling shall be provided at all Service Air tapping/discharge points.
- 4.13.13 Water Piping shall be AWW C-200 / ANSI B 36.10 / ASTM A 53, Type-E, Gr. B / IS-1239Heavy /IS-3589 Gr.410.
- 4.13.14 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed on flanges also.
- 4.13.15 Rubber lined pipes shall be with flanged connection.
- 4.13.16 Teflon sealant tapes shall be used for threaded joints.
- 4.13.17 Selection of Valves shall be as follows:
- i) Compressed Air Service:
- a) For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.
- b) All airline valves shall be ball valve type. For compressed air application, valve material shall be with SS304 internals.

4.13.09(b) For Instrument Air piping - Stainless Steel as per ASTM A-312 Gr. 304 for Sizes up to 50 NB as per schedule 40 ANSI B36.10. and above 50 NB as per Schedule 10S ANSI B36.10. shall be followed

Added: 4.13.09(b)



- ii) For Water Service: Cast iron valves with GM internals as per IS-780 / equivalent and other applicable standards above 50 mm size. Gunmetal valves as per IS-778 / equivalent up to size 50mm.

4.14.00 **Layout Considerations**

- 4.14.01 Compressor house can be steel framed structure with brick wall up to windowsill height & single skin metal panel cladding above it.
- 4.14.02 Adequate access and space shall be provided for maintenance of all equipment.
- 4.14.03 Clear gap of min. 800mm shall be provided between equipment, taking into consideration all piping and structures.
- 4.14.04 Clear access should be provided to all equipment.
- 4.14.05 Access / ladder and platform shall be provided for maintenance of receiver instruments.
- 4.14.06 Adequate lay down area and maintenance space shall be considered in the maintenance bay.
- 4.14.07 Layout should be such that equipment can be easily handled and shifted for maintenance. Necessary maintenance access will be provided in the layout.
- 4.14.08 Easy approach for vehicles to handle the equipment near maintenance bay shall be provided.
- 4.14.09 Easy access to shift material and equipment to and from the building should be provided
- 4.14.10 Air compressors will be installed indoor in a separate compressor room. Air compressor room should be located away from dusty, high temperature & high humidity environment. Especially fresh air inlet to compressor house/compressors shall be from a dust free area.
- 4.14.11 The compressor house can be located at the ground floor of service building. Necessary sound proofing shall be provided on the roof and walls of the compressor room.
- 4.14.12 SG US EOT crane arrangement will be provided so that the heaviest component can be handled during maintenance.
- 4.14.13 The air receivers will be located outdoors adjacent to the compressor room.
- 4.14.14 Complete ADP equipment shall be located indoor and preferably mounted on a skid.

5.00.00 **PERFORMANCE GUARANTEE REQUIREMENT**

Description/Parameter	Unit	Values
Free Air Delivery	Nm ³ /min	As per system requirement and approved by owner/consultant during detailed engineering
Discharge pressure of compressor air system at various locations	kg/cm ² (g)	As per system requirement and approved by owner/consultant during detailed engineering
Power Consumption	kW	As per system requirement and



		approved by owner/consultant during detailed engineering
Volumetric and overall efficiency of machine		As per approved standards
Dew Point tests to be carried out on Air Drying Plant		As per approved standards
Vibration & noise level of rotating equipments		As per approved standards

6.00.00 OPERATION AND CONTROL PHILOSOPHY

6.01.00 Plant Compressed Air System

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

6.01.02 Individual compressor control shall be through microprocessor based control system as per manufacturer's standard and overall control of compressed air system shall be through BOP C&I part of DDCMIS.

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

- i) Local Mode: Individual compressor is operated from Local Integral Control System.
- ii) Remote Mode: Individual compressor is operated through DDCMIS OWS.

6.01.04 Group Control is envisaged to clock more or less equal number of running hours for each Instrument Air Compressor. Due to this feature in case of increase in air demand, the Unit which had clocked least no. of running hours shall be started and loaded. Similarly when the air demand goes down, the Unit which had clocked most no. of running hours shall be unloaded and stopped.

6.01.05 All the process inputs (digital or analog), other than specific to compressors shall be taken directly to DDCMIS; especially -

- i) Status of each compressor
- ii) IA pressure, high/low
- iii) SA pressure, high/low
- iv) Status of each ADP
- v) Dew point of IA

6.01.06 The connectivity of Integral compressor control system with DDCMIS shall be provided through Hardwired / Soft link depending upon manufacturer's product standard.

6.01.07 Hardwired connectivity shall be provided for critical/Start/Stop signal for IA & SA compressor.

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

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE AREA AT UKAI TPS	PART - A
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01	SECTION - 9
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - B

- 6.01.09 Auto sequence operation of instrument air compressors & service air compressors has been envisaged through an OEM standard micro-controller located at compressor house. Instruments required shall be provided to meet auto sequencing operation & instruments shall be provided during detail engineering with vendor drawing / documents.
- 6.01.10 Inter changeability of service air compressor to instrument air compressor in case of emergency shall be automatic.
- 6.01.11 The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor:
- "Air temperature high" at inlet to last stage Alarm & trip
 - "Low lube oil pressure" Alarm & trip
 - "High Lube oil supply temperature" Alarm & trip
 - "High oil filter differential pressure" Alarm
 - "Low lube oil level in lube oil sump" Alarm
 - "High inlet air filter differential pressure" Alarm & trip
 - "Low cooling water flow to air compressor" Alarm
 - "High Air drying plant differential pressure" - Alarm
 - "Low cooling water flow at return line of compressor" - Alarm
 - "Low cooling water inlet header pressure"-Alarm
 - "Low air pressure at discharge line of each compressor" – Alarm
- 6.01.12 High DP (differential pressure) across filters (for each filter) – Alarm
- 6.01.13 Additional signals to be provided for monitoring purpose:
- IA header pressure - High/Low
 - SA header pressure - High/Low
 - Dew point - high
- 6.01.14 Each compressor shall be provided with a microprocessor based controller/regulator
- 6.01.15 All protections and interlocks should be programmed in the controller/regulator
- 6.01.16 The controller/regulator unit shall be integral with display, LED indications, start/stop buttons, scroll keys, tabulator keys, function keys etc.
- 6.01.17 Function keys shall be used for the following:
- To manually load/unload the compressors
 - To reset the machine
 - To have an access to all data collected by the Regulator
 - To call up or to programme settings



6.01.18 To facilitate programming and controlling the compressor, menu driven programmes shall be in the controller/regulator. Menu shall have access to the following:

- i) Main Screen – Should show the operating status of the compressor, including the following information about:
 - a) Auto / manual mode operation
 - b) Local / remote control operation
 - c) Discharge air pressure of the unit at this point in time
 - d) Time based start / stop function is active or not
- ii) Status Data – Gives information regarding protection functions, including the following information about:
 - a) Status of any existing Warning
 - b) Status of any Shut-down reason
 - c) Service warning
- iii) Measured Data
- iv) Counters
- v) Modify Parameters
- vi) Service alerts
- vii) Retrieve saved data

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

6.01.20 Unless otherwise mentioned in the relevant electrical part/section, automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.

~~7.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED~~

~~7.01.00 Drawings and Documents to be Submitted with the bid~~

~~7.01.01 Write up on compressed air system~~

~~7.01.02 Filled in Data Sheet B~~

~~7.02.00 Drawings and Documents to be Submitted after Award of Contract~~

~~7.02.01 Design basis report/Design Memorandum of Plant Compressed Air System~~

~~7.02.02 Instrument air requirements for various systems~~

~~7.02.03 Sizing Calculation for Compressed Air System~~

~~7.02.04 Control Philosophy of Compressed Air System~~

~~7.02.05 Bill of quantities for compressed air system~~

~~7.02.06 Technical Data Sheets of Compressors~~

Deleted - 7.00.00



GUJARAT STATE ELECTRICITY COPORATION LIMITED

VOLUME - III

1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE
AREA AT UKAI TPS

PART - A

BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01

SECTION - 9

TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM

REV. - B

8.00.00 DATA SHEET – A (FILLED DATA SHEETS)

8.01.00 Compressor

Sr. No.	Item	Unit	Requirement	
8.01.01	Type of Compressor		High efficiency, Oil Free, Screw/ Centrifugal	
8.01.02	Quantity	Nos.	Instrument Air ~~N_{IA} Working + one (1) Standby~~	Service Air ~~N_{SA} Working + one (1) Standby~~
8.01.03	Capacity (each)	Nm ³ /min	~~Adequate (min 45)~~	
8.01.04	Discharge pressure at rated condition at after cooler outlet.	kg/cm ² (g)	8.5	
8.01.05	Discharge pressure of instrument air at ADP outlet	kg/cm ² (g)	8	
8.01.06	Location		Indoor, Compressor House	
8.01.07	Testing Standard		ISO 1217	
8.01.08	Cooling		Water cooled. Water from DMCW network.	
8.01.09	Maximum outlet air temperature after high pressure stage of compressor at design capacity	Deg C	160-220	
8.01.10	Maximum outlet air temperature after cooler or Plant air system	Deg C	45	
8.01.11	Maximum Cooling water pressure drop	Bar	1	
8.01.12	Cooling water line design pressure	Bar	10	
8.01.13	Regeneration Air Temperature	Deg C	160-220	
8.01.14	Compressor chamber casing		Cast iron with corrosion resistant coating	
8.01.15	Rotors		Forged Carbon Steel with special coating	
8.01.16	Timing gears		Low alloy steel	
8.01.17				
8.01.18	Noise Level	dB(A)	85 dB (A)	
8.01.19	Type of drive		High Efficiency, Electric Motor(~~with VSD~~)	
8.01.20	Air quality		As per ISO 8573-1 Class 1	

8.02.00 Air Receiver

Sr. No.	Item	Requirement
8.02.01	Number of receivers (min.)	~~As per system requirement. However min.~~



GUJARAT STATE ELECTRICITY CORPORATION LIMITED

VOLUME - III

**1X800MW ULTRA SUPER CRITICAL UNIT NO.# 7 ON ASH DYKE
AREA AT UKAI TPS**

PART - A

BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT #7-TS-01

SECTION - 9

TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM

REV. - B

		~~requirement is as below:~~ ~~1 no. for each compressor (min. 10m³)~~ ~~1 no. for unit (min. 10m³)~~ ~~1 no. for FGD (min. 5m³)~~ ~~2nos. for AHP (min. 5m³)~~ ~~1 no. WTP (min. 2m³)~~
8.02.02	Location	Outdoor
8.02.03	Design pressure & temperature	Minimum 1.5 times compressor discharge pressure (or 12.75kg/cm ² (g) minimum) / 50°C(minimum)
8.02.04	Design code	ASME Sec-VIII or IS-2825/IS-7938
8.02.05	Material of construction of shell plate, flange covers and manhole necks (if not seamless)	ASTM A36 / ASTM A516 Grade 60 or IS 2062
8.02.06	Nozzles and seamless manhole necks	ASTM A53 Grade B / ASTM A106 Grade B or IS 1239 Heavy / IS 3589 Gr. 410
8.02.07	Corrosion allowance (min.)	3 mm
8.02.08	Inspection Manhole	Yes (min. 600 mm dia.)

8.03.00 Piping Valves and Fittings

Sr. No.	Item	Requirement
8.03.01	Design Code	ANSI B 31.1
8.03.02	Piping material	ASTM A53 type E Grade B / IS 1239 heavy grade ERW up to 150 mm / IS 3589 Gr. 410 above 150mm, galvanized as per IS 4736
8.03.03	Fittings	A 105/A 234 Gr. WPB, galvanised or as compatible with the pipe material
8.03.04	Valves	Cast Steel/Forged Steel body with SS/GM internals as per BIS/BS/ASTM standards& as specified
8.03.05	Joints	Threaded / screwed sockets/unions/flanged

**GUJARAT STATE ELECTRICITY CORPORATION LIMITED**

VOLUME - II

**1x800 MW ULTRA SUPERCRITICAL UNIT NO. #7ON ASH DYKE
AREA AT UKAI TPS**

SECTION - 2

BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT# 7-TS-01

LEAD TECHNICAL SPECIFICATION

REV. - A

- x) Necessary lifting equipments (Chain pulley blocks, manual/electrical hoist, cranes) of adequate capacity and type for maintenance of the equipments wherever required.

2.16.07 CIRCULATING WATER SYSTEM

Supplies and services under CW system are as follows:

- i) CW Channel, Fore-bay and CW Pump House
- ii) 3 x 50% Circulating Water Pumps along with drive motors, discharge piping, valves, hydraulic packs, rubber expansion joints, etc.
- iii) 1 no. Start-up ACW pump of adequate capacity & head.
- iv) Stop log gates and Screens as required for the pumps.
- v) 3 X 50% Auxiliary Cooling Water (Booster) Pumps along with drive motors, discharge piping, valves, electric actuators, REJs etc.
- vi) 2x100% Automatic self-cleaning filters in the ACW circuit.
- vii) Complete CW & ACW system piping
- viii) CW model studies
- ix) CW transient analysis
- x) CW treatment systems as per technical specification
- xi) All integral and interconnecting piping including pipe fittings, valves, stubs for instrumentation, pipe supports, specialities etc.

2.16.08 COMPRESSED AIR SYSTEM**i) Compressors**

- ~~a) 'N_{IA}' Working + one (1) Standby skid mounted, oil free, water cooled, rotary screw or centrifugal compressors of adequate capacity and discharge pressure to meet instrument air (IA) requirements of the complete 1x800 MW power plant, except CHP dust suppression system & AHP.~~
- ~~b) 'N_{SA}' Working + one (1) Standby skid mounted oil free, water cooled, rotary screw or centrifugal compressors of adequate capacity and discharge pressure to meet service air (SA) requirements of the complete 1x800 MW power plant, except AHP.~~
- c) Compressors shall include the following minimum accessories:
 - 1) Air intake filters
 - 2) Silencer
 - 3) Inter cooler for multi-stage compressor complete with trap station with bypass arrangement.
 - 4) After cooler complete with trap station with bypass arrangement.
 - 5) Sound proof enclosure

Deleted- 2.16.08(i)a &b

ii) *Air Drying Plant*

- a) ~~'N/A' Working + one (1) Standby~~ Heat of Compression (HOC) Rotary drum type or conventional twin tower type air-dryers (with specified margin), to match instrument air compressor capacity, along with all accessories including control panel, flow meter, online digital dew point meter at the outlet of each dryer, etc. 'Open through (Blower reactivated)' type ADP is also acceptable.
- b) A dew point analyzer shall be installed at the discharge of each air dryer to monitor the quality of instrument air delivered from the system.
- c) Air drying plants will be interconnected with operation of selection valves from DCS

iii) *Air Receivers*

- a) Air receivers ~~of minimum 10m³ capacity~~ to hold air and minimize pressure fluctuations for each compressor near compressor house.
- ~~b) Additional air receivers of similar/adequate capacity shall be provided at different locations shall be provided based on layout, process requirements and as specified.~~
- c) Instrument air and service air receivers shall be provided along with all accessories such as pressure gauges, safety relief valves, electronic type auto drain traps, manual isolation / blow off auto drain valves, bypass control valve, fittings, temperature indicators, transmitters, etc.
- d) Air receivers shall also be interconnected with operation of selection valves from DCS

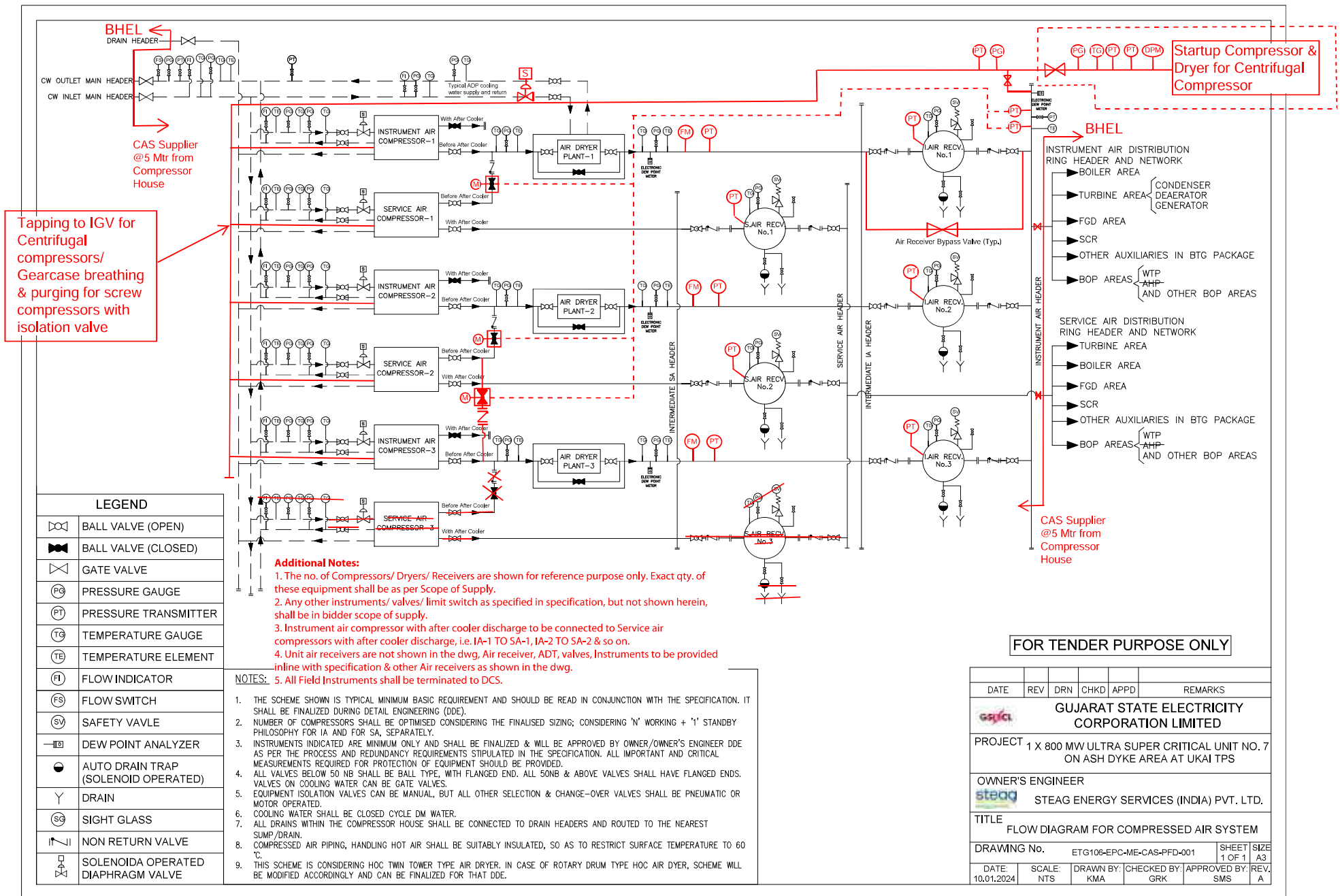
iv) *Miscellaneous*

- a) Complete piping (integral and interconnecting), fittings, couplings, expansion joints, valves, gates and supports/hangers, required for the plant compressed air system including distribution network and ring header.
- b) Isolation valves for individual equipments
- c) Cooling water system
- d) All filters/strainers, intermediate and terminal air receivers, etc.
- e) Under-slung EOT cranes to handle all equipments in the system.
- f) Complete instrumentation required for both local and remote monitoring, process control and performance evaluation for all process parameters.

~~2.16.09 AIR CONDITIONING AND VENTILATION SYSTEM~~~~i) Air Conditioning for Main Plant and Control Building~~

- ~~a) 1x100% Vapour absorption machine (working) and 1 x 100% Screw chilling machine (standby) complete with all accessories as described here in after.~~
- ~~b) 1 no. of PRDS for regulating the steam parameter as per VAM operating requirement.~~

Deleted -
2.16.08(iii)(b)



(M) MOTORIZED VALVE
(FM) FLOW METER

INSTRUMENT AIR COMPRESSOR	500KW	-----	S	2	1	C	U	N	C	Motor	15-20SEC	*						Refer notes	
SERVICE AIR COMPRESSOR #	500KW	-----	S	2	0	C	U	N	C	Motor	15-20SEC	*						(i), (ii) and (iii).	
AIR DRYER (INCL. HEATER)	9KW	-----	S	2	1	E	D	N	C	Panel	-----	*							
IA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*						DG SUPPLY	
SA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*							
UPS SUPPLY FOR MICROPROCESSOR PANELS & SEQUENTIAL PANEL	7.5KW	-----	S	1	1	D	S	N	C	Panel	-----	*						230VAC UPS	BY C&I
RECEIVER DRAIN ADT	0.5KW	-----	S	7	0	E	S	N	I	ADT	-----	**							
AFTER COOLER DRAIN ADT	0.5KW	-----	S	-	-	E	S	N	I	ADT	-----	*						(Qty. as applicable)	
UTILITY COMPRESSOR FOR CENTRIFUGAL COMPPRESSOR	9KW	-----	S	1	0	D	S	N	I	Motor	5 SEC	*							
UTILITY DRYER FOR CENTRIFUGAL COMPPRESSOR	1KW	-----	S	1	0	D	S	N	I	Panel	-----	*							
MOTORISED VALVE	1KW	-----	S	3	0	D	B	N	I	ACTUATOR	-----	*							

NOTES:

- 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) Suitable protection shall be included in the HT Switchgear logic to prevent frequent start stop of the compressor HT motors.**
- * - Compressor House.**
- ** - 5 nos. outside Compressor House, 1 no. for TG Area, 1 no. in DM Plant Area.**

Service Air Compressor will be 1 Working + 1 Standby during Normal Operation but During Start-up both Service Air Compressor will be in Working condition.

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
 SPECIFIC TECHNICAL REQUIREMENTS Annexure IV: 2x660 MW MAHAGENCO Koradi		

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure III 2X660 MW UNITS-11 & 12 KORADI TPS	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: Dec. 2025
	COMPRESSED AIR SYSTEM	
	SPECIFIC TECHNICAL REQUIREMENT - MECHANICAL	
1.0	The compressed air system shall consist of Instrument Air compressors, Air Drying Plants (ADPs), Service Air compressors, Air receivers, interconnecting compressed air piping, cooling water piping, drain piping, fittings, valves, instruments, compressor & dryer inbuilt microprocessor control panels, sequential panel in the compressor house.	
2.0	Three (03) numbers (2 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for instrument air duty for the complete plant each of 53Nm ³ /min. capacity & 8.5 kg/cm ² (g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works.	
3.0	Three (03) numbers (2 working+ 1 standby) Air Drying Plants (one for each instrument air compressor) of 63.6 Nm ³ /min. capacity with all interconnecting piping, valves, fittings, etc. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 deg C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". Discharge pressure available at the outlet of Air drying Plant shall be minimum 8.0 Kg/cm ² (g).	
4.0	Three (03) numbers (2 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for service air duty for the complete plant each of 53Nm ³ /min. capacity & 8.5 kg/cm ² (g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works. 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.	
5.0	Air Receivers a.) 15.0m ³ capacity air receivers, total Six (6) numbers to be provided, one for each instrument air & service air compressor, located outside compressor house. b.) 10.0M ³ capacity air receivers, total Two (2) numbers to be provided, one for each unit, located in TG building in B-C bay. c.) 5.0m ³ capacity air receiver, total One (1) number to be provided for FGD located near Absorber area.	
6.0	All the equipments shall be designed for continuous duty as well as for intermittent operation. Frequent start/stop of the system shall neither result deterioration in performance nor damage to the equipment.	
7.0	The compressors and Air Drying plants shall operate under the following ambient conditions. i. Minimum temperature : 10 deg. C ii. Maximum temperature : 50 deg. C iii. Design condition (Temperature : 40 deg.C & 75% RH) iv. Height above MSL (m) : 304.75 M	
8.0	The condensate drainage system of air compressors & air drying plant must be designed to handle the maximum possible moisture load generated when ambient humidity reaches 85% during monsoon.	
9.0	The compressor capacity & discharge pressure of instrument air system and service air system shall be identical.	
10.0	The heat exchangers are DMCW cooled and the maximum cooling water temperature at compressor coolers inlet shall be 38 deg. C. The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-10 deg C.	
11.0	Noise level shall not exceed 85 dBA to a reference level of 0.0002 microbar when measured at a distance of 1.5 meter above the floor and 1m horizontal distance. Required acoustic enclosures may 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. For eventual noise, from the discharge line, accessories and/or ancillary equipment which are not included, a suitable correction factor may be allowed for background & ambient noise, backup calculation shall be submitted by bidder during detail engineering for approval.	
12.0	Vibration level of screw compressor shall be as per VDI-3836. However, velocity vibration shall be limited to 10 mm/sec (rms). Vibration level of centrifugal compressor shall be as per manufacturer standard & proven practice.	
13.0	Air Compressors (Screw /Centrifugal type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement. As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room. Parallel operation of compressors shall be possible without any undue vibration and noise.	
14.0	The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors/ dryers. Similarly, the flow in cooling water piping shall be designed for the design capacity of each compressor/dryer and the flow in header and ring mains to be designed for the total capacity of working compressors & dryers.	
15.0	All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover by bidder.	
16.0	The canopy shall be designed to cater the load of air filter with 100% choked condition.	
17.0	SCREW AIR COMPRESSORS	
17.1	CODES AND STANDARDS - The design, manufacture, testing and performance of the various components of the rotary screw type air compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727, ISO-1217 and CAGI).	
17.2	DESIGN AND CONSTRUCTION	
a.)	Design & construction of compressor shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure III 2X660 MW UNITS-11 & 12 KORADI TPS	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec. 2025
	COMPRESSED AIR SYSTEM	
18.0	CENTRIFUGAL AIR COMPRESSORS	
18.1	CODES AND STANDARDS - The design, manufacture, testing and performance of air compressors and accessories shall comply with the requirements of one or more of the relevant codes as applicable (IS-2825, IS-4503, CAGI, IS-5727, IS-6206, ASME-PTC-10, API 672 and IS-11727).	
18.2	DESIGN AND CONSTRUCTION	
a.)	Design & construction of compressor shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	
b.)	Each compressor shall be provided with Inlet Guide Vane (IGV) control for suction air volume control.	
c.)	Each compressor shall be provided with coupling guard with fixing arrangement.	
d.)	Proper and robust supporting arrangement shall be provided from foundation/ floor for overhang casing, oil coolers, air piping, cooling water piping, oil piping, etc.	
e.)	Compressors shall be provided with adequate safety, protection control system including anti surge protection with bypass valve etc. and auto dual control (either; controlled for constant pressure or constant volume flow). The duty points shall be at least 15% away from the anti surge line.	
f.)	Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). Compressor shall be provided with IGV at the suction flange.	
19.0	INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW/CENTRIFUGAL)	
19.1	Design & construction of inter cooler, after cooler & oil cooler of compressors, air dryers including external after cooler (as applicable) shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	
20.0	INTAKE AIR FILTER AND SILENCER shall meet the minimum requirement mentioned in the specification	
21.0	AIR DRYING PLANT	
21.1	Design & construction of dryer shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of dryer is also acceptable.	
22.0	CONTROL PHILOSOPHY	
22.1	The CAS supplier shall include controls & instrumentation to facilitate safe, reliable and efficient operation of air compressors, air drying plant & CAS as a whole. The controls, protection, interlock and instrumentation system shall meet the minimum requirements mentioned in the specification and shall be subjected to approval of the BHEL & Customer during post award engineering stage.	
22.2	Whenever the operation of an auxiliary equipment is interlocked with main motor running status, the actual feedback from HT switchgear needs to be considered instead of start/stop command.	
	Proper logging of abnormal conditions should be ensured in compressor system itself with adequate alarms/annunciations on compressor local panel as well as plant DCS. The logged data should be easily retrievable at later stage for any analysis.	
	Control of the compressors should be designed in such a manner it comes to fail safe condition during unhealthy conditions or malfunctioning of any input external to compressor. For example, to save the compressor from further damages, cooling water supplies should not be stopped/ air intake valve should not be closed, if the compressor is running under abnormal condition or proper status feedback from HT switch gear is not available.	
23.0	For Centrifugal compressors, as per OEM recommendation, Start-up air compressor and air dryer along with piping, valves, instruments etc. shall be provided by CAS supplier. Additionally, tapping from instrument air main header shall also be taken and connected to the start-up compressor outlet piping along with valves and instruments and shall be used in case of outage of start-up compressor / dryer.	
24.0	CAS supplier to note that RTD/BTD of HT motor of air compressor shall be terminated to temperature scanner / microprocessor (one for each compressor to be provided by CAS Supplier) mounted on compressor itself. Interlocks and protection for RTD/BTD of compressor motor has to be provided from compressor panel itself.	
25.0	Control and Instrumentation – Individual compressor control shall be through compressor mounted microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR. Interface module for the overall control of compressed air system through DDCMIS shall be provided by CAS Supplier.	
26.0	Sequential panel for ensuring equal no. of running hours of each IA & SA set of compressors shall be provided by CAS Supplier.	
27.0	Junction Box for cable termination purpose shall be provided by CAS Supplier.	
28.0	HT motors for Instrument Air and Service Air Compressors, which are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder at its Works. HT motors shall be of BHEL make. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Also, once the motors are delivered at successful bidder's works / factory, any damage to motor shall be bidders' responsibility and rectification work shall be carried by bidder at its own cost. Further insurance of these motors after delivered at bidder's works shall be in bidder scope in line CAS package insurance, as per insurance terms & conditions defined under GCC.	
29.0	Foot cum flange mounted motors shall be of 1500 RPM only. While foot mounted motors shall be 3000/ 1500 RPM.	
30.0	Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors.	
31.0	CAS supplier scope also includes - Pipe supporting structure over the insert plate for pedestal supported pipe, wall supported pipe, insert plate and supporting structure for floor supported pipe. All MS structures for cross overs, valve, instrument, equipment operating and maintenance platform; approach ladder for access to pit/ trench. All Equipment base plate, foundation anchor bolts.	
32.0	Paint required for painting of all items under the package for corrosion protection and to meet color coding required by customer.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure III 2X660 MW UNITS-11 & 12 KORADI TPS	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec. 2025
	COMPRESSED AIR SYSTEM	
33.0	SCOPE OF SERVICES: Scope of services by CAS supplier shall include but not necessarily limited to the following: 1.) Erection & Commissioning of Compressed Air System (Refer Annexure-B). 2.) Unloading, Storage, handling and transportation at site. 3.) Pre commissioning & Commissioning activities for Compressed Air System. 4.) Trial operation, AMC for storage and Preventive / Breakdown maintenance , PG Test & handover of Compressed Air System.	
34.0	CAS supplier shall terminate compressed air piping at common IA header and common SA header downstream of air receiver closer to pipe rack/pedestal (around 5.0 m from compressor house building).	
35.0	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed socket or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.	
36.0	Piping material - Compressed air (Instrument & service air) - ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.	
37.0	Piping material - Equipment cooling water - IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410 /IS-1239 Heavy.	
38.0	MOC of Valves for Compressed air & DM Cooling water: Cast Carbon Steel body valves with SS internals for sizes 65NB & above and Forged Carbon Steel/ Gun Metal valves for sizes upto 50NB. Ball valves shall be provided for compressed air application and gate valves for cooling water application.	
39.0	P&ID of CAS and Compressor house layout attached in this annexure are to be read along with this specification and deemed to be included in scope of bidder.	
40.0	Annual maintenance contract (AMC) for Preventive / Breakdown maintenance of Compressed air system (Refer Annexure-A) is in CAS supplier scope.	
41.0	Performance test for compressors shall be carried out at shops with job motor only.	

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

1.00.00 GENERAL

1.01.00 This section covers minimum requirements for design, engineering, manufacture & assembly, inspection, supply, erection, testing commissioning and performance testing of complete Compressed Air System for 2x 660 MW pulverized fuel based thermal power plant; to meet well established engineering practices, safety codes and other relevant codes and standards. Plant Compressed Air System will cover the following:

1.01.01 Instrument Air System (IA),

1.01.02 Service Air System (SA)

2.00.00 SYSTEM DESCRIPTION

2.01.00 The plant compressed air system is mainly comprised of instrument air system and service air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while service air is required for general plant services like operation of pneumatic tools, cleaning etc.

2.02.00 Plant compressed air system shall consist of Air Compressors, Air-Drying Plants (ADP), Air Receivers & complete compressed air piping including distribution piping. Compressed air system would cater to the requirements of Instrument Air & Service Air for the complete plant, except as specified.

2.03.00 Instrument air is dehumidified & dried to requisite level before use. Oil free air is required from the compressors especially for instrument air service. The instrument air distribution will be through main header & it will be ensured that sudden leakage in any part of the instrument air lines will not affect instrument air supply to any of the other supply points.

~~2.04.00 Configuration of IA compressors shall be 'N_{IA}' working for each unit and one (1) common standby, with individual ADP and air receiver for each compressor.~~

2.05.00 The plant service air system will be designed & provided with suitable manifolds to allow adequate discharge points in all operation & maintenance areas.

~~2.06.00 Configuration of SA compressors shall be 'N_{SA}' working for each unit and one common standby, with individual air receiver for each compressor.~~

2.07.00 Both IA and SA compressors shall be identical.

2.08.00 The compressors shall be so arranged such that each service air compressors shall be able to supply air upstream of each adjacent ADP through an isolation valve and a non-return valve and control valve; so that in the event of failure of instrument air compressor, Service air compressor shall be used as standby IA compressor.

2.09.00 Additional air receivers of adequate capacity shall be provided at different locations based on layout and process requirements.

~~2.09.01 Unit air receivers of min. 10 m³ shall be provided for SG & TG auxiliaries, of each unit.~~

~~2.09.02 Dedicated air receiver of min. 5m³ shall be provided for FGD area.~~

Deleted - 2.04.00, 2.06.00,
2.09.01 & 2.09.02.

Amit Kumar
Garg
Digitally signed by Amit Kumar
Garg
DN: cn=Amit Kumar Garg,
ou=STEAG, email=amit.kumar.garg@steag.in,
c=IN
Date: 2023.11.07 12:06:12 +05'30'

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Page 2
-------------------------------	--	--------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

2.10.00 All other compressed air requirement of the plant may be catered from the plant compressed air system.

~~2.11.00 However, if due to layout constrains, additional compressors are required to meet the plant compressed air requirements, 2x100% compressors of adequate capacity with associated ADP (as required), receivers and piping shall be provided to meet the plant requirements.~~

Deleted - 2.11.00

3.00.00 CODES AND STANDARDS

Amit Kumar Garg
Digitally signed by Amit Kumar Garg
DN: cn=Amit Kumar Garg, o=MAHAGENCO,
email=amit.kumar.garg@mahenco.com,
c=IN
Date: 2025.11.07 12:07:46 +05'30'

3.01.00 All materials, design, fabrication, manufacture, testing, and installation shall be as per the stipulation of applicable approved International standards so far as they are equal to or more stringent than this specification. In addition to the codes and standard mentioned elsewhere in the specification, the latest edition of following standards and their amendments of any or their approved equivalent shall be followed:

Measurement of air flow for compressor	BS 726
Unfired pressure vessel	IS 2825
Specification for shell & tube type heat exchanger	IS 4503
Testing of Positive Displacement Type Air Compressors and Exhausters	IS 5456
Guide for selection, installation and maintenance of air compressor plants with operating pressure up to 10 bar	IS 6206
Air receivers for compressed air installation	IS 7938
Measurement of air flow of compressors and exhausters by nozzles	IS 10431
Code of practice for compressor safety	
Technical supply conditions for Dynamic compressors	IS 11563
Compressed air dryer	IS 11989
Technical supply condition for air screw compressor	IS 12258
Displacement compressors – Acceptance test	IS/ISO 1217
Turbo-compressors – Performance test code	IS/ISO 5389
Fusion Welded Steel Air Receiver	BS-5169/1975
Compressed Air Dryers – Specification and Testing	ISO-7183 (Part-I)
Compressed Air Dryers – Performance rating	ISO-7183 (Part-II)
Compressed air quality	IS/ISO 8573
Simplified Acceptance Test for Air Compressor and Exhausters	BS-1571
Quality Standard for Instrument air	ISA-S7.0.01
Pressure Vessels	ASME Sec VIII Div 1
Steel Pipes Flanges and Fittings	ANSI-B16.5
Butterfly Valves	BS 5155 / AWWA C 504
Diaphragm Valves	BS 5156
Vibration	ISO 7919 / ISO 10816

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

American Society of Mechanical Engineers	ASME
Compressed Air & Gas Institute	CAGI
Occ. Safety Health Admin.	OSHA
Reputed manufacturers standard	RMS
Tubular Exchanger Manufacturer's Association	TEMA
Verein Deutscher Ingenieure	VDI

4.00.00 GENERAL TECHNICAL REQUIREMENTS

- 4.01.00 The plant shall be designed to meet the complete requirements for a 2x660 MW pulverized fuel based thermal power plant taking into consideration the plant location, environmental conditions, meteorological conditions, available input quality considerations to meet continuous, safe, efficient, economic and reliable working of the complete system for a period not less than 30 years.
- 4.02.00 All the equipment shall be protected against external corrosion by providing suitable painting. The steel surfaces to be supplied with painting shall be thoroughly cleaned before applying painting, by brushing, shot blasting etc. Galvanized surfaces shall not be applied with any painting
- 4.03.00 The system shall be designed for continuous and efficient operation to satisfy the system requirements.
- 4.04.00 Equipment operating on instrument and service air system shall be designed for a pressure of 120% of rated discharge pressure of each compressor.
- 4.05.00 Satisfactory operation in parallel shall be ensured, without any uneven load sharing, undue vibration and keeping noise level within permissible limits for the number of compressors working simultaneously in the same room.
- 4.06.00 Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). - **Compressor turndown is applicable for Centrifugal compressor only.**
- 4.07.00 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 micron.
- 4.08.00 The instrument air quality shall confirm to ISO-8573, Class-1 purity standard
- 4.09.00 Minimum design requirements are specified herein.
- 4.10.00 **Air Compressors**
- 4.10.01 Type of air compressors shall be oil free, multistage rotary screw / **Oil free Centrifugal type.**
- 4.10.02 Compressor speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.
- 4.10.03 The instrument air compressor should deliver air at 8.5 kg/cm² (minimum) at IA outlet and 8.0 kg/cm² (minimum) at ADP outlet.
- 4.10.04 The service air compressor should deliver air at 8.5 kg/cm² (minimum) at SA compressor outlet.
- ~~4.10.05 The compressor sizing shall be duly selected considering, requirement of consumption points, margin for wear & tear losses (5%) & margin for leakages (10%), margin for contingency demand (10%).~~

**Modify -4.06.00, 4.10.01
Deleted - 4.10.05**

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Amit Kumar Garg Project Director, India Team ETG - India Energy Services Pvt. Ltd. 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000	Page 4
-------------------------------	--	--	---------------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- 4.10.06 The compressors' capacity will be designed for 40°C DBT and 75% RH at atmospheric pressure at site.
- 4.10.07 Testing of compressor will be as per ISO: 1217.
- 4.10.08 The plant service air compressors should deliver air at the same pressure as that of the instrument air compressors.
- 4.10.09 Service air compressors and instrument air compressors shall be interconnected for flexibility in operation.
- 4.10.10 The continuous motor rating (at 50°C ambient) will be at least ten percent (10%) above the maximum load demand of the driven equipment under the entire operating range. When the driver is not directly coupled to the compressor, due consideration will be made for losses in power transmission, in addition to the above margin.
- 4.10.11 System shall be designed for compressed air velocity of 15 m/sec.
- 4.10.12 Noise level should not exceed 85 dBA when measured at distance of 1.0 meter from compressor and at a height of 1.5 m above the floor. Acoustic enclosure as required shall be provided.
- 4.10.13 Each compressor shall be suitable for single compressor operation or parallel operation with other compressors. Further, the compressor would run either on loaded or unloaded condition depending upon the compressed air requirement without any instability in performance, vibration, noise, pressure fluctuations etc. Variable speed drive to control the loading of compressors is also acceptable, if the proneness of the same is established.

~~4.10.14 Compressors shall be sized for the following conditions:-~~

- ~~i) Normal operation of all units~~
- ~~ii) Start of one unit and normal operation of other units~~
- ~~iii) Worst condition of two units starting simultaneously.~~

~~4.10.15 Total air requirement shall be assessed as follows:-~~

- ~~i) For instrument air requirement~~

~~$$Z = \{[2(A+B) + C + D] \times (1 + mw + ml)\} \times (1 + cd)$$~~

~~Where;~~

~~A = Instrument air requirement of SG & Auxiliaries (including FGD, DeNOx & MRHS) of each unit~~

~~B = Instrument air requirement of TG & auxiliaries of each unit~~

~~C = Instrument air requirement of WTP and other BoP facilities.~~

~~D = Station C&I requirement~~

~~mw = wear & tear losses (5%)~~

~~ml = margin for leakages (10%)~~

~~cd = margin for contingency demand (10%)~~

~~Z = Total instrument air requirement~~

Deleted - 4.10.14,
4.10.15

Amit Kumar
Garg
Digitally signed by Amit Kumar
Garg
DN: cn=Amit Kumar Garg,
ou=BTG, email=amit.garg@stgindia.com,
c=IN
Date: 2023.11.17 10:21:25 +05'30'

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

~~ii) For service air requirement~~

$$\text{Y} = \{[2(A+B) + C] \times (1 + mw + ml)\} \times (1 + cd)$$

~~Where;~~

~~A = Service air requirement of SG & Auxiliaries (including FGD, ESP, DeNOx, & MRHS) of each unit~~

~~B = Service air requirement of TG & auxiliaries of each unit~~

~~C = Service air requirement of WTP and other BoP facilities.~~

~~mw = wear & tear losses (5%)~~

~~ml = margin for leakages (10%)~~

~~cd = margin for contingency demand (10%)~~

~~Y = Total service air requirement~~

~~iii) All regulating/intermittent requirement shall be considered as continuous requirement for purpose of calculation. No diversity factor (i.e. Diversity factor = 1) needs to be considered as they are assumed to be simultaneous requirement.~~

~~iv) Atomising air for LDO firing during start up shall be considered as continuous requirement.~~

4.10.16 Each compressor shall be selected to meet the higher of the above demand, taking into consideration that IA and SA compressors shall be identical; for interchange-ability and optimisation of spares inventory.

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

4.10.18 The stator (casing) shall be of CI IS 210 FG 260, with integral jacket cooling. Cleaning of jacket during maintenance should be easy.

4.10.19 ROTORS:

i) Rotor will be one-piece construction with a suitable forged carbon steel or stainless steel coated with corrosion resistant material to minimize leakage and wear.

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

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

iv) These gears will be designed to counteract and minimise the axial forces incurred in compression.

v) Rotors shall be dynamically balanced.

vi) Bearings shall be high precision antifriction type. Minimum operating life of bearing shall be 40,000 hrs.

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Page 6
-------------------------------	--	--------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- 4.10.20 Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 110% of compressor rated BkW at rated conditions.
- 4.10.21 Drive shall be directly coupled, through flexible coupling to squirrel cage induction motor.
- 4.10.22 Safety valves to be provided on low pressure and high pressure stages.
- 4.10.23 INTAKE FILTERS:
- Heavy duty dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the cylinders.
 - Filtering efficiency should be minimum 99% for particles 3 micron or higher.
 - Maximum pressure drop across filter at design flow rate in new condition be 250 mm of Water column.
 - Design Airflow rate corresponding to compressor airflow.
 - To be made of densely packed, replaceable type paper as filtering media.
 - Filter to be designed to have sound suppressing characteristics.
 - Preferable filter & silencer should be combined type.
- 4.10.24 Closed circuit DM cooling water system of the plant will be used for cooling in the compressed air system.
- 4.10.25 INTER COOLER AND AFTER COOLER:
- Inter cooler, after cooler & oil cooler shall be of water cooled with shell & tube or plate type heat exchanger, with water on the tube side in case of shell & tube type heat cooler.
 - Inter cooler & after cooler shall be designed in accordance with sec. VIII, Div 1 of ASME code or equivalent & TEMA.
 - 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. However, plate type oil coolers as per OEM standard & proven design are also acceptable.
 - The coolers shall be designed for the maximum heat load & at least 10 % design margin shall be provided in the tubes/plates.
 - Design pressure in waterside should not be less than shut off head of DM cooling water pump.
 - Compressors should be able to work effectively with maximum DMCW inlet temperature of 38°C (indicative). Amit Kumar Garg
 - Temperature of air at outlet of after cooler shall not exceed 8°C above the DMCW inlet temperature.
 - 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 °C. However, the instruments or the pneumatic devices requires air temperature less than 45 °C, the same shall be achieved at the outlet header.

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Page 7
-------------------------------	--	--------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- ix) Shall be designed for easy maintenance.
 - x) Adequately sized safety valve shall be provided for both inter cooler & after cooler as per manufacturer practice.
 - xi) Each intercooler & after cooler shall be provided with moisture separator unit, with suitable baffling. Moisture separator units shall be equipped with a level gauge glass with isolating cock.
 - xii) Cooler shells, channels and covers shall be of steel (SA 285 Gr or equivalent). Tube sheet shall be of Brass or SS and the tubes shall be of admiralty brass or aluminium brass or copper or SS 304. In case of PHEs plates shall be of SS.
- 4.10.26 Electrically operated automatic drain trap station with bypass valve & isolation valves shall be provided for moisture separator for automatic draining of condensed moisture. Manual draining facility shall also be provided.
- 4.10.27 Pulsation damper of approved design shall be provided as required on the compressor suction and discharge manifold.
- 4.11.00 **Air Drying Plant (ADP)**
- 4.11.01 Air-drying plant shall be of 'Heat of Compression (HoC)' desiccant type (conventional or rotary drum type), drying by adsorption process through a desiccant medium. 'Open Through (Blower reactivated)' type is also acceptable.
- 4.11.02 Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant -
- i) In case of 'HoC' type ADP, the reactivation of desiccant will be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber.
 - ii) In 'Open Through' type ADP, for regeneration of desiccant, atmospheric air shall be filtered, heated through an electric heater and passed through the desiccant before exhausted to atmosphere. The reactivated desiccant shall be cooled through same atmospheric air without heater in operation.
- 4.11.03 In case of twin tower dryers –
- i) The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying.
 - ii) 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.
 - iii) After this period (reactivation cycle), the adsorber tower which was under drying mode shall be put under regeneration/reactivation mode while the other tower will take over the drying duty.
 - iv) 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.
- 4.11.04 The adsorber tower shall be designed with sufficient cross-sectional area resulting low air velocity and pressure drop. Minimum 20% of desiccant depth shall be provided as free board in adsorber vessels. Adsorber vessels to be provided with suitable number of inspection/sight windows of "Persplex" for

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

observation of adsorbent condition. Desiccant filling and removal connections shall be provided for the adsorber vessels.

- 4.11.05 Air drying plant receiving compressed air saturated with moisture, shall be capable of operating continuously to provide reliable moisture free compressed air, without any air purge loss. For calculating moisture load, relative humidity and DBT at ADP inlet shall be taken as 100% & 50°C respectively.
- 4.11.06 Design temperature shall be 60°C.
- 4.11.07 Quality of outlet air from ADP shall be in accordance to ISO 8573-1, class 1 as follows:
- Dew point at outlet of the air drying plant will be minus (-) 40°C at atmospheric pressure.
 - Dust particle size in instrument air shall be less than One (1) micron & max, particle concentration limited to 1mg/m³.
 - Oil content of Instrument air shall be less than 0.01 mg/m³.
 - Contaminants – No corrosive hazardous, toxic or flammable materials.
- 4.11.08 Nominal flow rate shall be 1.2 times of compressor capacity
- 4.11.09 Desiccant shall be activated alumina only and adsorption capacity and density of the same shall not be more than 8% and 900 kg/m³ respectively.
- 4.11.10 Material of Construction (MOC) of rotary drum type HOC dryer shall be as per reputed manufacturer standard.
- 4.11.11 Thermal insulation should be provided for all hot pipelines and vessels
- 4.11.12 Prefilter and after filter (for twin tower type ADP)
- The 2x100% pre-filters shall remove dust, water, and oil drops and shall protect the air dryers. Pre-filters shall be of the coalescing type.
 - The 2x100% after-filters shall be dry type and shall remove particulates in the range of 1 to 5 microns.
 - The filtering media shall be of ceramic candle type elements, designed to withstand at least 50% of static pressure as differential pressure.
 - However, as per manufacturer's standard & proven design, any superior material to the material specified is also acceptable.
 - The pre- filters shall be provided with automatic electrically operated drain trap arrangement with isolation and bypass valves.
- Note: The requirement of pre-filter & after filter is applicable to conventional twin tower type of HOC dryer. Same is not applicable for Rotary drum type HOC dryer.
- 4.11.13 Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.
- 4.11.14 For HoC, Adsorbers shall be sized so that even when the compressor is operating at part load, complete regeneration shall be achieved within the cycle

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

time and quality of air (dew point) shall be maintained throughout the design cycle period.

- 4.11.15 Non-lubricated two way / three way / four way valves ball valves with pneumatic actuators be provided.
- 4.11.16 All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, heat exchangers/de-humidifiers / coolers etc associated with ADP shall be designed in accordance with Section VIII, Division 1, of ASME Code or equivalent. The pressure vessels shall be provided with air tight gasketed manholes/handholes and relief valves.
- 4.11.17 Air drying pant shall be suitable for part load operation while maintaining the outlet air dew point as specified herein.
- 4.11.18 Dew point measurement shall be provided at each ADP outlet and also at IA header after receivers.
- 4.11.19 Required no. of sampling connections should be provided.
- 4.12.00 **Air Receiver**
- ~~4.12.01 The minimum capacity of each air receiver shall be 10 M³ (nominal), 5 M³ (nominal) & 2 M³ (nominal) as per requirement.~~
- ~~4.12.02 Each air receiver shall be so sized that even in the event of total stoppage of air flow from the compressors, the pressure in the receiver shall not fall below 5.5kg/cm² within two (2) minutes of such stoppage, while maintaining an outflow of air at a rate equal to the rated capacity of one compressor, during such period.~~
- 4.12.03 In no case, the size of each air receiver be less than that is arrived from IS 7938.
- 4.12.04 Air receivers shall be designed for outdoor service
- 4.12.05 Design code: ASME Sec. VIII Div I or IS 2825. Corrosion allowance of minimum 3mm shall be considered.
- 4.12.06 The air receivers will be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.
- 4.12.07 Air receivers shall be designed for minimum 1.5 times compressor discharge pressure {13 kg/cm² (g)} and 50°C respectively.
- 4.12.08 The material of construction of shell, dished ends, flanges etc of the air receivers shall be of carbon steel IS 2062 or equivalent.
- 4.12.09 Moisture trap & Auto drain for each air receiver shall be provided.
- 4.12.10 Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, pressure transmitter, temperature indicator, minimum 500 mm dia. manhole for inspection.
- 4.12.11 In addition to above, each air receiver shall be provided with –
- Drain connection with electrically/pneumatically operated auto drain trap arrangement,
 - Isolation valves at inlet and outlet,
 - Check valves at inlet and outlet,

Deleted - 4.12.01,
4.12.02

Amit
Kumar
Garg

Digitally signed by Amit Kumar Garg
DN: cn=Amit Kumar Garg,
o=BS&L, ou=PS&L,
email=amit.kumar.garg@bs&L,
c=IN
Date: 2023.11.07 12:26:57
+05'30'

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Page 10
-------------------------------	--	---------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- iv) Bypass valve.
- v) Safety valve
- 4.12.12 Relief valves to suit compressor capacity and set pressure of the same at least 10% above working pressure shall be provided. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure.
- 4.12.13 Adequate no. of air receivers shall be provided at various locations based on layout and system requirement. Capacity of these air receivers shall be adequate to meet to meet their intended requirement.
- 4.13.00 **Piping and Valves**
- 4.13.01 Compressed air piping shall be designed for the maximum anticipated flow requirements, with air velocity of 15 m/s.
- 4.13.02 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs. Compressor piping should have 1-2 degree slope in order for the pipe to drain condensation easily.
- 4.13.03 The pressure drop in the compressor pipeline up to air receiver should not exceed 5% of the preset pressure of the air compressor. Pipe diameters should be selected accordingly.
- 4.13.04 Branch connections must be top take-off type as far as possible.
- 4.13.05 Drain valve and globe valve should be installed at the end of the main pipeline / headers at the lowest point.
- 4.13.06 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation.
- 4.13.07 Moisture traps & Auto drains shall be provided at all strategic locations/points, including the distribution network.
- 4.13.08 Ring header shall be provided around the plant.
- 4.13.09 All interconnecting compressed air piping shall conform to ASTM A 53 Type-E, Gr. B or IS-1239 heavy, galvanized / IS 3589 Gr 410; galvanized to IS- 4736 or equivalent. The fitting shall either be same as the parent material or malleable iron to IS-1879 (galvanized). In case thickness calculated is more than heavy grade, suitable schedule as per ANSI B 36.10 shall be followed.
- 4.13.10 Compressed air piping from air compressor to after cooler and other lines handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg. C.
- 4.13.11 The pipe joints will be screwed coupling type for sizes up to 50 NB and above 50 NB the same will be welded/flanged. All pipe lines shall have butt welded connections with minimum flange joint connections to valves, vessels and equipment.
- 4.13.12 All the distribution valves shall be ball valve type. Isolation valve with quick (hose) coupling shall be provided at all Service Air tapping/discharge points.
- 4.13.13 Water Piping shall be AWW C-200 / ANSI B 36.10 / ASTM A 53, Type-E, Gr. B / IS-1239 Heavy / IS-3589 Gr.410.

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Page 11
-------------------------------	--	---------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- 4.13.14 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed on flanges also.
- 4.13.15 Rubber lined pipes shall be with flanged connection.
- 4.13.16 Teflon sealant tapes shall be used for threaded joints.
- 4.13.17 Selection of Valves shall be as follows:
- i) Compressed Air Service:
 - a) For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.
 - b) All airline valves shall be ball valve type. For compressed air application, valve material shall be with SS304 internals.
 - ii) For Water Service: Cast iron valves with GM internals as per IS-780 / equivalent and other applicable standards above 50 mm size. Gunmetal valves as per IS-778 / equivalent up to size 50mm.
- 4.14.00 Layout Considerations**
- 4.14.01 Compressor house can be steel framed structure with brick wall up to windowsill height & single skin metal panel cladding above it.
- 4.14.02 Adequate access and space shall be provided for maintenance of all equipment.
- 4.14.03 Clear gap of min. 800mm shall be provided between equipment, taking into consideration all piping and structures.
- 4.14.04 Clear access should be provided to all equipment.
- 4.14.05 Access / ladder and platform shall be provided for maintenance of receiver instruments.
- 4.14.06 Adequate lay down area and maintenance space shall be considered in the maintenance bay.
- 4.14.07 Layout should be such that equipment can be easily handled and shifted for maintenance. Necessary maintenance access will be provided in the layout.
- 4.14.08 Easy approach for vehicles to handle the equipment near maintenance bay shall be provided.
- 4.14.09 Easy access to shift material and equipment to and from the building should be provided
- 4.14.10 Air compressors will be installed indoor in a separate compressor room. Air compressor room should be located away from dusty, high temperature & high humidity environment. Especially fresh air inlet to compressor house/compressors shall be from a dust free area.
- 4.14.11 SG US EOT crane arrangement will be provided so that the heaviest component can be handled during maintenance.
- 4.14.12 The air receivers will be located outdoors adjacent to the compressor room.

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

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

5.00.00 PERFORMANCE GUARANTEE REQUIREMENT

Description/Parameter	Unit	Values
Free Air Delivery	Nm ³ /min	As per system requirement and approved by owner/consultant during detailed engineering
Discharge pressure of compressor air system at various locations	kg/cm ² (g)	As per system requirement and approved by owner/consultant during detailed engineering
Power Consumption	kW	As per system requirement and approved by owner/consultant during detailed engineering
Volumetric and overall efficiency of machine		As per approved standards
Dew Point tests to be carried out on Air Drying Plant		As per approved standards
Vibration & noise level of rotating equipments		As per approved standards

6.00.00 OPERATION AND CONTROL PHILOSOPHY

6.01.00 Plant Compressed Air System

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

6.01.02 Individual compressor control shall be through microprocessor based control system as per manufacturer's standard and overall control of compressed air system shall be through BOP C&I part of DDCMIS.

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

- i) Local Mode: Individual compressor is operated from Local Integral Control System.
- ii) Remote Mode: Individual compressor is operated through DDCMIS OWS.

6.01.04 Group Control is envisaged to clock more or less equal number of running hours for each Instrument Air Compressor. Due to this feature in case of increase in air demand, the Unit which had clocked least no. of running hours shall be started and loaded. Similarly when the air demand goes down, the Unit which had clocked most no. of running hours shall be unloaded and stopped.

6.01.05 All the process inputs (digital or analog), other than specific to compressors shall be taken directly to DDCMIS; especially -

- i) Status of each compressor
- ii) IA pressure, high/low
- iii) SA pressure, high/low

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- iv) Status of each ADP
- v) Dew point of IA
- 6.01.06 The connectivity of Integral compressor control system with DDCMIS shall be provided through Hardwired / Soft link depending upon manufacturer's product standard.
- 6.01.07 Hardwired connectivity shall be provided for critical/Start/Stop signal for IA & SA compressor.
- 6.01.08 On tripping of the working compressor, the standby compressor shall come into operation automatically in case of very low pressure in the system.
- 6.01.09 Auto sequence operation of instrument air compressors & service air compressors has been envisaged through an OEM standard micro-controller located at compressor house. Instruments required shall be provided to meet auto sequencing operation & instruments shall be provided during detail engineering with vendor drawing / documents.
- 6.01.10 Inter changeability of service air compressor to instrument air compressor in case of emergency shall be automatic.
- 6.01.11 The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor:
 - i) "Air temperature high" at inlet to last stage Alarm & trip
 - ii) "Low lube oil pressure" Alarm & trip
 - iii) "High Lube oil supply temperature" Alarm & trip
 - iv) "High oil filter differential pressure" Alarm
 - v) "Low lube oil level in lube oil sump" Alarm
 - vi) "High inlet air filter differential pressure" Alarm & trip
 - vii) "Low cooling water flow to air compressor" Alarm
 - viii) "High Air drying plant differential pressure" - Alarm
 - ix) "Low cooling water flow at return line of compressor" - Alarm
 - x) "Low cooling water inlet header pressure"-Alarm
 - xi) "Low air pressure at discharge line of each compressor" – Alarm
- 6.01.12 High DP (differential pressure) across filters (for each filter) – Alarm
- 6.01.13 Additional signals to be provided for monitoring purpose:
 - i) IA common header pressure - High/Low
 - ii) SA common header pressure - High/Low
 - iii) Dew point - high
- 6.01.14 Each compressor shall be provided with a microprocessor based controller/regulator
- 6.01.15 All protections and interlocks should be programmed in the controller/regulator

Doc no.: ETG061-BTG-ME-CAS-TS	STEAG Energy Services India Pvt. Ltd.	Page 14
-------------------------------	--	---------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

- 6.01.16 The controller/regulator unit shall be integral with display, LED indications, start/stop buttons, scroll keys, tabulator keys, function keys etc.
- 6.01.17 Function keys shall be used for the following:
- To manually load/unload the compressors
 - To reset the machine
 - To have an access to all data collected by the Regulator
 - To call up or to programme settings
- 6.01.18 To facilitate programming and controlling the compressor, menu driven programmes shall be in the controller/regulator. Menu shall have access to the following:
- Main Screen – Should show the operating status of the compressor, including the following information about:
 - Auto / manual mode operation
 - Local / remote control operation
 - Discharge air pressure of the unit at this point in time
 - Time based start / stop function is active or not
 - Status Data – Gives information regarding protection functions, including the following information about:
 - Status of any existing Warning
 - Status of any Shut-down reason
 - Service warning
 - Measured Data
 - Counters
 - Modify Parameters
 - Service alerts
 - Retrieve saved data
- 6.01.19 Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.
- 6.01.20 Unless otherwise mentioned in the relevant electrical part/section, automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.

~~**7.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED**~~

~~**7.01.00 Drawings and Documents to be Submitted with the bid**~~

~~**7.01.01 Write-up on compressed air system**~~

~~**7.01.02 Filled-in Data Sheet-B**~~

**Deleted - 7.00.00 &
PAGE-16**

Amit Kumar
Garg

Digitally signed by Amit Kumar Garg
DN: cn=Amit Kumar Garg, o=BHEL,
ou=FEEL,
email=amit.kumar.garg@bhel.in,
c=IN
Date: 2025.11.07 12:36:59 +05'30'

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

8.00.00 DATA SHEET – A (FILLED DATA SHEETS)

8.01.00 Compressor

Sr. No.	Item	Unit	Requirement	
8.01.01	Type of Compressor		High efficiency, Oil Free, Screw/ ~~Centrifugal~~	
8.01.02	Quantity	Nos.	Instrument Air	Service Air
			~~'N_{IA}' Working + one (1) Standby~~	~~'N_{SA}' Working + one (1) Standby~~
8.01.03	Capacity (each)	Nm ³ /min	~~Adequate (min 40)~~	
8.01.04	Discharge pressure at rated condition at after cooler outlet.	kg/cm ² (g)	8.5	
8.01.05	Discharge pressure of instrument air at ADP outlet	kg/cm ² (g)	8	
8.01.06	Location		Indoor, Compressor House	
8.01.07	Testing Standard		ISO 1217	
8.01.08	Cooling		Water cooled. Water from DMCW network.	
8.01.09	Maximum outlet air temperature after high pressure stage of compressor at design capacity	Deg C	160-220	
8.01.10	Maximum outlet air temperature after cooler or Plant air system	Deg C	45	
8.01.11	Maximum Cooling water pressure drop	Bar	1	
8.01.12	Cooling water line design pressure	Bar	10	
8.01.13	Regeneration Air Temperature	Deg C	160-220	
8.01.14	Compressor chamber casing		Cast iron with corrosion resistant coating	
8.01.15	Rotors		Forged Carbon Steel with special coating	
8.01.16	Timing gears		Low alloy steel	
8.01.17				
8.01.18	Noise Level	dB(A)	85 dB (A)	
8.01.19	Type of drive		High Efficiency, Electric Motor ~~(with VSD)~~	
8.01.20	Air quality		As per ISO 8573-1 Class 1	

8.02.00 Air Receiver

Sr. No.	Item	Requirement
8.02.01	Number of receivers (min.)	~~As per system requirement. However min. requirement is as below:~~

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - A
	RFx No. 3000046202 (BTG Package)	SECTION - 6
	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	REV. - 0

		~~1 no. for each compressor (min. 10m³)~~ ~~1 no. for each unit (min. 10m³)~~ ~~1 no. each unit FGD (min. 5m³)~~	
8.02.02	Location	Outdoor	
8.02.03	Design pressure & temperature	Minimum 1.5 times compressor discharge pressure (or 12.75 kg/cm ² (g) minimum) / 50°C (minimum)	
8.02.04	Design code	ASME Sec-VIII or IS-2825/IS- 7938	
8.02.05	Material of construction of shell plate, flange covers and manhole necks (if not seamless)	ASTM A36 / ASTM A516 Grade 60 or IS 2062	
8.02.06	Nozzles and seamless manhole necks	ASTM A53 Grade B / ASTM A106 Grade B or IS 1239 Heavy / IS 3589 Gr. 410	
8.02.07	Corrosion allowance (min.)	3 mm	
8.02.08	Inspection Manhole	Yes (min. 600 mm dia.)	

8.03.00 Piping Valves and Fittings

Sr. No.	Item	Requirement
8.03.01	Design Code	ANSI B 31.1
8.03.02	Piping material	ASTM A53 type E Grade B / IS 1239 heavy grade ERW up to 150 mm / IS 3589 Gr. 410 above 150mm, galvanized as per IS 4736
8.03.03	Fittings	A 105/A 234 Gr. WPB, galvanised or as compatible with the pipe material
8.03.04	Valves	Cast Steel/Forged Steel body with SS/GM internals as per BIS/BS/ASTM standards & as specified
8.03.05	Joints	Threaded / screwed sockets/unions/flanged

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - II
	KORADI THERMAL POWER STATION 2X660 MW UNITS - 11 & 12 PROJECT	-
	RFx No. 3000046202 (BTG Package)	SECTION - 2
	LEAD TECHNICAL SPECIFICATION	REV. - 0

- ~~a) 2x50% for each unit And 1x50% common standby for both units, skid mounted, oil free, water cooled, rotary screw compressors of adequate capacity and discharge pressure to meet instrument air (IA) requirements of the complete 2x660 MW power plant, except CHP & AHP.~~
- ~~b) 1x100% for each unit And 1x100% common standby for both units, skid mounted oil free, water cooled, rotary screw compressors of adequate capacity and discharge pressure to meet service air (SA) requirements of the complete 2x660 MW power plant, except CHP & AHP.~~
- ~~c) Any other compressors with associated dryers (as required), receivers and piping system, required to meet plant compressed air requirements, at any of the areas associated with the plant and if its requirement cannot be met by the main compressed air system. These compressors (2x100%) may be selected to meet the system requirements.~~

Deleted - (i) a, b & c

- d) Compressors shall include the following minimum accessories:

Amit Kumar
Garg

Digitally signed by Amit Kumar Garg, DN: cn=Amit Kumar Garg, o=MAHARASHTRA STATE POWER GENERATION CO. LTD., email=amit.kumar.garg@mahgenco.com, c=IN, Date: 2025.11.07 12:50:12 +05'30'

- 1) Air intake filters
- 2) Silencer
- 3) Inter cooler for multi-stage compressor complete with trap station with bypass arrangement.
- 4) After cooler complete with trap station with bypass arrangement.
- 5) Sound proof enclosure

ii) *Air Drying Plant*

- ~~a) 2x50% for each unit And 1x50% common standby for both units, Heat of Compression (HOC) Rotary drum type or conventional twin tower type air-dryers (with specified margin), to match instrument air compressor capacity, along with all accessories including control panel, flow meter, online digital dew point meter at the outlet of each dryer, etc. 'Open through (Blower reactivated)' type ADP is also acceptable.~~
- b) A dew point analyzer shall be installed at the discharge of each air dryer to monitor the quality of instrument air delivered from the system.
- c) Air drying plants will be interconnected with operation of selection valves from PLC

Amit Kumar
Garg

Digitally signed by Amit Kumar Garg, DN: cn=Amit Kumar Garg, o=MAHARASHTRA STATE POWER GENERATION CO. LTD., email=amit.kumar.garg@mahgenco.com, c=IN, Date: 2025.11.07 12:52:39 +05'30'

iii) *Air Receivers*

Amit Kumar
Garg

Digitally signed by Amit Kumar Garg, DN: cn=Amit Kumar Garg, o=MAHARASHTRA STATE POWER GENERATION CO. LTD., email=amit.kumar.garg@mahgenco.com, c=IN, Date: 2025.11.07 12:54:01 +05'30'

- ~~a) Air receivers of minimum 10m³ capacity to hold air and minimize pressure fluctuations for each compressor near compressor house.~~
- ~~b) Additional air receivers of similar/adequate capacity shall be provided different locations shall be provided based on layout, process requirements and as specified.~~
- c) Instrument air and service air receivers shall be provided along with all accessories such as pressure gauges, safety relief valves, electronic type auto drain traps, manual isolation / blow off auto drain valves, bypass control valve, fittings, temperature indicators, transmitters, etc.

Deleted - (iii) b

Amit Kumar
Garg

Digitally signed by Amit Kumar Garg, DN: cn=Amit Kumar Garg, o=MAHARASHTRA STATE POWER GENERATION CO. LTD., email=amit.kumar.garg@mahgenco.com, c=IN, Date: 2025.11.07 12:54:01 +05'30'

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - II
	KORADI THERMAL POWER STATION 2X660 MW UNITS - 11 & 12 PROJECT	-
	RFx No. 3000046202 (BTG Package)	SECTION - 2
	LEAD TECHNICAL SPECIFICATION	REV. - 0

d) Air receivers shall also be interconnected with operation of selection valves from PLC

iv) *Miscellaneous*

- a) Complete piping (integral and interconnecting), fittings, couplings, expansion joints, valves, gates and supports/hangers, required for the plant compressed air system including distribution network and unit wise ring header.
- b) Isolation valves for individual equipments
- c) Cooling water system
- d) All filters/strainers, intermediate and terminal air receivers, etc.
- e) Under-slung EOT cranes to handle all equipments in the system.
- f) Complete instrumentation required for both local and remote monitoring, process control and performance evaluation for all process parameters.

2.13.07 AIR CONDITIONING AND VENTILATION SYSTEM

j) *Air Conditioning for Main Plant and Control Building*

Amit Kumar Garg
Digitally signed by Amit Kumar Garg
DN: cn=Amit Kumar Garg, o=BSIL,
ou=PSB,
email=amit.kumar.garg@bsil.co.in, c=IN
Date: 2023.11.07 12:56:10 +05'30'

- a) 1x100% Vapour absorption machine (working) and 1 x 100% Screw chilling machine (standby) complete with all accessories as described here in after.
- b) 1 no. of PRDS for regulating the steam parameter as per VAM operating requirement.
- c) Two (2) Nos. Back pull out or Horizontal Split Casing Centrifugal Condenser Water Pump Sets (1W + 1SB) each complete with all accessories as described here in after. These pumps shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- d) Two (2) Nos. Back pull out or Horizontal Split Casing Centrifugal Chilled Water Pump Sets (1W + 1SB) each complete with all accessories as described here in after. These pumps shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- e) Two (2) Nos. Fibre glass reinforced plastic (FRP) construction Cooling Towers ('N'W + 1SB) each complete with all accessories i.e. fan, motor, FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc. The capacity of the cooling tower shall be equal to the condenser cooling capacity. These cooling towers shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- f) PLC / DCS based control, common for AC Plant.
- g) Air Handling Unit (AHU) / Fan Coil Units (FCU) as below:
 - 1) Three (3) nos. (2W and 1S) sheet metal cabinet type (double skin) air handing units of sectionalized construction each complete with all accessories, to match the AC load of Central Control Room, Control

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - C
	RFx No. 3000046202 (BTG Package)	
	TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION	REV. - 0

~~3.32.16 All the alarms related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, AWU etc. in the control system.~~

~~3.32.17 The fans (both supply and exhaust fans) associated with mechanical ventilation system shall be operated locally.~~

3.33.00 Compressed Air Control System

3.33.01 Microprocessor based control system with LED colour graphic terminal has been envisaged for operation and control of air compressors. Hardwire and suitable soft link communication with standalone DCS shall be provided for operation, control and monitoring of compressed air system.

3.33.02 The Contractor shall include controls & instrumentation to facilitate safe, reliable and efficient operation for the system. The controls, protection, interlock and instrumentation system offered by the contractor shall be subjected to approval of the Employer during post award engineering stage.

3.33.03 Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.

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

3.33.05 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.

3.33.06 An electrically operated automatic valve shall be provided on cooling water return line of each compressor & dryer (if applicable) which will automatically shut off the cooling water supply, in case any of the compressor/dryer is not running for more than set time duration.

3.33.07 Suitable interlock shall also be provided for opening the valve before starting of any of the compressor.

3.33.08 The following indications shall be made available in the control panels for repeating the same in main plant Control System / Panels.

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

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

Deleted - 3.32.16,
3.32.17

Doc no.: ETG061-BTG-C&I-TS	STEAG Energy Services India Pvt. Ltd.	Amit Kumar Garg Project Director, Maharashtra State Power Generation Co. Ltd., Corporation Area, Koradi Thermal Power Station, Koradi, Dist. Solapur, Maharashtra - 431 122	Page 87
----------------------------	--	--	---------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	PART - C
	RFx No. 3000046202 (BTG Package)	
	TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION	REV. - 0

3.33.10	Each compressor shall be in the control panel to operate either in Base duty (Auto Load- Unload) or Standby duty (Auto On-Off) mode in case of Screw and unload/modulate/energy optimization (Auto Dual Mode) in case of centrifugal
3.33.11	In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve.
3.33.12	In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor should start in unloaded condition and the compressor shall be fully loaded.
3.33.13	When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by a timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a pre-set time.
3.33.14	The control system shall provide warning to the operator that a hot-start condition exists for the motor driver and adequate cool-down period has not occurred after the motor was shut down.
3.33.15	The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor: (a) "Air temperature high" at inlet to last stage Alarm & trip (b) "Low lube oil pressure" Alarm & trip (c) "High Lube oil supply temperature" Alarm & trip (d) "High oil filter differential pressure" Alarm (e) "Low lube oil level in lube oil sump" Alarm (f) "High inlet air filter differential pressure" Alarm & trip (g) "Low cooling water flow to air compressor" Alarm
3.33.16	The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air temperature", "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.
3.33.17	Control philosophy as per manufacture's standard and proven practice shall also acceptable and finalized during detailed engineering with approval of owner.

Doc no.: ETG061-BTG-C&I-TS	STEAG Energy Services India Pvt. Ltd.	Page 88
----------------------------	--	---------

	MAHARASHTRA STATE POWER GENERATION CO. LTD.		VOLUME - III
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT		PART - C
	RFx No. 3000046202 (BTG Package)		
	TECHNICAL SPECIFICATION CONTROL & INSTRUMENTATION		REV. - 0

~~maintaining safe condition of the plant without endangering the safety of equipment and without influencing the process being controlled.~~

10.01.11 Failure of equipment used for alarm & trip purposes shall initiate alarm.

10.01.12 Automatic un-administered switchover to standby equipment (such as fan /compressor) is foreseen in case of either running equipment is not adequate to maintain the desired process condition or due to tripping of running equipment.

10.01.13 End positions of manually operated suction valves of critical pumps and all other manual operated critical isolation valves shall be monitored & interlocked.

10.01.14 In case of HT motors, winding temperature for each stator winding and bearing temperature of motors & driven equipment shall be monitored for abnormal rise.

10.01.15 Each Compressor's Winding temp RTD signals, bearing temp RTD signals and vibration monitoring system signals (for both X & Y directions on each o the bearings) shall be hardwired to Microprocessor based control System and DCS directly from field/VMS panel.

10.01.16 All Drives shall have its local control station comprising of start and emergency stop pushbutton and with a local & remote selection switch in SWGR/MCC (Refer electrical volume of the specification). Local stop pushbutton shall always be active. During the trial run of drives from local, safety permit and protection shall be ensured.

~~10.01.17 Ergonomically & aesthetically designed furniture viz. control desks & chairs shall be provided for workstations, programming stations, PCs and various peripherals at control room/computer room/equipment room. Furniture shall include documentation racks, tables for laydown etc.~~

10.01.18 Instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in the specification. All field wiring should be through conduits. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503.

10.01.19 Any predictable or planned deterioration and/or obsolescence of equipment shall be clearly brought out in the Bid.

10.01.20 The control system shall be designed to prevent abnormal swings due to loss of control power, instrument air, failure of any system component, open/short circuits or any other such failure or degradation in the system and shall drive the plant and equipment to fail safe condition.

10.01.21 Mean Time between Failure (MTBF) of the instruments shall be considerably higher than the equipment they shall cater to in order to avoid shutdown on

Doc no.: ETG061-BTG-C&I-TS

STEAG Energy Services India Pvt. Ltd.

Page 205

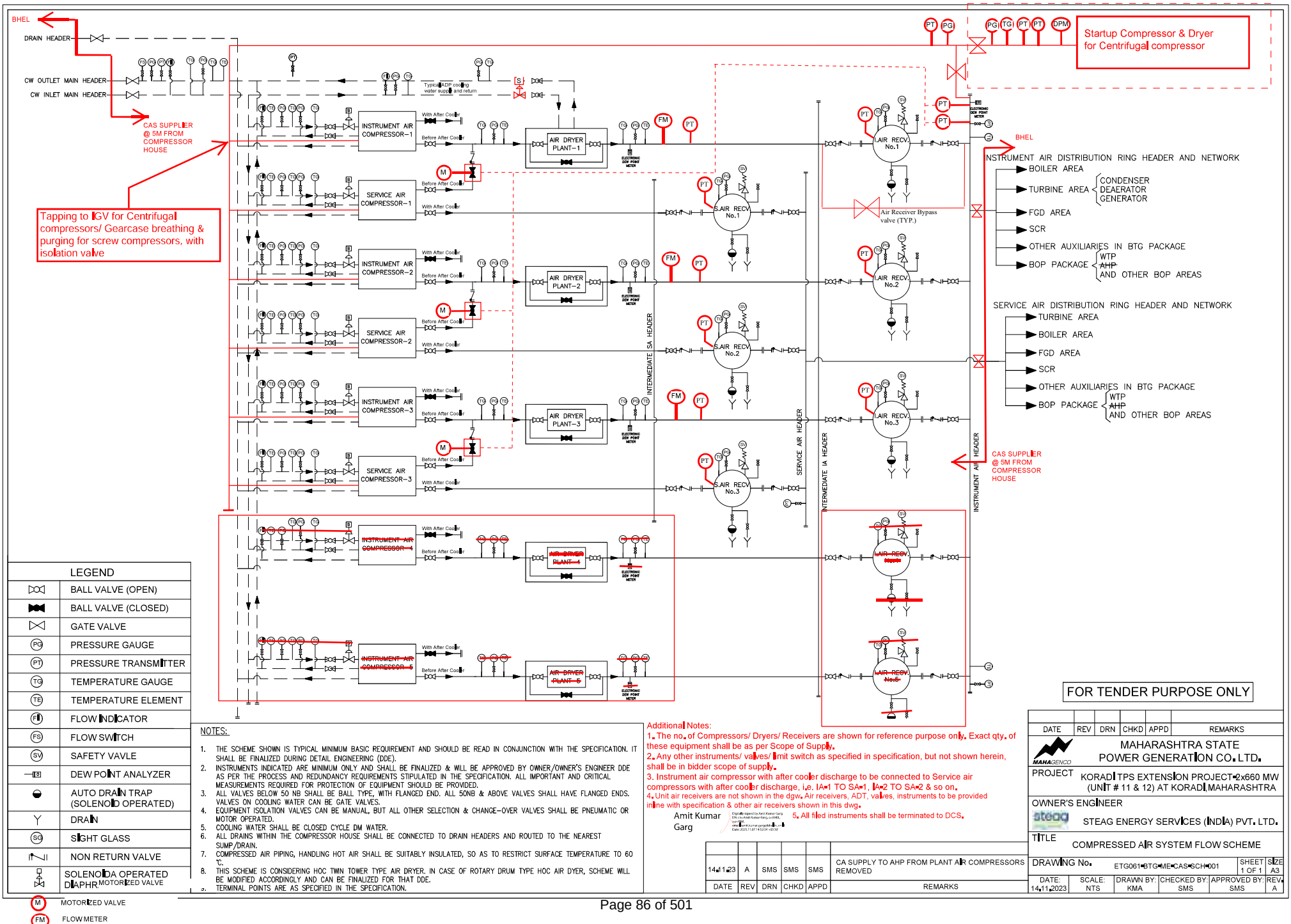
Deleted - 10

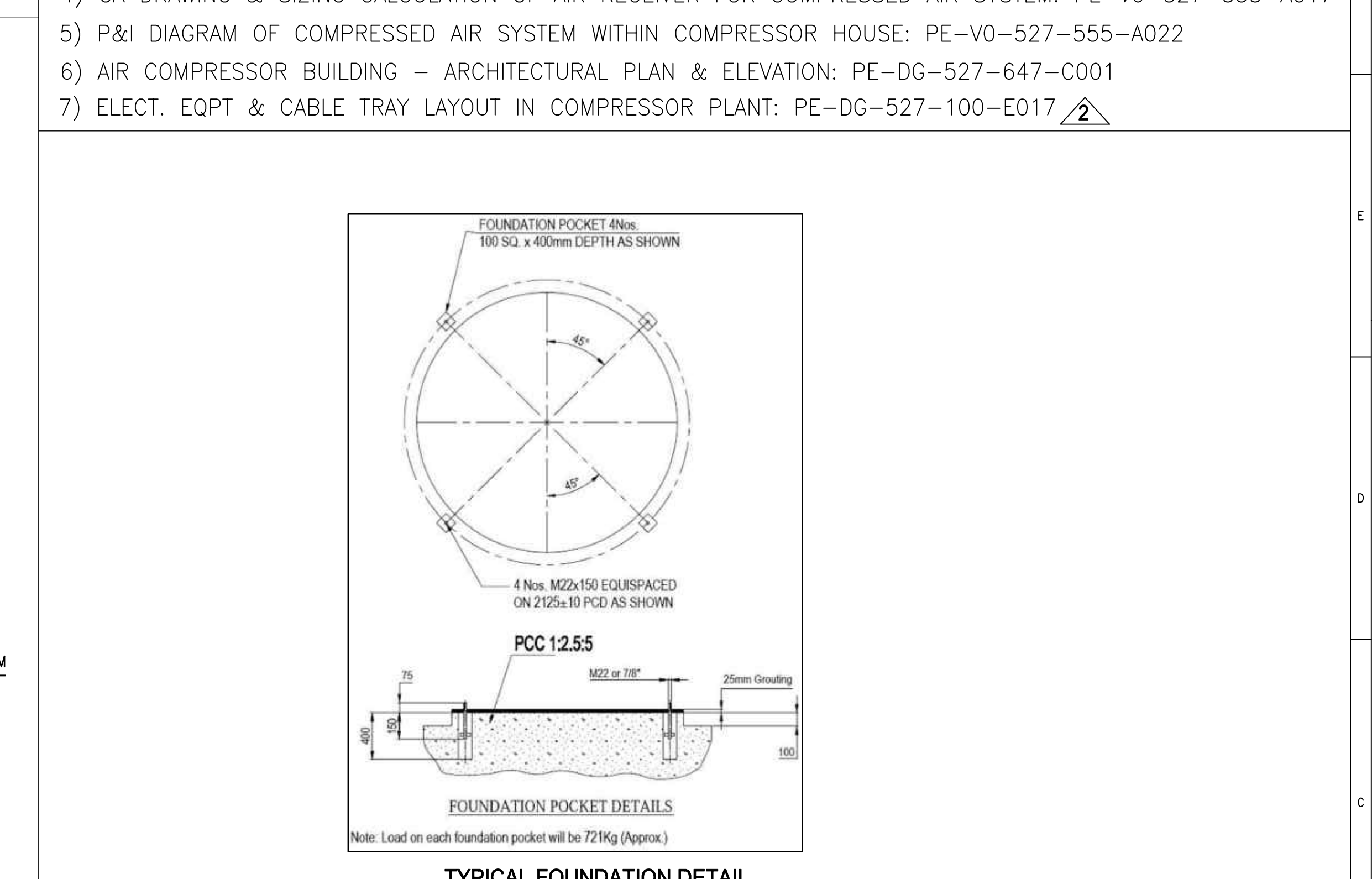
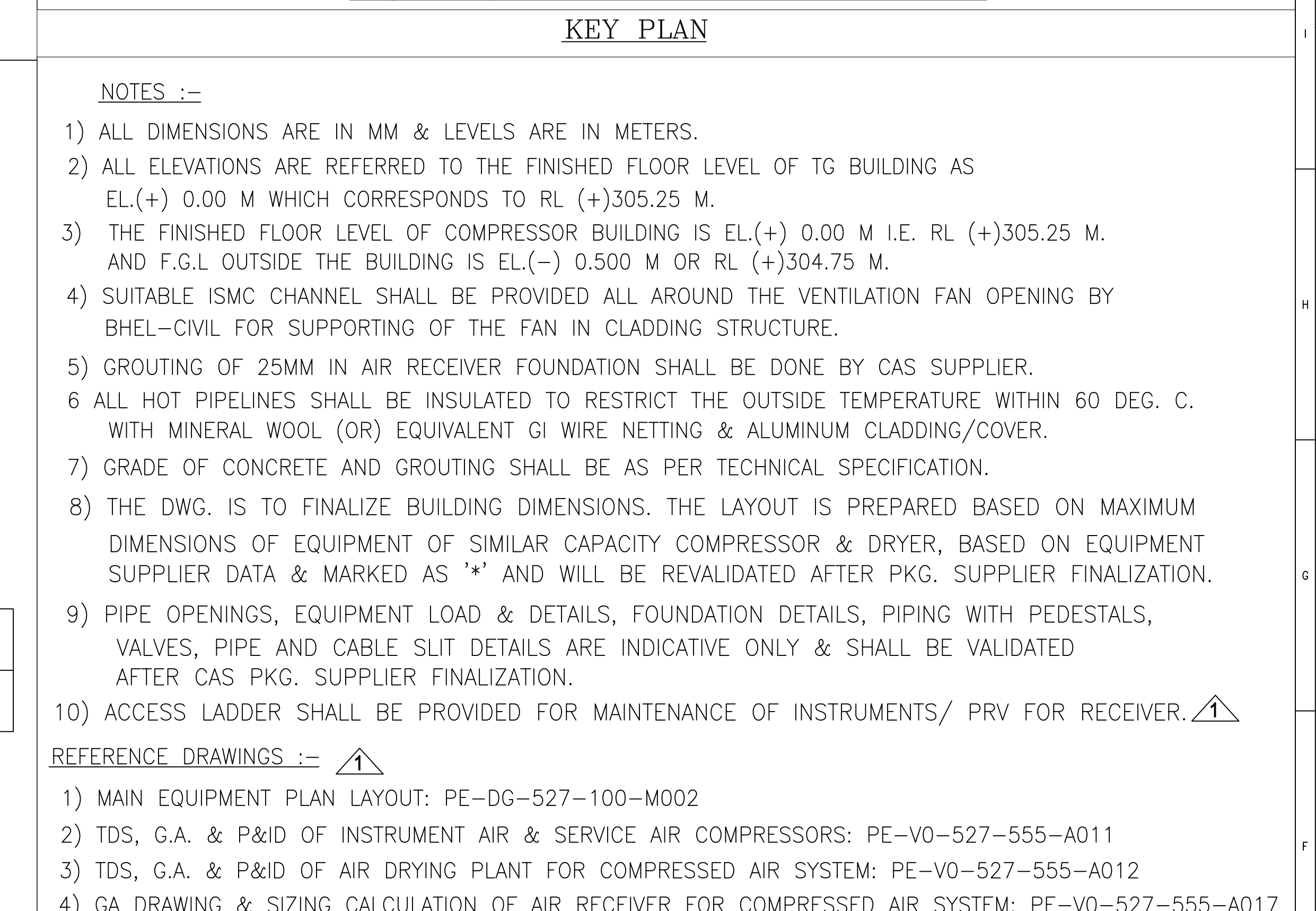
Amit Kun
Garg

Deleted - 10.01.17

Amit Kumar
Garg

Digitally signed by Amit Kumar Garg
DN: cn=Amit Kumar Garg, o=STEAG,
c=IN
Date: 2023.11.01 14:50:57 +05'30'



[illegible]

INSTRUMENT AIR COMPRESSOR	490KW	-----	S	2	1	C	U	N	C	Motor	15-20SEC	*						Refer notes	
SERVICE AIR COMPRESSOR	490KW	-----	S	2	1	C	U	N	C	Motor	15-20SEC	*						(i), (ii) and (iii).	
AIR DRYER (INCL. HEATER)	9KW	-----	S	2	1	E	D	N	C	Panel	-----	*							
IA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*						DG SUPPLY	
SA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*							
UPS SUPPLY FOR MICROPROCESSOR PANELS & SEQUENTIAL PANEL	7.5KW	-----	S	2	1	D	S	N	C	Panel	-----	*						230VAC UPS	BY C&I
RECEIVER DRAIN ADT	0.5KW	-----	S	9	0	E	S	N	I	ADT	-----	**							
AFTER COOLER DRAIN ADT	0.5KW	-----	S	-	-	E	S	N	I	ADT	-----	*						(Qty. as applicable)	
UTILITY COMPRESSOR FOR CENTRIFUGAL COMPPRESSOR	9KW	-----	S	1	0	D	S	N	I	Motor	5 SEC	*							
UTILITY DRYER FOR CENTRIFUGAL COMPPRESSOR	1KW	-----	S	1	0	D	S	N	I	Panel	-----	*							
MOTORISED VALVE	1KW	-----	S	3	0	D	B	N	I	ACTUATOR	-----	*							

NOTES:

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) Suitable protection shall be included in the HT Switchgear logic to prevent frequent start stop of the compressor HT motors.

iv) Location := (*):- Compressor House. (**):- 6 nos. outside Compressor House, 2 nos. for TG (one for each Unit), 1 no. in FGD Area.

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
SPECIFIC TECHNICAL REQUIREMENTS Annexure V: 1x800 MW HPGCL Yamunanagar		

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure V 1 X 800 MW HPGCL YAMUNANAGAR STPP COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: DEC 2025
SPECIFIC TECHNICAL REQUIREMENT - MECHANICAL		
1.0	The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying (ADPs) Plants, Service Air compressors& their motor drives , air receivers, instrumentation and control, control panels and interconnecting compressed air piping in the compressor house.	
2.0	Three (03) numbers (2 working+ 1 standby) oil free, rotary screw/centrifugal type, air compressors for instrument air duty for the complete plant each of 50Nm³/min. capacity & 8.5 kg/cm²(g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issued by BHEL at compressor supplier's works.	
3.0	Three (03) numbers (2 working+ 1 standby) Air Drying Plants (one for each instrument air compressor) of 55NM ³ /min (1.10 times capacity of IA compressor) capacity with all interconnecting piping, valves, fittings, etc. The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40 dig C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3 "Quality Standard for Instrument Air". Discharge pressure available at the outlet of Air drying Plant shall be minimum 8 Kg/cm ² (g).	
4.0	Three (03) numbers (3 working+ 1 standby) oil free, rotary screw/centrifugal type air compressors for service air duty for the complete plant each of 50Nm ³ /min. capacity & 8.5 kg/cm ² (g) discharge pressure with intercooler, aftercooler, lubrication system, automatic drain traps (zero purge loss type) and other accessories. Motor shall be free issue by BHEL at compressor supplier works. 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.	
5.0	Air Receivers - The design pressure and temperature shall be minimum 12.75 Kg/cm ² (g) and 80 deg.C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME Code or equivalent. Relief valves shall be provided to suit compressor capacity and set pressure of the same shall be atleast 10% above working pressure. The spring in relief valve shall not reset for any pressure more than 10% above or below the design set pressure. Each receiver shall be provided with pressure indicator, temperature indicator and drain connection with electrically operated automatic drain trap arrangement with isolation and bypass valves. The drain trap shall be timer based. Manual draining facility shall also be provided in the drain trap. The material of construction of shell, dished ends, flanges, etc of the air receivers shall be of carbon steel as per IS:2062 or equivalent.	
5.1	One(1) number of air receiver of minimum capacity 15 m ³ at the discharge of each air compressor (Total: 06 numbers).	
5.2	One(1) number unit air receiver of minimum capacity 10 m ³ to be located in TG building. (Total: 01 numbers).	
6.0	All the equipments shall be designed for continuous duty as well as for intermittent operation. Frequent start/stop of the system shall neither result deterioration in performance nor damage to the equipment.	
7.0	The compressors and Air Drying plants shall operate under the following ambient conditions. i. Minimum temperature : 3 deg. C ii. Maximum temperature : 50 deg. C iii. Design condition (Temperature : 45 deg.C & 85% RH) iv. Height above MSL (m) :270	
8.0	The compressor capacity & discharge pressure of instrument air system and service air system shall be identical.	
9.0	The heat exchangers are DMCW cooled and the maximum cooling water temperature at compressor coolers inlet shall be 38 deg. C. The temperature rise of cooling water in the heat exchangers of the Compressed air system shall be limited to 5-10 deg C.	
10.0	Noise level shall not exceed 85 dBA when measured at a distance of 1.0 meter from the compressor. Acoustic enclosures as required 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.	
11.0	Air Compressors (Screw /Centrifugal type) shall be designed for continuous operation with high efficiency to satisfy the performance requirement As more than one compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously in the same room. Parallel operation of compressors shall be possible without any undue vibration and noise.	
12.0	The flow in compressed air piping shall be designed for the design capacity of each compressor and the flow in header and ring mains to be designed for the total capacity of working compressors.	
13.0	All hot vessels/pipelines/ valves shall be insulated to restrict the outside temperature within 60 deg.C or less with mineral wool (or equivalent), GI wire netting and aluminum cladding/cover.	
14.0	The canopy shall be designed to cater the load of air filter with 100% choked condition.	
15.0	SCREW AIR COMPRESSORS	
15.1	CODES AND STANDARDS - The design, manufacture, testing and performance of the various components of the rotary screw type air compressors shall comply with the requirements of relevant codes (IS-5456, IS-10431 [part -1], ASME PTC-9, IS-6206, IS-5727, ISO-1217 and CAGI) ans as specified in STR ANNEXURE-1 .	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure V 1 X 800 MW HPGCL YAMUNANAGAR STPP COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: DEC 2025
15.2	DESIGN AND CONSTRUCTION	
	Design & construction of compressor shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of compressor is also acceptable.	
a.)	The compressor shall be oil free multistage, horizontal, water cooled, rotary screw type, heavy duty, rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.	
b.)	Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 115% of compressor rated BKW at rated conditions.	
c.)	The rotor and shaft shall be of single piece of construction made of forged steel (AISC 1141 or equivalent). The stator (casing) shall be of Cast-Iron (IS-210) construction with integral jacket cooling. The rotors shall be dynamically balanced, design with asymmetric profile, to keep leakage losses to a minimum and ensure high efficiency.	
d.)	The seal rings and retainers shall be of stainless steel construction and be free for radial self adjustment along the rotor shafts.	
e.)	Bearings shall be high precision antifriction type IS- 25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement and minimum operating life of 40000 running hours.	
f.)	Lubrication system shall be as per as per specification	
h.)	Gears shall have a rating of AGMA-12 or equivalent. Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position.	
16.0	CENTRIFUGAL AIR COMPRESSORS	
16.1	CODES AND STANDARDS - The design, manufacture, testing and performance of air compressors and accessories shall comply with the requirements of one or more of the relevant codes as applicable (IS-2825, IS-4503, CAGI, IS-5727, IS-6206, ASME-PTC-10, API 672 and IS-11727).	
16.2	DESIGN AND CONSTRUCTION	
a.)	Each compressor unit shall be complete with electric motor drive of suitable capacity. Driver rating shall be minimum 115% of compressor rated BKW at rated conditions or BKW at unthrottled minimum ambient temperature whichever is higher	
b.)	Air Compressors shall be oil free centrifugal air compressors with non-contact air/oil seals, each capable of delivering continuously rated volume flows at rated delivery pressure. Compressor components shall be interchangeable as far as possible.	
c.)	The rotor shaft shall be made of Stainless Steel. The rotors shall be dynamically balanced to reduce vibration. The gaskets shall be of asbestos free material. Any superior material & type (as per proven practice and relevant standard) of various components of screw compressor is also acceptable.	
d.)	Each compressor shall be provided with Inlet Guide Vane (IGV) control for suction air volume control.	
e.)	Each compressor shall be provided with coupling guard with fixing arrangement.	
f.)	Proper and robust supporting arrangement shall be provided from foundation/ floor for overhang casing, oil coolers, air piping, cooling water piping, oil piping, etc.	
g.)	Compressors shall be provided with adequate safety, protection control system including anti surge protection with bypass valve etc. and auto dual control (either; controlled for constant pressure or constant volume flow). The duty points shall be at least 15% away from the anti surge line.	
h.)	Compressor shall have 25% minimum turndown capability (at 45 deg C & 75% RH). Compressor shall be provided with IGV at the suction flange.	
17.0	INTERCOOLER, AFTERCOOLER & OIL COOLERS (FOR SCREW/CENTRIFUGAL)	
a.)	Design & construction of inter cooler, after cooler & oil cooler of compressors, air dryers including external after cooler (as applicable) shall meet the	
b.)	INTAKE AIR FILTER AND SILENCER shall meet the minimum requirement mentioned in the specification	
19.0	AIR DRYING PLANT	
	Design & construction of dryer shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components of dryer is also acceptable.	
21.0	CONTROL PHILOSOPHY	
21.1	The minimum requirements are specified herein and the same shall be elaborated by CAS supplier. The CAS supplier shall include controls & instrumentation to facilitate safe, reliable and efficient operation for the system. The controls, protection, interlock and instrumentation system offered by the contractor shall meet the minimum requirements mentioned in the specification and be subjected to approval of the BHEL & Customer during post award engineering stage.	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure V 1 X 800 MW HPGCL YAMUNANAGAR STPP COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: DEC 2025
21.2	Any of the compressor and Air drying Plant may be selectable for "shutdown", "working" or "standby" duty.	
21.3	On tripping of working equipment, the standby equipment shall come into operation automatically in case of very low air pressure in the system. 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.	
21.4	An electrically operated automatic valve shall be provided on cooling water return 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.	
21.5	The following indications shall be made available in the control panels for repeating the same in main plant Control System / Panels. (a) Status of each compressor (b) Instrument air pressure low/high (c) Service air pressure low/high (d) Dew point of instrument air (e) Status of each ADP	
21.6	Lube oil pressure and temperature in the oil circuit of compressor shall be automatically controlled.	
	For Centrifugal compressors, as per OEM recommendation, Start-up air compressor and air dryer along with piping, valves, instruments etc. shall be provided by CAS supplier. Additionally, tapping from instrument air main header shall also be taken and connected to the start-up compressor outlet piping along with valves and instruments and shall be used in case of outage of start-up compressor / dryer.	
21.7	Automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.	
21.8	Whenever the operation of an auxiliary equipment is interlocked with main motor running status, the actual feedback from HT switchgear needs to be considered instead of start/stop command. Proper logging of abnormal conditions should be ensured in compressor system itself with adequate alarms/annunciations on compressor local panel as well as plant DCS. The logged data should be easily retrievable at later stage for any analysis. Control of the compressors should be designed in such a manner it comes to fail safe condition during unhealthy conditions or malfunctioning of any input external to compressor. For example, to save the compressor from further damages, cooling water supplies should not be stopped/ air intake valve should not be closed, if the compressor is running under abnormal condition or proper status feedback from HT switch gear is not available.	
21.9	Screw /Centrifugal compressor	
a.)	Each compressor shall be in the control panel to operate either in Base duty (Auto Load- Unload) or Standby duty (Auto On-Off) mode in case of Screw and unload/modulate/energy optimization (Auto Dual Mode) in case of centrifugal. In "Base duty" mode, whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unloaded condition. When system pressure drops due to more demand, the load-unload circuit shall operate again to bring the compressor to 100% load after closing the blow -off valve. In "Stand-by" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a pre-set lower limit, compressor should start in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to pre-set high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by a timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a pre-set time.	
b.)	The control system shall provide warning to the operator that a hot-start condition exists for the motor driver and adequate cool-down period has not occurred after the motor was shut down.	
c.)	The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the safe operational requirement of the equipment/system each compressor: (a) "Air temperature high" at inlet to last stage - Alarm & trip (b) "Low lube oil pressure" - Alarm & trip (c) "High Lube oil supply temperature" - Alarm & trip (d) "High oil filter differential pressure" - Alarm (e) "Low lube oil level in lube oil sump" - Alarm (f) "High inlet air filter differential pressure" - Alarm & trip (g) "Low cooling water flow to air compressor" - Alarm	

	SPECIFIC TECHNICAL REQUIREMENTS: Annexure V 1 X 800 MW HPGCL YAMUNANAGAR STPP COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001 Rev. No. 00 Date: DEC 2025
22.0	Air Drying Plant	
a.)	Sequential operation of the adsorber towers & air compressors shall be controlled automatically with a provision for manual take over.	
b.)	Change over of tower from drying mode to regeneration mode shall happen automatically if the dew point is high at the outlet of ADP sensed by the dew point (using aluminium oxide probe) meter/sensor. Automatic operation during regeneration, starting and stopping of blowers, starting and stopping of heaters, etc shall be timer controlled. During the process, in case, operation is taken over manually from the panel through push button or selector switch, the sequential operation shall start with the manual initiation for each of the steps.	
c.)	The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air temperature", "Low cooling water flow", "Low air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc. shall be provided for measurement and monitoring of the same.	
d.)	For rotary drum type Air drying plant, control philosophy as per manufacture's standard and proven practice is also acceptable.	
23.0	For Centrifugal compressors, as per OEM recommendation, Start-up air compressor and air dryer along with piping, valves, instruments etc. shall be provided by CAS supplier. Additionally, tapping from instrument air main header shall also be taken and connected to the start-up compressor outlet piping along with valves and instruments and shall be used in case of outage of start-up compressor / dryer.	
24.0	CAS supplier to note that RTD/BTD of HT motor of air compressor shall be terminated to temperature scanner / microprocessor (one for each compressor to be provided by CAS Supplier) mounted on compressor itself. Interlocks and protection for RTD/BTD of compressor motor has to be provided from compressor panel itself.	
25.0	Control and Instrumentation – Individual compressor control shall be through compressor mounted microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR. Interface module for the overall control of compressed air system through DDCMIS shall be provided by CAS Supplier.	
26.0	Sequential panel for ensuring equal no. of running hours of each IA & SA set of compressors shall be provided by CAS Supplier.	
27.0	Junction Box for cable termination purpose shall be provided by CAS Supplier.	
28.0	HT motors for Instrument Air and Service Air Compressors, which are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder at its Works. HT motors shall be of BHEL make. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Also, once the motors are delivered at successful bidder's works / factory, any damage to motor shall be bidders' responsibility and rectification work shall be carried by bidder at its own cost. Further insurance of these motors after delivered at bidder's works shall be in bidder scope in line CAS package insurance, as per insurance terms & conditions defined under GCC.	
29.0	Foot cum flange mounted motors shall be of 1500 RPM only. While foot mounted motors shall be 3000/ 1500 RPM.	
30.0	Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors.	
31.0	CAS supplier scope also includes - Pipe supporting structure over the insert plate for pedestal supported pipe, wall supported pipe, insert plate and supporting structure for floor supported pipe. All MS structures for cross overs, valve, instrument, equipment operating and maintenance platform; approach ladder for access to pit/ trench. All Equipment base plate, foundation anchor bolts.	
32.0	Paint required for painting of all items under the package for corrosion protection and to meet color coding required by customer.	
33.0	SCOPE OF SERVICES: Scope of services by CAS supplier shall include but not necessarily limited to the following: 1.) Erection & Commissioning of Compressed Air System (Refer Annexure-B). 2.) Unloading, Storage, handling and transportation at site. 3.) Pre commissioning & Commissioning activities for Compressed Air System. 4.) Trial operation, AMC for storage and Preventive / Breakdown maintenance , PG Test & handover of Compressed Air System.	
34.0	CAS supplier shall terminate compressed air piping at common IA header and common SA header downstream of air receiver closer to pipe rack/pedestal (around 5.0 m from compressor house building).	
35.0	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.	
36.0	Piping material - Compressed air (Instrument & service air) - ASTM A-53 type E Gr. B galvanized/ IS 1239 Gr heavy galvanized/IS 3589 Gr 410 galvanized. Galvanized shall be to IS- 4736 or equivalent.	
37.0	Piping material - Equipment cooling water - IS-2062 Gr.-E-250B/ASTM A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410 /IS-1239 Heavy.	
38.0	Valve material - Compressed air & Cooling water application - Valve body material shall be cast carbon steel for sizes 65 mm NB & above and gun metal or forged carbon steel for sizes 50 NB and below.	
39.0	P&ID of CAS and Compressor house layout attached in this annexure are to be read along with this specification and deemed to be included in scope of bidder.	
40.0	Void.	
41.0	Annual maintenance contract (AMC) for Preventive / Breakdown maintenance of Compressed air system (Refer Annexure-A) is in CAS supplier scope.	
42.0	Performance test for compressors shall be carried out at shops with job motor only.	

CHAPTER – 23

COMPRESSED AIR SYSTEM

23.1 INTENT

23.1.1 This chapter is intended to cover the Design, Engineering, Manufacture, Fabrication, Assembly, Inspection, Testing at Manufacture's works, Packing, Transportation, Delivery, Receipt, Unloading, Storage and handling at site, supervision of Erection, Testing, Commissioning and Field Acceptance / Performance Guarantee test of Compressed Air System consisting of air compressors and their motor drives, receivers and air drier units with all associated accessories and auxiliaries as specified herein after and as required for safe trouble free operation and maintenance.

23.1.2 It not intended to specify completely herein, all details of design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation.

~~23.1.3 Compressed Air is mainly required in the following areas:~~

- ~~a. Pulverized coal sampling.~~
- ~~b. APH soot blowing.~~
- ~~c. Boiler Area~~
- ~~d. Turbine Generator (TG) and Auxiliaries.~~
- ~~e. CPU Area~~
- ~~f. DM Plant & Water system area.~~
- ~~g. TG & SG area cleaning and maintenance.~~
- ~~h. Fuel oil pump house area~~
- ~~i. LDO atomization~~
- ~~j. Station C & I area~~
- ~~k. CHP area~~
- ~~l. AHP Area~~
- ~~m. Mill Reject System area~~
- ~~n. FGD Plant~~
- ~~o. ETP~~
- ~~p. SCR~~
- ~~q. Ammonia Handling~~
- ~~r. H₂ Plant~~
- ~~s. Lime Slurry Preparation~~
- ~~t. Gypsum Dewatering~~
- ~~u. Chlorine Dioxide system~~
- ~~v. STP~~
- ~~w. Absorber~~
- ~~x. Any other area (if required) which is not covered above.~~

~~Besides, dedicated Compressed Air Systems as described in respective Chapters shall be provided for each of the following areas:~~

- ~~(a) Coal Handling System~~
- ~~(b) Ash Handling System~~

23.2 System Description

23.2.1 The compressed air system shall consist of Instrument Air compressors & their motor drives, Air Drying Plants (ADPs), Service Air compressors & their motor drives, air receivers, instrumentation and control, control panels, interconnection compressed air piping, ~~Instrument air piping network and service air piping network.~~

23.2.2 The air compressors & drives, instruments, control panels and ADPs shall be located indoor inside the compressor house and the air receivers shall be located outside the compressor house. ~~The compressor house shall be provided with an electrically operated, overhead traveling type (EOT) crane as specified in Volume III, Chapter 28.~~

23.2.3 The IA system shall supply required quality air to various pneumatically operated valves and instruments of SG, TG and all BOP systems (except coal handling system and ash handling system). The SA system shall meet the service air requirement of the unit.

23.2.4 The compressors shall be arranged such that all the service air compressors shall be able to supply air upstream of each ADP through an isolation valve and a non-return valve and control valve so that in event of failure of instrument air compressor, instrument air is ensured continuously from service air compressor. The valves and piping arrangement for such interconnection shall also be provided.

23.2.5 All the piping works for IA & SA system including all accessories shall be provided.

23.2.6 Air from Instrument air compressors shall be dried in respective Air Drying Plants in compressor house and delivered to the Air receivers. From the Compressed air piping header at the downstream of Air receivers, one instrument air piping header for main plant and one for balance of plant shall be provided. A separate service air header shall be tapped off from the pipe header at Service Air receiver outlet header and distributed to respective areas.

23.3 Codes & Standards

The equipment to be provided under this section shall 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:

- BS-726 : Measurement of Air Flow for Compressor
- IS-2825 : Code for unfired pressure vessels.
- IS-4503 : Shell and Tube Type Heat Exchanger
- IS-5456 : Code of Practice for testing of positive displacement type air Compressors and exhausters.
- IS-5727 : Glossary of terms relating to compressors and exhausters.
- IS-1239 Part-1 : Mild Steel tubes, tubulars and other wrought steel pipes.
- IS-1239 Part-2 : Mild steel tubes, tubulars and other wrought steel fittings.

- IS-6206 : Guide for selection, installation and maintenance of air compressors/plants with operating pressure up to 10 bar.
- ANSI-B16.5 : Steel Pipes Flanges and Fittings.
- IS-7938 : Air Receivers for Compressed Air Installations.
- IS-10431 Part-I : Measurement of Air Flow of Compressor and Exhausters by nozzles.
- ASME PTC-9 : Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers.
- BS-5169/1975 : Fusion Welded Steel Air Receiver.
- ISO-7183 : Compressed Air Dryers -Specification and Testing.
- ISO-7183 (Part-II): Compressed Air Dryers - Performance rating.
- IS-12258 : Technical supply condition for Screw Air Compressor.
- BS-1571 : Simplified Acceptance Test for Air Compressor and Exhausters.
- IS-2062 : Steel for General Structural Purpose-Specification.
- IS-11989 : Compressed air dryer.
- ISO 8753.1 : Filter quality classes.

23.4 **Design Requirements & Performance Guarantee:**

23.4.1 Air Compressors shall be identical and all equipment shall be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Data Sheet enclosed with this section. Frequent start/ stop of the system shall not result deterioration in performance nor damage to the equipment.

23.4.2 The compressors and Air Drying Plants shall operate under the following ambient conditions.

- a) Minimum Temperature : 3⁰ C
- b) Maximum Temperature : 50⁰ C
- c) Design Condition (Temp & RH) : 45⁰ C & 85%

23.4.3 The capacity of each IA compressor and SA compressor shall be 50 NM³/min (minimum) or as computed by procedure for capacity determination of IA and SA in clause 23.4.10 below, whichever is higher. The discharge pressure at the outlet of after cooler shall not be less than 8.5 Kg/cm² (g).

23.4.4 Compressed Air System shall ensure a reliable supply of adequate quantity and quality of oil free dry air on continuous and intermittent basis. It consists of two sub systems namely,

- i) Instrument Air (IA) for Instrumentation and Control purposes.
- ii) Service Air (SA) for some boiler equipment, general house cleaning and other miscellaneous usage.

23.4.5 The normal pressure of Instrument Air supply at the outlet of Air Dryer shall be minimum 8.0 kg/cm² (g) (minimum). Corresponding to the normal pressure at the outlet of dryer, the rated discharge pressure of IA compressor shall be worked out, allowing for pressure drops in system piping, equipment and all other accessories. The rated discharge pressure of IA compressor shall be computed as per guidelines specified above or 8.5 kg/cm² (g) (minimum) at the

outlet of after cooler, whichever is higher. Each Service Air compressor shall be designed to deliver service air at a rated discharge pressure equal to the rated discharge pressure of each Instrument Air Compressor. The maximum expected pressure in the system shall be computed by considering 20% overpressure over and above the rated discharge pressure of each air compressor as computed above.

23.4.6 Noise level shall not exceed 85 dBA when measured at a distance of 1.0 M from the compressor. Acoustic enclosures as required 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.

23.4.7 Service air compressors and instrument air compressors shall be interconnected for flexibility in operation, designed for continuous operation with high efficiency to satisfy the system requirements. The compressors shall be of indoor duty complete with air coolers necessary valves with vent pipe work ducted to a safe discharge outlet.

dry screw /centrifugal
type

23.4.8 Compressors shall be identical oil free, rotary, ~~dry screw type~~, water cooled, horizontal and multistage. Each compressor shall have an inlet filter and silencer unit having inlet area large enough to ensure that frequent filter changes are not required. The silencer unit shall comply with the statutory noise requirements specified for which necessary acoustic enclosure shall be provided for housing the compressors. Drive motor shall comply with standard specification for induction motors enclosed with the specification and shall be connected directly to the gear box of the compressor.

23.4.9 Each air compressor shall have its own control panel with indication lights for power on; service hour-run meter; load hour-run meter; inlet air filter differential pressure high; outlet air pressure & temperature (analogue gauge); oil filter differential pressure high; separator element differential high; motor overload; low oil level; compressor temperature high; oil temperature before and after oil cooler (analog gauge). The compressor shall trip on motor overload; low oil level; and compressor temperature high.

~~23.4.10 Total Instrument Air requirements shall be assessed by the following guidelines:~~

~~$Z = \{(A+B)+C+D\} \times [1 + (mw + ml)/100]$ where,~~

~~A = Instrument Air requirement for SG & auxiliaries (continuous).~~

~~B = Instrument Air requirement (continuous) for TG & auxiliaries~~

~~C = Instrument Air requirement (continuous) for WTP and other facilities~~

~~D = Station C&I requirement (continuous).~~

~~mw = Wear & tear margin (10%)~~

~~ml = Leakage margin (10%)~~

~~Z = Total Instrument Air requirement~~

~~The total Service Air requirement shall be assessed by considering the following guideline:~~

~~$Y = \{(E+F)+G+H\} \times [1 + (mw + ml)/100]$ where~~

~~Y = Total service air requirement (continuous)~~

~~E = Service Air requirement (continuous) for SG, TG & auxiliaries.~~

~~F = Service Air requirement (continuous) for WTP and other facilities.~~

~~F = 2.5 NM³/min (minimum)~~

~~G = Service Air Requirement for AHP~~
~~H = Service Air Requirement for CHP~~
~~mw = Wear & tear margin (10%)~~
~~ml = Leakage margin (10%)~~

~~Each Service Air Compressor shall have capacity identical to that of each IA compressor but in no case less than the value Y as computed above.~~

~~While calculating the air requirement of bidder's equipment/ plant/ systems for continuous requirement of service air, no diversity factor shall be considered and they are assumed to be of "Simultaneous Requirements". The intermittent requirement of service air, if any, shall be converted into continuous requirement by considering frequency of such requirements or selecting an appropriate diversity factor and such diversity factor shall not be less than 0.6.~~

- 23.4.11 Equipment operating on Instrument Air and Service Air System shall be designed for a pressure of 120% of rated discharge pressure of each air compressor.
- 23.4.12 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 Micron.
- 23.4.13 Compressed air system equipment requiring DMCW cooling water shall be capable of operation at design capacity with DMCW cooling water inlet temperature subject to a maximum of 38^o C (indicative). The above equipment shall also be capable to withstand a pressure not less than ~~the shut off head of each DMCW pump.~~ 12 kg/cm2(g)
- 23.4.14 After cooler outlet air temperature shall not exceed ~~8^oC~~ above the cooling water inlet temperature. 10 °C
- 23.4.15 As more than one (1) compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, and keeping noise level within permissible limits for the number of compressors working simultaneously.
- ~~23.4.16 Each Air Receiver shall be so sized that even in the event of total stoppage of air inflow to the same, the pressure in the Air Receiver shall not fall below 5.5 kg/cm² (g) within two 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 shall be less than that arrived from IS: 7938.~~
- 23.4.17 Air receivers shall be provided for service air and instrument air separately as shown in the flow diagram.
- 23.4.18 Air receivers shall be designed in accordance with ASME Section-VIII or IS: 2825. Corrosion allowance of minimum 3 mm shall be considered for the design. The air receiver shall be of vertical cylindrical design with dished ends.
- 23.4.19 The air receiver shall have inlet / outlet connections, safety relief valves, fusible plugs, pressure gauges, pressure switches, temperature gauges, flanged pipe connections, inspection manholes with automatic drain traps. The air receiver shall have access platforms for maintenance of safety relief valves and instruments.

- 23.4.20 Three (3) HOC type air drying plants shall be provided (2W +1S) and shall be designed to deliver continuous instrument air. The capacity of each air drying plant shall be provided to match the corresponding 1.10 times capacity of each Instrument air compressor. Discharge pressure available at the outlet of Air Drying Plant shall be minimum 8 Kg/cm² (g) or more as per requirement.
- 23.4.21 The air drying plants receiving compressed air saturated with moisture shall be capable of operating continuously to provide reliable moisture free compressed air. Dew point of the outlet air measured at the stated operating pressure shall be as mentioned in Data Sheet or lower throughout the operation. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet shall be taken as 100% & 50°C respectively. (Suitable to handle inlet air temperature of 60°C).
- 23.4.22 The drying process shall employ heat of compression type air drying plant using adsorption process through a desiccant medium drying to remove moisture from air. The air drying plant shall be considered to remove the moisture and dry air shall have following quality:
- (a) Dew point at atmospheric pressure (-) 40° C.
 - (b) Oil content 0.01 ppm (maximum tolerable) or oil free.
 - (c) Dust – Practically dust free but maximum particle size 1 micron. Air quality after air drying plant shall be in accordance with ISA – 57.3 (Instrument Society of America) quality standards for instrument air.
 - (d) Contaminants - No corrosive hazardous, toxic or flammable materials.
- 23.4.23 Air Driers shall be suitable for part load operation while maintaining the air outlet dew point as specified above. Necessary instruments and controls shall be provided to ensure that the specified dew point is maintained irrespective of input variations.
- 23.4.24 Air Dryers shall include at least the following:
- a) Pre-filters with condensate discharge trap stations.
 - b) After-filters with condensate discharge trap station.
 - c) Inter connecting piping, fittings, specialties, drain trap station etc. complete with isolation valves, solenoid valves, check valves, pressure relief valves etc. Including all drain piping as required.
 - d) Complete control and instrumentation including control cabling from instrument to junction boxes including junction boxes, tubing, wiring inside plant.
 - e) Terminal counter flanges with nuts, bolts, gaskets, etc.
- 23.4.25 Compressed air piping shall be sized for minimum pressure drops and considering velocity range ~~as specified elsewhere in Volume III as per IS: 6206.~~ All pipelines shall have butt welded connections with flange joints for connection

15 m/sec max



to vessels and equipment. All pipelines shall be suitably supported and routed such that there shall be minimum hindrance for the operating personnel.

23.5 Scope of Supply

23.5.1 The Instrument Air System shall include but not limited to the following:

- a. Three (3) (2W+1S), oil free, dry screw type, water cooled, horizontal multistage rotary screw compressors. Each IA compressor capacity shall be 50 Nm³/min (minimum) ~~or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 above, whichever is higher,~~ at pressure 8.5 kg/cm² (g) (minimum) at the outlet of after cooler.
- b. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps
- c. Suction filter along with blow off valve and silencer
- d. Three (3) (2W+1S) Heat of Compression (HOC) type Air Drying Plants along with Pre-filter & After-filter in the air inlet & outlet of Air Dryer respectively to ensure dry moisture free Instrument quality air. Capacity of each drier shall be 1.1 times to capacity of each IA compressor.
- e. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, mass flow meters, control panels etc. Flow meter against each IA compressor shall be provided.
- f. Three (3) vertical Air Receivers each of minimum 15 M³ capacity complete with supporting structure, pressure gauges and switches, safety valves, drain traps etc.
- g. PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc.
- h. Instrument air distribution piping as required with all valves and instrumentation.

23.5.2 The Service Air System shall include but not limited to the following:

- a. Three (3) (2W+1S), oil free, dry screw type, water cooled, horizontal multistage rotary screw compressors. Each SA compressor capacity shall be 50 Nm³/min (minimum) ~~or as computed by procedure for capacity determination of IA and SA in clause no. 23.4.10 above, whichever is higher,~~ at 8.5 kg/cm² (g) pressure minimum at the outlet of after cooler.
- b. Shell and tube type water cooled Inter cooler and After cooler with moisture separators and drain traps
- c. Suction filter along with blow off valves and silencer
- d. All instruments as required including pressure switches, temperature switches, pressure gauges, temperature gauges, control panels
- e. Three (3) nos. vertical Air Receivers [of capacity 15 M³ (min)] complete with welded supporting stand and foundation bolt, pressure gauge and

switch, safety valves, drain cock as minimum.

- f. ~~PLC based control panel for control and monitoring of the Compressed air system, field instruments, control cables, etc.~~
- g. Service air distribution piping as required with all valves and instrumentation.

~~23.5.3 EOT crane for handling of air compressors and air drying plants shall be provided as detailed in Volume III, Chapter - 28.~~

23.6 Design & Construction:

The minimum requirements of design and construction features of various components of compressed air system are described below.

The motor drives shall be as per electrical specification.

23.6.1 Air Compressors

Compressors shall be multi stage oil free screw/centrifugal type.

Multiple compression chambers shall be designed to ensure minimum unbalance and arranged in compact manner suitable for easy accessibility and maintenance of the compressors.

The compression chamber, housing two precision made screw type rotors, for each stage shall be designed with large port for fast filling and low velocities.

The stator (casing) shall be of Cast- Iron IS-210 construction with integral jacket cooling. Suitable arrangement for cleaning of the cooling jackets during maintenance of compressor shall be provided.

The Rotors and shaft shall be of single piece of construction made of forged steel (AISIC 1141 or equivalent) Rotors shall be dynamically balanced, design with asymmetric profile, to keep leakage losses to a minimum and ensure high efficiency.

Highly precise timing gears to maintain rotors in correct relative position shall be shaft mounted, oil lubricated and designed to counteract the axial forces incurred in compression.

Bearing shall be high precision antifriction type IS-25 Grade 84). The axial thrust load shall be minimized by dividing the axial load of compression on the main and auxiliary bearings through suitable balancing arrangement and minimum operating life of 40000 running hours.

Shaft seals of floating restrictive ring type design to prevent air and oil leakage along the shaft into the elements. The shaft seals rings and retainers shall be of stainless steel construction and be free for radial self-adjustment on the rotor shafts.

The safety valves shall be provided on low pressure and high pressure stages to safeguard low pressure & high pressure circuit. Inlet throttle valve shall be provided to throttle the incoming air during idling period.

A direct shaft driven positive displacement type oil pump or a separate motor driven oil pump shall be provided. The lubrication system shall consist of lube oil reservoir, lube oil pumps, suction strainers for pumps, supply & return system, oil cooler and twin two full-flow (2 x 100%) of filters, required instruments etc. the filters with replacement and re-pressurizing during operations.

The motor rating (at the design ambient temperature specified for the electric drive in the electrical specification) shall be sized as specified in the electrical volume.

Couplings shall be of non-lubricated flexible element spacer type and coupling guards shall be provided.

The inlet air filter & silencer shall be located at the downstream of discharge blow off valve.

The instrumentation, controls and panels shall conform to the requirements specified in ~~Volume V~~ C & I part of technical specification.

Each compressor shall be provided with name plate, base plate, anchor bolts and shim packs, anti-vibration pads, eye bolts, operation & maintenance tools.

23.6.2 Lubrication System

The compressor package shall include a lubricant management system which shall lubricate the bearings and seal and the compressor chamber (screw rotor housing) shall be totally separated from bearing/ gear chamber.

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 rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system shall be protected by a relief valve.

The heat exchanger of the lube oil cooler shall be water cooled. The heat exchanger shall be located within the compressor skid.

The fouling factors shall be considered as per recommendation of TEMA.

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

The cooler shall be designed in accordance with the requirement of IS 2825.

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

23.6.3 Gear Box

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

23.6.4 Intercoolers, aftercoolers & oil Coolers



Intercoolers, after coolers and oil coolers shall be of water cooled & shell and tube type with water on the tube side. Intercoolers & aftercoolers shall be designed in accordance with Section VIII of ASME code or equivalent.

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

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.

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

Oil coolers shall be equipped with vent & drain connections on oil and water sides. Oil temperature control valve with manual override feature or bypass construction shall be provided to maintain constant temperature. Vent & drain connections for intercoolers and aftercoolers shall be provided.

Design pressure shall be minimum 12 kg/cm² (g) based on shut-off head of DMCW pumps.

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

Adequately sized safety valves shall be provided for both intercoolers and aftercoolers.

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

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.

Cooler shells, channels and covers shall be of steel (SA 285 Gr or Equivalent). Tube sheet shall be of SS and the tubes shall be of admiralty brass or Aluminium brass or Copper or SS 304.

23.6.5

Air Receivers

One air receiver for each compressor outside Compressor house shall be provided.

Capacity of each of the air receiver outside the compressor house shall be minimum 15 M³ (nominal). Air Receivers shall be located outdoor and shall be vertical cylindrical with dished ends.

The design pressure and temperature shall be minimum 12.75kg/m²(g) and 80° C respectively. Receivers shall be designed in accordance with Section VIII, Division 1 of ASME code or equivalent.



Air receivers are to be provided with gasketed 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.

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. Filter material to have composition and structure as that of the material welded. Electrodes to be dried before use.

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.

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

23.6.6 Intake Air Filter & Silencers

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

The filters shall be complete with integral silencers. Separate silencers, if specified shall be provided and all other accessories. The filtering elements shall be easily removable for cleaning or for replacement.

The filters shall be designed for an efficiency of not less than 99% for particles 2 microns and larger.

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

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

23.6.7 Air Drying Plants

Three (3) HOC type air drying plants shall be provided (two working and one standby) for instrument air. The capacity of each air drying plant shall be same as that of the Instrument air compressors.

23.6.7.1 Codes and Standards

The design, manufacture, testing and performance of the various components of Air Drying Plant shall comply with at least the requirements of one or more of the following codes, as applicable:

- | | | | |
|------|------------|---|------------------------------------|
| i. | IS-11989 | : | Specification for Air Dryers. |
| ii. | IS-2825 | : | Code for Unfired Pressure Vessels. |
| iii. | IS-11327 | : | HOC type units. |
| iv. | ISO 8753.1 | : | Filter quality classes. |

23.6.7.2 **Technical requirements**

~~The capacity of air drying plant shall be equal to the capacity of the individual air compressors.~~ The Air drying plant, at its rated capacity, shall be designed to deliver continuously air at dew point of minus (-) 40° C at atmospheric pressure and the Quality of dry outlet air to conform to Instrument Society of American Standard S7.3

"Quality Standard for Instrument Air".

Discharge pressure available at the outlet of Air drying Plant shall be minimum 8.0 Kg/cm² (g) or more as per the requirement.

The compressors and Air Drying plants shall operate under the following ambient conditions.

- | | | | |
|-------|--|---|--------------|
| (i) | Minimum temperature | : | 3° C |
| (ii) | Maximum temperature | : | 50° C |
| (iii) | Design condition (temperature & Relative humidity) | : | 45° C & 85 % |
| (iv) | Height above MSL | : | 270 M |

Air Drying (ADP) Plant shall be of "Heat of Compression (HOC) type".

Drying shall be by adsorption process through a desiccant medium.

Regeneration of desiccant shall be achieved by "Heat of compression" method without any air purge loss. Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in "Heat of compression type ADP".

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

The reactivation shall be achieved by the heat of the compressed air itself. The hot unsaturated compressed air from the outlet of last stage of compressor shall be passed through the adsorber tower. The moist air shall be cooled in dehumidifier and passed through the second adsorber for final drying. The design reactivation cycle/period of the tower shall be less than 8 hours including cooling period for desiccant.

Each ADP shall be provided with 2 nos. 100% capacity pre-filters and 2 nos. 100% 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.

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

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

Required sample connections to piping be provided for sampling of air at desired locations.

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

All pressure vessels such as pre-filters, after-filters, adsorber vessels, heaters, and 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 gasketed manholes/hand holes and relief valves

Quantity of desiccant to be calculated shall take into account residual moisture content at the end of regeneration cycle.

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.

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

Complete ADP equipment shall be mounted on a skid.

Required sample connections in piping be provided for sampling of air at desired locations.

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

23.6.8 Interconnecting Piping, Fittings and Valves

The interconnecting piping & valves within compressor house for compressed air & cooling water etc shall be designed in line with layout requirements indicated in Chapter : Layout Requirement of Volume III.

23.6.9 Moisture Separator

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

23.6.10 Solenoid Valves & Multi way Valves

The solenoid valve shall be of approved make. The solenoid valves shall have heavy duty, double impregnated tropicalized coils (single or double solenoid as

required) and shall be suitable for the operating temperature and for operation continuously energised in a tropical climate.

The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be of continuous duty and of epoxy moulded type, Class F. The enclosure shall be water tight, dust tight weather proof and shall conform to NEMA 4X standard. The valves shall be suitable for mounting in any position. Solenoid coils shall be Class H high temperature construction and shall be suitable for continuous operation. Type of operation and electrical ratings shall be subject to owner's approval.

23.7 Control Philosophy

23.7.1 General

The minimum requirements are specified herein and the same shall be elaborated by the bidder. The bidder shall include controls & instrumentation to facilitate safe, reliable and efficient operation of the system. The controls, protection, interlock and instrumentation system offered by the bidder shall be subjected to approval of the owner during post award engineering stage.

Any of the compressor and air drying plant may be selectable for "shutdown", "working" or "standby" duty.

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

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.

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

The following indications shall be made available in the control panels for repeating the same in main plant control system/ panels.

- a. Status of each compressor
- b. Instrument air pressure low/ high
- c. Service air pressure low/ high
- d. Dew point of instrument air
- e. Status of each ADP

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

~~Unless otherwise mentioned in Volume IV,~~ automatic motor overload control system shall be included to permit continuous operation of compressors at minimum ambient air without exceeding the name plate rating of the motor.

23.7.2 Screw Compressors /Centrifugal Compressor

23.7.2.1 Each compressor shall be in the control panel to operate either in base duty (Auto Load/ unload) or Standby duty (Auto On – Off) mode.



- 23.7.2.2 In "Base duty", whenever air supply from compressors exceeds the demand, control system shall operate the load-unload circuit at a predetermined set pressure, throttle the inlet valve and open the blow off valve. The compressor shall run in unload 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.
- 23.7.2.3 In "Standby" mode the compressor shall automatically assist base load compressors during periods of peak air demand. When air pressure in the system reaches a preset lower limit, the compressor shall be started in unloaded condition and the compressor shall be fully loaded. When the pressure in the system rises to preset high value, the compressor shall be unloaded and shall run in idling mode for a specific period (set by timer). The compressor may be loaded to full load in case of drop in system pressure or compressor may be stopped in case the system pressure does not drop and compressor continues to idle for more than a preset time.
- 23.7.2.4 The control system shall provide warning to the operator that a hot start condition exists for the motor driver and adequate cool down period has not occurred after the motor was shut down.
- 23.7.2.5 The alarms and shutdown scheme mentioned below are suggestive and shall be provided as per manufacturer's standard practice meeting the sage operational requirement of the equipment/ system of each compressor:
- | | | |
|----|---|--------------|
| a. | "Air temperature high" at inlet stage | Alarm & trip |
| b. | Low Lube Oil Pressure | Alarm & trip |
| c. | High Lube Oil Supply temperature | Alarm & trip |
| d. | High Oil filter differential pressure | Alarm & trip |
| e. | Low Lube oil level in lube oil sump | Alarm & trip |
| f. | High inlet air filter differential pressure | Alarm & trip |
| g. | Low cooling water flow to air compressors | Alarm & trip |

23.7.3 **Air Drying Plant**

- 23.7.3.1 The control system shall provide the (as minimum) alarms, "High Reactivation air temperature", "Low Reactivation air Temperature", "Low Cooling Water Flow", "Low Air pressure at the outlet of ADP" and "High dew point at the outlet of ADP". Adequate number of temperature elements etc shall be provided for measurement and monitoring the same.

Design & construction of equipments shall meet the minimum requirement mentioned in the specification. Any superior material (as per proven practice of OEM and relevant standard) of various components is also acceptable.

DATA SHEET

AIR COMPRESSOR AND AUXILIARIES

S. No.	ITEM		DETAIL
1.0	PERFORMANCE DATA		
1.1	Free Air Delivery	:	Bidder to compute and indicate as per guidelines specified
1.2	Capacity	:	50 Nm ³ /min (minimum), 8.5 Kg/cm ²
1.3	Noise level	:	Noise level shall not exceed 85 dBA when measured at a distance of 1M from the compressor. Acoustic enclosures as required shall be provided to meet the above condition.
1.4	Vibration limit (measured at top and bottom of main bearing)	:	40 microns
2.0	CONSTRUCTION FEATURES		
2.1	Location	:	Indoor
2.2	Number of compressors	:	Three (3) IA compressors (2W+1S) and Three (3) SA compressors (2W+1S) connected on a common discharge manifold
2.3	Type	:	Oil-free, dry screw type, water cooled, horizontal, two (2) stage, rotary screw /Centrifugal compressor.
2.4	Service	:	Instrument Air and Service Air
2.5	Duty	:	Continuous
2.6	Type of Drive	:	Electric Motor
2.7	Design ambient temperature for drive	:	50°C
2.8	Number of starts per hour	:	Refer Electrical specification
2.9	Type of transmission	:	Gear
2.10	Ant vibration arrangement required	:	Yes
2.11	Type of control	:	Dual i.e. both load-unload and auto start/ stop
2.12	Type of Annunciation	:	Audio-visual
2.13	Flange standard	:	ANSI B-16.5/equivalent

S. No.	ITEM		DETAIL
3.0	MATERIAL OF CONSTRUCTION		
3.1	Compressor chamber	:	Grey Cast Iron IS 210 Gr FG 260 coated with corrosion resistant material
3.2	Rotors	:	Forged carbon steel EN-8M coated with corrosion resistant material
3.3	Bearing	:	Oil lubricated Antifriction type suitable for at least 40,000 running hours.
3.4	Timing Gear	:	Alloy Steel AISI 862 CH Ni Cr Mo Steel
3.5	Base Plate	:	MS
3.6	Shaft	:	EN-8/8M
3.7	Inlet throttle valve & housing	:	SS-304
3.8	Shaft seals	:	Stainless Steel
3.9	Safety valves	:	Stainless Steel
3.10	Tube of oil cooler	:	SS-304/Cu Nickel
3.11	Outer casing of coolers	:	Carbon Steel / Grey Cast Iron IS: 210, FG 220
3.12	Non Return Valve		Stainless steel spring loaded type.
3.13	Gear Box	:	Grey Cast Iron IS: 210 Gr FG 260
3.14	Gears	:	Alloy Steel
4.0	SUPPLY OF ACCESSORIES & SERVICES		
4.1	Intake air filters with silencers	:	Yes
4.2	Intercoolers	:	Yes
4.3	After coolers with moisture separators	:	Yes
4.4	Coupling guards	:	Yes
4.5	Air receivers	:	Yes
4.6	Foundation bolts, nuts, sleeves, inserts etc.	:	Yes
4.7	All interconnecting air and cooling water piping, complete with valves, fittings as shown in relevant tender drawings and as required for reliable and smooth operation of the system	:	Yes

S. No.	ITEM		DETAIL
4.8	Eye bolts, lifting tackle, tools, etc.	:	Yes
4.9	Control panels complete with all accessories	:	Yes
4.10	Instrument gauge panels complete with all accessories	:	Yes
5.0	DM COOLING WATER DATA		
5.1	Quality	:	DM Water
5.2	Design inlet temperature	:	38°C (maximum
5.3	Design pressure	:	Bidder to indicate. Shall not be less than 12kg/cm² (g). ~~DMCW pump.~~
5.4	Normal inlet pressure	:	Bidder to indicate. Shall be equal to the rated TDH of DMCW pump 3.5 to 5 bar
5.5	pH value	:	8.5 to 9.5
5.6	Maximum pressure drop allowable between inlet and outlet points	:	6.0 to 8.0 MWC
6.0	DRIVE MOTOR		
6.1	Drive motor for compressor shall comply with the requirements of relevant Clause of this Chapter and electrical part of the specification	:	Yes/No
7.0	COMPRESSOR ACCESSORIES		
7.1	INTAKE AIR FILTER	:	
7.1.1	Numbers required	:	One (1) with each compressor
7.1.2	Location	:	Indoor, at the suction of each air compressor
7.1.3	Type	:	Dry type
7.1.4	Silencer	:	Yes
7.1.5	Air flow rate	:	To suit compressor rating
7.1.6	Particle removing efficiency	:	99.9% up to particle size of 2 Micron
7.1.7	Maximum allowable pressure drop at stated air flow rate in new condition of filter (viscosity of air at normal ambient temperature)	:	150 mm WG
7.2	AIR RECEIVER		

S. No.	ITEM		DETAIL
7.2.1	Numbers required	:	One (1) for each IA compressor + (1) for each SA compressor at the Compressor Outlet. Further, dedicated receivers as required for the system shall be provided.
7.2.2	Installation	:	Outdoor
7.2.3	Type	:	Vertical cylindrical with torispherical dished ends.
7.2.4	Design pressure / Temperature	:	Minimum 1.5 times compressor discharge pressure (or 12.75 kg/cm ² (g) minimum) / 80° C (minimum)
7.2.5	Hydraulic test Pressure	:	150 % design pressure.
7.2.6	Design code	:	ASME Sec-VIII or IS-2825/IS-7938/ Approved equal
7.2.7	Capacity of each air receiver	:	15 M ³
7.2.8	Material of construction of shell	:	MS to IS-2062
7.2.9	Material of construction of dished ends	:	MS to IS-2062
7.2.10	Material of construction of flanges	:	MS to IS-2062
7.2.11	Corrosion allowance		3.0 mm (minimum)
7.2.12	Supply of Accessories & Services	:	
7.2.12.1	Flanges with nuts, bolts and gaskets	:	Yes
7.2.12.2	Pressure gauge with snubber	:	Yes
7.2.12.3	Pressure Transmitter	:	Yes
7.2.12.4	Temperature gauge	:	Yes
7.2.12.5	Relief valve	:	Yes, set pressure shall be at least 10% above working pressure
7.2.12.6	Trap station	:	Yes
7.2.12.7	Vent valve/plug	:	Yes
7.2.12.8	Supporting stand with necessary foundation bolts, nuts, sleeves etc	:	Yes
7.2.12.9	Eye bolts, lifting tackle etc.	:	Yes
7.2.12.10	Automatic Drain Trap		Yes
7.2.12.11	Painting	:	

S. No.	ITEM		DETAIL
a.	External	:	Two coats of epoxy Primer and two finish coats of epoxy paints.
b.	Internal	:	Cleaned and one coat of black bituminous paint applied.
7.3	INTERCOOLER, AFTERCOOLER, MOISTURE SEPARATOR, PIPING, VALVES ETC:		
7.3.1	After cooler :		
a.	Installation	:	Indoor
b.	Type	:	Shell and Tube
c.	Relief Valve	:	Yes
d.	Moisture Separator	:	Yes
e.	Trap Station	:	Yes
f.	Temperature Indicator	:	Yes
g.	Temperature Switch	:	Yes
h.	Temperature Transmitter	:	Yes
7.3.2	Intercooler :		
a.	Installation	:	Indoor
b.	Type	:	Shell and Tube
c.	Relief Valve	:	Yes
d.	Trap Station	:	Yes
e.	Pressure Gauge	:	Yes
f.	Temperature Indicator	:	Yes
g.	Temperature Switch	:	Yes
h.	Temperature Transmitter	:	Yes
i.	Moisture Separator	:	Yes
7.3.3	Supply of Accessories and Services	:	
a.	Supporting stands with bolts, nuts and gaskets	:	Yes

S. No.	ITEM		DETAIL
b.	Eye bolts, lifting tackle etc with tools and tackle	:	Yes
c.	Flanged connections for supply and return of cooling water	:	Yes
7.3.4	Material of Construction :		
a.	Tube	:	Cu Nickel/Stainless steel within star profile
b.	Shell	:	IS 2062
c.	Tube Sheet	:	IS 2002 Gr 2
d.	Baffles	:	IS 2062
e.	Flanges	:	IS 2062
7.3.5	Piping, Valves and Fittings for Compressed Air System :		
a.	Pipes for cooling water line and service water line	:	IS-1239 (Heavy grade) up to 150 NB. IS-3589 for sizes above 150 NB with minimum pipe thickness of 6 mm.
b.	Pipes for Instrument & service air line & interconnecting air line	:	ASTM A-53 type EGr. B galvanized /IS 1239 heavy galvanized /IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
7.3.6	Fittings		
a.	Fittings for cooling water line & service water line	:	ASTM A-234 Gr. WPB for sizing including 65 NB and above. And ASTM A105 for sizes up to 50 NB
b.	Fittings for Instrument air piping & interconnecting air piping	:	Stainless steel as per ASTM A-182 F304

AIR DRYING PLANT AND AUXILIARIES

S. No.	ITEM		DETAIL
1.0	GENERAL INFORMATION		
1.1	Numbers of Air drying Plant	:	Three (3) (2W + 1S) One (1) for each IA compressor
1.2	Duty	:	Continuous
1.3	Operation	:	Fully Automatic
1.4	Service	:	Instrument Air
1.5	Installation	:	Indoor
1.6	Type	:	HOC
1.7	Outlet dew point	:	(-) 40° C at atmospheric pressure
1.8	Annunciation	:	Local and remote
1.9	Location	:	Indoor skid mounted
2.0	MATERIAL OF CONSTRUCTION		
2.1	Adsorber vessel		IS 2062
2.2	All internals of adsorber vessels		SS 304
2.3	Cooler shells, channels and covers Cooler Tube sheet & tubes		Same as that in intercoolers/after coolers
2.4	Relief valves		SS
2.5	Desiccant		Silica gel or Activated Alumuna
2.6	Air piping		Galvanized steel to IS 1239 (H)/IS 3589 (min. 6 mm thick)
2.7	Valves in Air Line		CI or Cast steel or Forged steel body with stainless steel trim
2.8	Valves in water pipe lines		SS/Bronze/Gunmetal
3.0	PERFORMANCE SPECIFICATION		
3.1	Air drying capacity	:	1.10 times the instrument air compressor capacity
3.2	Inlet air pressure	:	To suit compressor rating
3.3	Air flow (Free Air delivery)	:	To suit compressor rating
3.4	Inlet air temperature	:	~~Refer met data in Volume II,~~ ~~However,~~ shall be suitable to handle air inlet temperature of 60 °C.

S. No.	ITEM		DETAIL
3.5	Maximum allowable air pressure drop	:	0.5 kg/cm ²
3.6	Design Requirement	:	(-) 40° C dew point at outlet (at atmospheric pressure). Dust laden, not more than 0.1 ppm, oil free
4.0	SUPPLY OF ACCESSIONS AND SERVICES FOR EACH ADP		
4.1	Pre-filters and After Filters	:	2 x 100% with automatic drain trap filter arrangement & with ceramic candle type
4.2	Dew point indicator on line	:	Yes
4.3	Instruments as per specification, Tender drawing and as required for safe and trouble free operation	:	Yes
4.4	Control panel with accessories	:	Yes
4.5	All interconnecting piping complete with fittings, valves etc.	:	Yes
4.6	Insulation	:	Yes
4.7	Base frame, foundation bolts, nuts, sleeves etc.	:	Yes
4.8	Vessel internal paint	:	Anti-corrosive

INSTRUMENT AIR COMPRESSOR	520KW	-----	S	2	1	C	U	N	C	Motor	15-20SEC	*						Refer notes	
SERVICE AIR COMPRESSOR	520KW	-----	S	2	1	C	U	N	C	Motor	15-20SEC	*						(i), (ii) and (iii).	
AIR DRYER (INCL. HEATER)	9KW	-----	S	2	1	E	D	N	C	Panel	-----	*							
IA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*						DG SUPPLY	
SA COMPRESSOR AUX. SUPPLY (INCL. OIL PUMP)	7.5KW	-----	S	2	1	D	S	Y	C	Panel	-----	*							
UPS SUPPLY FOR MICROPROCESSOR PANELS & SEQUENTIAL PANLEL	7.5KW	-----	S	1	1	D	S	N	C	Panel	-----	*						230VAC UPS	BY C&I
RECEIVER DRAIN ADT	0.5KW	-----	S	8	0	E	S	N	I	ADT	-----	**							
AFTER COOLER DRAIN ADT	0.5KW	-----	S	-	-	E	S	N	I	ADT	-----	*						(Qty. as applicable)	
UTILITY COMPRESSOR FOR CENTRIFUGAL COMPPRESSOR	9KW	-----	S	1	0	D	S	N	I	Motor	5 SEC	*							
UTILITY DRYER FOR CENTRIFUGAL COMPPRESSOR	1KW	-----	S	1	0	D	S	N	I	Panel	-----	*							
MOTORISED VALVE	1KW	-----	S	2	0	D	B	N	I	ACTUATOR	-----	*							

NOTES:

- 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) Suitable protection shall be included in the HT Switchgear logic to prevent frequent start stop of the compressor HT motors.**
- * - Compressor House.**
- ** - 6 nos. outside Compressor House, 2 nos. for TG**

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
ANNEXURE A Annual maintenance contract services		

ANNEXURE - A

ANNUAL MAINTENANCE CONTRACT SERVICES

The bidder scope covers the Annual maintenance contract (AMC) for Preventive / Breakdown maintenance for a period of One (1) year from the date of successful commissioning of Compressed air system.

AMC scope also covers all regular maintenance by certified and trained service engineers. Total Six visits (06) (Including 2 Breakdown visit) shall be provided in a year and each visit shall consist of 1 to 2 days, depending upon the nature of work.

1.0 Scope of Work & Supply:

The scope of work and supply includes:

1. To carry out Preventive Maintenance checks as per mentioned schedule provided by bidder ensuring min. one routine visit per quarter, to attend Air compressors, its motor, Air dryer and all its accessories.
2. In case of breakdown, bidder shall depute qualified Service manpower and rectify the same with in strict time frame, not exceeding 48 hours.
3. Following operational spares are in CAS supplier scope
 - a) Lube oil (Qty. for 1 Lot in Ltr. shall be as per oil tank capacity for One Compressor) - **01 x no of compressor for each specific project.**
 - b) Lube oil filters with seals - **02 x no of compressor for each specific project.**
 - c) Air filters with gaskets - **02 x no of compressor for each specific project.**
 - d) Service kit including seals, washers and rings for inter cooler & after cooler - **01 x no of compressor for each specific project.**

Spares, consumables, maintenance kits etc. required for preventive AMC / breakdown shall be provided to successful bidder's service provider by BHEL on the written request basis. Any specific item not available in BHEL inventory, shall be provided by bidder on mutual settlement of related commercial issues.

2.0 General Checklist for Air compressor: -

The checklists are intended for general description of work to be carried out. They are not intended to cover all minute details. The work shall be executed in accordance with Manufacturer's O&M Manuals and modern techniques. Preventive Maintenance checks includes but not limited to as specified below:

MAINTENANCE OF SCREW COMPRESSOR

- Carry out external cleaning of equipment.
- Check the oil level in the tank if low top-up with oil.
- Change the lube oil & lube oil filter element.
- Check the tightness of foundation bolt & take corrective action, if applicable.
- Check the coupling gear installed between compressor and motor.
- Check & clean the air breather in oil tank.
- Setting and checking of safety valves
- Pressure switch setting, Trips condition checking.
- Blow down valve functioning and repairing if necessary

- Clean the inlet air filter / oil filter element.
- Checking / cleaning of all heat exchangers.
- Checks the leakage in oil line, water line and airline if found then rectify the same.
- Cleaning of cooling water inlet line strainer, back flushing of air and oil cooler, air purging oil scavenging & connecting tube, Cleaning & servicing of moisture separator installed at compressor outlet, cleaning of all moisture & dust separating filter elements as prescribed by manufacturer.
- Check for Electrical connections intact.
- Check for compressor control panel as per manufacturer recommendation.
- Any other maintenance as recommended by manufacturer.

MAINTENANCE OF AIR DRYER

- Carry out external cleaning of equipment.
- Clean the suction filter/ moisture strainer.
- Check the tightness of foundation bolts & take corrective action if required.
- Assisting for inspection / repair / servicing during expert visit as per instructions.
- Check change over valve.
- Check for any leakages in pipeline.
- Check for Electrical connections intact.
- Equipment external and internal cleaning.
- Any other maintenance as recommended by manufacturer.

3.0 Tools and tackles

Tools and tackles required for handling the component will be provided to the Bidder (successful bidder) on the written request basis. Bidder shall not claim any delay or compensation due to unavailability of these items, if any. In such cases bidder need to arrange the required tools and tackles at his own cost.

- 4.0** Bidder is to arrange all the safety gears like helmets, air plugs, safety shoes etc. during the maintenance.
- 5.0** In case of breakdown, Bidder is to depute service manpower within 48 hrs. without fail.
- 6.0** For Breakdown Maintenance, Bidder is to service and operate the compressor with satisfactory operating parameters within a week (6 working days) of reporting.
- 7.0** Bidder is to submit the Servicing Report (SR) of completed Breakdown Maintenance.
- 8.0** If any damage to the equipment and its accessories due to improper maintenance by bidder shall be recovered from the bidder.

	TECHNICAL SPECIFICATION	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	COMPRESSED AIR SYSTEM	Rev. No. 00
		Date: Dec 2025
ANNEXURE B Instruction Manuals		

ANNEXURE - B

INSTRUCTION MANUALS

The vendor shall submit Instruction Manuals for all the equipment's covered under the Contract. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

A) ERECTION MANUALS

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of a particular equipment/system. The erection manual should contain the following as a minimum.

- a) Erection strategy.
- b) Sequence of erection.
- c) Erection instructions.
- d) Critical checks and permissible deviation/ tolerances.
- e) List of tools, tackles, heavy equipment's like cranes, dozers, etc.
- f) Bill of Materials
- g) Procedure for erection and General Safety procedures to followed during erection/installation.
- h) Procedure for initial checking after erection.
- i) Procedure for testing and acceptance norms.
- j) Procedure / Check list for pre-commissioning activities.
- k) Procedure / Check list for commissioning of the system.
- l) Safety precautions to be followed in electrical supply distribution during erection.

B) OPERATION & MAINTENANCE MANUALS

The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left-hand side.

The arrangement and contents of O & M manuals shall be as follows:

1) Chapter 1 - Plant Description: To contain the following sections specific to the equipment/system supplied

- (a) Description of operating principle of equipment / system with schematic drawing / layouts.
- (b) Functional description of associated accessories / controls. Control interlock protection write up.
- (c) Integrated operation of the equipment along with the intended system. (This to be given by the supplier of the Main equipment by considering the operating instruction given by the associated suppliers).

- (d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment along with its accessories and auxiliaries.
- (e) Design data against which the plant performance will be compared.
- (f) Master list of equipment, Technical specification of the equipment/ system and approved data sheets.
- (g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).
- (h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

- (a) Protection logics provided for the equipment along with brief philosophy behind the logic, Drawings etc.
- (b) Limiting values of all protection settings.
- (c) Various settings of annunciation/interlocks provided.
- (d) Start-up and shut down procedure for equipment along with the associated systems in step mode.
- (e) Do's and Don'ts related to operation of the equipment.
- (f) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.
- (g) Parameters to be monitored with normal value and limiting values.
- (h) Equipment isolating procedures.
- (i) Trouble shooting with causes and remedial measures.
- (j) Routine testing procedure to ascertain healthiness of the safety devices along with schedule of testing.
- (k) Routine Operational Checks, Recommended Logs and Records.
- (l) Change over schedule if more than one auxiliary for the same purpose is given.
- (m) Preservation procedure on long shut down.
- (n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance- To contain the following sections specific to the equipment supplied.

- (a) Exploded view of each of the equipment's. Drawings along with bill of materials including name, code no. & population.
- (b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.
- (c) List of Special T/P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.
- (d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.
- (e) Preventive Maintenance schedules linked with running hours/calendar period along with checks to be carried out.
- (f) Overhauling schedules linked with running hours/calendar period along with checks to be done.

- (g) Long term maintenance schedules
- (h) Consumables list along with the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.
- (i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement.
- (j) Tolerance for fitment of various components.
- (k) Details of sub vendors with their part no. in case of bought out items.
- (l) List of spare parts with their Part No., total population, life expediency & their interchangeability with already supplied spares to NTPC.
- (m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.
- (n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.
- (o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipment have been supplied.

After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-C. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer. If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-C.

PLANT HANDBOOK AND PROJECT COMPLETION REPORT

PLANT HANDBOOK

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipment and systems covering the complete project including

- i) Design and performance data.
- ii) Process & Instrumentation diagrams.
- iii) Single line diagrams.
- iv) Sequence & Protection Interlock Schemes.
- v) Alarm and trip values.
- vi) Performance Curves.
- vii) General layout plan and layout of main plant building and auxiliary buildings
- viii) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start up and commissioning activities.

PROJECT COMPLETION REPORT

The Contractor shall submit a Project Completion Report at the time of handing over the plant.

DRAWINGS

a) i) All the plant layouts shall be made in computerized 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.

ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-C. The soft copies shall also be submitted.

iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per Annexure-C.

b) All documents/text information shall be in latest version of MS Office/MS Excel/PDF format as applicable.

c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

d) Each drawing submitted by the Contractor (including those of sub-vendors) shall bear a title block at the right-hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

e) The drawings submitted by the vendor (or their sub vendors) shall bear title block in addition to vendor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission in line with Suggestive MDL.

Further, space shall be identified on each drawing for Approval stamp and electronic signature.

f) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

g) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.

h) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

i) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/ representative of Employer based on requirements of such piping indicated in approved/ finalised Flow Scheme/ Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package. Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

j) As Built Drawings After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to "as built" conditions and submit no. of copies as per Annexure C.

k) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/ drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

l) The Contractor shall submit adequate prints of drawing / data / document as per Annexure-C. The Employer shall review the drawings and return soft copy to the Contractor authorizing either to proceed with manufacture or fabrication or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

m) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the contract documents and the entire works covered under these specifications shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025

ANNEXURE C

Hard print requirement for drgs/ docs.

	TECHNICAL SPECIFICATION		PE-TS-510/ 527/ 528/ 529/ 530-555-A001	
	COMPRESSED AIR SYSTEM		Rev. No. 00	
			Date: Dec 2025	

Project wise details of hard prints of drawing/ documents as mentioned below are in bidder scope.

A) 2x660 MW DVC RAGHUNATHPUR and 2x660 MW KORBA WEST

S.No.	Description of Drgs./Docs.	No. of Prints	No. of Portable Hard Disk
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents		
	First submission and submission with major changes		
	Layout (A0&A1 sizes)	3	-
	Other Drawings/ Documents (A0 & A1 sizes)	3	-
	P&ID (All sizes)	3	-
	a) Final drawings/documents (Directly to site)	3	2
	b) "As Built" Drawing/ Documents (Directly to site)	3	2
	c) Analysis reports of Equipments / piping / structures components/system employing software packages as detailed in the specifications.	2	2
2	Erection Manual (Directly to site)	3 sets	2
3	Operation & Maintenance manual		
	i) First Submission	0	0
	ii) Final Submission (Directly to site)	3 sets	2
4	Plant Hand Book		
	i) Final submission	1	1
5	Commissioning and Performance Test Procedure manual		
	i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	3 sets	2
6	Performance and Functional Guarantee Test Report		
	i) First Submission	1 set	--
	ii) Approved copies (Directly to site)	3 sets	2
7	Project Completion Report (Directly to site)	3 sets	2

B) 1x800 MW UKAI TPS and 2x660 MW Koradi

S.No	Description	Consultant	HQ	Site
1	Drawings and documents for approval	0	3 Print	0
2	Drawings and documents for information	0	3 Print	0
3	Approved drawings and documents	0	2 Print	2 Print
4	Testing and commissioning procedures	0	2 Print	2 Print
5	O&M Manuals	0	2 Print	4 Print
6	As built drawings	0	2 Print	4 Print
7	Performance Test Reports		6 Print	

Note: Only soft copies to be submitted to consultant. However, hardcopies should be submitted to consultant, whenever specifically sought.

C) 1x800 MW Yamunanagar

S.No	Description	Consultant	HQ	Site
1	Drawings and documents for approval (First submission)	1 Print	2 Print	
2	Drawings and documents for approval (Resubmission)	1 Print	2 Print	
3	Drawings / documents Approved by HPGCL	1 Print	2 Print	4 Print
4	Drawings / doc for Information	1 Print	2 Print	2 Print

	TECHNICAL SPECIFICATION COMPRESSED AIR SYSTEM	PE-TS-510/ 527/ 528/ 529/ 530-555-A001
		Rev. No. 00
		Date: Dec 2025
ELECTRICAL SPECIFICATION		

	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS, TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM(CAS) PACKAGES (ELECTRICAL PORTION)	SPECIFICATION NO. PE-TS-510/ 527/ 528/ 529/ 530-555-A001 VOLUME II B REV 00 DATE 10.12.2025 PAGE 1 OF 1
---	---	--

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

- 1.1 Scope for supply, erection and testing & commissioning of various equipment forming part of electrical system for this package shall be as per **Annexure-E.1** "SCOPE MATRIX BETWEEN BHEL AND COMPRESSED AIR SYSTEM(CAS) VENDOR (EPC PROJECTS)".
- 1.2 Make of all electrical equipment/ items supplied shall be reputed make. Same shall be subject to approval of BHEL/customer after award of contract without any commercial & time implications. Tentative make list of various Electrical items is attached.
- 1.3 All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
- 1.4 In case of any conflict between the Technical Datasheet of LT Motors (Annexure-E.2) & respective project technical specification (A Technical Datasheet of LT Motor (Annexure-E.3A/ 3B/ 3C/ 3D/ 3E), the more stringent will prevail.

2.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 2.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated.
- 2.2 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.

3.0 LIST OF ENCLOSURES

1. Electrical scope Matrix between BHEL & CAS vendor (Annexure-E.1).
2. Technical Datasheet of LT Motor (Annexure-E.2)
3. Motor Technical specification, Quality Plan & Sub-vendor list (Annexure-E.3A): 1X800MW HPGCL YAMUNANAGAR TPS Project.
4. Motor Technical specification, Quality Plan & Sub-vendor list (Annexure-E.3B): 2X660 MW MSPGCL KORADI TPS PROJECT
5. Motor Technical specification, Quality Plan & Sub-vendor list (Annexure-E.3C): 2X660 MW DVC RAGHUNATHPUR TPS PROJECT
6. Motor Technical specification, Quality Plan & Sub-vendor list (Annexure-E.3D): 1X800 MW GSECL UKAI TPS PROJECT
7. Motor Technical specification, Quality Plan & Sub-vendor list (Annexure-E.3E): 2X660 MW CSPGCL KORBA WEST TPS PROJECT
8. Technical specification of miscellaneous items (Annexure-E.4)
9. Load data format (Annexure-E.5).
10. Cable Schedule Format (Annexure-E.6)

ANNEXURE-E.1
SCOPE MATRIX BETWEEN BHEL AND CAS VENDOR (EPC PROJECTS)
PACKAGE: COMPRESSED AIR SYSTEM(CAS)

1. **PROJECT:** 2X660 MW MSPGCL KORADI TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW HPGCL YAMUNANAGAR TPS

S.NO	DETAILS	SCOPE OF SUPPLY	SCOPE OF ERECTION	SCOPE OF TESTING & COMMISSIONING	REMARKS
1.	3.3KV/ 6.6KV HT Switchgear	BHEL	BHEL	BHEL	3.3kV for Koradi & Raghunathpur Projects 6.6kV for Yamunanagar, Ukai Projects & Korba West projects
2.	415V ACDB / MCC	BHEL	BHEL	BHEL	415 V AC (Normal/ Emergency) , 3 phase, 3 wire 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. Any other voltage level (AC/DC) required will be derived by the vendor. For UPS (1Phase 230V AC) Power supply, C&I specification/ scope to be referred.
3.	Local Push Button Station (for motors)	BHEL	BHEL	BHEL	Located near the motor.
4.	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	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Cabling/termination at BHEL equipment by BHEL and at Vendor equipment by Vendor.
5.	Junction box for control & instrumentation cable	Vendor	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
6.	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
7.	Cable trays, accessories & cable tray support system	BHEL	BHEL	BHEL	
8.	Cable glands, lugs and bimetallic washers for equipment supplied by Vendor	Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty copper lugs for power & control cables.

ANNEXURE-E.1
SCOPE MATRIX BETWEEN BHEL AND CAS VENDOR (EPC PROJECTS)
PACKAGE: COMPRESSED AIR SYSTEM(CAS)

1. **PROJECT:** 2X660 MW MSPGCL KORADI TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW HPGCL YAMUNANAGAR TPS

S.NO	DETAILS	SCOPE OF SUPPLY	SCOPE OF ERECTION	SCOPE OF TESTING & COMMISSIONING	REMARKS
9.	Galvanised Steel Conduit and conduit accessories, 50/75mm Galvanised Steel cable Troughs for local cabling between equipment supplied by vendor	Vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 50/75 mm. cable trays/ conduits/ Galvanised steel cable troughs as per approved layout drawing during contract stage.
10.	Lighting	BHEL	BHEL	BHEL	
11.	Equipment grounding (Including Electronic earthing) & lightning protection	BHEL	BHEL	BHEL	Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing
12.	Below grade grounding	BHEL	BHEL	BHEL	
13.	3.3KV/ 6.6kV HT Motors with base plate and hardware	BHEL	Vendor	Vendor	Motor will be free supply by BHEL to CAS vendor works. Same will be assembled along with compressor at CAS vendor works for testing. Further same set will be erected, tested and commissioned by CAS vendor at site. 3.3kV HT motors for Koradi & Raghunathpur Projects 6.6kV HT motors for Yamunanagar, Ukai Projects & Korba West projects
14.	LT Motors with base plate and foundation hardware	Vendor	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
15.	Mandatory spares	Vendor	-	-	Vendor to quote as per specification.
16.	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	Vendor	
17.	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above	Vendor Vendor	- -	- -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.

ANNEXURE-E.1
SCOPE MATRIX BETWEEN BHEL AND CAS VENDOR (EPC PROJECTS)
PACKAGE: COMPRESSED AIR SYSTEM(CAS)

1. **PROJECT:** 2X660 MW MSPGCL KORADI TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW HPGCL YAMUNANAGAR TPS

S.NO	DETAILS	SCOPE OF SUPPLY	SCOPE OF ERECTION	SCOPE OF TESTING & COMMISSIONING	REMARKS
	c) Cable block diagram	Vendor	-	-	
18.	Equipment layout drawings	BHEL/Vendor		-	For preparation of cabling layout drawings by BHEL, vendor shall furnish Electrical equipment layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling.
19.	Electrical Equipment GA drawing	Vendor		-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract without any price & time implication to BHEL.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.

ANNEXURE - E.2

	TECHNICAL SPECIFICATION FOR CAS PACKAGE(ELECTRICAL PORTION)		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS,		Issue No: 01
			Rev. No. 00
			Date : 10.12.25
B-02 (LT MOTORS TECHNICAL DATA)			
SL.NO	DESCRIPTION	UOM	DETAIL
1.0	DESIGN CODES & STANDARDS		
1.1	Three phase induction motors :		IS15999, IEC:60034, IS: 12615, IS: 325
1.2	Energy Efficient motors		IS 12615, IEC:60034-30
1.3	Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity		IS 12075/IEC 60034-14
1.4	Designation of Methods of Cooling of Rotating Electrical Machines		IS 6362
1.5	Designation for types of construction and mounting arrangement of rotating electrical machines		IS 2253
2.0	DESIGN /SYSTEM PARAMETERS		
2.1	Rated voltage	V	415
2.2	Frequency	Hz	50
2.3	Permissible variations for		
a)	Voltage	%	+/-10
b)	Frequency	%	(+)5 to (-)5
c)	Combined	%	10 (absolute sum)
2.4	System fault level at rated voltage for 1 sec	kA	50
2.5	Short time rating for terminal boxes for 0.25 sec	kA	50
2.6	Type of motors		Squirrel cage induction motor
a)	Non-VFD		Suitable for direct on line starting
b)	VFD (if applicable)		Suitable for inverter duty
2.7	Efficiency class		
a)	Output rating (at 50 deg.C ambient temperature)		Efficiency class
i)	upto 50 KW		a) Super Premium Efficiency Class-IE4 for DVC Raghunathpur & CSPGCL Korba West Projects b) Premium Efficiency Class-IE3 for HPGCL Yamunanagar, GSECL UKAI, MSPGCL Koradi.
ii)	50- 200 KW		Premium Efficiency Class-IE3 for all projects.
2.8	Rating		
a)	Motor duty		Continuously rated-S1
b)	Design margin over continous max. demand of the driven equipment (minimum) (If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail).		10%
3.0	CONSTRUCTION FEATURES		
3.1	Winding		Electrolytic grade copper conductor
3.2	Enclosure Details		
a)	Degree of protection		
i)	Indoor application		IP 55
ii)	Outdoor application		IP 55 (Additional Canopy to be provided)
b)	Method of ventilation		Totally enclosed fan cooled (TEFC) type
3.3	Insulation		
a)	Class		'F' with temperature rise limited to 70 Deg. C
b)	General Characteristics		Non-hygroscopic, oil resistant, flame resistant
c)	Special Characteristics		VPI insulation for VFD motors
3.4	Main terminal box		
a)	Type		Detachable type
b)	Location		In accordance with Indian Standards clearing the motor base- plate/ foundation
c)	Terminals		Stud or lead wire type, substantially constructed and thoroughly insulated from the frame

	TECHNICAL SPECIFICATION FOR CAS PACKAGE(ELECTRICAL PORTION)		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS,		Issue No: 01
			Rev. No. 00
			Date : 10.12.25
d)	Markings		Phase markings on terminals and direction of rotation marked on the non-driving end
e)	DOP		Same as motor
f)	Rotation		360 Deg. rotatable in steps of 90 Deg.
g)	Space heater (for ratings 30 kW and above)		Suitable for 240V, 50Hz 1 ph AC. Separate terminal box provided for space heaters.
h)	Cable glands/lugs/gland plates		
i)	Size		As per cable size used
ii)	Lugs		Solderless crimping type heavy duty copper lugs
iii)	Glands		Double compression Ni-Cr plated brass glands
iv)	Gland plate thickness		3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables)
3.5	Earthing points		
a)	No. of points on motor body		Two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.
b)	No. of points on motor terminal box		One earthing point complete with tapped holes, GI bolts and washers.
c)	Earthing Flat size (Indicative)		Motor Earthing Terminal will be suitable for termination of Earthing Flat size (tentative) indicated below. Final size will be confirmed by BHEL during contract stage.
i)	LT Motors above 125 KW		50 x 6mm GS flat
ii)	25 KW to 125 KW		25 x 6mm GS flat
iii)	1KW to 25 KW		25 x 3mm GS flat
iv)	Fractional kW		8 SWG GS Wire
3.6	Painting		Corrosion proof epoxy based paint with suitable additives to be used.
a)	Paint shade		Project specific paint shade shall be confirmed by BHEL during contract stage
b)	Thickness of paint		The thickness of finish coat shall be minimum 50 microns (minimum total DFT 100 microns). (Above is the minimum requirement. Also refer respective project specification - Annexure-E.3A/ 3B/ 3C/ 3D/ 3E).
3.7	Minimum spacing between gland plate & centre of bottom terminal stud		
a)	UP to 3 KW		As per manufacturer's practice.
b)	Above 3 KW - upto 7 KW		85 mm
c)	Above 7 KW - upto 13 KW		115 mm
d)	Above 13 KW - upto 24 KW		167 mm
e)	Above 24 KW - upto 37 KW		196 mm
f)	Above 37 KW - upto 55 KW		249 mm
g)	Above 55 KW - upto 90 KW		277 mm
h)	Above 90 KW - upto 125 KW		331 mm
i)	Above 125 KW-upto 200 KW		385/203 (For Single core cables only) mm
3.8	Minimum inter-phase and phase-earth air clearances with lugs installed		
a)	UP to 110 KW		10mm
b)	Above 110 KW and upto 150 KW		12.5mm
c)	Above 150 KW		19mm
4.0	PERFORMANCE PARAMETERS		
4.1	Starting requirement		
a)	Minimum permissible voltage as a percentage of rated voltage, at start to bring the driven equipment upto rated speed		Up to 80% of rated voltage

	TECHNICAL SPECIFICATION FOR CAS PACKAGE(ELECTRICAL PORTION)		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS,		Issue No: 01
			Rev. No. 00
			Date : 10.12.25
b)	Maximum locked rotor current		As per IS 12615 (For DVC Raghunathpur, CSPGCL Korba West, HPGCL Yamunanagar & GSECL UKAI Projects)
c)	Maximum locked rotor current		As per IS 12615 without any positive tolerance (For MSPGCL Koradi project)
d)	Starting duty (Cold/ Hot Motor Starting)		Refer respective project specification (Annexure-E.3A/ 3B/ 3C/ 3D/ 3E).
e)	The locked rotor withstand time		Speed switches mounted on the motor shaft shall be provided in cases where below requirements are not met.
f)	Starting time of motors at minimum permissible voltage during starting		The locked rotor withstand time under hot condition at highest voltage limit
i)	upto 20 secs.		atleast 2.5 secs. more than starting time
ii)	more than 20 secs. and upto 45 secs		atleast 5 secs. more than starting time
iii)	more than 45 secs.		more than starting time by at least 10% of the starting time
e)	Ratio of locked rotor KVA at rated voltage to rated KW (max.)		
i)	From 50KW & upto 110KW		11
ii)	From 110 KW & upto 200 KW		9
4.2	Torque		
a)	Accelerating torque at any speed with the lowest permissible starting voltage		at least 10% motor full load torque
b)	Pull out torque at rated voltage		at least 205% of full load torque
4.3	Noise level (max.)		85 dB(A) at 1m from motor
4.4	Vibration limits		As per IS 12075/ IEC 60034-14.
5.0	INSPECTION/TESTING		
5.1	Type testing requirement w.r.t submission of reports and conduction of type tests		Refer respective project specification (Annexure-E.3A/ 3B/ 3C/ 3D/ 3E).
5.2	Project specific type test report validity period is as mentioned. <i>(In absence of type tests reports or in case reports are not found to be meeting the specification/standards requirements, validity period, vendor shall conduct all such type tests without any commercial/delivery implication to BHEL and reports shall be submitted to the owner for approval.)</i>		For MSPGCL Koradai project- Within 5 years prior to 24.07.24. For DVC Raghunathpur project- Within 10 years prior to 09.12.24. For CSPGCL Korba West project- Within 10 years prior to 14.11.24. For HPGCL Yamunanagar project- Within 5 years prior to 25.03.25. For GSECL Ukai project- Within 5 years prior to 18.12.24
5.3	All acceptance and routine tests as per the specification and relevant standards shall be carried out.Charges for these shall be deemed to be included in the equipment price.		
5.4	Quality plan attached with the respective project specification (Annexure-E.3A/ 3B/ 3C/ 3D/ 3E). is to be followed.		

	TECHNICAL SPECIFICATION FOR CAS PACKAGE(ELECTRICAL PORTION)		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS,		Issue No: 01
			Rev. No. 00
			Date : 10.12.25
B-02 (TECHNICAL DATA - PART-B(SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT))			
SL.NO		UOM	DETAIL
1.0	GENERAL		
i)	Manufacturer & Country of origin.		
ii)	Equipment driven by motor)		
iii)	Motor type		
iv)	Country of origin		
v)	Quantity	nos.	
2.0	DESIGN AND PERFORMANCE DATA		
i)	Frame size		
ii)	Type of duty		
iii)	Type of enclosure and method of cooling		
vi)	Type of mounting		
vii)	Direction of rotation as viewed from DE END		
viii)	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard	(KW)	
ix)	(A) Derated rating for specified normal condition i.e. 50 deg. C ambient temperature	(KW)	
	(B) Rating as specified in load list	(KW)	
xi)	Rated speed at rated voltage and frequency	rpm	
xii)	At rated Voltage and frequency		
	a) Full load current	A	
	b) No load current	A	
xiii)	Power Factor at		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
	e) NO load		
	f) Starting.		
xiv)	Efficiency at rated voltage and frequency		
	a) 100% load		
	b) At duty point		
	c) 75% load		
	d) 50% load		
xv)	Starting current(<i>inclusive of IS tolerance</i>) at		
	a. 100 % voltage	A	
	b. Minimum starting voltage	A	
xvi)	Starting time with minimum permissible voltage		
	a. Without driven equipment coupled	sec	
	b. With driven equipment coupled	sec	
xvii)	Safe stall time with 110% of rated voltage		
	a. From hot condition	sec	

	TECHNICAL SPECIFICATION FOR CAS PACKAGE(ELECTRICAL PORTION)		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS,		Issue No: 01
			Rev. No. 00
			Date : 10.12.25
	b. From cold condition	sec	
xviii)	Torques :		
	a. Starting torque at min. permissible voltage	(kg-mtr.)	
	b. Pull up torque at rated voltage.	(kg-mtr.)	
	c. Pull out torque	(kg-mtr.)	
	d. Min accelerating torque available	(kg-mtr.)	
	e. Rated torque	(kg-mtr.)	
xix)	Stator winding resistance per phase (at 20 Deg.C.)	Ohm	
xx)	GD ² value of motors		
xxi)	Locked rotor KVA input (at rated voltage)		
xxii)	Locked rotor KVA/KW.		
xxiii)	Bearings		
	a. Type		
	b. Manufacturer		
	c. Self Lubricated or forced Lubricated		
	d. Recommended Lubricants		
	e. Guaranteed Life in Hours		
	f. Whether Dial Type thermometer provided		
	g. Oil pressure Gauge/switch		
	i. Range		
	ii. Contact Nos. & ratings		
	iii. Accuracy		
xxiv)	Vibration		
	a) Velocity	mm/s	
	b) Displacement	microns	
xxv)	Noise level	db	
3	CONSTRUCTIONAL FEATURES		
i	Stator winding insulation		
	a. Class & Type		
	b. Tropicalised (Yes/No)		
	c. Temperature rise over specified max.		
	i. Cold water temperature of 38 DEG. C.		
	ii. Ambient Air 50 DEG. C.		
	d. Method of temperature measurement		
	e. Stator winding connection		
	f. Number of terminals brought out		
ii	Type of terminal box for		
	a. stator leads		
	b. space heater		
	c. Temperature detectors		
	d. Instrument switch etc.		
iii)	For main terminal box		
	a. Location		
	b. Entry of cables		
	c. Recommended cable size		

	TECHNICAL SPECIFICATION FOR CAS PACKAGE(ELECTRICAL PORTION)		PE-TS-510/ 527/ 528/ 529/ 530-555-A001
	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS,		Issue No: 01
			Rev. No. 00
			Date : 10.12.25
	d. Fault level	MVA	
iv)	Temperature detector for stator winding		
	a Type		
	b. Nos. provided		
	c . Location		
	d. Make		
	e. Resistance value at 0 deg. C	ohms	
vi)	Paint shade		
vii).	Weight of(approx)		
	a. Motor stator (KG)		
	b. Motor Rotor (KG)		
	c. Total weight (KG)		
4	Relevant motor curves		



1X800MW HPGCL YAMUNANAGAR TPS
2X660 MW MSPGCL KORADI TPS,
2X660 MW DVC RAGHUNATHPUR TPS,
1X800 MW GSECL UKAI TPS,
2X660 MW CSPGCL KORBA WEST TPS,

TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM(CAS) PACKAGES (ELECTRICAL
PORTION)

SPECIFICATION NO. PE-TS-510/ 527/ 528/
529/ 530-555-A001

VOLUME II B
REV 00
PAGE 1 OF 1

DATE 10.12.2025

Annexure-E.3A

Motor Technical specification, Quality Plan & Sub-vendor list

1X800MW HPGCL YAMUNANAGAR Project

CHAPTER – 16
AC & DC MOTORS
CONTENTS

S. No.	Description	Page No.
16.01.00	Scope	3
16.02.00	Location Of Motors	3
16.03.00	Codes And Standards	3
16.04.00	Type	4
16.05.00	Voltage (Nominal)	5
16.06.00	Frequency (Nominal)	5
16.07.00	Number Of Phases	5
16.08.00	Speed	5
16.09.00	Type Of Starting	5
16.10.00	Duty	5
16.11.00	Supply Variations	6
16.12.00	Abnormal Conditions Capability	6
16.13.00	Starting Capability	7
16.14.00	Starting Voltage Requirement	8
16.15.00	Torque Requirements	8
16.16.00	Starting Time	8
16.17.00	Class of Insulation	8
16.18.00	Temperature Rise Under Normal Conditions	9
16.19.00	Bus Transfer Withstand Capability	9
16.20.00	Type of Enclosure	9
16.21.00	Method Of Cooling	10
16.22.00	Type Of Mounting	10
16.23.00	Maximum Mechanical Vibrations	10
16.24.00	Noise Level	10
16.25.00	Winding & Insulation	11
16.26.00	Direction of Rotation	12
16.27.00	Bearings	12
16.28.00	Shaft Extension	13



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



S. No.	Description	Page No.
16.29.00	Drain Holes	13
16.30.00	Lifting Devices	13
16.31.00	Dowel Pins	13
16.32.00	Centering Spigot	13
16.33.00	Ease Of Maintenance	13
16.34.00	Nameplates	13
16.35.00	Finish	13
16.36.00	Terminal Boxes	13
16.37.00	Type And Size of Cables	15
16.38.00	Grounding	16
16.39.00	Embedded Temperature Detectors	16
16.40.00	Bearings Temperature Indicators	16
16.41.00	Space Heaters	17
16.42.00	Hot Air Temperature Detector	17
16.43.00	Water Flow Indicator	17
16.44.00	Moisture Detectors	17
16.45.00	Bed Plate	17
16.46.00	Other Accessories	17
16.47.00	Tests	18
16.48.00	Information With Proposal	20
16.49.00	Information on Award Of Contract	20
16.50.00	Dc Motor	21
16.51.00	Drawings, Data & Manuals	21
	Datasheet	22



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



CHAPTER – 16
AC & DC MOTORS**16.01.00 SCOPE**

This chapter covers design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

16.01.01 Site Conditions

Site conditions are covered in 'General Project Information', contained in specification of the driven equipment.

16.01.02 Gases, Fumes & Dust Particles

General – Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

16.01.03 Dust Particles

- i) Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.
- ii) Indoor Locations.
- iii) Coal conveyors - As for outdoor as per clause 16.01.03 (i) above.
- iv) Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

16.01.04 Special Fumes

- i) Water treatment plant and acid cleaning room - Acid and alkali fumes present.
- ii) Fuel oil pumping areas & Hydrogen generation plant - Explosive fumes (flameproof motors required).
- iii) For the purpose of design of equipment/systems, an ambient temperature of 50°C and relative humidity of 95% (at 40°C) shall be considered. The equipment shall operate in a highly polluted environment.

16.02.00 LOCATION OF MOTORS - As required**16.03.00 CODES AND STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as mentioned in Chapter 37 except where modified and/or supplemented by this specification.



Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

16.04.00 TYPE**16.04.01 AC Motors:**

- i) Squirrel cage induction motor suitable for direct-on-line starting.
- ii) Continuous duty LT motors rated above 0.37kW up to 160 KW Output rating (at 50° C ambient temperature), shall be **Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30. However, this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.
- iii) Crane, hoist & elevator duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF or VFD motors.

16.04.02 DC Motors

- i. D.C. motor provided for emergency service shall be shunt wound type. It can also be of compound-wound type with the series field shorted.
- ii. Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

16.04.03 VFD Motors

- i. Induction motors to be operated in adjustable-speed drive applications should be derated as per NEMA/IEC standard due to the reduction in cooling resulting from any reduction in operating speed and the effect of additional losses introduced by harmonics generated by the control.
- ii. Inverter duty motors shall be self-ventilated without any auxiliary blower. Force ventilation shall be subject to Owner approval.
- iii. Inverter duty motors shall have VPI insulation systems that do not degrade readily due to transient voltage spikes and have an adequate thermal margin.
- iv. Inverter duty motors are designed according to the requirements of IEC 60034 Part-17 & Part-25 or NEMA MG-1, Part-30, Part-31 and have performance characteristics match with the driven equipment and variable speed requirement.



- v. The motor should be capable of producing a breakaway torque of at least 140% of rated torque requiring not more than 150% rated current when the voltage boost is adjusted to develop rated flux in the motor and when the inverter is able to produce the required minimum fundamental frequencies.
- vi. The breakdown torque at any frequency within the defined frequency range shall be not less than 150% of the rated torque at that frequency when rated voltage for that frequency is applied.
- vii. The motor shall be provided with insulated bearing on one side.
- viii. Normally the maximum safe speed shall be as per IEC/NEMA, however it should be coordinated with VFD requirement.

16.05.00 **VOLTAGE (NOMINAL)**

16.05.01 LV Motors

For motors up to and including 160 KW - Four hundred fifteen (415) V.

16.05.02 MV Motors

For motors above 160 kW up to and including 1500kW - Six-point six (6.6) kV.

16.05.03 HV Motors

- i) For motors above 1500kW - eleven (11) KV
- ii) All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

16.06.00 **FREQUENCY (NOMINAL)** - fifty (50) Hertz

16.07.00 **NUMBER OF PHASES** - Three (3)

16.08.00 **SPEED** - As required by the driven equipment

16.09.00 **TYPE OF STARTING** - Direct on-line

16.10.00 **DUTY**

16.10.01 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency and voltage variation. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

16.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- 16.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly coordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon on driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.
- 16.10.04 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.
- 16.10.05 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.
- 16.10.06 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment at least twenty-five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.
- 16.10.07 HV & MV motors shall have full load efficiency of 95% minimum and rated full load power factor of 0.8 minimum. The required power factor shall be achieved without using external capacitor. Tolerance on this efficiency value shall be applicable as per IEC 60034. However, this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.
- 16.11.00 **SUPPLY VARIATIONS** Motors shall be capable of running continuously at full load under following variations in power supply.
- 16.11.01 Voltage (percent of nominal voltage) Plus minus ($\pm$) ten (10) for LT
Plus minus ($\pm$) Six (6) for MV & HT
- 16.11.02 Frequency (percent of minimal frequency) Plus Three 3 & minus (-) five (5)
- 16.11.03 Combined voltage & frequency (percent) Ten (10) (sum of absolute percentage value of voltage and frequency variation)
- 16.12.00 **ABNORMAL CONDITIONS CAPABILITY**
- Motor shall have following capabilities as specified design ambient temperature: -
- 16.12.01 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.
- 16.12.02 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.
- 16.12.03 Low Voltage Running: -
- Motor shall be capable of running satisfactorily at seventy-five (75) percent nominal voltage for five (5) minutes.



16.12.04 Momentary Low Voltage Withstanding:

Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

16.13.00 **STARTING CAPABILITY**

16.13.01 Low Voltage Starting

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80) percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

16.13.02 Cold Motor Starting

Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes. (With initial temperature of the motor at ambient temperature)

16.13.03 Hot Motor Starting

Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes. (With initial temperature of the motor at full load operating level)

16.13.04 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

16.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

i) -DELETED-

ii) Motors (above 1000 KW up to 3000 KW)..... 600%. Subject to 20% IS tolerance.

iii) Motors above 3000 KW.....450%. Not subject to any positive tolerance. For energy efficient

iv) LT motors, locked rotor current shall be as per IS: 12615.

v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance



- 16.13.06 Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.
- 16.14.00 **STARTING VOLTAGE REQUIREMENT**
- 16.14.01 All Motors (except Mill Motors)
- i) 80% of rated voltage for Motors up to 4000 kW
 - ii) 75% of rated voltage for Motors above 4000 kW
- 16.14.02 For Mill Motors:
- i) 85% of rated voltage for Motors above 1000 kW
 - ii) 90% of rated voltage for Motors below 1000 kW
- 16.15.00 **TORQUE REQUIREMENTS**
- 16.15.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10%. Motor full load torque.
- 16.15.02 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.
- 16.16.00 **STARTING TIME**
- 16.16.01 For motors with starting time up-to 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at-least 2.5 secs. more than starting time.
- 16.16.02 For motors with starting time more than 20 secs. and up-to 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at-least 5 secs. more than starting time.
- 16.16.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at-least 10% of the starting time.
- 16.16.04 At no stage, speed switch shall be provided to achieve requirements mentioned in Clause No. 16.16.01 to 16.16.03.
- 16.17.00 **CLASS OF INSULATION**
- 16.17.01 LV Motors Class F.
- 16.17.02 HV & MV Motors Class F
- 16.17.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both MV, HV & LT motors. The temperature under abnormal running conditions shall be limited to 5°C above class 'B' limits.
- 16.17.04 The value of the polarization index for motors above 160kW should not be less than 2 when determined according to IS: 78114.0



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



16.17.05 For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages,

16.17.06 HT motors shall withstand 1.2/50 micro sec impulse Voltage wave of $4U+5$ kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034 – Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

16.18.00 TEMPERATURE RISE UNDER NORMAL CONDITIONS

16.18.01 Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S. No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
i)	50°C	60°C	70°C

16.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C, over inlet cooling water temperature mentioned elsewhere, by resistance method.

16.19.00 BUS TRANSFER WITHSTAND CAPABILITY

Motors shall be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The manufacturer/ vendor shall indicate the special precautions taken to meet the above requirements and confirm.

16.19.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

16.19.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

16.19.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

16.20.00 TYPE OF ENCLOSURE

16.20.01 Outdoor Motors..... IP 55 (Additional canopy to be provided by Bidder).

16.20.02 Indoor Motors IP 55



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



16.20.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

16.21.00 **METHOD OF COOLING**

16.21.01 Method of cooling shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW).

The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However, VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor.

Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below

(a) Fuel oil area: Group – IIB

(b) Hydrogen generation : Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)

16.21.02 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

16.22.00 **TYPE OF MOUNTING** As required for the driven equipment.

16.23.00 **MAXIMUM MECHANICAL VIBRATIONS**

Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.

16.24.00 **NOISE LEVEL**

16.24.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). at 1m from operating motor measured in accordance with IS: 10265.

16.24.02 Motor body shall have two earthing points on opposite sides.

16.24.03 The spacing between gland plate & centre of terminal stud shall be as per Table-I.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



TABLE – I	
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS	
Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm
UP to 3 KW	As per manufacturer's practice.
Above 3 KW - up to 7 KW	85
Above 7 KW - up to 13 KW	115
Above 13 KW - up to 24 KW	167
Above 24 KW - up to 37 KW	196
Above 37 KW - up to 55 KW	249
Above 55 KW - up to 90 KW	277
Above 90 KW - up to 125 KW	331
Above 125 KW-up to 160 KW	203

16.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

16.24.05 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

16.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

16.25.00 WINDING & INSULATION

16.25.01 Type : Non-hygroscopic, oil resistant, flame resistant

16.25.02 11kV & 6.6 kV AC motors : Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be F/B class electrolytic copper grade polymica insulated rectangular bar type copper conductor. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & inter-turn insulation surge withstand level shall be as per IEC-60034 part-15

16.25.03 240VAC, 415V AC & 220V DC motors : Thermal Class(F)



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



16.26.00 DIRECTION OF ROTATION

- 16.26.01 As needed by driven equipment.
- 16.26.02 The 3-phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.
- 16.26.03 If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

16.27.00 BEARINGS

- 16.27.01 Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.
- 16.27.02 Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.
- 16.27.03 If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.
- 16.27.04 Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.
- 16.27.05 For MV & HV motors rated 1000KW and above , the bearing housing shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.
- 16.27.06 When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.
- 16.27.07 Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.
- 16.27.08 Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.



- 16.27.09 Bearings shall be of internationally reputed make subject to the approval of the Owner/Consulting Engineer.
- 16.27.10 Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.
- 16.28.00 **SHAFT EXTENSION** Key slotted bare shaft extension of required length with key on driving end.
- 16.29.00 **DRAIN HOLES** Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.
- 16.30.00 **LIFTING DEVICES** Motors shall be provided with eye-bolts, lugs or other means to facilitate safe lifting.
- 16.31.00 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven equipment assembly) or at site after erection (for separate supplies of above equipment).
- 16.32.00 **CENTERING SPIGOT**..... Flange mounted motor shall have centering spigot to match driven equipment socket.
- 16.33.00 **EASE OF MAINTENANCE**..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.
- 16.34.00 **NAMEPLATES**..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:-
- 16.34.01 In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.
- 16.34.02 Temperature rise under normal/abnormal conditions.
- 16.34.03 Type of bearing and recommended lubricants.
- 16.35.00 **FINISH**
- 16.35.01 Motor shall have synthetic enamel paint shade as mentioned in Chapter 1.
- 16.35.02 All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.
- 16.36.00 **TERMINAL BOXES**
- 16.36.01 General



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.
- ii) The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box as per Cl 16.36.02 (ii).
- iii) Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

16.36.02 Main Terminal Box

- i) LV Motors Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.
- ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing. Alternately if elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided.
- iii) Neutral terminal box for MV/HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.
- iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables. For 11/6.6kV motors removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided in case of cable boxes.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as mentioned in Data Sheet) without rupture for a duration of at least 0.25 seconds.
- vi) Phase to Phase/ Phase to Earth Air Clearance: -
 - a) Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:-

Motor MCR in KW	Clearance
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

- vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

16.37.00 TYPE AND SIZE OF CABLES

16.37.01 Space Heaters

- i) For LV Motors: Two-point five (2.5) sq mm, two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).
- ii) For MV & HV Motors: Two-point five (2.5) sqmm two core copper conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I). For higher rating HV/MV motors 3 phase space heater shall be used and cable size shall be 3Cx6 sqmm copper.
- iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- iv) Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.
- v) For Moisture Detectors.....As for space heaters as per Clause 16.37.01 (i) above.

16.37.02 For Main Terminals: -

- i) LT Motors



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



- a) Three (3) core cables Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).
- b) Single core cables Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).
- ii) HV & MV Motors
- Three (3) core cables stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 6.6 KV / 11 KV unearthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).
- 16.38.00 **GROUNDING**
- 16.38.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.
- 16.38.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors up to 5.5 KW) for size of conductor specified shall be provided.
- 16.38.03 HV & MV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.
- 16.39.00 **EMBEDDED TEMPERATURE DETECTORS**
- HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition, one (1) duplex type RTD shall be provided in each bearing. However, for air compressor, being high speed drive, each motor bearing shall be provided with minimum two numbers of duplex RTDs connected to two numbers of dual input transmitters with display unit. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg C.
- 16.40.00 **BEARINGS TEMPERATURE INDICATORS**
- HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to



operate at lower value to give alarm and other set at a higher value to trip the motor.

16.41.00 SPACE HEATERS

16.41.01 Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.

16.41.02 The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

16.41.03 The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

16.42.00 HOT AIR TEMPERATURE DETECTOR

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). In addition, one (1) duplex type RTD shall be provided in each enclosure for alarm and if trip is required for cooling air temperature, temperature switch shall be provided.

16.43.00 WATER FLOW INDICATOR

If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits. In addition, one (1) duplex type RTD shall be provided in each water inlet and outlet circuit

16.44.00 MOISTURE DETECTORS

Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

16.45.00 BED PLATE

Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

16.46.00 OTHER ACCESSORIES

Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.



16.47.00 **TESTS**

16.47.01 HV & MV Motors

i) Routine Tests

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Owner's representative, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests

a) For each type & rating of HV & MV motors the Bidder shall submit for Owner's approval the reports of all the type tests as per relevant standards. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been conducted at an independent laboratory. Period - Within 5 Years from the zero date.

b) In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

- a) No load saturation and loss curve up to approximately 115% of rated voltage.
- b) Measurement of noise at no load.
- c) Momentary excess torque test (subject to test bed constraint).
- d) Full load test (subject to test bed constraint)
- e) IR + PI
- f) Partial Discharge
- g) Winding resistance



- h) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETDs are provided, the temperature shall be measured by ETD's also for the record purpose. In case due to test bed limitations at the manufacturing works, mixed frequency method as per latest IEC 60034 is also acceptable.
- i) Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15
- j) Surge-withstand test on interturn insulation shall be as per IEC60034, part-15
- k) Degree of protection test for the enclosure followed by IR, HV and no-load run test.
- l) Terminal box-fault level withstand test for each type of terminal box.
- m) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

16.47.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of Consultant /Owner or his representative.

ii) List of minimum tests for which reports have to be submitted

The following minimum type test reports shall be submitted for each type and rating of LT motor of above 30 KW only

- a) Measurement of resistance of windings of stator and wound rotor.
- b) No load test at rated voltage to determine input current power and speed.
- c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
- d) Full load test to determine efficiency power factor and slip.
- e) Temperature rise test.
- f) Momentary excess torque test.
- g) High voltage test.
- h) Test for vibration severity of motor.
- i) Test for noise levels of motor(Shall be limited as per clause No. 1.24.00 of this section)
- j) Test for degree of protection and
- k) Over speed test.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



i) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

iii) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

16.48.00 **INFORMATION WITH PROPOSAL**

16.48.01 AC Motor Data Sheet.

16.48.02 Dimension Drawing/Foundation load details of motor and driven equipment.

16.48.03 Manufacturer's catalogue showing constructional details.

16.49.00 **INFORMATION ON AWARD OF CONTRACT**

16.49.01 Motor Data Sheet

Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

16.49.02 Following characteristics curves: -

- i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment except for mill motor. For mill motor torque speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment
- ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage
- iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.
- iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor thermal withstand curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.
- v) Efficiency, power factor, current and speed versus power output curves.



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor speed time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

vii) Negative phase sequence current withstand characteristics.

16.50.00 **DC MOTOR**

16.50.01 D.C. Motor provided for emergency service shall be shunt / compound wound type. The starting current shall be as per manufacturer's standard.

16.50.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

16.50.03 Starter panel complete with all accessories shall be included in the scope of supply.

16.51.00 **DRAWINGS, DATA & MANUALS**

16.51.01 Minimum Drawings, data & manuals for the motors to be submitted

- i) Dimensional General Arrangement drawing
- ii) Foundation Plan & Loading
- iii) Cable end box details
- iv) Space requirement for rotor removal
- v) Thermal withstand curves hot & cold
- vi) Starting and speed torque characteristics at 80% & 100% voltage except for mill motor. For mill motor Starting and speed torque characteristics at 90% & 100% voltage.
- vii) Complete motor data
- viii) Erection & Maintenance Manual
- ix) Test reports
- x) QAP



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



DATASHEET

	Auxiliary power supply	
1.1	HV supply	
	11kV, 3 Φ , 3W, 50 Hz non effectively earthed Earthed through resistance, limiting earth fault current to 400 Amps	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
	HV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.2	MV supply	
	6.6kV, 3 Φ , 3W, 50 Hz non effectively earthed. Earthed through resistance, limiting earth fault current to 400 Amps	Motors above 160kW up to and including 1500kW
	Fault level	40 kA for 1 second
	MV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.3	LV supply	
	415V, 3 Φ , 3W, 50 Hz effectively earthed	Motors below and including 160kW
	Fault level	50kA for 1 second
	110V, 1 Φ , 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
	LT motors rated up to 90 kW	shall be controlled through MPCB/ MCCB and contactor.
	LT motors rated more than 90 kW	Shall be controlled through air circuit breaker
1.4	DC supply	
	220V, 2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	-----
	Frequency	-----
	Combined voltage & frequency	-----
2.2	DC supply	198 to 240 V
Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.		



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



QUALITY PLAN

E12: AC & DC MOTORS

ATTRIBUTES/ CHARACTERISTICS ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Make/Type/Rating/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722/IS 9283	Vibration	overspeed	Tan delta, shaft voltage and polarization index test
Tan Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y			Y						
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										Y
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y									
Wound stator	Y	Y					Y	Y										Y
Wound Exciter	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				

Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y												
Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y																
Complete Motor	Y	Y	Y				Y								Y	Y	Y	Y1	
Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for LT motors up to 50 KW. 2. Additional routine tests for flameproof motors shall be applicable as per relevant standard. 3. Makes of all major bought out items shall be subject to Owner/Owner Engineer approval. Y1 = for HT Motor / Machines only.																			

SUB-VENDOR LIST

SUB-VENDOR LIST

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES53	LV MOTORS (NON FLAME PROOF)	1	A24	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	0129-2567580, 09871799449	
	LV MOTORS (NON FLAME PROOF)	2	E1027	BHARAT BULEE LTD.	BHARAT BULEE 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.bharatbulee.com	
	LV MOTORS (NON FLAME PROOF)	3	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	
	LV MOTORS (NON FLAME PROOF)	4	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	044-49681447	
	LV MOTORS (NON FLAME PROOF)	5	K01	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555, MALLS WARAM WEST ,BANGALORE 560055	Tel: +91-80-23374865 Fax: +91-80-23377706	
	LV MOTORS (NON FLAME PROOF)	6	L04	LAXMI HYDRAULICS PVT. LTD.	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	0217- 2357001-005	APPROVED UPTO 200KW
	LV MOTORS (NON FLAME PROOF)	7	M01	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006	Ph: +91-129-2286421, 2265340, 4006601 to 4006610	
	LV MOTORS (NON FLAME PROOF)	8	A35	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045	Ph: (011) 2539 7763	
	LV MOTORS (NON FLAME PROOF)	9	E1115	RAJINDRA ELECT INDUSTRIES	14 SHAH IND. ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	91-22-26730823, 26730789; 91(122)-26730154	
	LV MOTORS (NON FLAME PROOF)	10	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.bhaduria@siemens.com	
	LV MOTORS (NON FLAME PROOF)	11	HM06	HAVELLS INDIA LIMITED	Plot No. SP 181-189, Industrial Area Phase-II, Neemrana, Dist. Alwar, Rajasthan-301705, India	M: 9644355595 Mr. Kapil Jain (L): +91120-4772317 (Kapil Jain <Kapil.Jain@havelis.com>)	APPROVED UPTO 200KW
ES11	CABLE GLANDS	1	E1201	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	Mr. Vijay Mohan Sood +(91)-(120)-2525694 +(91)-(120)-3052594 +(91)-(11)-23287156 vijay_mohansood@yahoo.com	
	CABLE GLANDS	2	E1017	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068	033 2473 0850	
	CABLE GLANDS	3	E1206	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	44-24995505,22680990-4	
	CABLE GLANDS	4	E1036	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063	91-022-26852961/62/63 comet@vsnl.net	
	CABLE GLANDS	5	DW08	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770,/022-29270876/ 022-29270878.	
	CABLE GLANDS	6	E1044	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND. ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059	91-22-28324829 / 66919034 devang@electromacglands.com	
	CABLE GLANDS	7	I01	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001	91-33-2480161/62/63/64 Fax : 91-33-2485766	
ES12	CABLE LUGS	1	E1040	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770,/022-29270876/ 022-29270878.	
	CABLE LUGS	2	E1149	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	033 2282 2540	
ES16	GI CONDUITS	BIS APPROVED MAKE					
ES17	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE					
ES19	FLEXIBLE CONDUIT (PVC COATED)	REPUTED MAKE					

Note:-

Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors make based on their experience, which will be subject to Owner (End Customer)/BHEL approval.

Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.



1X800MW HPGCL YAMUNANAGAR TPS
2X660 MW MSPGCL KORADI TPS,
2X660 MW DVC RAGHUNATHPUR TPS,
1X800 MW GSECL UKAI TPS,
2X660 MW CSPGCL KORBA WEST TPS,

TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM(CAS) PACKAGES (ELECTRICAL
PORTION)

SPECIFICATION NO. PE-TS-510/ 527/ 528/
529/ 530-555-A001

VOLUME II B
REV 00
PAGE 1 OF 1

DATE 10.12.2025

Annexure-E.3B

Motor Technical specification, Quality Plan & Sub-vendor list

2X660 MW MSPGCL KORADI TPS PROJECT



14.00.00 AC & DC MOTORS

14.01.00 SCOPE

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors – HT, LT and DC Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

14.01.01 Site Conditions

Site conditions are covered in 'Project Data', contained in specification of the driven equipment.

14.01.02 Gases, Fumes & Dust Particles

General - Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

14.01.03 Dust Particles

- i) Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.
- ii) Indoor Locations.
- iii) Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

14.01.04 Special Fumes

- i) Acid cleaning room - Acid and alkali fumes present.
- ii) Fuel oil pumping areas & Hydrogen generation plant - Explosive fumes (flameproof motors required).
- iii) For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

14.02.00 LOCATION OF MOTOR - As Required

14.03.00 CODES STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification.

Code	Name of standard
IS : 325	Specification for three phase induction motor.
IS : 900	Code of Practice for installation and maintenance of induction motors


MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME – III

**KORADI THERMAL POWER STATION
2X660 MW UNITS - 11 & 12 PROJECT**

PART – B

RFx No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION ELECTRICAL

REV. - 0

Code	Name of standard
IS : 996	Single phase AC motors
IS : 1231	Dimensions of three-phase foot-mounted induction motors
IS : 1271	Thermal evaluation and classification of electrical insulation.
IS : 2223	Dimensions of flange mounted ac induction motors.
IS : 2254	Dimensions of vertical shaft motors for pumps
IS : 3043	Code of practice for earthing.
IS : 3177	Crane duty motors
IS : 4029	Guide for testing three phase induction motors.
IS : 4691	Degree of protection for enclosures of rotating electrical machinery.
IS : 4722	Specification for rotating electrical machinery.
IS : 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS : 4889	Methods of determination of efficiency of rotating electrical machines.
IS : 5571	Guide for selection of electrical equipment for hazardous areas.
IS : 6362	Designation of Method of Cooling of Rotating electrical machines.
IS : 8223	Dimensions and output ratings for foot mounted rotating electrical machines with frame numbers 355 to 1000.
IS : 8789	Values of performance characteristics for three phase induction motors.
IS : 12065	Noise level of motors.
IS : 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS : 12615	Induction motors - Energy efficient, three-phase, squirrel cage – Specification
IS : 12802	Temperature rise measurement of rotating electrical machines.
IS : 12824	Temperature rise measurement of rotating electrical machines
IS : 12824	Type of duty and classes of rating assigned.
IS : 14222	Requirements and method of Impulse withstand test
IEC: 60034-1	Rotating electrical machines.
ISO : 1940-1	Mechanical vibration – Determination of permissible residual unbalance
NEMA, MG-1	Motors and Generators
DIN/IEC/IS	RTD
BS 5308 part II	RTD triad Cable



Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

14.04.00 TYPE

14.04.01 AC Motors:

- i) Squirrel cage induction motor suitable for direct-on-line starting.
- ii) Crane duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF.

14.04.02 DC Motors shall generally be of shunt wound type rated for 220V DC.

14.05.00 VOLTAGE (NOMINAL)

14.05.01 LV Motors

For motors upto and including 200 KW - Four hundred fifteen (415) V.

14.05.02 MV Motors

For motors above 200 kW and including 1500kW. Three point three (3.3) kV.

14.05.03 HV Motors

- i) For motors above 1500kW - Eleven (11) KV

14.06.00 FREQUENCY (NOMINAL) - Fifty (50) Hertz

14.07.00 NUMBER OF PHASES - Three (3)

14.08.00 SPEED - As required by the driven equipment

14.09.00 TYPE OF STARTING

Direct on-line where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application

14.10.00 DUTY

14.10.01 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency and voltage



variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

14.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.

14.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly co-ordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.

14.10.04 Maximum torque shall not be less than 200% of full load torque.

14.10.05 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.

14.10.06 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.

14.10.07 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.

14.10.08 All the duty motors shall be energy efficient type. For LT motors, the efficiency class shall be IE3 class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.

14.11.00 SUPPLY VARIATIONS

Motors shall be capable of running continuously at full load under following variations in power supply.

14.11.01 **Voltage (percent of nominal voltage)** Plus minus (+) ten (10%) for LT motors and Plus minus (+) six (6) for HT motors.

14.11.02 **Frequency (percent of minimal frequency)**..... Plus minus (+) five (5%)

14.11.03 **Combined voltage & frequency (percent)** Ten (10%) (sum of absolute percentage value of voltage and frequency variation)

14.12.00 ABNORMAL CONDITIONS CAPABILITY

Motor shall have following capabilities as specified design ambient temperature:

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME – III
	KORADI THERMAL POWER STATION 2X660 MW UNITS - 11 & 12 PROJECT	PART – B
	RFx No. 3000046202 (BTG Package)	
	TECHNICAL SPECIFICATION ELECTRICAL	REV. - 0

14.12.01 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.

14.12.02 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

14.12.03 Low Voltage Running:-

14.12.04 Motor shall be capable of running satisfactorily at seventy five (75) percent of nominal voltage for five (5) minutes.

14.12.05 Momentary Low Voltage Withstanding:

14.12.06 Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

14.13.00 STARTING CAPABILITY

14.13.01 Low Voltage Starting

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80) percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

14.13.02 Cold Motor Starting

Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

14.13.03 Hot Motor Starting

Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

14.13.04 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

14.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

Doc no.: ETG061-BTG-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 330
-----------------------------	--	----------



- i) Motors upto 1000 KW 600% subject to IS Tolerance of plus 20%
- ii) Motors (above 1000 KW upto 3000 KW) 600%. Not subject to any positive tolerance.
- iii) Motors above 3000 KW.....450%. Not subject to any positive tolerance.
- iv) For energy efficient LT motors, locked rotor current shall be as per IS: 12615 without any further positive tolerance.
- v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.

14.14.00 STARTING VOLTAGE REQUIREMENT

14.14.01 All Motors (except Mill Motors)

- i) 80% of rated voltage for Motors upto 4000 kW
- ii) 75% of rated voltage for Motors above 4000 kW

14.14.02 For Mill Motors:

- i) 85% of rated voltage for Motors above 1000 kW
- ii) 90% of rated voltage for Motors below 1000 kW

14.15.00 TORQUE REQUIREMENTS

14.15.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

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

14.16.00 STARTING TIME

14.16.01 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be atleast 2.5 secs. more than starting time.

14.16.02 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be atleast 5 secs. more than starting time.

14.16.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by atleast 10% of the starting time.

14.16.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.



14.17.00 CLASS OF INSULATION

14.17.01 LV Motors Class F.

14.17.02 HV & MV Motors Class F

14.17.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both MV, HV & LT motors. The temperature under abnormal running conditions shall be limited to 50C above class 'B' limits.

14.17.04 The value of the polarization index for motors above 160kW should not be less than 2 when determined according to IS: 78114.0

14.18.00 TEMPERATURE RISE UNDER NORMAL CONDITIONS

14.18.01 Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
i)	50°C	60°C	70°C

14.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method.

14.19.00 BUS TRANSFER WITHSTAND CAPABILITY

14.19.01 Motors shall be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The motor shall not puncture its insulation during its lifetime.

14.19.02 The motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

14.19.03 The motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

14.19.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.



MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME – III

KORADI THERMAL POWER STATION 2X660 MW UNITS - 11 & 12 PROJECT

PART – B

RFx No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION ELECTRICAL

REV. - 0

14.20.00 TYPE OF ENCLOSURE

- 14.20.01 Outdoor Motors.....IPW 55 (Additional canopy to be provided by Bidder).
- 14.20.02 Indoor Motors IP 55
- 14.20.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

14.21.00 METHOD OF COOLING

- 14.21.01 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).
- 14.21.02 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Purchaser.

14.22.00 TYPE OF MOUNTING As required for the driven equipment.

14.23.00 MAXIMUM MECHANICAL VIBRATIONS

Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.

14.24.00 NOISE LEVEL

- 14.24.01 Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A) at 1m from operating motor measured in accordance with IS: 10265.
- 14.24.02 Motor body shall have two earthing points on opposite sides.
- 14.24.03 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

TABLE – I		
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS		
Motor MCR in KW	:	Minimum distance between centre of stud and gland plate in mm
UP to 3 KW	:	As per manufacturer's practice.
Above 3 KW - upto 7 KW	:	85
Above 7 KW - upto 13 KW	:	115



TABLE – I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Above 13 KW - upto 24 KW	:	167
Above 24 KW - upto 37 KW	:	196
Above 37 KW - upto 55 KW	:	249
Above 55 KW - upto 90 KW	:	277
Above 90 KW - upto 125 KW	:	331
Above 125 KW-upto 160 KW	:	203

14.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

14.24.05 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

14.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box for differential protection.

14.25.00 WINDING & INSULATION

14.25.01 Type: Non-hygroscopic, oil resistant, flame resistant

14.25.02 11kV & 3.3 kV AC motors: Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be of copper. The winding insulation process shall be total Vacuum Pressure Impregnated(VPI). The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.

14.25.03 240VAC, 415V AC & 220V DC motors : Thermal Class(F)

14.26.00 DIRECTION OF ROTATION

14.26.01 As needed by driven equipment.

14.26.02 The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

14.26.03 If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

14.27.00 WINDING



- i) Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- ii) For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- iii) Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill.
- iv) For HT motors, insulation shall be Vacuum Impregnated (VPI).
- v) HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 600034-15.
- vi) For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.
- vii) For LT motors of rating more than 90KW, shall be provided with 2 nos of RTD's on each phase of the stator winding for its temperature measurement.

14.28.00 BEARINGS

- 14.28.01 Furnishing of all labour, skilled and unskilled, supervisory and administrative personnel, erection tools and tackles, testing equipment implements, supplies, consumables & hardware for timely efficient execution of complete work.
- 14.28.02 Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.
- 14.28.03 Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.
- 14.28.04 If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.
- 14.28.05 Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.



- 14.28.06 For MV & HV motors rated 1000 KW and above, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.
- 14.28.07 When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.
- 14.28.08 Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.
- 14.28.09 Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.
- 14.28.10 All VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- 14.28.11 Bearings shall be of reputed make subject to the approval of the Purchaser/Consulting Engineer.
- 14.28.12 Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.
- 14.29.00 SHAFT EXTENSION** Key slotted bare shaft extension of required length with key on driving end.
- 14.30.00 DRAIN HOLES** Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.
- 14.31.00 LIFTING DEVICES** Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- 14.32.00 DOWEL PINS.....** It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven equipment assembly) or at site after erection (for separate supplies of above equipment).
- 14.33.00 CENTERING SPIGOT.....** Flange mounted motor shall have centering spigot to match driven equipment socket.



14.34.00 EASE OF MAINTENANCE..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

14.35.00 NAMEPLATES..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:-

14.35.01 In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

14.35.02 Temperature rise under normal/abnormal conditions.

14.35.03 Type of bearing and recommended lubricants.

14.36.00 FINISH

14.36.01 Motor shall have synthetic enamel paint shade.

14.36.02 All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

14.37.00 TERMINAL BOXES

14.37.01 General

- i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Purchaser /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.
- ii) The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box.
- iii) Terminal bushings and clamps shall be non-absorbent, non- inflammable,



insulated material for connecting with cable.

14.37.02 Main Terminal Box

- i) HV Motors.....Terminal box shall be capable of being turned through 360 degrees in steps of 180 degrees. LV Motors Main terminal box shall be capable of being turned through 360 degree steps of 90 degrees.
- ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing.
- iii) Neutral terminal box for HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.
- iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables.
- v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.

- a) Min. fault level for 11kV Motors - 840 MVA
- b) Min. fault level for 3.3 kV Motors - 250 MVA
- c) Min. fault level for 415V Motors - 50 KA

vi) Phase to Phase/ Phase to Earth Air Clearance:-

- a) Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:-

- | | | |
|--------------------------------|---|-----------|
| • Motor MCR in KW | - | Clearance |
| • UP to 110 KW | - | 10mm |
| • Above 110 KW and upto 150 KW | - | 12.5mm |
| • Above 150 KW | - | 19mm |

- vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

14.38.00 TYPE AND SIZE OF CABLES

14.38.01 Space Heaters

- i) For LV Motors: Two point five (2.5) mm², two (2) core copper conductor



PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).

- ii) For MV & HV Motors: Six (6) mm² two core aluminium conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- iv) Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.
- v) For Moisture Detectors.....As per space heaters

14.38.02 For Main Terminals:-

- i) LT Motors
 - a) Three (3) core cables Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).
 - b) Single core cables Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).
- ii) HV & MV Motors
 - a) Three (3) core cables stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 3.3 KV / 11 KV un earthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

14.39.00 GROUNDING

14.39.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

14.39.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.

14.39.03 HV & MV Motors.....Non-corrodible metallic grounding pad shall be



welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

14.40.00 EMBEDDED TEMPERATURE DETECTORS

HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C.

14.41.00 BEARINGS TEMPERATURE INDICATORS

HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to operate at lower value to give alarm and other set at a higher value to trip the motor.

14.42.00 SPACE HEATERS

14.42.01 Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.

14.42.02 The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

14.42.03 The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

14.43.00 HOT AIR TEMPERATURE DETECTOR

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). If alarm and trip are required for cooling air temperature, temperature switch shall be provided.

14.44.00 WATER FLOW INDICATOR



If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.

14.45.00 MOISTURE DETECTORS

Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

14.46.00 BED PLATE

Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

14.47.00 OTHER ACCESSORIES

Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

14.48.00 DC MOTOR

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.

14.49.00 TESTS

14.49.01 HV & MV Motors

i) Routine Tests

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Purchaser's representative, for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests



- a) For each type & rating of HV & MV motors the Bidder shall conduct all the type test as per relevant IEC and IS standards for all the proposed motors to be supplied under this contract and the test(s) should be conducted at an independent laboratory.

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

- a) No load saturation and loss curves upto approximately 115% of rated voltage.
- b) Measurement of noise at no load.
- c) Momentary excess torque test (subject to test bed constraint).
- d) Full load test(subject to test bed constraint)
- e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
- f) High voltage test
- g) Test for vibration severity of motor
- h) Degree of protection (Test for suitability of IP55/ IPW- 55 as per IS 4691 as type test. Type test certificate for first numeral (IP5X) shall be acceptable in lieu to test, provided the test motor is identical to motor being supplied. Second numeral (IPX5) test shall be carried out on one motor of each type and rating.)
- i) Overspeed test.
- j) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.49.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of consultant /purchaser or his representative.

ii) List of minimum tests for which type test are to be conducted



The following minimum type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

- a) Measurement of resistance of windings of stator and wound rotor.
- b) No load test at rated voltage to determine input current power and speed.
- c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
- d) Full load test to determine efficiency power factor and slip .
- e) Temperature rise test.
- f) Momentary excess torque test.
- g) High voltage test.
- h) Test for vibration severity of motor.
- i) Test for noise levels of motor
- j) Test for degree of protection and
- k) Over speed test.
- l) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

iii) For all other LT motors less than 50KW, Type test reports shall be submitted. In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements and the type test reports are not within 5 years from the date of Bid opening, the Bidder shall conduct all such tests under this contract free of cost to the Purchaser and submit the reports for approval,for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price

iv) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.50.00 INFORMATION WITH PROPOSAL

14.50.01 AC Motor Data Sheet.

14.50.02 Dimension Drawing/Foundation load details of motor and driven equipment.

14.50.03 Manufacturer's catalogue showing constructional details.

14.51.00 INFORMATION ON AWARD OF CONTRACT

14.51.01 Motor Data Sheet

Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.



14.51.02 Following characteristics curves:-

- i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment.
- ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.
- iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.
- v) Efficiency, power factor, current and speed versus power output curves.
- vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- vii) Negative phase sequence current withstand characteristics.

14.52.00 **DRAWINGS, DATA & MANUALS**

14.52.01 Minimum Drawings, data & manuals for the motors to be submitted

- i) Dimensional General Arrangement drawing
- ii) Foundation Plan & Loading
- iii) Terminal box details
- iv) Space requirement for rotor removal
- v) Thermal withstand curves hot & cold
- vi) Starting and speed torque characteristics at 80% & 100% voltage
- vii) Complete motor Data sheet
- viii) Motor sizing calculation
- ix) Erection & Maintenance Manual
- x) Test reports
- xi) QAP

DATA SHEET

1	Auxiliary power supply	
1.1	HV supply	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	44 /50kA for 1 second
1.2	MV supply	
	3.3kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors above 200kW upto and including 1500kW
	Fault level	40 kA for 1 second
1.3	LV supply	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control



MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME – III

**KORADI THERMAL POWER STATION
2X660 MW UNITS - 11 & 12 PROJECT**

PART – B

RFX No. 3000046202 (BTG Package)

TECHNICAL SPECIFICATION ELECTRICAL

REV. - 0

		and protective devices
1.4	DC supply	
	220V, 2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	-----
	Frequency	-----
	Combined voltage & frequency	-----
2.2	DC supply	198 to 240 V

Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

NOTE:

All electrical equipment mounted outdoor shall have RAL 5012 paint shade. All electrical equipment mounted indoor (non-air conditioned areas) shall have RAL 7042 paint shade while those located in air-conditioned areas shall have RAL 7035 paint shade. Panel interior shall be RAL 9010.

SUB-VENDOR LIST

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME-V
	KORADI THERMAL POWER STATION 2x660 MW UNITS - 11 & 12 PROJECT	
	RFx No. 3000046202 (BTG Package)	ANNEXURE - 4
	SUB-VENDOR LIST	REV. - 0

SR. NO.	ITEM		Koradi 2x660 MW
57.00	LT MOTORS (415V)	(a)	ALSTOM
		(b)	BHEL
		(c)	CROMPTON GREAVES LTD
		(d)	KIRLOSKAR ELECTRIC CO. LTD

Doc no.: ETG061-BTG-GEN-VL	STEAG Energy Services India Pvt. Ltd.	Page 40
----------------------------	---------------------------------------	---------

**MAHARASHTRA STATE POWER GENERATION CO. LTD.**

VOLUME-V

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT****RFx No. 3000046202 (BTG Package)****ANNEXURE - 4****SUB-VENDOR LIST****REV. - 0**

SR. NO.	ITEM		Koradi 2x660 MW
		(e)	SIEMENS
		(f)	MARATHON ELECTRIC
		(g)	ABB
		(h)	BHARAT BIJLEE
		(i)	LAXMI HYDRAULIC LTD
58.00	DC MOTORS	(a)	ALSTOM
		(b)	BHEL
		(c)	CROMPTON GREAVES LTD.
		(d)	KIRLOSKAR ELECTRIC CO. LTD.
		(e)	SIEMENS

SUB-VENDOR LIST CONTINUED

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES11	CABLE GLANDS	1	E1201	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA	Mr. Vijay Mohan Sood +(91)-(120)-2525694 +(91)-(120)-3052594 +(91)-(11)-23287156 vijay_mohansood@yahoo.com	
	CABLE GLANDS	2	E1017	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA 700068	033 2473 0850	
	CABLE GLANDS	3	E1206	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018	44-24995505,22680990-4	
	CABLE GLANDS	4	E1036	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063	91-022-26852961/62/63 comet@vsnl.net	
	CABLE GLANDS	5	DW08	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770./022-29270876/ 022-29270878.	
	CABLE GLANDS	6	E1044	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059	91-22-28324829 / 66919034 devang@electromacglands.com	
	CABLE GLANDS	7	I01	INCAB	HARE STREET,KOLKATA, WEST BENGAL-700001	91-33-2480161/62/63/64 Fax : 91-33-2485766	
ES12	CABLE LUGS	1	E1040	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). 4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	CEO : Mr. Jayantibhai S. Patel TEL: 022-32504770./022-29270876/ 022-29270878.	
	CABLE LUGS	2	E1149	UNIVERSAL MACHINES LTD.		033 2282 2540	
ES16	GI CONDUITS	BIS APPROVED MAKE					
ES17	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE					
ES19	FLEXIBLE CONDUIT (PVC COATED)	REPUTED MAKE					

Note : Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors make based on their experience, which will be subject to Owner (End Customer)/BHEL approval.

Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.

	1X800MW HPGCL YAMUNANAGAR TPS 2X660 MW MSPGCL KORADI TPS, 2X660 MW DVC RAGHUNATHPUR TPS, 1X800 MW GSECL UKAI TPS, 2X660 MW CSPGCL KORBA WEST TPS, TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM(CAS) PACKAGES (ELECTRICAL PORTION)	SPECIFICATION NO. PE-TS-510/ 527/ 528/ 529/ 530-555-A001 VOLUME II B REV 00 DATE 10.12.2025 PAGE 1 OF 1
---	--	--

Annexure-E.3C

Motor Technical specification, Quality Plan & Sub-vendor list

2X660 MW DVC RAGHUNATHPUR TPS PROJECT

NOTE: In the specification wherever word “NTPC” and “Contractor “are mentioned, same shall be read as “DVC/BHEL” and "Compressed Air System-Vendor” respectively.

CLAUSE NO.	TECHNICAL REQUIREMENTS																						
	MOTORS																						
1.00.00	GENERAL REQUIREMENTS																						
1.01.00	This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A" Degree of Protection Degree of protection for various enclosures as per IEC60034-05 shall be as follows :- <table><tr><td>i)</td><td>Indoor motors</td><td>-</td><td>IP 55</td></tr><tr><td>ii)</td><td>Outdoor motors</td><td>-</td><td>IP 55 (Additional Canopy to be provided)</td></tr><tr><td>iii)</td><td>Cable box-indoor area</td><td>-</td><td>IP 55</td></tr><tr><td>iv)</td><td>Cable box-Outdoor area</td><td>-</td><td>IP 55</td></tr></table>			i)	Indoor motors	-	IP 55	ii)	Outdoor motors	-	IP 55 (Additional Canopy to be provided)	iii)	Cable box-indoor area	-	IP 55	iv)	Cable box-Outdoor area	-	IP 55				
i)	Indoor motors	-	IP 55																				
ii)	Outdoor motors	-	IP 55 (Additional Canopy to be provided)																				
iii)	Cable box-indoor area	-	IP 55																				
iv)	Cable box-Outdoor area	-	IP 55																				
2.00.00	CODES AND STANDARDS																						
	<table><tr><td>1)</td><td>Three phase induction motors</td><td>:</td><td>IS15999/IEC:60034</td></tr><tr><td>2)</td><td>Single phase AC motors</td><td>:</td><td>IS 996/ IEC:60034</td></tr><tr><td>3)</td><td>Crane duty motors</td><td>:</td><td>IS:3177, IS/IEC:60034</td></tr><tr><td>4)</td><td>DC motors/generators</td><td>:</td><td>IS:4722, IS/IEC:60034</td></tr><tr><td>5)</td><td>Energy Efficient motors</td><td>:</td><td>IS 12615, IEC:60034-30</td></tr></table>			1)	Three phase induction motors	:	IS15999/IEC:60034	2)	Single phase AC motors	:	IS 996/ IEC:60034	3)	Crane duty motors	:	IS:3177, IS/IEC:60034	4)	DC motors/generators	:	IS:4722, IS/IEC:60034	5)	Energy Efficient motors	:	IS 12615, IEC:60034-30
1)	Three phase induction motors	:	IS15999/IEC:60034																				
2)	Single phase AC motors	:	IS 996/ IEC:60034																				
3)	Crane duty motors	:	IS:3177, IS/IEC:60034																				
4)	DC motors/generators	:	IS:4722, IS/IEC:60034																				
5)	Energy Efficient motors	:	IS 12615, IEC:60034-30																				
3.00.00	TYPE																						
3.01.00	AC Motors: a) Squirrel cage induction motor suitable for direct-on-line starting. b) Continuous duty LT motors upto 50 KW Output rating (at 50 deg.C ambient temperature), shall be super Premium Efficiency class-IE4, 50-200 KW shall be of Premium Efficiency class – IE3, conforming to IS 12615, or IEC:60034-30. HT motors shall have minimum design efficiency of 95 %. However, tolerance on this efficiency value shall be applicable as per IEC 60034 c) Motor operating through variable frequency drives shall be suitable for inverter duty with VPI insulation. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.																						
3.02.00	DC Motors	Shunt wound.																					
4.00.00	RATING																						
	(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor. (b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.																						
5.00.00	TEMPERATURE RISE																						
	Air cooled motors (AC &DC) 70 deg. C by resistance method for thermal class 155(F) insulation. Water cooled 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for thermal class 155(F) insulation.																						
6.00.00	OPERATIONAL REQUIREMENTS																						
RAGHUNATHPUR THERMAL POWER STATION PHASE-II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B Page 196 of 501	SUB SECTION-II-B-02 MOTORS																				
			PAGE 1 OF 5																				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
6.01.00	Starting Time			
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.			
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.			
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.			
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.			
6.02.00	Torque Requirements			
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor rated torque.			
6.02.02	Pull out torque at rated voltage shall not be less than 205% of rated torque. It shall be 275% for crane duty motors.			
6.03.00	NOT USED			
7.00.00	DESIGN AND CONSTRUCTIONAL FEATURES			
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.			
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below			
	(a)	Fuel oil area	: Group – IIB	
	(b)	Hydrogen generation	: Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)	
7.03.00	Winding and Insulation			
	(a)	Type	: Electrolytic grade Copper conductor, Non-hygroscopic, oil resistant, flame resistant Insulation.	
	(b)	Starting duty	: Two hot starts in succession, with motor initially at normal running temperature. However , conveyor motors shall be suitable for 3 consecutive hot starts	
	(c)	11kV, 6.6 KV & 3.3 kV AC motors	: Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.	
	(d)	240VAC, 415V AC & 220V DC motors	: Thermal Class (F) or better	
7.04.00	Motors rated above 1000KW shall have insulated bearings/housing to prevent flow of shaft currents.			
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.			
7.06.00	Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A) (Tolerance limits as per IS/IEC shall be applicable on specified values). Vibration			
RAGHUNATHPUR THERMAL POWER STATION PHASE-II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B Page 197 of 501	SUB SECTION-II-B-02 MOTORS	PAGE 2 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.07.00 7.08.00 7.09.00 7.10.00 7.11.00 7.12.00 7.13.00 7.14.00 7.15.00 8.00.00 9.00.00 10.00.00 10.01.00	shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting vibration pads. Contractor shall ensure the adequate size of vibration pads for mounting of suitable vibration sensors. In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with 3 numbers duplex RTDs connected to three numbers dual input transmitters with display. However for air compressor, being high speed drive, each motor bearing shall be provided with minimum two numbers of duplex RTDs connected to two numbers dual input transmitters with display unit. Motor body shall have two earthing points on diagonally opposite sides. 11 KV motors shall be offered with: i) Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds. OR ii) Dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box--PSTB shall be suitable for fault level of 50KA/40KA for 0.12 seconds (Fault level shall be as per system fault level for 11 KV system defined elsewhere in the specification). Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided. 3.3/6.6 KV motors shall be offered with dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box. Alternately Elastimold type Terminal box should also be accepted as per OEM standard proven practice. Contractor shall provide termination kit for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA/500MVA for 0.12 sec for 3.3/6.6KV respectively. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided. The spacing between gland plate & centre of bottom terminal stud shall be as per Table-I. All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment. The motors shall be suitable for bus transfer schemes provided on the 11kV, 6.6 KV, 3.3 kV /415V systems without any injurious effect on its life. For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box. NOT USED. NOT USED. NOT USED. TYPE TEST HT MOTORS LIST OF TYPE TESTS TO BE CONDUCTED The following type tests shall be conducted on each type and rating of HT motor (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary excess torque test (subject to test bed constraint). (d) Full load test(subject to test bed constraint) (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
RAGHUNATHPUR THERMAL POWER STATION PHASE-II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE	TECHNICAL SPECIFICATION SECTION – VI, PART-B Page 198 of 501 SUB SECTION-II-B-02 MOTORS PAGE 3 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS		
10.02.00	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED		
	The following type test reports shall be submitted for each type and rating of HT motor		
	(a)	Degree of protection test for the enclosure followed by HV and no load run test.	
	(b)	Terminal box-fault level withstand test for each type of terminal box (phase side only) of HT motors only.	
	(c)	Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15	
	(d)	Surge-withstand test on inter-turn insulation shall be as per clause no. 4.2 of IEC 60034, part-15	
	LT Motors		
	LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED		
	The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only		
	1.	Measurement of resistance of windings of stator and wound rotor.	
2.	No load test at rated voltage to determine input current power and speed		
3.	Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)		
4.	Full load test to determine efficiency power factor and slip		
5.	Temperature rise test		
6.	Momentary excess torque test.		
7.	High voltage test		
8.	Test for vibration severity of motor.		
9.	Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)		
10.	Test for degree of protection and		
11.	Overspeed test.		
12.	Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1		
10.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.		
10.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.		
TABLE - I			
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS			
Motor MCR in KW		Minimum distance between centre of bottom terminal stud and gland plate in mm	
UP to 3 KW		As per manufacturer's practice.	
Above 3 KW - upto 7 KW		85	
Above 7 KW - upto 13 KW		115	
Above 13 KW - upto 24 KW		167	
Above 24 KW - upto 37 KW		196	
Above 37 KW - upto 55 KW		249	
Above 55 KW - upto 90 KW		277	
Above 90 KW - upto 125 KW		331	
Above 125 KW-upto 200 KW		385/203 (For Single core cables only)	
RAGHUNATHPUR THERMAL POWER STATION PHASE-II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B Page 199 of 501	SUB SECTION-II-B-02 MOTORS PAGE 4 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS										
	For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm. PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE: NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows: <table><tr><th>Motor MCR in KW</th><th>Clearance</th></tr><tr><td>UP to 110 KW</td><td>10mm</td></tr><tr><td>Above 110 KW and upto 150 KW</td><td>12.5mm</td></tr><tr><td>Above 150 KW</td><td>19mm</td></tr></table>			Motor MCR in KW	Clearance	UP to 110 KW	10mm	Above 110 KW and upto 150 KW	12.5mm	Above 150 KW	19mm
Motor MCR in KW	Clearance										
UP to 110 KW	10mm										
Above 110 KW and upto 150 KW	12.5mm										
Above 150 KW	19mm										
RAGHUNATHPUR THERMAL POWER STATION PHASE-II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B Page 200 of 501	SUB SECTION-II-B-02 MOTORS PAGE 5 OF 5								

QUALTIY PLAN

QAP FOR LT MOTORS 50 KW AND ABOVE

CLAUSE NO	QUALITY ASSURANCE																			
MOTOR																				
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	TESTS/ CHECKS	Visual	Dimensional	Make/Type/Rating /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing (WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	Routine & Acceptance tests as per IS-4722 /IS- 9283/ IS2148/ IEC60034/ IEC 60079-1/ IS-12615	vibration	Over speed	Tan delta, shaft voltage & polarization index test	Paint shade, thickness & adhesion
Plates for stator frame, end shield, spider etc.		Y	Y	Y	Y	Y				Y										
Shaft		Y	Y	Y	Y	Y	Y			Y										
Magnetic Material		Y	Y	Y	Y			Y			Y		Y							
Rotor Copper/Aluminium		Y	Y	Y	Y			Y		Y			Y							
Stator copper		Y	Y	Y	Y			Y		Y			Y							
SC Ring		Y	Y	Y	Y	Y		Y	Y	Y										
Insulating Material		Y		Y	Y			Y					Y							
Tubes, for Cooler		Y	Y	Y	Y	Y				Y		Y								
Sleeve Bearing		Y	Y	Y	Y	Y				Y		Y								
Stator/Rotor, Exciter Coils		Y	Y	Y				Y	Y											
Castings, stator frame, terminal box and bearing housing etc.		Y	Y	Y	Y	Y			Y											
Fabrication & machining of stator, rotor, terminal box		Y	Y			Y			Y	Y										
Wound stator		Y	Y					Y	Y											
Wound Exciter		Y	Y					Y	Y											
Rotor complete		Y	Y					Y						Y	Y					
RAGHUNATHPUR THERMAL POWER STATION PHASE- II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE		TECHNICAL SPECIFICATION SECTION - VI							SUB SECTION MOTORS							PAGE 1 OF 2				

CLAUSE NO	QUALITY ASSURANCE																		
	Exciter, Stator, Rotor, Terminal Box assembly	Y	Y				Y												
	Accessories, RTD, BTD, CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y															
	Complete Motor	Y	Y	Y											Y	Y	Y	Y1	Y
Note: 1) The manufacturer is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, following methodology to be followed for Inspection Categorization: Note for LT Motor: i. Motor rating up to 50 KW: Inspection CAT- III: Acceptance of Motor up to 50 KW is based on COC of the Manufacturer and Main Contractor confirming as follows: “It is hereby confirmed that the above-mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot starts, pull out torque, starting KVA/KW, temperature rise, distance between center of stud gland plate and tested in accordance with approved drawing /data sheets.” ii. ii) Motor rating above 50 KW & less than 75 KW: Inspection CAT- II as per NTPC approved MQP: Acceptance of Motor rating above 50 KW & less than 75 KW is based on NTPC review of Routine Test inspection report as per IS:12615 - 2018 (including latest revision) duly witnessed by main contractor along with COC of the Manufacturer and Main Contractor confirming as follows: “It is hereby confirmed that the above-mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage frequency variation, hot starts, pull out torque, starting KVA/KW, temperature rise, distance between center of stud gland plate, space heater and tested in accordance with approved drawing /data sheets.” iii. iii) Motor rating 75 KW & above: Inspection CAT-I: As per NTPC approved MQP. 2) Additional routine tests for Flame proof motors shall be applicable as per relevant standard. 3) Makes of major bought out items for HT motors will be subject to NTPC approval. 4) Y1 = for HT Motor / Machines only. 5) For LT Motors, stator core stack length & grade, no load loss and winding resistance w.r.t. type tested motor for IE2/IE3 shall be checked/verified in addition to Compliance of relevant standard IS:12615/IEC requirement. In case actual results are not within the tolerance limit as declared by manufacturer during QP submission, the motor shall be subjected to efficiency test.																			
RAGHUNATHPUR THERMAL POWER STATION PHASE- II (2X660 MW) STEAM GENERATOR ISLAND PACKAGE		TECHNICAL SPECIFICATION SECTION - VI							SUB SECTION MOTORS					PAGE 2 OF 2					

SUB-VENDOR LIST

18	LT MOTOR	CAT - I							
	Refer Note-7				ABB	FARIDABAD	A*	JECT TO VERIFICATION	UPTO 55KW
					ABB	BANGALORE	A*		UPTO 690V, 475kW
					JYOTI LTD.	VADODARA	A		
					TIPM	JAPAN	A		UPTO 15 KW (NON FLAME PROOF)
					HYOSUNG	SOUTH KOREA	A		
					WEG	BRAZIL	A		
					HYUNDAI	SOUTH KOREA	A		
					LHP	SOLAPUR	A		UPTO 400KW FROM B-16 WORKS. UPTO 200KW FROM B-11 WORKS.
					CGL	AHMEDNAGAR	A		RQP, FOR FLAME PROOF MOTOR
					TMEIC	JAPAN (NAGASAKHI)	A		
					NGEF	BANGALORE	A		UPTO 15 KW
					BHARAT BIJLEE	MUMBAI	A		UPTO 160kW, RQP, FOR FLAME PROOF ALSO
					KEC	BANGALORE/ HUBLI*	A		*UPTO 90KW, RQP, FOR FLAME PROOF ALSO
					MARATHON	KOLKATA	A		RQP (UPTO 690V & 600 KW) FOR FLAME PROOF ALSO
					ABB	SWEDEN	A		UPTO 55KW
					HAVELL	NEEMRANA	A		UP TO 90KW
					KAWAMATA	JAPAN	A		UP TO 75 KW
					HEM Industries	DAMAN	A		UP TO 30 KW
					TIPS	JAPAN	A		UP TO 45KW

5	Cable Lugs	CAT III							
					Dowells	Mumbai	A		
					Chetna	Nasik	A		
					3D	Umbergaon	A		
					Any other make's model with VDE or CE or UL or CSA marking or BIS approved with CML no.		A		
6	Cable gland	CAT III							
					Arup Engg	Kolkata	A		
					Comet Industries (Cosmos)	Mumbai	A		
					Sunil & Co	Kolkata	A		
					Braco	Mumbai	A		
					Quality Precision	Kolkata	A		
7	MCCB / SFU	CAT III			C&S Ltd	Noida	A		
					GE	Bangalore	A		
					L&T	Mumbai	A		
					SIEMENS	Mumbai/Aurangabad	A		
					Any make's model with VDE or CE or UL or CSA marking or BIS approved with CML no.		Refer note 2		
8	LT PVC Copper Wires (as per IS 694)	CAT III			BIS Approved Sources		A		Wires shall have the ISI marked with valid CML No. Refer Note- 1
9	PVC Conduit/Hume Pipe/ GI conduit/ Pipes	CAT III			BIS Licensee/ ISI marked with CML Number		A		
10	1.LT AC / DC Control & Selector Switch 2.Indicating Meters 3.Transducer 4.Indicating Lamp 5.LT fuse 6.Push Button 7.Terminal Block 8.MCB 9. Thermal Overload Relay 10.LT Contactor	CAT III			Make-model with mark of CE/VDE/ UL /CSA / BIS with CML no. Refer Note-1		A		

Note - 7:	i) For Motors less than 50 KW: CAT-III. Acceptance of Motor less than 50 KW is based on COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate and tested in accordance with approved drawing / data sheets". ii) For Motors 50 KW and less than 75 KW : CAT- II. Acceptance of Motor is based on NTPC review of Routine Test inspection report as per IS: 12615 / applicable standards duly witnessed by main contractor along with COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing /data sheets". iii) For Motors 75 KW & above : CAT- I . AS PER NTPC APPROVED QUALITY PLAN (To be submitted seperately for NTPC review & approval). iv) DC motors (all rating) - Inspection CAT-I
-----------	---

LEGENDS/ संकेतिका SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY /प्रणाली आपूर्तिकर्ता/ सब -वैडर की स्वीकृति की स्थिति की श्रेणी (SHALL BE FILLED BY NTPC एनटीपीसी द्वारा भरा जाएगा). A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter “A” in the list along with the condition of approval, if any / इन मदों के लिए प्रस्तावित वैडर एनटीपीसी को स्वीकार्य है। अनुमोदन की शर्त, यदि कोई हो, के साथ-साथ पत्र "क" में इंगित किया जाए । DR – For these items “Detailed required” for NTPC review. To be identified with letter “DR” in the list. एनटीपीसी द्वारा इन मदों की समीक्षा के लिए “विस्तृत ब्यारे की आवश्यकता” होगी। सूची में "DR" पत्र में इंगित किया जाना चाहिए। QP/INSPN CATEGORY: क्यूपी/ निरीक्षण की श्रेणी: CAT-I/ श्रेणी- I: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है और एनटीपीसी द्वारा अंतिम स्वीकृति भौतिक निरीक्षण के दौरान उपलब्ध गवाह के आधार पर दी जाएगी। CAT-II/ श्रेणी- II: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है। हालाँकि एनटीपीसी द्वारा कोई भौतिक निरीक्षण नहीं किया जाएगा। एनटीपीसी द्वारा अंतिम स्वीकृति अनुमोदित क्यूपी के अनुसार दस्तावेजों की समीक्षा के आधार पर दी जाएगी। CAT-III/ श्रेणी-III: For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by NTPC shall be on the basis of Certificate of Conformance (COC) by Main Contractor. UNITS/WORKS इकाईयाँ/ कार्य: Place of manufacturing/ निर्माण का स्थान Place of Main Supplier of multi units/works/बहु- इकाईयों/ कार्यों के मुख्य सप्लायर का स्थान. : Control measure of item covered in quality plan of main item.					
Format No./ प्रारूप सं:	QS-01-QAI-P-1B/F1-R0				Engg. Div./ QA&I

ES16	GI CONDUITS	BIS APPROVED MAKE					
ES17	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE					
ES18	FLEXIBLE CONDUITS (LEAD COATED)	1	P03	PLICA INDIA PVT. LTD.	V.P.AGARWAL MANAGING DIRECTOR, PLICA INDIA PVT. LTD. 149, MODEL TOWN EAST GHAZIABAD - 201009	M - 9810052131 / 0120-4563979 / 9810557567 Mail: agr@plicaindia.com	

Note:-

Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors make based on their experience, which will be subject to Owner (End Customer)/BHEL approval. Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.



1X800MW HPGCL YAMUNANAGAR TPS
2X660 MW MSPGCL KORADI TPS,
2X660 MW DVC RAGHUNATHPUR TPS,
1X800 MW GSECL UKAI TPS,
2X660 MW CSPGCL KORBA WEST TPS,

TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM(CAS) PACKAGES (ELECTRICAL
PORTION)

SPECIFICATION NO. PE-TS-510/ 527/ 528/
529/ 530-555-A001

VOLUME II B
REV 00
PAGE 1 OF 1

DATE 10.12.2025

Annexure-E.3D

Motor Technical specification, Quality Plan & Sub-vendor list

1X800 MW GSECL UKAI TPS PROJECT

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED		VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS		PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01		SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL		REV. 0

14.00.00

AC & DC MOTORS

14.01.00

SCOPE

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors – HT, LT and DC Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

14.01.01

Site Conditions

Site conditions are covered in 'Project Data', contained in specification of the driven equipment.

14.01.02

Gases, Fumes & Dust Particles

General - Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

14.01.03

Dust Particles

i)

Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.

ii)

Indoor Locations.

iii)

Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

14.01.04

Special Fumes

i)

Acid cleaning room - Acid and alkali fumes present.

ii)

Fuel oil pumping areas & Hydrogen generation plant - Explosive fumes (flameproof motors required).

iii)

For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

14.02.00

LOCATION OF MOTOR - As Required

14.03.00

CODES STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification.

Code	Name of standard
IS : 325	Specification for three phase induction motor.
IS : 900	Code of Practice for installation and maintenance of induction motors

Doc no.: ETG106-EPC-ELEC-TS

STEAG Energy Services India Pvt. Ltd.

Page 324

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

Code	Name of standard
IS : 996	Single phase AC motors
IS : 1231	Dimensions of three-phase foot-mounted induction motors
IS : 1271	Thermal evaluation and classification of electrical insulation.
IS : 2223	Dimensions of flange mounted ac induction motors.
IS : 2254	Dimensions of vertical shaft motors for pumps
IS : 3043	Code of practice for earthing.
IS : 3177	Crane duty motors
IS : 4029	Guide for testing three phase induction motors.
IS : 4691	Degree of protection for enclosures of rotating electrical machinery.
IS : 4722	Specification for rotating electrical machinery.
IS : 4728	Terminal marking and direction of rotation for rotating electrical machinery.
IS : 4889	Methods of determination of efficiency of rotating electrical machines.
IS : 5571	Guide for selection of electrical equipment for hazardous areas.
IS : 6362	Designation of Method of Cooling of Rotating electrical machines.
IS : 8223	Dimensions and output ratings for foot mounted rotating electrical machines with frame numbers 355 to 1000.
IS : 8789	Values of performance characteristics for three phase induction motors.
IS : 12065	Noise level of motors.
IS : 12075	Measurement and evaluation of vibration of rotating electrical machines.
IS : 12615	Induction motors - Energy efficient, three-phase, squirrel cage – Specification
IS : 12802	Temperature rise measurement of rotating electrical machines.
IS : 12824	Temperature rise measurement of rotating electrical machines
IS : 12824	Type of duty and classes of rating assigned.
IS : 14222	Requirements and method of Impulse withstand test
IEC: 60034-1	Rotating electrical machines.
ISO : 1940-1	Mechanical vibration – Determination of permissible residual unbalance
NEMA, MG-1	Motors and Generators
DIN/IEC/IS	RTD
BS 5308 part II	RTD triad Cable

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

14.04.00 TYPE

14.04.01 AC Motors:

- i) Squirrel cage induction motor suitable for direct-on-line starting.
- ii) Crane duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF.
- iii) All LT motors rated 0.37 kW and higher with S1 duty (at 50 deg.C ambient temperature), shall be of Premium Efficiency class –IE3, conforming to IS 12615, or IEC:60034-30. HT motors shall have minimum design efficiency of 95 %. However, tolerance on this efficiency value shall be applicable as per IEC 60034.
- iv) Motor operating through variable frequency drives shall be suitable for inverter duty with VPI insulation. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.

14.04.02 DC Motors shall generally be of shunt wound type rated for 220V DC.

14.05.00 VOLTAGE (NOMINAL)

14.05.01 LV Motors

For motors upto and including 160 KW - Four hundred fifteen (415) V.

14.05.02 MV Motors

For motors above 160 kW and including 1500kW. Three point three (3.3) kV / 6.6 kV.

14.05.03 HV Motors

- i) For motors above 1500kW - Eleven (11) kV

14.06.00 FREQUENCY (NOMINAL) - Fifty (50) Hertz

14.07.00 NUMBER OF PHASES - Three (3)

14.08.00 SPEED - As required by the driven equipment

14.09.00 TYPE OF STARTING

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

Direct on-line where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application

14.10.00 DUTY

- 14.10.01 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency and voltage variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.
- 14.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.
- 14.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly co-ordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.
- 14.10.04 Maximum torque shall not be less than 200% of full load torque.
- 14.10.05 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.
- 14.10.06 Online Insulation Resistance monitoring system shall be provided in all HT motors.
- 14.10.07 Online vibration monitoring system shall be provided and connected to plant DCS for all HT motors.
- 14.10.08 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.
- 14.10.09 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.
- 14.10.10 All the duty motors shall be energy efficient type.. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.

14.11.00 SUPPLY VARIATIONS

Motors shall be capable of running continuously at full load under following variations in power supply.

- 14.11.01 **Voltage (percent of nominal voltage)** Plus minus (+/-) ten (10%) for

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

	LT motors and Plus minus (+/-) six (6%) for HT motors.
14.11.02	Frequency (percent of minimal frequency) Plus minus (+/-) five (5%)
14.11.03	Combined voltage & frequency (percent) Ten (10%) (sum of absolute percentage value of voltage and frequency variation)
14.12.00	ABNORMAL CONDITIONS CAPABILITY
	Motor shall have following capabilities as specified design ambient temperature:
14.12.01	The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.
14.12.02	Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.
14.12.03	Low Voltage Running:-
14.12.04	Motor shall be capable of running satisfactorily at seventy five (75) percent of nominal voltage for five (5) minutes.
14.12.05	Momentary Low Voltage Withstanding:
14.12.06	Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.
14.13.00	STARTING CAPABILITY
14.13.01	Low Voltage Starting
	Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80) percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.
14.13.02	Cold Motor Starting
	Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.
14.13.03	Hot Motor Starting
	Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills

Doc no.: ETG106-EPC-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 328
-----------------------------	--	----------

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes.

14.13.04 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

14.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

- ii) Motors (above 1000 KW upto 3000 KW) 600%. Not subject to any positive tolerance.
- iii) Motors above 3000 KW.....450%. Not subject to any positive tolerance.
- iv) For energy efficient LT motors, locked rotor current shall be as per IS: 12615.
- v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.

14.14.00 STARTING VOLTAGE REQUIREMENT

14.14.01 All Motors (except Mill Motors)

- i) 80% of rated voltage for Motors upto 4000 kW
- ii) 75% of rated voltage for Motors above 4000 kW

14.14.02 For Mill Motors:

- i) 85% of rated voltage for Motors above 1000 kW
- ii) 90% of rated voltage for Motors below 1000 kW

14.15.00 TORQUE REQUIREMENTS

14.15.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

14.15.02 Full out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

14.16.00 STARTING TIME

14.16.01 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be atleast 2.5 secs. more than starting time.

14.16.02 For motors with starting time more than 20 secs. and upto 45 secs. at

Doc no.: ETG106-EPC-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 329
-----------------------------	--	----------

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be atleast 5 secs. more than starting time.

14.16.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by atleast 10% of the starting time.

14.16.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

14.17.00 CLASS OF INSULATION

14.17.01 LV Motors Class F.

14.17.02 HV & MV Motors Class F

14.17.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both MV, HV & LT motors. The temperature under abnormal running conditions shall be limited to 50°C above class 'B' limits.

14.17.04 The value of the polarization index for motors above 160kW should not be less than 2 when determined according to IS: 7814.0

14.18.00 TEMPERATURE RISE UNDER NORMAL CONDITIONS

14.18.01 Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
i)	50°C	60°C	70°C

14.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method.

14.19.00 BUS TRANSFER WITHSTAND CAPABILITY

14.19.01 Motors shall be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The motor shall not puncture its insulation during its lifetime.

Doc no.: ETG106-EPC-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 330
-----------------------------	--	----------

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0
14.19.02	The motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.	
14.19.03	The motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.	
14.19.04	The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.	
14.20.00	TYPE OF ENCLOSURE	
14.20.01	Outdoor Motors.....IP 55 (Additional canopy to be provided by Bidder).	
14.20.02	Indoor Motors IP 55	
14.20.03	IP-55 degree of protection shall be achieved without application of any compound, putty etc.	
14.21.00	METHOD OF COOLING	
14.21.01	Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW). Totally enclosed tube ventilated (TETV) type motors shall be acceptable for HT motors only.	
14.21.02	Large capacity motors not available with above types of cooling may be accepted with IC 81 W or IC 91 W (CACW) cooling subject to the approval of the Purchaser.	
14.22.00	TYPE OF MOUNTING As required for the driven equipment.	
14.23.00	MAXIMUM MECHANICAL VIBRATIONS	
	Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.	
14.24.00	NOISE LEVEL	
14.24.01	Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A) at 1m from operating motor measured in accordance with IS: 10265.	
14.24.02	Motor body shall have two earthing points on opposite sides.	
Doc no.: ETG106-EPC-ELEC-TS		Page 331

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

- 14.24.03 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

TABLE – I	
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS	
Motor MCR in KW	: Minimum distance between centre of stud and gland plate in mm
UP to 3 KW	: As per manufacturer's practice.
Above 3 KW - upto 7 KW	: 85
Above 7 KW - upto 13 KW	: 115
Above 13 KW - upto 24 KW	: 167
Above 24 KW - upto 37 KW	: 196
Above 37 KW - upto 55 KW	: 249
Above 55 KW - upto 90 KW	: 277
Above 90 KW - upto 125 KW	: 331
Above 125 KW-upto 160 KW	: 203

- 14.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

- 14.24.05 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

- 14.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box for differential protection.

14.25.00 WINDING & INSULATION

- 14.25.01 Type: Non-hygroscopic, oil resistant, flame resistant

- 14.25.02 11kV, 6.6 kV & 3.3 kV AC motors: Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be of copper. The winding insulation process shall be total Vacuum Pressure Impregnated(VPI). The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.

- 14.25.03 240VAC, 415V AC & 220V DC motors : Thermal Class(F)

14.26.00 DIRECTION OF ROTATION

- 14.26.01 As needed by driven equipment.

- 14.26.02 The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

Doc no.: ETG106-EPC-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 332
-----------------------------	--	----------

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED		VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS		PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01		SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL		REV. 0
14.26.03	If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.		
14.27.00	WINDING		
	i) Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere. ii) For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages. iii) Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill. iv) For HT motors, insulation shall be Vacuum Impregnated (VPI). v) HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulsethstand voltage as per IEC 600034-15. vi) For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum. vii) For LT motors of rating more than 90KW, shall be provided with 2 nos of RTD's on each phase of the stator winding for its temperature measurement.		
14.28.00	BEARINGS		
14.28.01	Furnishing of all labour, skilled and unskilled, supervisory and administrative personnel, erection tools and tackles, testing equipment implements, supplies, consumables & hardware for timely efficient execution of complete work.		
14.28.02	Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.		
14.28.03	Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.		
Doc no.: ETG106-EPC-ELEC-TS		STEAG Energy Services India Pvt. Ltd.	Page 333

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED		VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS		PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01		SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL		REV. 0
14.28.04	If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.		
14.28.05	Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.		
14.28.06	For MV & HV motors rated 1000 KW and above, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.		
14.28.07	When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.		
14.28.08	Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.		
14.28.09	Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.		
14.28.10	All VFD operated motors shall have insulated bearings to prevent flow of shaft currents.		
14.28.11	Bearings shall be of reputed make subject to the approval of the Purchaser/Consulting Engineer.		
14.28.12	Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.		
14.29.00	SHAFT EXTENSION Key slotted bare shaft extension of required length with key on driving end.		
14.30.00	DRAIN HOLES Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.		
14.31.00	LIFTING DEVICES Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.		
14.32.00	DOWEL PINS..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed		
Doc no.: ETG106-EPC-ELEC-TS		STEAG Energy Services India Pvt. Ltd.	Page 334

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

driving + driven equipment assembly) or at site after erection (for separate supplies of above equipment).

14.33.00 CENTERING SPIGOT..... Flange mounted motor shall have centering spigot to match driven equipment socket.

14.34.00 EASE OF MAINTENANCE..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

14.35.00 NAMEPLATES..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:-

14.35.01 In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

14.35.02 Temperature rise under normal/abnormal conditions.

14.35.03 Type of bearing and recommended lubricants.

14.36.00 FINISH

14.36.01 Motor shall have synthetic enamel paint shade. Paint shade of motors through out the plant shall be same as specified in Clause No. 1.41.01.

14.36.02 All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

14.37.00 TERMINAL BOXES

14.37.01 General

- i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Purchaser /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.
- ii) The terminal boxes shall be complete with cable glands and termination

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box.

- iii) Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

14.37.02 Main Terminal Box

- i) HT Motor terminal box (Phase side) shall be Phase Segregated (PSTB) type and LT motor terminal box shall be non-phase segregated type. Both HT & LT motor terminal box shall be located in accordance with Indian Standards clearing the motor base- plate/ foundation. HV Motors Terminal box shall be capable of being turned through 360 degrees in steps of 180 degrees. LV Motors Main terminal box shall be capable of being turned through 360 degree steps of 90 degrees.
- ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing.
- iii) Neutral terminal box for HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.
- iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables.
- v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.

a)	Min. fault level for 11kV Motors	-	840 MVA
b)	Min. fault level for 3.3 kV Motors	-	250 MVA
c)	Min. fault level for 415V Motors	-	35 MVA
- vi) Phase to Phase/ Phase to Earth Air Clearance:-
 - a) Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:-

•	Motor MCR in KW	-	Clearance
•	UP to 110 KW	-	10mm
•	Above 110 KW and upto 150 KW	-	12.5mm
•	Above 150 KW	-	19mm

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

- vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

14.38.00 TYPE AND SIZE OF CABLES

14.38.01 Space Heaters

- i) For LV Motors: Two point five (2.5) mm², two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).
- ii) For MV & HV Motors: Six (6) mm² two core aluminium conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).
- iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm² ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm², ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).
- iv) Bearing Temperature Indicators - For each indicator, 0.5 mm² six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.
- v) For Moisture Detectors.....As per space heaters

14.38.02 For Main Terminals:-

- i) LT Motors
 - a) Three (3) core cables Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).
 - b) Single core cables Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).
- ii) HV & MV Motors
 - a) Three (3) core cables stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 3.3 kV / 11 kV un earthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

14.39.00 GROUNDING

Doc no.: ETG106-EPC-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 337
-----------------------------	--	----------

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED		VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS		PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01		SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL		REV. 0
14.39.01	General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.		
14.39.02	LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.		
14.39.03	HV & MV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.		
14.40.00	EMBEDDED TEMPERATURE DETECTORS		
	HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C.		
14.41.00	BEARINGS TEMPERATURE INDICATORS		
	HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to operate at lower value to give alarm and other set at a higher value to trip the motor.		
14.42.00	SPACE HEATERS		
14.42.01	Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.		
14.42.02	The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.		
14.42.03	The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.		
Doc no.: ETG106-EPC-ELEC-TS		STEAG Energy Services India Pvt. Ltd.	Page 338

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED		VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS		PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01		SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL		REV. 0
14.43.00	HOT AIR TEMPERATURE DETECTOR		
	If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). If alarm and trip are required for cooling air temperature, temperature switch shall be provided.		
14.44.00	WATER FLOW INDICATOR		
	If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.		
14.45.00	MOISTURE DETECTORS		
	Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.		
14.46.00	BED PLATE		
	Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.		
14.47.00	OTHER ACCESSORIES		
	Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.		
14.48.00	DC MOTOR		
	DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed.		
	Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.		
14.49.00	TESTS		
14.49.01	HV & MV Motors		
	i) Routine Tests		
Doc no.: ETG106-EPC-ELEC-TS		STEAG Energy Services India Pvt. Ltd.	Page 339

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Purchaser's representative, for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests

- a) For each type & rating of HV & MV motors the Bidder shall conduct all the type test as per relevant IEC and IS standards for all the proposed motors to be supplied under this contract and the test(s) should be conducted at an NABL accredited independent laboratory.

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

- a) No load saturation and loss curves upto approximately 115% of rated voltage.
- b) Measurement of noise at no load.
- c) Momentary excess torque test (subject to test bed constraint).
- d) Full load test(subject to test bed constraint)
- e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
- f) High voltage test
- g) Test for vibration severity of motor
- h) Degree of protection
- i) Overspeed test.
- j) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
- k) Tan delta measurement on coils

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

- l) Surge withstand test for inter turn insulation, m) Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box.

14.49.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of consultant /purchaser or his representative.

List of minimum tests for which type test shall be conducted for each type and rating of LT motor of 90 kW above.

- a) Measurement of resistance of windings of stator and wound rotor.
 - b) No load test at rated voltage to determine input current power and speed.
 - c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
 - d) Full load test to determine efficiency power factor and slip .
 - e) Temperature rise test.
 - f) Momentary excess torque test.
 - g) High voltage test.
 - h) Test for vibration severity of motor.
 - i) Test for noise levels of motor
 - j) Test for degree of protection and
 - k) Over speed test.
 - l) Type test reports for motors located in fuel oil area and explosive gas area having flame proof enclosures as per IS 2148 / IEC 60079-1
- ii) For all other LT motors less than 90 kW, Type test reports from NABL accredited laboratory shall be submitted. In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements and the type test reports are not withing 5 years from the date of Bid opening, the Bidder shall conduct all such tests under this contract free of cost to the Purchaser and submit the reports for approval,for which a minimum 7 days notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price
- iii) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

14.50.00 INFORMATION WITH PROPOSAL

14.50.01 AC Motor Data Sheet.

Doc no.: ETG106-EPC-ELEC-TS	STEAG Energy Services India Pvt. Ltd.	Page 341
-----------------------------	--	----------

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

14.50.02 Dimension Drawing/Foundation load details of motor and driven equipment.

14.50.03 Manufacturer's catalogue showing constructional details.

14.51.00 INFORMATION ON AWARD OF CONTRACT

14.51.01 Motor Data Sheet

Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

14.51.02 Following characteristics curves:-

- i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment.
- ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.
- iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.
- v) Efficiency, power factor, current and speed versus power output curves.
- vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.
- vii) Negative phase sequence current withstand characteristics.

14.52.00 DRAWINGS, DATA & MANUALS

14.52.01 Minimum Drawings, data & manuals for the motors to be submitted

- i) Dimensional General Arrangement drawing
- ii) Foundation Plan & Loading
- iii) Terminal box details
- iv) Space requirement for rotor removal
- v) Thermal withstand curves hot & cold
- vi) Starting and speed torque characteristics at 80% & 100% voltage
- vii) Complete motor Data sheet
- viii) Motor sizing calculation
- ix) Erection & Maintenance Manual
- x) Test reports
- xi) QAP

DATA SHEET

1	Auxiliary power supply	
---	------------------------	--

	GUJARAT STATE ELECTRICITY CORPORATION LIMITED	VOLUME - III
	1X800 MW ULTRASUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	PART - B
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT#7 -TS-01	SECTION - 1
	TECHNICAL SPECIFICATION ELECTRICAL	REV. 0

1.1	MV/HV supply	
	6.6 kV, 11 kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	50kA for 3 second
1.2	MV supply	
	3.3 kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors above 160kW upto and including 1500kW
	Fault level	40 kA for 3 second
1.3	LV supply	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 160kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
1.4	DC supply	
	220V, 2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	-----
	Frequency	-----
	Combined voltage & frequency	-----
2.2	DC supply	198 to 240 V

Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

SUB-VENDOR LIST

	GUJARAT STATE ELECTRICITY COPORATION LIMITED	VOLUME - V
	1X800 MW ULTRA SUPER CRITICAL UNIT NO#7 ON ASH DYKE AREA AT UKAI TPS	
	BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT # 7-TS-01	ANNEXURE - 4
	SUB – VENDOR LIST	REV. - 0

SR. NO.	DETAILS OF EQUIPMENT/SYSTEM	VENDOR'S NAME
13	LT AC MOTORS	ABB, CROMPTON GREAVES, ALSTOM INDUSTRIAL, GEC, KIRLOSKAR ELECTRIC CO, NGEF, JYOTI, SIEMENS, BHARAT BIJLEE LTD, LG, TOSHIBA, GE, MELCO, BHEL
14	LT AC GEARED MOTORS	GEC, ALSTOM, KIRLOSKER ELECTRIC CO.

Doc no.: ETG106-EPC- SUB-VENDOR	STEAG Energy Services India Pvt. Ltd.	Page 33
---------------------------------	--	---------



GUJARAT STATE ELECTRICITY COPORATION LIMITED

VOLUME - V

1X800 MW ULTRA SUPER CRITICAL UNIT NO#7 ON ASH DYKE
AREA AT UKAI TPS

BID SPECIFICATION NO.: ETG106-EPC-UKAI/UNIT # 7-TS-01

ANNEXURE - 4

SUB – VENDOR LIST

REV. - 0

SR.
NO.

DETAILS OF EQUIPMENT/SYSTEM

VENDOR'S NAME

39

CABLE GLAND

BRACO, COMET, CONTRACT,
HARDWARE INDUSTRIES, ELECT
ENG, LAPP

SUB-VENDOR LIST

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES12	CABLE LUGS	1	E1040	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.	CEO : Mr. Jayantibhai S. Patel 022-32504770./022-29270876/ 022-29270878.	
	CABLE LUGS	2	E1149	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001	033 2282 2540	
ES16	GI CONDUITS	BIS APPROVED MAKE					
ES17	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE					
ES19	FLEXIBLE CONDUIT (PVC COATED)	REPUTED MAKE					

Note:-

Make of all the equipment/instrument under this specification shall be subjected to Owner (End Customer)/BHEL approval in the event of order. The bidder may propose name of additional sub-vendors make based on their experience, which will be subject to Owner (End Customer)/BHEL approval.

Owner (End Customer)/BHEL approval reserves the right to accept/reject any make or sub-vendor after award of contract. Approval and rejection of makes shall not have any price & time implication to the purchaser after award of contract.



1X800MW HPGCL YAMUNANAGAR TPS
2X660 MW MSPGCL KORADI TPS,
2X660 MW DVC RAGHUNATHPUR TPS,
1X800 MW GSECL UKAI TPS,
2X660 MW CSPGCL KORBA WEST TPS,

TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM(CAS) PACKAGES (ELECTRICAL
PORTION)

SPECIFICATION NO. PE-TS-510/ 527/ 528/
529/ 530-555-A001

VOLUME II B
REV 00
PAGE 1 OF 1

DATE 10.12.2025

Annexure-E.3E

Motor Technical specification, Quality Plan & Sub-vendor list

2X660 MW CSPGCL KORBA WEST TPS PROJECT

NOTE: In the specification wherever word "NTPC" and "Contractor" are mentioned, same shall be read as "CSPGCL/BHEL" and "Compressed Air System-Vendor" respectively.

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.00.00	OPERATIONAL REQUIREMENTS
6.01.00	Starting Time
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
6.02.00	Torque Requirements
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor rated torque.
6.02.02	Pull out torque at rated voltage shall not be less than 205% of rated torque. It shall be 275% for crane duty motors.
6.03.00	NOT USED
7.00.00	DESIGN AND CONSTRUCTIONAL FEATURES
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.
7.02.00	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below
7.03.00	(a) Fuel oil area : Group – IIB (b) Hydrogen generation : Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)
	Winding and Insulation (a) Type : Electrolytic grade Copper conductor, Non-hygroscopic, oil resistant, flame resistant Insulation. (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature. However , conveyor motors shall be suitable for 3 consecutive hot starts (c) 11kV, 6.6 KV & 3.3 kV AC motors : Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15. (d) 240VAC, 415V AC & 220V DC motors : Thermal Class (F) or better
7.04.00	Motors rated above 1000KW shall have insulated bearings/housing to prevent flow of shaft currents.
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
	SUB SECTION-II-B-02 MOTORS PAGE 2 OF 5 Page 236 of 501

CLAUSE NO.	TECHNICAL REQUIREMENTS
7.06.00	Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A) (Tolerance limits as per IS/IEC shall be applicable on specified values). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting vibration pads. Contractor shall ensure the adequate size of vibration pads for mounting of suitable vibration sensors.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with 3 numbers duplex RTDs connected to three numbers dual input transmitters with display. However for air compressor, being high speed drive, each motor bearing shall be provided with minimum two numbers of duplex RTDs connected to two numbers dual input transmitters with display unit.
7.08.00	Motor body shall have two earthing points on diagonally opposite sides.
7.09.00	11 KV motors shall be offered with: i) Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds. OR ii) Dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box--PSTB shall be suitable for fault level of 50KA/40KA for 0.12 seconds (Fault level shall be as per system fault level for 11 KV system defined elsewhere in the specification). Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided.
7.10.00	3.3/6.6 KV motors shall be offered with dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box. Alternately Elastimold type Terminal box should also be accepted as per OEM standard proven practice. Contractor shall provide termination kit for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA/500MVA for 0.12 sec for 3.3/6.6KV respectively. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.
7.11.00	The spacing between gland plate & centre of bottom terminal stud shall be as per Table-I.
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 6.6 KV, 3.3 kV /415V systems without any injurious effect on its life.
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.15.00	NOT USED.
8.00.00	NOT USED.
9.00.00	CW motor shall be designed with minimum power factor of 0.8 at design duty point.
10.00.00	TYPE TEST
10.01.00	HT MOTORS
	LIST OF TYPE TESTS TO BE CONDUCTED The following type tests shall be conducted on each type and rating of HT motor (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary excess torque test (subject to test bed constraint). (d) Full load test(subject to test bed constraint) (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is
	SUB SECTION-II-B-02 MOTORS PAGE 3 OF 5

CLAUSE NO.	TECHNICAL REQUIREMENTS
10.02.00 10.03.00 10.04.00	required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose. LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED The following type test reports shall be submitted for each type and rating of HT motor (a) Degree of protection test for the enclosure followed by HV and no load run test. (b) Terminal box-fault level withstand test for each type of terminal box (phase side only) of HT motors only. (c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15 (d) Surge-withstand test on inter-turn insulation shall be as per clause no. 4.2 of IEC 60034, part-15 LT Motors LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only 1. Measurement of resistance of windings of stator and wound rotor. 2. No load test at rated voltage to determine input current power and speed 3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors) 4. Full load test to determine efficiency power factor and slip 5. Temperature rise test 6. Momentary excess torque test. 7. High voltage test 8. Test for vibration severity of motor. 9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section) 10. Test for degree of protection and 11. Overspeed test. 12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price. The type test reports once approved for any projects shall be treated as reference. For subsequent projects of Employer, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.
	SUB SECTION-II-B-02 MOTORS PAGE 4 OF 5 Page 238 of 501

CLAUSE NO.	TECHNICAL REQUIREMENTS																																												
	TABLE - I DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS <table><tr><th>Motor MCR in KW</th><th colspan="2">Minimum distance between centre of bottom terminal stud and gland plate in mm As per manufacturer's practice.</th></tr><tr><td>UP to 3 KW</td><td colspan="2">85</td></tr><tr><td>Above 3 KW - upto 7 KW</td><td colspan="2">115</td></tr><tr><td>Above 7 KW - upto 13 KW</td><td colspan="2">167</td></tr><tr><td>Above 13 KW - upto 24 KW</td><td colspan="2">196</td></tr><tr><td>Above 24 KW - upto 37 KW</td><td colspan="2">249</td></tr><tr><td>Above 37 KW - upto 55 KW</td><td colspan="2">277</td></tr><tr><td>Above 55 KW - upto 90 KW</td><td colspan="2">331</td></tr><tr><td>Above 90 KW - upto 125 KW</td><td colspan="2">385/203 (For Single core cables only)</td></tr><tr><td>Above 125 KW-upto 200 KW</td><td colspan="2"></td></tr></table> For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm. PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE: NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows: <table><tr><th>Motor MCR in KW</th><th colspan="2">Clearance</th></tr><tr><td>UP to 110 KW</td><td colspan="2">10mm</td></tr><tr><td>Above 110 KW and upto 150 KW</td><td colspan="2">12.5mm</td></tr><tr><td>Above 150 KW</td><td colspan="2">19mm</td></tr></table>			Motor MCR in KW	Minimum distance between centre of bottom terminal stud and gland plate in mm As per manufacturer's practice.		UP to 3 KW	85		Above 3 KW - upto 7 KW	115		Above 7 KW - upto 13 KW	167		Above 13 KW - upto 24 KW	196		Above 24 KW - upto 37 KW	249		Above 37 KW - upto 55 KW	277		Above 55 KW - upto 90 KW	331		Above 90 KW - upto 125 KW	385/203 (For Single core cables only)		Above 125 KW-upto 200 KW			Motor MCR in KW	Clearance		UP to 110 KW	10mm		Above 110 KW and upto 150 KW	12.5mm		Above 150 KW	19mm	
Motor MCR in KW	Minimum distance between centre of bottom terminal stud and gland plate in mm As per manufacturer's practice.																																												
UP to 3 KW	85																																												
Above 3 KW - upto 7 KW	115																																												
Above 7 KW - upto 13 KW	167																																												
Above 13 KW - upto 24 KW	196																																												
Above 24 KW - upto 37 KW	249																																												
Above 37 KW - upto 55 KW	277																																												
Above 55 KW - upto 90 KW	331																																												
Above 90 KW - upto 125 KW	385/203 (For Single core cables only)																																												
Above 125 KW-upto 200 KW																																													
Motor MCR in KW	Clearance																																												
UP to 110 KW	10mm																																												
Above 110 KW and upto 150 KW	12.5mm																																												
Above 150 KW	19mm																																												
	I	SUB SECTION-II-B-02 MOTORS	PAGE 5 OF 5																																										