ऊर्जा दक्ष मध्यम वोल्टेज इंडक्शन मोटरों के लिए विनिर्देश

SPECIFICATION FOR ENERGY EFFICIENT MEDIUM VOLTAGE INDUCTION MOTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	11 10 19	REVISED & ISSUED AS STANDARD SPECIFICATION	RKR	VKJ	SA	RKT
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Abbreviations:

AL	:	Aluminium
BASEEFA	:	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mines and Fuel Research
CPRI	:	Central power research institute
CT	:	Current Transformer
CU	:	Copper
DGMS	:	Directorate General of Mines Safety
DOL	:	Direct On Line
EIL	:	Engineers India Limited
ERTL	:	Electronics Regional test laboratory
FM	:	Factory Mutual
FRP	:	Fiber Reinforced Plastic
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
JEC	:	Japanese Electro-technical Committee
KLPL	:	Karandikar laboratories Pvt. Ltd.
LCIE	:	Laboratoire Central des Industries Electriques
NEMA	:	National Electrical Manufacturers Association
PESO	:	Petroleum and Explosive Safety Organisation
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
RPM	:	Revolutions per Minute
UL	:	Underwriter's Laboratories
VFD	:	Variable Frequency Drive
VDE	:	Verband Deutscher Elektrotechniker

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CONTENTS

1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of energy efficient-High efficiency (IE2/IE3 as specified in data sheet) three phase medium voltage squirrel cage induction motors.

2.0 CODES AND STANDARDS

2.1 The squirrel cage induction motors and their components shall comply with the latest editions of following standards issued by BIS (Bureau of Indian Standards) unless otherwise specified:

IS - 5	:	Colours for ready mixed paints and enamels.
IS - 1076	:	Preferred numbers.
IS - 1231	:	Dimensions of three phase foot mounted induction motors.
IS - 1271	:	Electrical insulation- Thermal evaluation and designation.
IS - 2223	:	Dimensions of flange mounted AC Induction motors.
IS - 2253	:	Designation for types of construction and mounting arrangement of rotating electrical machines.
IS - 2254	:	Dimensions of vertical shaft motors for pumps.
IS - 2968	:	Dimensions of slide rails electric motors.
IS - 4029	:	Guide for testing three phase induction motors.
IS - 4889	:	Method of determination of efficiency of rotating electrical machines.
IS - 6362	:	Designation of methods of cooling of rotating electrical machines.
IS - 7816	:	Guide for testing insulation resistance of rotating machines.
IS - 8223	:	Dimensions and output series for rotating electrical machines.
IS - 8789	:	Values of performance characteristics for three phase induction motors.
IS - 9283	:	Motors for submersible pump sets.
IS - 12065	:	Permissible limits of noise level for rotating electrical machines.
IS - 12075	:	Mechanical vibration of rotating Electrical Machines with shaft heights 56 mm and higher - measurement, evaluation and limits of vibration severity.
IS – 12615	:	Energy Efficient induction motors - Three phase squirrel cage.
IS - 12824	:	Type of duty and classes of rating assigned to rotating electrical machines.
IS - 13529	:	Guide on effects of unbalanced voltages on the performance of three phase cage induction motors.
IS - 13555	:	Guide for selection and application of three phase induction motors for different types of driven equipment.
IS - 14568	:	Dimensions and output series for rotating electrical machines, frame numbers 355 to 1000 and flange numbers 1180 to 2360.
IS / IEC60079-0:		Electrical apparatus for explosive gas atmospheres (General requirements)
IS/IEC-60079-1:		Explosive atmospheres-Equipment protection by flame proof enclosures "d".
IS/IEC60079-2 :		Explosive protection by pressurized enclosure "p".
IS/IEC60079-7 :		Explosive atmospheres-Equipment protection by increased safety – "e".
IS/IEC-60079-15:		Construction, test & marking of type of protection "n" electrical apparatus.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code)
IS/IEC 60034-1 :		Rotating electrical machines:-Rating & Performance
IS/IEC 60034-2-1:		Rotating electrical machines:-Part-2-1 : Standard method for determining losses and efficiency from test
IS/IEC-60034-5:		Degrees of protection provided by the internal design of rotating electrical machines.
IS/IEC 60034-8:		Rotating electrical machines-Terminal marking and direction of rotation

IS/IEC 60034-30:	Rotating electrical machines-Efficiency class of line operated AC motors
IS/IEC 61241:	Electrical apparatus for use in the presence of combustible dust
IS/IEC 60072-1:	Dimensions and output services for operating electrical machines Part-1 : Frame number 56-400 and flange number 55 to 1080

2.2 In case of imported motors, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.

2.3 The motors shall also conform to the provisions of CEA regulations and other statutory regulations currently in force in the country.

2.4 In case Indian Standards are not available, standards issued by IEC/ BS/ VDE/ IEEE/ JEC/NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of the art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to ensure the end user for placement of order for spares and services.

4.0 OPERATING CONDITIONS

4.1 Ambient Conditions

Motors shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in refineries, petrochemical, fertilizer and metallurgical plants. Service conditions shall be as specified in the motor data sheet. If not specifically mentioned therein, a design ambient temperature of 40 ° C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

4.2 Frequency and Voltage Variations

Unless otherwise agreed, motors shall be designed for continuous operation at rated output under the following conditions:

a) The terminal voltage differing from its rated value by not more than ± 6 % or
b) The frequency differing from its rated value by not more the ± 3 % or
c) Any combination of (a) and (b)

4.3 Starting

a) Motors shall be designed for direct-on-line starting or other method of starting as specified in datasheet.

b) Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.

c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. In addition, Locked Rotor withstand time under hot conditions at 75% & 100% voltages, shall be minimum 1.4 times the starting time at the corresponding voltage.

d) Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the motor terminals.

e) Motors shall be designed to allow the minimum number of consecutive starts indicated in Table below:

Starts	Min. no. of consecutive starts
No. of consecutive start-ups with initial temp. of the motor at ambient level (cold)	3
No. of consecutive start-ups with initial temp. of the motor at full load operating level (hot).	2

4.4 Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. Directional arrow should be manufactured from corrosion resistant material. When a motor is provided with bi-directional fans, a double-headed arrow should be provided.

Normally, clockwise rotation is desired as observed from the driving (coupling) end, when the terminals UVW are connected to a power supply giving a terminal phase sequence in the order UVW. Counter-clockwise rotation of the motor shall be obtained by connecting the power supply to terminals so that the phase sequence corresponds to the reversed alphabetical sequence of the terminal letters. Ample space shall be provided at the terminal box for interchanging any two external leads for obtaining the reverse phase sequence.

5.0 PERFORMANCE

5.1 Motors shall be rated for continuous duty (S_1), unless otherwise specified.

5.2 Unless specified, the starting current (as % rated current) shall be as per IS 12615:2011, subject to IS tolerance

5.3 In particular cases, when the starting current is to be limited, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification. Unless otherwise specified the minimum pull-up torque of motors, at rated voltage & frequency shall be minimum 50% of the rated full load torque.

5.4 In particular cases, when the starting with reduced voltage is specified, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification.

5.5 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified starting and operating conditions.

In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75 kW and shall be 90% of rated value for motors above 75 kW.

5.6 The breakdown torque at the rated voltage shall be not less than 175% of the rated load torque with no negative tolerance. Unless otherwise agreed, the breakdown torque shall not exceed 300% of the rated load torque.

In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors, crushers, ball mills) the minimum value of pull out torque at 75% of the rated voltage shall be more than the peak value of pulsating torque and the current pulsation shall be limited to 40%.

5.7 Motors fed by variable frequency drive shall additionally meet the following requirements

5.7.1 The motors shall be suitable for the current wave forms produced by the power supply including harmonics generated by the drive. The necessary coordination by motor manufacturers with drive manufacturers regarding harmonics generated by VFD shall be taken care and incorporated in motor design suitably.

5.7.2 The motors shall be designed to operate continuously at any speed over the range as per process requirement with minimum range as 10–100% of rated speed or as specified in data sheet. The characteristics shall be based on the application – in terms of constant torque / variable torque as per the driven equipment. Additional cooling fan shall be provided if required to limit the temperature rise to specified limits, alternatively option of applying suitable de-rating may be considered.

5.7.3 The motors shall withstand torque pulsation resulting from harmonics generated by the solid state power supply.

5.7.4 The motors required to be transferred to DOL bypass mode shall be rated for specified variations in line voltage and frequency.

5.8 The minimum values for performance characteristics of these motors shall be as given in the tables 1, 2 & 3 of IS 12615-2011 for IE2/IE3 motors, subjected to tolerance as per IS/IEC. Motor meant for application with VFD, the efficiency value can be one class lower as per IS.

6.0 CONSTRUCTIONAL DETAILS

6.1 Windings

6.1.1 Unless otherwise specified, motors shall be provided with class `B' insulation as a minimum. In case of motors with class 'F' insulation, the permissible temperature rise above the specified ambient temperature shall be limited to those specified in the applicable Indian standards for class `B' insulation.

6.1.2 The winding shall be tropicalised. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

6.1.3 Windings shall be adequately braced to prevent any relative movement during operation. In this respect, particular care shall be taken for the stator windings for direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases that lie together. Core laminations must be capable of withstanding burnout for rewind at 350 °C without damage or loosening.

6.1.4 In case of motors driving equipment with pulsating loads, special care shall be taken for the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.

6.1.5 The windings shall be connected in delta. However, for motors rated 2.2 kW and below, star connection may be accepted. In case of motors with star-delta starting, the motor windings shall be fully insulated for delta connection.

6.1.6 The ends of the windings shall be brought out into a terminal box. These shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and non-flammable material.

6.1.7 All motors shall be provided with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 2.2 kW which may be accepted with three terminals.

6.2 Terminal Box and Cable Entries

6.2.1 Unless otherwise agreed, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. The terminal box shall have side cable entry from non-driving end. However, as a special case, terminal box located on top may also be accepted, particularly for hazardous area motors, in case manufacturer has only top mounted terminal box design which is duly tested/certified by CIMFR and approved by PESO for installation in hazardous area. The terminal box design shall allow rotation in steps of 90 ° C to facilitate cable entry from any direction at site.

6.2.2 Terminal box cover shall be provided with handles to facilitate easy removal. However, for terminal box covers weighing less than 5 kg., terminal box covers without handles can be accepted.

6.2.3 The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Copper lugs and nickel-plated brass (or aluminum if specifically required), double compression type cable glands shall be supplied along with the motors for the specified cable sizes for power and space heater cables.

6.2.4 For flameproof motors, terminal box can be provided in increased safety 'Exe' execution.

6.2.5 The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the minimum cables sizes as specified below for 2 pole, 4 pole or 6 pole motors:

Motor rating up to and including	Size of phase conductor (mm^2)
2.2 kW and below	2.5 cu
3.7 kW	6 cu
5.5 kW	10 cu
7.5 kW	16 cu
9.3 kW	16 cu
11.0 kW	16 cu
15.0 kW	50 Al.
18.5 kW	70 Al
22.0 kW	70 Al
30.0 kW	95 Al
37.0 kW	120 Al
45.0 kW	150 Al
55.0 kW	240 Al
75.0 kW	2x95 Al
90.0 kW	2x120 Al

110.0 kW	2x240 Al
125.0 kW/132 kW	2x240 Al
160.0 kW	2x240 Al

NOTE: - Exact cable size for the motor shall be informed during vendor drawing review. Vendor to provide required size of the terminal box.

6.2.6 Cable sizes for motors having synchronous speeds 750 RPM and below shall be as agreed between the purchaser and manufacturer.

6.3 Motor Casing and Type of Enclosure

6.3.1 The minimum degree of motor enclosures including terminal boxes and bearing housing shall be IP-55 as per IS/IEC.

6.3.2 Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors (Type Ex d/Exde).

6.3.3 All internal and external metallic parts, which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents, which may be present in the atmosphere. Screws and bolts shall be of rust proof material or protected against corrosion.

6.3.4 Unless otherwise agreed, motors shall have standard frame sizes (min.) for various output ratings as stipulated in IS/IEC.

6.4 Bearing and Lubrication

6.4.1 Motors shall have grease lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years, (40, 000 hours) at rated operating conditions
(The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure).

6.4.2 The bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.

6.4.3 In cases such as pumps for hot liquids where the driven equipment operates at high temperatures, bearings shall be cooled by a shaft-mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven equipment by conduction or convection.

6.4.4 Bearings shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust / moisture e.g. labyrinth seal/ oil seal/ V seal. Where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices, which ensure passage of grease through the bearings.

6.4.5 Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessity of re-lubrication.

6.5 Cooling System

All motors shall be self ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.

For motors operating in hazardous area, the fans shall be of an anti-static non-sparking material.

6.6 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. Die cast aluminum rotors for motors in hazardous areas may be accepted provided the same are type tested and approved by competent authorities.

6.7 Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

6.8 Lifting Hooks

All motors weighing more than 30 kg. shall be provided with lifting hooks of adequate capacity.

6.9 Earth Terminals

Two earth terminals located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

7.0 MISCELLANEOUS ACCESSORIES

7.1 Anti-Condensation Heaters

All motors rated 30 kW and above shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shutdown periods.

For motors with heaters installed in hazardous atmospheres (Zone - 1 or Zone - 2), such heaters shall conform to the provisions of applicable Indian Standards and temperature classification specified in the motor data sheet.

The heater leads shall be brought out, preferably, to a separate terminal box which shall be of the same specification and grade of protection as the main terminal box.

A warning label with indelible red inscription shall be provided on the motor to indicate that the heater supply shall be isolated before carrying out any work on the motor.

7.2 Name Plates

In addition to the motor rating plate, a separate number plate for motor tag number shall be fixed in a readily visible position. This number shall be as per the motor data sheets.

8.0 CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 120 % of the synchronous speed. For flexible rotors this shall be between 60 % and 80 % of the synchronous speed; the second actual critical speed shall be above 120 % of the synchronous speed.

9.0 PAINTING

All metal surfaces shall undergo manufacturer's standard cleaning /painting cycle. After preparation of the under surface, the equipment shall be painted with two coats of epoxy based final paint. Color shade of final paint shall be 632 of IS: 5/ RAL-7031. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then these shall be greased.

10.0 INSPECTION AND TESTING

10.1 During fabrication, the equipment shall be subjected to inspection by EIL / Owner or by an agency authorised by the Owner, if specified / agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. All routine / acceptance tests shall be carried out at manufacturer's works under his care and expense.

10.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/ DGMS approval certificates, BIS license and original drawings referred in type test certificates shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of dispatch.

10.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.

10.4 For VFD fed motors, all tests as specified in VFD specification shall be followed.

10.5 All equipments shall be subjected to various routine / acceptance tests as per Inspection & Test plan no. 6-81-1064.

11.0 CERTIFICATION

The motors and associated equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRI/ ERTL/ BASEEFA/ LCIE/ UL/ FM/ KLPL or equivalent). All indigenous motors shall conform to Indian standards and shall be certified by recognised testing agencies. All motors (indigenous & imported) shall also have valid statutory approvals (e.g. PESO, DGMS etc). as applicable for the specified location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

12.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/cases to prevent damage to the finish. Crates/cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO Nos.' etc. shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature, unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

विक्रेता कार्यशाला में सकारात्मक सामग्री पहचान के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR POSITIVE MATERIAL IDENTIFICATION (PMI) AT SUPPLIER'S WORKS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	19.09.16.	REVISED AND RE-ISSUED	TKK	HP	RKS	RN
2	20.10.11	REVISED AND RE-ISSUED	RKS	SCG	AKC	DM
1	15.07.08	REVISED AND RE-ISSUED	NKR	SSL	SKP	VC
0	07.12.00	ISSUED AS STANDARD SPECIFICATION	AKC	AKB	AKB	MI

Abbreviations:

API	:	American Petroleum Institute
AS	:	Alloy Steel
HIC	:	Hydrogen Induced Cracking
LSTK	:	Lump Sum Turn Key
NACE	:	National Association of Corrosion Engineers
PMI	:	Positive Material Identification
RTJ	:	Ring Type Joint
Sch	:	Schedule
SS	:	Stainless Steel
TPI or TPIA	:	Third Party Inspection Agency

Inspection Standards Committee

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Mr. Rajeev Kumar
Mr. Himangshu Pal
Mr. Neeraj Mathur
Mr. T Kamalakannan
Mr. Mahendra Mittal
Mr. Deepak Gupta (Project)

CONTENTS

1.0 SCOPE

1.1 This specification applies to the requirements for Positive Material Identification (PMI) to be performed at the Supplier's works on Metallic Materials procured either directly by the Owner/EIL/ LSTK contractor or indirectly through the sub-Suppliers.

1.2 This specification covers the procedures and methodology to be adopted to assure that the chemical composition of the material is consistent with the material specifications as specified in purchase documents using 'Alloy Analyzer' at the time of final inspection before dispatch.

1.3 The scope of this specification shall include but shall not be limited to Positive Material Identification (PMI) to be performed on Materials listed below:

1.3.1 For alloy Steel materials as below:

- Alloy Steel Pipes including Clad Pipes
- Alloy Steel Flanges & Forgings
- Alloy Steel Fittings including Clad Fittings
- Alloy Steel Fasteners
- Alloy Cast & Forged steel valves
- Alloy Steel Instrumentation Items (Control Valves, Safety Valves etc.)
- Longitudinal Pipe & Fittings Welds.
- Gaskets (for Ring Type Joints)

1.3.2 For Carbon Steel materials as below:

- All Carbon Steel Piping items under NACE or HIC or H2 or Wet Hydrogen Sulfide (H_2S), Hydrofluoric acid (HF), Sulfuric acid (H_2SO_4) services etc.
- Carbon Steel flanges and valves (Rating 900# and above)

Following items shall be excluded from scope of PMI examination.

- Gaskets other than for Ring Type Joints
- Internal Components of Valves

1.4 All grades of material supplies including Stainless Steels shall be liable for PMI test at site. In case of any defective materials being found at site, the Supplier shall be responsible to effect replacement of such defective materials at project site without any delays to the satisfaction of EIL site RCM (Resident Construction Manager).

2.0 REFERENCE DOCUMENTS

2.1 API Recommended Practice 578 (First Edition, May 1999) - Material Verification Program for New and Existing Alloy Piping Systems.

3.0 DEFINITIONS

3.1 **Supplier:** Any Supplier or Manufacturer on whom an order is placed for the supply of referred items. This definition shall also include any sub-Supplier or manufacturer on whom a sub-order is placed by the Supplier.

3.2 **Inspection Lot:** A group of items offered for inspection covered under same size, Heat and Heat treatment lot.

3.3 **Alloy Material:** Any metallic material (including welding filler materials) that contains alloying elements such as Chromium, Nickel, Molybdenum or Vanadium, which are intentionally added to enhance mechanical or physical properties and/or corrosion resistance.

4.0 PMI EXAMINATION

4.1 The Supplier shall submit a procedure of PMI to comply with the requirements of this Specification. Approval of PMI Procedure shall be obtained from Owner / EIL / TPIA prior to commencing manufacture / inspection of product.

4.2 PMI examination of materials is independent of any certification, markings or colour coding that may exist and is aimed at verifying that the alloy used are as per specified grades.

4.3 The Supplier shall identify all incoming alloy materials and maintain full traceability of all alloy materials, including all off-cuts. Transfer of identification marks shall be undertaken prior to cutting to ensure maintenance of identification on off-cuts.

4.4 The Supplier shall ensure that all alloy materials are segregated and stored in separately identified locations to prevent the mix up of materials of different alloy specifications or alloy material with carbon steel. Non ferro-magnetic materials shall be segregated at all times from ferro-magnetic materials.

4.5 PMI examination is subject to surveillance inspection by Owner / EIL / TPIA.

5.0 ACCEPTABLE METHODS FOR PMI

5.1 The method used for PMI examination shall provide a quantitative determination of the alloying elements like Chromium, Nickel, Molybdenum or Vanadium in Alloy Steel items.

5.2 Instruments or methods used for PMI examination shall be able to provide quantitative, recordable, elemental composition results for positive identification of alloying elements present.

5.3 The acceptable instruments for alloy analyzer shall be either "Portable X-Ray fluorescence" or "Optical Emission" type each capable of verifying the percentage of alloy elements within specified range.

5.4 Chemical spot testing, magnets, alloy sorters and other methods using eddy current or triboelectric testing methods are not acceptable for PMI examination.

5.5 The PMI instrument used shall have the sensitivity to detect the alloying elements in the specified range.

5.6 All PMI instruments shall have been serviced within a 6 month period of the time of use to verify the suitability of batteries, sources etc., and the data of the last service shall be stated on the PMI Report Form (Sample enclosed).

5.7 Each analyzer must be calibrated according to the manufacturer's specification at the beginning and end of each shift. Instrument must be checked against known standard for each alloy type to be inspected during the shift.

5.8 Certified samples, with full traceability, of a known alloy materials shall be available for use as a random spot check on the instrument calibration.

5.9 The surfaces to be examined shall be prepared by light grinding or abrasive paper and solvent cleaner. Evidence of Arc burn resulting from examination shall be removed by light grinding or abrasive paper. No permanent marks, which are injurious to the usage of product in service, are acceptable.

5.10 Alloy Steel ring type joint Gaskets shall be inspected by using portable X-Ray fluorescence instrument.

5.11 Testing shall be done as per the procedures outlined by the manufactures of alloy analyzer being used. Modification of these procedures if any must be approved by Owner/EIL.

5.12 The persons performing PMI shall demonstrate their capabilities to the satisfaction of Owner/EIL/TPIA visiting engineer. If the Supplier has qualified operator on their rolls, he may perform the examination. Otherwise PMI examination shall be sub-contracted to an independent testing agency approved by EIL.

5.13 Whenever material is identified as not meeting requirements by the visiting engineer a rejection note shall be issued.

6.0 EXTENT OF PMI EXAMINATION

Following sampling plans shall be applicable for PMI examination of various items.

A.	Flanges, Fittings Valves, RTJ Gaskets	-	100%
B.	Pipes	-	100% (for pipes procured from traders). 2 random samples drawn from each Size/Heat/Lot (for pipes procured directly from mills)
C.	Fasteners	-	

Lot Size	Sample Size
Upto 100	2% (Min 2)
101 to 500	1% (Min 3)
501 and above	0.5% (Min 5)

Note:

a. For Welded Pipes and Fittings, PMI shall be performed on Base Metal as well as weldments.

7.0 ACCEPTANCE CRITERIA

7.1 Base Metal

PMI test results showing presence of characteristic elements upto 10% less than the minimum specified value in the material specification and upto 10% more than the maximum specified value in the material specification shall be acceptable.

7.2 Deposited Weld Metal

For deposited weld metal using welding consumables matching with base metals, the recorded presence of characteristic elements upto 12.5% less than the minimum specified value in the welding consumable specification and upto 12.5% more than the maximum specified value in the welding consumable specification shall be acceptable.

8.0 REJECTION CRITERIA

8.1 If PMI test results fall outside the acceptable range as specified in 7.0 above, the supplier shall obtain a quantitative check analysis performed by a laboratory acceptable to Owner / EIL / TPIA for a complete chemical analysis. Alternatively, the item can be tested with a spark analyser for verification. Results of this analysis shall be submitted to Owner / EIL / TPIA for final decision.

Decision of Owner / EIL / TPIA shall be final in this regard.

8.2 If any sample drawn to PMI test on the basis of percentage selection as per 6.0 above, fails to meet specification requirements, 100% of items of lot shall be tested for PMI by supplier. Any failure thereafter during sample check shall mean rejection of whole lot.

9.0 RECORDING AND DOCUMENTATION

The results of PMI examination shall be recorded in a Report Format as enclosed with this specification.

10.0 MARKING

10.1 All alloy materials tested by PMI shall be identified using either of the following methods by indicating "PMI OK"

a) Bar Code/Hologram Sticker
b) A low stress stamp marking

POSITIVE MATERIAL IDENTIFICATION REPORT BULK MATERIALS							Page of
Project:	Client						Job No.
PMI Report No.	Supplier/Sub-Supplier						
Purchase Order No.	Testing Agency						
Purchase Requisition No:	PMI Location						
Bulk Item Type (as per Requisition)							
Material Specification/Grade Number of items in Lot							
Requisition Item No./ Description	Major content, Weight Percent						Remarks Accept/Reject
Element	Cr	Ni	Mo	V	Ti*	Cb / Nb **	
Specified Range							
Actual observations 1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
Instrument Type / ID Last Service Date	Inspection Agency						Witnessed By

* To be reported in case of SS321 Material

** To be reported in case of SS347 Material

ऊर्जा दक्ष मध्यम वोल्टेज मोटरों के लिए निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR ENERGY EFFICIENT MEDIUM VOLTAGE MOTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	12 11 2018	ISSUED FOR IMPLEMENTATION	MM	RS	RKS	RKT

Abbreviations

BIS	:	Bureau of Indian Standard
CIMFR	:	Central Institute of Mining & Fuel Research
EIL	:	Engineers India Limited
FM	:	Factory Mutual
FLP	:	Flame Proof
ITP	:	Inspection and Test Plan
IP	:	Ingress Protection
IC	:	Inspection Certification
IEC	:	International Electro technical Commission
JEC	:	Japanese Electro technical Committee
MTC	:	Material Test Certificate
NEMA	:	National Electrical Manufacturers Association
PO	:	Purchase Order
PESO	:	Petroleum Explosive Safety Organization
PR	:	Purchase Requisition
QC	:	Quality Control
TC	:	Test Certificate
TPI or TPIA	:	Third Party Inspection Agency
VDR	:	Vendor Data Requirement
VFD	:	Variable Frequency Drive

Inspection Standards Committee

Convenor : Mr. RK Singh

Members:
Mr. Rajeev Kumar
Mr. Neeraj Mathur
Mr. Himangshu Pal
Mr. R Muthuramalingam
Mr. T Kamalakannan
Mr. Mahendra Mittal
Mr. Deepak Gupta (Projects)

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of three phase medium voltage energy efficient squirrel cage induction motors.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred therein /Job specifications / Approved documents/ Relevant IEC/IS.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Raw Material: Body (casting or fabrication), Rotor Shaft, Core Laminations, Copper, Insulation Material, Bearings, Cable Boxes, Cable Glands, etc.	Chemical, Physical Properties, Finish as per Relevant Standard	100%	Material Test Certificates / Test records	H	H	-

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.0	**In-process Inspection**						
3.1	Motor Assembly	Vacuum Impregnation and Bracing of Winding, Core Assembly, Rotor Bars and End Rings Assembly, Rotor Balancing, Terminal Box Mounting and Clearances in between, Bearing Setting, etc. as per Supplier's Internal Standards	100%	Test Records	-	H	R
4.0	**Final Inspection**						
4.1	Motor (Routine Tests)	• Visual Check (Nameplate, Terminal Box Location, Terminal Type, Clearances, Size, Entries, Space Adequacy & Gland Size, Direction of Rotation etc.) • Dimensions Check (Including Shaft Height etc., Foundation Hole Dia and Distance, Shaft Dia.) • Cable Glands, Cable Lugs Size and No. of Entries in Terminal Box • Winding Resistance • No Load Test and Measurement of Voltage, Speed, Current, Power Input • Reduced Voltage Starting and Running • Insulation Resistance before & after High Voltage Test • High Voltage (Per Phase) • Vibration at No Load • Noise Level	100%	Inspection test records	-	H	See Note 4 & 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.2	Motor (Type Tests)	• Full Load Test and Measurement of Voltage, Current, Power, Slip, Power Factor, Bearing Noise. • Efficiency and Pf at 100%, 75% and 50% Load • Temp Rise Test • Momentary Overload Test • Vibration • Over Speed • Measurement of Starting Torque, Starting Current, Full Load Torque, Pull Out Torque by JEC/IEC (By Logarithmic Proportion Current Method II	One sample from each type/rating	Inspection test records	-	H	See Note 4 & 5
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing with suitable plugs to prevent Ingress of Moisture and any damage during Transportation and Storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports • Test Certificate from Recognized Testing Laboratory for Area Classification. • BIS Certificate for FLP Motors and Accessories as applicable.	100%	Supplier's Test Records / Certificates from statutory bodies /	-	H	H

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		• PESO approved Certificates for Motors and Accessories as applicable. • Degree of Protection of Terminal Box and Body • IC Issuance		Inspection Certificate (IC)			
6.2	Final Document submission	Compilation of Inspection Reports, Drawings, etc. as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. For VFD application motors, separate FAT procedure to be submitted for EIL/ TPIA approval.
2. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable.
3. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred therein/ Job specifications /Approved documents.
4. Motors up to 55 KW would be accepted based on Manufacturer's test certificates. Higher rating will have witness by TPIA appointed by Main Supplier.
5. Motors ordered with integration test (VFD fed motors) requirement as per PR shall be witnessed by EIL/ TPIA and main supplier for integration test (irrespective of rating) at motor manufacturer's works.

1.0 In case of any conflict between BHEL spec TC 54015 Rev 04 and other enquiry documents, the following preferential order shall govern.

1.1 BHEL Specification TC54015 Rev 04
1.2 Customer spec 6-51-0064-SPEC FOR MV MOTORS
1.3 Customer Specifications B378-999-16-50-DS-6401-MOTOR DS
1.4 Customer specs 6-81-0001-PMI SPEC
1.5 Customer specs B378-000-02-42-PCS-0001-PAINTING SPEC
1.6 ITP for 6-81-1064-ITP FOR MV MOTORS
1.7 Annexures to purchase specification TC54015 Rev 04, TC54373 Rev 03,TC54197 Rev 04, TC64015-R01 & TC51108-R02
1.8 International standards/codes/recommended practices as applicable.
1.9 SQP for pump and motor

2.0 Special notes (To be complied without deviation):

2.1 Noise level of the complete package shall be restricted within 85 dbA at any point located 1 m away from the equipment. If the noise level exceeds the specified value, necessary modifications to meet the noise level criteria, shall be provided by the vendor without any cost/time implications.
2.2 Vendor shall supply cable glands (Double compression type nickel plated brass flameproof) and tinned Cu/Al crimping type lugs for equipment supplied by them.
2.3 All nuts and bolts shall be of SS304.
2.4 All the Equipment's shall be packed for an outdoor storage period of 12 Months.
2.5 Customer drawing, Spare part and document numbers will be informed after placement of order.
2.6 All brought out material shall be procured from EIL approved vendor list.
2.7 All Austenitic stainless steel shall IGC practice E tested
2.8 All SS and Alloy Steel Material shall be PMI tested as per IBCE-6373-C00-ISP-QMS-000-0002
2.9 All Stabilized Grade (SS 321 and SS 347) if applicable shall be stabilized heat Treated at 900 Deg. for 4 Hours
2.10 All electrical equipment for use in hazardous areas shall be certified by CIMFR, PTB, Baseefa, UL, FM or equivalent independent testing agency for the service and the area in which it can be used and shall be approved by PESO/CCOE. Copies of Hazardous area test certificates & PESO/CCOE approval shall be furnished.
2.11 Vendor shall submit the valid PESO/CCOE certificate for the applicable instruments.
2.12 All cable glands/adapters/blocking plugs for hazardous area equipment shall meet the requirement of IS/IEC: 60079-0.
2.13 All motors shall be provided with GI canopy.
2.14 The preliminary Power cable size is 2.5 mm2 (CU), Final cable sizes of power Cable shall be finalized during detailed engineering.

Rev. No.	Revisions	Prepared:	Reviewed:	Approved	Date
00	Issue	ANSHUL	Sunil B J	PD Mahulikar	26.02.22

2.15 Provisions, as required in motor/Motor terminal box for termination of the final cable size (higher than 2.5 mm2 (CU) shall be made accordingly without any cost & time implications.

2.16 Oil Console for Barring gear motors shall be powered from a nearby 5pin socket (Provided by customer). Vendor to provide suitable flameproof motor starter used in Zone 2,Gas group IIC ,Temp class T3 with 30 metres of armoured copper conductor trailing cable with plug.

2.17 Oil Console for Barring gear motor vendor to provide integral starters; connection between motor and starter shall be through armoured copper conductor cable and shall have motor protections, other hardware such as switch, fuse, contactor & BMR etc.

2.18 The Motors shall be Ex n, Zone 2, Gas group IIC Temp class T3, IE3 class efficiency as per data sheet.

2.19 Fans shall be of an anti-static non-sparking material and shall not be with plastic material.

2.20 The specification TC54373-R04 shall be read in place Spec TC54175 wherever mentioned in specifications TC54197-R10.

2.21 Equipment earthing shall be done at 2 points and both earth connections shall be brought to skid inbuilt earth plate by means of 10mm (3/8") dia G.I wire rope, the same shall be supplied along with motor.

2.22 All the instruments and valves shall comply the clause 4.0 of customer specification INSTRUMENTS

2.23 The make of all the items including instruments & solenoid valve shall be as per B378-101-KA-MR-5040 Project supplier list

3.0 Special requirement of SOV: -

3.1 All solenoid Solenoid valves used in hazardous area shall be Flameproof Exd type (110 V AC).Solenoid valve body material shall be SS316. SOV shall be provided with flameproof enclosure.

3.2 Solenoid valves shall be universal type and shall be continuous rated type with class H coil insulation.Solenoid valve shall be of SS body with SS 316 trim, as a minimum. Positioners with inbuilt Solenoid valves shall not be considered. Atmospheric vents shall be fitted with SS/Brass bug screens, to prevent blockage of port because of bugs and to save the port from dust. **Solenoid valve shall be explosion proof with area of classification ZONE 1 GAS GR IIC, T3 type and shall be as per IEC 60085/IS1271. Vendor shall submit the CCOE & PESO certificate for the same.**

3.3 BSP process connection is not acceptable. Process connection shall be NPT (F) and size shall be suitable for application.

3.4 Solenoid valve shall have integral junction box for external cable termination. Flying leads are not acceptable.

3.5 Size & type of electrical cable entry shall be specified

4 Special requirement of Pressure Gauge: -

4.3 Dial size for pressure gauge shall be 150mm.

4.4 Pressure Gauge case material shall be SS316.

4.5 Pressure gauge shall be solid front design.

4.6 Movement assembly of pressure gauge shall be SS304 minimum.

4.7 Pressure Gauge shall be in line with customer's Hook-up documents IBCE-6373-C00-INC-STD-000-0001

4.8 BHEL to confirm that selected pressure gauge shall be as per project requirement (Doc. No. 6684-INS-101-EB-0003, Project Engineering Specification for Instrumentation)

4.9 Pressure instrument shall be with 3/4" 800SW isolation gate valve, adapter can be used if required.

5 **Warranty requirement for GAIL Propyelene Compressor package is:** Warranty requirement shall be as -12 months from the date of first commercial operation of the plant or 24 months from the date of last dispatch whichever period expires first

6 Enclosures:

6.1 BHEL Specification TC54015 Rev 04
6.2 Customer spec 6-51-0064-SPEC FOR MV MOTORS
6.3 Customer Specifications B378-999-16-50-DS-6401-MOTOR DS
6.4 Customer specs 6-81-0001-PMI SPEC
6.5 Customer specs B378-000-02-42-PCS-0001-PAINTING SPEC
6.6 ITP for 6-81-1064-ITP FOR MV MOTORS
6.7 Annexures to purchase specification TC54015 Rev 04, TC54373 Rev 03,TC54197 Rev 04, TC64015-R01 & TC51108-R02
6.8 International standards/codes/recommended practices as applicable.
6.9 SQP for pump and motor

List of suppliers

SOLENOID VALVES (SOV)	
1	ROTEX AUTOMATION LTD
2	AVCON CONTROLS PVT. LTD.
3	ASCO NUMATICS (INDIA) P. LIMITED
4	ASCO JOUCOMATIC LTD
5	ALCON ALEXANDER CONTROLS LIMITED
6	ASCO JOUCOMATIC SA
7	HERION WERKE
8	PRECISION INSTRUMENT COMPANY
9	ROTEX AUTOMATION LTD
10	SCHRADER DUNCAN LIMITED
11	THOMPSON VALVES LTD
12	VERSA BV

PRESSURE GAUGES	
1	PRECISION MASS PRODUCTS PVT. LTD.
2	BAUMER TECHNOLOGIES INDIA PVT.LTD(W058)
3	BADOTHERM PROCESS INSTRUMENTS B.V.
4	FORBES MARSHALL (HYD) PVT. LTD
5	GAUGES BOURDON (I) PVT. LTD. (GEN.INST)
6	H GURU INSTRUMENTS (SOUTH INDIA) PVT. LTD
7	H.GURU INDUSTRIES
8	MANOMETER (INDIA) PVT. LTD.
9	THERMAL INSTRUMENT (I) P LTD (GEN.INST.)
10	WIKA INSTRUMENTS INDIA PVT LTD
11	WALCHANDNAGAR INDUSTRIES LTD(TIWAC DIVN)
12	WIKA ALEXANDER WIEGAND & CO GMBH

ANEXURE II to Purchase Specification TC54015 R04

BHEL Enquiry Ref No Date

Vendor offer Ref No Date

The vendor shall complete the experience record proforma as per below to prove that the equipment offered meets the EQC for technical acceptance. Vendor may furnish additional information to justify that the EQC is being met. In addition, manufacturer's catalogue and general reference e list for all the below equipment's shall also be furnished along with the proposal.

PROVEN TRACK RECORD FOR THE MODEL BEING OFFERED (FOR MORE THAN 8000 HOURS)

SL.NO	PLANT NAME /LOCATION	CLIENT	SERVICE	YEAR OF COMMISSIONING	NO. OF RUNNING HOURS LOGGED

Signature and stamp of vendor

Annexure-III to Purchase Specification TC54015 Rev 4

Technical Deviation Sheet (TDS Sheet):

S.No	Spec No	Description of Spec	Deviation	Reason

Vendor's Signature

Vendor's Company seal

Annexure-IV to purchase specification TC54015 R04
TURBINES AND COMPRESSORS
RATE CONTRACT : OCBG
BHEL, HYDERABAD

PRICE SCHEDULE

Enquiry ref. No: Date:
Offer ref no. Date:

Package-1

Sl.No	Description	Qty.	Price/Unit
01	Oil Console for Barring Gear Assembly consists of Mat Code:		
	a) OCBG,2LPM,100KG/CM2(G)415VAC,IIC,110VAC, SS 316, SIL3: TC9754015040	5 No	
	b) 3/2 EXPF SOLENOD VLV 110VAC, SS316, SIL-3: TC9754015074	10 No	
	c) SP PRESSURE GAUGE FOR OCBG - SS316 : TC9754015112	10 No	

Package-2

Sl.No	Description	Qty.	Price/Unit
01	Oil Console for Barring Gear Assembly consists of Mat Code:		
	a) OCBG2LPM,100BAR, 415VAC, IIC, 24VDC SIL3 SOV TC9754015236	5 No	
	b) 3/2 EXPF SOLENOD VLV 24VDC, SS316, SIL-3: TC9754015082	10 No	
	c) SP PRESSURE GAUGE FOR OCBG - SS316 : TC9754015112	10 No	

Package-3

Sl.No	Description	Qty.	Price/Unit
01	Oil Console for Barring Gear Assembly consists of Mat Code:		
	a) OCBG,2LPM,100KG/CM2(G)415VAC,IIC,110VAC, SS 316, SIL3: TC9754015040	2 No	
	b) 3/2 EXPF SOLENOD VLV 110VAC, SS316, SIL-3: TC9754015074	4 No	
	c) SP PRESSURE GAUGE FOR OCBG - SS316 : TC9754015112	4 No	
	d) Bearings for OCBG Motor TC9754015252	4 Set	

Package-4

Sl.No	Description	Qty.	Price/Unit
01	Oil Console for Barring Gear Assembly consists of Mat Code:		
	a) OCBG,2LPM,100KG/CM2(G)415VAC,IIC,24VDC, SS 316, SIL3: TC9754015236	2 No	
	b) 3/2 EXPF SOLENOD VLV 110VAC, SS316, SIL-3: TC9754015082	4 No	
	c) SP PRESSURE GAUGE FOR OCBG - SS316 : TC9754015112	4 No	
	d) Bearing for OCBG Motor TC9754015252	4 set	

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00	Issue	Anshul	S B J	Prafulla	26.02.22

Package 5

Sl.No	Description	Qty.	Price/Unit
01	Oil Console for Barring Gear Assembly consists of Mat Code:		
	a) OCBG,2LPM,100KG/CM2(G)415VAC,IIC,24V DC, SS 316, SIL2: TC9754015090	4 No	
	b) 3/2 EXPF SOLENOD VLV 24VDC, SS316, SIL-2: TC9754015104	8 No	
	c) SP PRESSURE GAUGE FOR OCBG - SS316 : TC9754015112	8 No	
	d) Bearing for OCBG Motor TC9754015252	8 set	

Notes: 1) Sl. Nos 01 will be considered for price evaluation. Each package(Package 1 to Package 5) shall be evaluated separately.
2) Any additional requirements which are essential for proper functioning of Oil Console for Barring Gear Assembly but not indicated in specification are included in the main offer.

Vendor's Signature **Vendor's Company seal**

Table 1: Check List
(TO BE FILLED BY THE VENDOR AND SUBMITTED ALONG WITH THE OFFER WITH OUT WHICH OFFER WILL NOT BE CONSIDERED)

S. No	Description	Vendor's Confirmation (Yes/No)
1	Compliance for BHEL specification TC54015 Rev 04	
2	Compliance for BHEL specification TC54197 Rev 10	
3	Compliance for BHEL specification TC54373 Rev 04	
4	Compliance to customer Motor data sheet - B378-999-16-50-DS-6401	
5	Compliance to customer specification 6-51-0064-SPEC FOR MV MOTORS	
6	Compliance to customer SPEC: 6-81-1064-ITP FOR MV MOTORS	
7	Compliance to Annexure-I of purchase spec TC 54015 Rev 04	
8	Submission of documents to be sent along with offer as per clause 8.1 of spec TC54373 Rev04.	
9	Price Schedule as per Annexure IV & signed filled copy of Price schedule (without prices) enclosed with technical offer.	
10	Customer spec: B378-000-02-42-PCS-0001-PAINTING SPEC	
11	Proven Track Record as per Annexure II of purchase spec TC54015, TC54373 & TC54197	
12	Customer spec: 6-81-0001-PMI SPEC	
13	Any additional requirements, which are essential for proper functioning of the equipment, included in the offer.	
14	Vendor shall confirm that the bill of material furnished along with offer is only indicative and the final BOM, which shall be furnished during detailed Engineering (after order placement) for the approval of BHEL. The additional items, if any required at later stage for complying BHEL specification or for the satisfactory working of the equipment shall be supplied by vendor without any price/delivery implications.	

Vendor's Signature

Vendor's Company seal

Rev. No.	Revisions	Prepared:	Reviewed:	Approved	Date
00	Issue	ANSHUL	S B J	PD MAHULIKAR	29.08.2022

SPECIFICATION FOR SURFACE PREPARATION AND PROTECTIVE COATING SYSTEM - NEW CONSTRUCTION

PROJECT : 500 KTA PDH PP PROJECT, USAR

OWNER : GAIL (INDIA) LTD.

JOB NO. : B378

Rev. No.	Date	Purpose	Prepared by	Reviewed by	Approved by
2	12.2.2021	Table 9.6 Sr No. c revised and Reissued For Tender	S S Pandey	P Chowdhary	A Roy
1	4.12.2020	Revised and Reissued For Tender	S S Pandey	P Chowdhary	A Roy
0	1.12.2020	Issued For Tender	S S Pandey	P Chowdhary	A Roy

Contents

1.0 GENERAL

1.1 This technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor. Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

1.3 This specification covers the requirement for protective coating for new construction.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to the following.

2.1.1 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services and chimneys if any. The items listed in the heading of tables of Coating Systems, is indicative only. However, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Extent of Work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

- All uninsulated Carbon Steel & Alloy Steel equipments like Vessels, Columns, Storage Tanks, Exchangers if any, parts of boilers etc.
- All uninsulated carbon steel and low alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.
- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and if any other insulated items present.
- All items contained in a package unit as necessary.
- All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.
- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining. (If present)
- Identification of colour bands on all piping as required including insulated aluminium clad, galvanized, SS and nonferrous piping.
- Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminium clad, galvanized, SS and non-ferrous piping.

- Marking / identification signs on painted surfaces of equipment/piping including hazardous service.
- Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)
- Over insulation surface of equipments and pipes wherever required.
- Painting under insulation for carbon steel, alloy steel and stainless steel as specified.
- Painting of pre-erection/fabrication and Shop primer.
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.
- All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in ETP plant.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating).

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the Owner, the same shall be painted as per the relevant specifications:

a. Uninsulated austenitic stainless steel.

b. Plastic and/or plastic coated materials

c. Non-ferrous materials like aluminum, Cu-Ni alloy.

2.3 Documents

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

a. Bill of quantities for piping, equipment, machinery and structures etc.

b. Piping Line List.

c. Painting specifications including special civil defence requirements.

2.4 Complete coating (i.e., primer, intermediate and top coats) of shop fabricated equipment and piping, may be carried out at shop. Any coating damage during transportation of equipment/piping to site shall be repaired by the fabricator/manufacturer in accordance with this specification.

2.5 In case of conflict between coating systems given in this document and any other system specified elsewhere in the applicable contractual documents like SOR, MR, and PR etc, Contractor shall approach the Client/Client's authorized representative for confirming the suitable coating systems.

2.6 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to EIL for deviation permit.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered under this specification.

International Organization for Standardization (ISO):

ISO 12944: Corrosion Protection of steel Structures by Protective Paint System

ISO 14713-2: Zinc Coatings - Guidelines and Recommendations for the Protections against Corrosion of Iron and Steel in Structures, Part-2: Hot Dip Galvanizing

ISO 8502-3: Preparation of steel substrates before application of paints and related products -Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)

ISO 8502-9: Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness - Part 9: Field method for the conductometric determination of water-soluble salts.

ISO 2808: Paints and varnishes - Determination of film thickness

National Association for Corrosion Engineer (NACE):

NACE SP 0198: Control of Corrosion under Thermal Insulation and Fireproofing Materials

NACE SP 0188: Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

Steel Structures Painting Council (SSPC)

SSPC VIS 1: Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

SSPC PA 2: Measurement of Dry Paint Thickness with Magnetic Gauges

American Society for Testing and Materials (ASTM):

ASTM D6677-18: Standard Test Method for Evaluating Adhesion by Knife

ASTM D1475-13: Standard Test Method for Density of Liquid Coatings, Inks, and Related Products

ASTM D5894–16: Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)

ASTM D823–18: Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels

ASTM D2369-10 (2015): Standard Test Method for Volatile Content of Coatings

ASTM D1640/D1640M-14(2018): Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings

ASTM D522/D522M–17: Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

ASTM D3363 - 05(2011): Standard Test Method for Film Hardness by Pencil Test

ASTM D2197–16: Standard Test Method for Adhesion of Organic Coatings by Scrape Adhesion

ASTM D968–17: Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D1044–13: Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion

ASTM D1849-95 (2019): Standard Test Method for Package Stability of Paint

ASTM D2247–15: Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity

ASTM D543–14: Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

ASTM D870–15: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion

ASTM D5146-10(2019): Standard Guide to Testing Solvent-Borne Architectural Coatings

ASTM D2485–18: Standard Test Methods for Evaluating Coatings for High Temperature Service

Other Applicable Standards:

RAL DUTCH: International Standard for colour shade (Dutch Standard)

ANSI A 13.1: Scheme for identification of piping systems: American National Standards Institution

ISO 8501-1 / SIS-05 59 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

3.2 The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.3 The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall carried out as per this standard

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. The manufacturer's test certificates / data sheets for all the above items shall be reviewed by Engineer-in-charge at site before start of work.

4.2 Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR

5.1 General

5.1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

a. Abrasive blast cleaning

b. Mechanical or power tool cleaning

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. The minimum acceptable standard, in case of thermally sprayed metal coatings, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent. In case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900 (latest edition) or SSPC-SP or ISO 8501-01.Blast cleaning shall be Sa 3 as per Swedish Standard in case thermally sprayed metal coatings.

Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc.

5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. In case of internal coating of storage tanks, dehumidifier shall be used, to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3^0C below the metal substrate temperature during centre period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by contractor for the given site conditions before starting operation of dehumidifier to ensure that desired values of dew point, moisture content in enclosed scope is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.
Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer interested with quality assurance for the work. In case the dehumidifier breaks down

in middle of the job, the same shall be replaced at the risk and the cost of the contractor and the entire unfinished work shall be repeated.

5.1.4 The Engineer in-charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances the contractor shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the owner.

5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.6 The external surface of R.C.C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCL solution for about 15 minutes shall be carried and surface must be thoroughly washed with water to remove acid & loose particles and then dried completely before application of paint.

5.2 Procedure for Surface Preparation

5.2.1 Air Blast Cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives like angular chilled cast iron or steel grit, copper slag or Nickel slag, $A1_2O_3$ particles at pressure of 7kg/cm^2 at an appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G16 – G42 conforming to SSPC AB1 and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G16 – G24. The combination of steel grits and shots shall be normally in the ratio of 3:1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to ¾". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer/first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.2 Mechanical or Power Tool Cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and /or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

5.3 Non-Compatible Shop Coat Primer

For equipments on which application of total protective coating (Primer + Intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipments (coated with Primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per this specification depending upon compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For Package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipments, structures, piping, etc., shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

5.7 Coating Procedure and Application

All paint coatings shall be applied by airless spray excepting at the following special cases where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application.

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20 km per hour.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. of the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional

coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter-coat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is sued to operate a pump to produce pressures of 1000 to 6000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of in built strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two pack). 30:1 pump ratio and 0.020-0.023” tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8” ID and not longer than 50 feet to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

5.7.7 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paint shall be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, doubers, or sheepkin.

5.7.8 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of Coated Surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Spot Repair of Damaged Primer

5.9.1 Where pre erection shop primer has been damaged at isolated localized spots during handling and transportation, or after erection / welding, the repair of damaged coating of pre-erection / pre-fabrication or shop primer shall be done as given below and as per the Table given at Clause no. 9.1 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate pre-erection / pre-fabrication or shop primer (F9) after erection / welding in the design temperature of -90°C to 400°C and damaged silicone aluminium (F-12) pre-erection / pre-fabrication or shop primer after erection / welding for design temperature range of 401 – 550 °C.

Surface Preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface over the intact adjacent surface surrounding the damaged area by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damage was observed on pre-erection / pre fabrication or shop primer of inorganic zinc silicate coating (F-9). Similarly one coat of F-12 shall be applied wherever damage observed on pre-erection **/** pre-fabrication shop primer of silicone aluminium (F-12).

5.9.3 Wherever if damaged areas are found extensive and spread over large areas, then entire pre-erection / pre-fabrication or shop primer shall be removed by blasting to achieve SSPC-SP-10 then entire blasted surface shall be primed again with F-9 or F-12 as applicable for the intended design temp.

5.10 Paint Application

5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface (SSPC-SP-10)

5.10.2 Shop priming / pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 Assessment of Painting Requirement:

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and chose the appropriate table.

- Identify the design temperature from the technical documents

- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.

- Identify the shop priming requirement from clause 9.1 based on compatibility of the above paint system.

- Identify the need of repair of shop primer and execute as per clause 9.1.

6.0 DOCUMENTATION/ RECORDS

6.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.

6.2 Daily progress report with details of weather conditions, particular of applications, no of coats and type of materials applied, anomalies, progress of work versus program.

6.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

6.4 Particulars of surface preparation and paint application during trials and during the work.

6.5 Details of non-compliance, rejects and repairs.

6.6 Type of testing equipments and calibration.

6.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 6.2 - 6.7 above as well as the approved procedure of work (6.1 above). The job record consisting of information as required in accordance to 6.2 - 6.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

7.0 SURFACE PREPARATION STANDARDS

Sr. No.	Description	Various International Standards (Equivalent)			Remarks
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1	Manual or hand tool cleaning Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen	St 2	SSPC-SP-2	-	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	St 3	SSPC-SP-3	-	
3	Dry abrasive blast cleaning There are four common grades of blast cleaning				
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	Sa 3	SSPC-SP-5	NACE No. 1	Where extremely clean surface can be expected for prolong life of paint system.
3.2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile.	Sa 2½	SSPC-SP-10	NACE No. 2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	Sa 2	SSPC-SP-6	NACE No. 3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.

Sr. No.	Description	Various International Standards (Equivalent)			Remarks
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important	Sa 1	SSPC-SP-7	NACE No. 4	

8.0 PAINT MATERIALS

Typical characteristics and codes of various paint materials used in this specification are as follows:

Table: Paint Materials Characteristics

Description	P-2	P-4	P-6	P-7
Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/wash primer	Epoxy zinc phosphate primer	Cold Galvanizing
Type and composition	Single pack, air drying chlorinated rubber based medium plasticized with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.
Volume Solids %, Minimum	37	9	49	37
DFT per coat, µ	40-45	8-10	40-50	40-50
Theoritical covering capacity in m^2/coat/ litre	8-10	8-10	8-10	4m²/kg
Weight per litre in Kg/litre	1.3±0.05	1.2±0.05	1.4±0.05	2.67 kg at 15°C
Touch dry at 30°C (max.)	30 min.	2 hrs.	30 min.	10 min.
Hard dry at 30 °C (max.)	8 hrs.	24 hrs.	8 hrs.	24 hrs.
Over-coating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
Pot life at 30 °C for two component paints	NA	NA	6 - 8 hrs.	NA
Adhesion (ASTM D4541)	NA	NA	>7 MPa	NA
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	60 (Method A)	NA	80 (Method A)	50 (Method A)

Table: Paint Materials Characteristics (Contd.)

Description	F-2	F-3	F-6A/B	F-6C	F-7
Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build coating	Solvent less epoxy coating	High build coal tar epoxy coating.
Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint.	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-pack Aromatic amine cured epoxy resin medium suitably pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
Volume Solids %, (Min.)	40	36	57	98	62
DFT per coat, µ	30-4	30-40	100-125	250-500	100-125
Theoritical covering capacity in M^2/coat/litre	10-15	11-15	5-6	2-3	5.2-6.5
Weight per liter in kgs/litre	1.15±0.03	1.15±0.03	1.42±0.03	1.40±0.03	1.40±0.03
Touch dry at 30 °C, (Max.)	30 min.	30 min.	3 hrs.	3 hrs.	4 hrs.
Hard dry at 30 °C, (Max.)	8 hrs.	8 hrs.	16 hrs.	16 hrs.	48 hrs.
Full cure at 30 °C (for immersion/ high temperature service)	NA	NA	5 days	5 days	5 days
Over-coating interval	Min.12 hrs.	Min. Overnight	Min. Overnight, Max. 5 days	Min. 8 hrs., Max. 48 hrs.	Min. 24 hrs., Max. 5 days
Pot life (approx.) at 30 °C for two component paints	5-8 hrs.	NA	3-6 hrs.	30 min.	4-6 hrs.
Adhesion (ASTM D4541)	>5 MPa	>4 MPa	>7 MPa	>8 MPa	>5 MPa
Abrasion Resistance (ASTM D4060) For 1000 g load	<300 mg /1000 cycles/CS17 or <100 mg /1000 cycles/CS10	NA	NA	NA	NA
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	80 (Method A)	60 (Method A)	80 (Method A)	120 (Method A)	125 (Method A)

Table: Paint Materials Characteristics (Contd.)

Description	F-8	F-9	F-11	F-12
Technical name	Self-priming type surface tolerant high build epoxy coating (complete rust control coating)	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C dry temp.	Heat resistant silicone Aluminium paint suitable upto 540°C dry temp.
Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self-curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test ASTM D4752.	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250°C.	Ambient Temperature Curing, Single pack silicone resin based medium with Aluminium flakes.
Volume Solids %, Min.	75	57	35	18
DFT per coat, µ	100-125	65-75	15-20	15-20 (Note-13)
Theoretical covering capacity in m^2/coat/litre	6.0-7.2	8-9	10-12	8-10
Weight per liter in kgs/litre	1.41±0.03	2.3±0.03	0.95±0.03	1.00±0.03
Touch dry at 30 °C (max.)	3 hrs.	30 min.	3 hrs.	30 min.
Hard dry at 30 °C (max.)	24 hrs.	12 hrs.	12 hrs.	24 hrs.
Full cure 30°C (for immersion /high temperature service)	5days	NA	NA	NA
Over-coating interval	Min. 10 hrs.	Min. 12 hrs. at 20 °C & 50% Relative Humidity	Min. 24 hrs.	Min. 24 hrs.
Pot life at 30 °C for two component paints	90 min.	4-6 hrs.	NA	NA
Adhesion (ASTM D4541)	>5 MPa	>5 MPa	NA	NA
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	80 (Method A)	400 (Method B)	250 (Method A)	540 (Method B)

Table: Paint Materials Characteristics (Contd.)

Description	F-14	F-15	F-16	F-17	F-20
Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardener	Ambient temperature curing Poly Siloxane coating/ High build cold applied inorganic copolymer based aluminium coating suitable for under insulation of CS and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Glass flake reinforced vinyl ester coating
Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Two component glass flake filled vinyl ester lining for under immersion services upto 90 °C.
Volume Solids %, Min.	67	67	58	98	98
DFT per coat, µ	100-125	75-100	75-100	300-450	500-600
Theoritical covering capacity in m^2/coat/ litre	5-8	4-5	7- 9	6.5- 8	1.6 minimum
Weight per liter in kgs/litre (mix paint)	1.45±0.03	1.65±0.03	1.3	1.7	>1.2
Touch dry at 30 °C (max.)	4 hrs.	3 hrs.	1 hr.	2 hrs.	2 hrs.
Hard dry at 30 °C (max.)	24 hrs	24 hrs	16 hrs	24 hrs	4 hrs.
Full cure 30 °C (for immersion /high temp. service)	7 days	7 days	NA	7 days	4 days
Over-coating interval	Min. 6 hrs., Max.5 days	Min. 36 hrs., Max. 21 days	Min.16 hrs., Max. NA	Min. 16 hrs., Max. 21 days	Min. 4 hrs., Max.3 days
Pot life at 30 °C (for two component paints)	4 hrs.	4-6 hrs.	1 hr.	1 hr.	50 min-1 hr.
Adhesion (ASTM D4541)	>6 MPa	>7 MPa	>8 MPa for Polysiloxane	>8 MPa	>7, Tensile strength >20N/mm2 (ASTM D 638)
Temperature Resistance (min.), °C (ASTM D 2485) *Note 8	125 (Method A)	150 (Method A)	550 (Method B)	150 (Method A)	90 (Method A)

Notes applicable for "Table: Paint Materials Characteristics"

1. Covering capacity and DFT achieved per coat depends on method of application. Covering capacity specified above is theoretical. For estimation of actual quantity of paints required, include the losses during application. Minimum specified DFT should be maintained in any case.
2. All primers and finish coats should be ambient temperature curing and air drying unless otherwise specified.
3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. Wherever a deviation is noticed from the specification in manufacturer data sheet, more stringent one between the data sheet and the specification shall prevail e.g. if this specification recommends Sa2½ and the manufacturer data sheet requires Sa3, the surface preparation shall be done as per Sa 3. However in another case if this specification requires the surface preparation of Sa 2½ and the manufacturer data sheet recommends only Sa 2 as minimum, the surface preparation shall be done as per Sa 2½.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. Higher specific gravity of F-9 is also acceptable.
6. Internationally recognized & acceptable testing method shall be used for lab testing wherever testing standards are not mentioned.
7. Theoretical covering capacity, hard dry, pot life, full cure period, & over coating interval shall be as per manufacturer's data sheets and no testing is required. Slight variation in the values of these parameters along with weight per liter may be permissible with the discretion of engineer-in-charge only.
8. Temperature resistance tests (ASTM D2485) shall be carried out for minimum required temperature resistance indicated.
9. Wherever ASTM D 2485 method B is applicable, test results of the panels subjected to salt spray (ASTM B 117) after muffle furnace exposure shall be submitted for pre-qualification purpose.
10. F-6A shall be suitable for immersion services.
11. F-6C shall be suitable for immersion services of hydrocarbons and DM water.
12. F-7 shall be suitable for immersion service of hydrocarbons & underground service up to 80 °C minimum.
13. Where F12 is used as primer, anchor profile height shall be as per F12 paint manufacturer recommendation.
14. F-14 shall be suitable for under insulation service up to 125 deg C.
15. F-15 shall be suitable for high temperature immersion & under insulation services.
16. F-17 shall be suitable for high temperature immersion service and underground services

9.0 COATING SYSTEMS

Corrosivity category C5-I (very high – industrial) in accordance with ISO 12944-2 and other International Standards/Practices are considered for selecting the Coating Systems for bare steel surfaces exposed to atmosphere. Atmospheric zone coating systems are selected for a high durability (beyond 15 years) period.

For insulated surfaces, coating selection is based on NACE 0198 guidelines and other successful international practices.

9.1 Repair of pre-erection/pre-fabrication or shop primer after erection/welding for all un-insulated CS, LTCS & low alloy steel items

Sr. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
1	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	See Note below and Clause 5.9.1
2	401 to 550	SSPC-SP-3	1 coat of F-12	20	

Note: The application and repair of pre-erection/pre-fabrication or Shop Primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 or F-12 as applicable.

9.2 Coating system for Gratings (Note 5), Rolling & Stationery Ladders, Spiral Stairways, Hand Rails

Sr. No.	Design Temp., °C	Coating System	Total DFT in Microns (min.)
1	Up to 60	Hot Dip Galvanizing to 80-85 microns as per ISO 14713-2/ ISO 1461 + 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 microns of Painting (excluding the thickness of galvanizing)

Notes:

1. No galvanized specimen shall have thickness less than 80 microns.

2. Repair of the damaged areas of galvanized coatings due to welding during erection shall be carried out as per recommended practice ASTM A 780, using cold galvanizing spray process. Organic paint systems are not acceptable for the repair.

3. After repair of damaged galvanized coating by cold galvanization (P-7), the repaired area shall be top coated with paint system as given in table above (i.e. 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).

4. Suggested cold galvanizing manufacturers are Zinga, Loctite, ZRC or equivalent make.

5. Galvanized gratings don't require painting in general except for safety reason such as escape routes, walkways. Hence, Galvanized gratings shall be painted for indication of escape routes or walkways only as per table above (i.e. 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).

9.3 Coating System for uninsulated and above ground (atmospheric zone) CS, LTCS & low allow steel surfaces

(Structural steel, pipings, vessels, columns, reactors, pumps, compressors, exchangers, valves & other equipment etc.)

Sr. No.	Design Temp., °C	Surface Preparation & Pre-erection/ Shop Primer	Coating System		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
1	-90 to -15	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/Coat	None	None	65-75	**a)** No over-coating to be done on F-9 as it will lead to mud cracking.
2	-14 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/Coat	1 coat of P-6 @ 40 µ DFT/coat (Tie/ Mist Coat)	2 coats of F-6A/ F-6B @ 100 µ DFT/Coat + 1 coat of F-2 @ 40µ DFT/Coat	345-355	
3	81 to 400	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/Coat	None	2 coats of F-12 @ 20µ DFT/Coat	105-115	
4	401 to 540	SSPC-SP-10; 2 coat of F-12 @ 20µ DFT/Coat	None	2 coats of F-12 @ 20µ DFT/Coat	80	

Notes:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per this specification.

3. Flare line within unit or offsite areas shall be coated as per Sr. No. 3 of above table

4. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per Sr. No. 3 of above table shall be followed.

5. For external surface of RCC Chimney, 2 coats of F-6B @ 100µ DFT/coat to obtain total DFT of 200 µ shall be applied after proper surface preparation as per clause no. 5.1.6.

6. In case of paint systems where finish (top) coat is F-12, the colour bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping.

9.4 Coating system for effluent treatment plant (ETP)

Sr. No.	Design Temp., °C	Surface Preparation	Coating System		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
1	For External Surfaces of C.S./M.S. items: Screens, Walk way bridges, Baffles, Dual media filters, Vertical pumps, piping in treated effluent sump, bio sludge pump, Screw pump and pump house, CS tanks, sumps and vessels.					
	-45 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat + 1 Coat of P-6 @ 40 µ	2 coats of F-6A/ F-6B @100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (2x100+40=240)	345-355	-
2	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-45 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat + 1 coat of epoxy based mist coat	3 coats of F-6A @100µ DFT/coat (3x100=300)	365-375	Note:1
3	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in Process sump, TPI separator (Process and Oil), Aeration Tank and Transfer sump etc.					
	-45 to 80	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% HCl acid followed by thorough water washing.	Epoxy Screed lining		3mm	Epoxy screed lining shall be applied as per specific manufacturer and Engineer-in-Charge instructions
4	C.S/M.S Dual media filters (Internal), Chemical dosing tanks (internal) such as Di-Ammonium Phosphate (DAP) and Urea					
	Up to 60	SSPC-SP-10	Natural Rubber Lining (As per IS 4682, Part 1 or equivalent International standards)		4.5mm	Natural Rubber lining shall be applied as per specific manufacturer and Engineer-in-Charge instructions

Notes:

1. Coating manufacturers shall provide their Quality control test certificate of coating materials (F-6A) for immersion service of the exposed effluent.

9.5 External coating systems for uninsulated carbon steel and low alloy steel Storage Tanks

Sr. No.	Design Temp., °C	Surface Preparation (Field)	Coating system		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
a	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external floating roof, outside surfaces (other than oil side surface) of external floating roof pontoons and associated external structural works.					
1	-45 to 80	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat ;	2 coats of F-6A/ F-6B @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat;	345-355	F-6 should be suitable for occasional water immersion
2	81 to 120	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat ;	1 coat of F-15 finish coat @80µ DFT/ coat + 1 coat of F-2 @ 40µ DFT/ coat;	280	-
3	121 to 400	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @20 µ DFT/ coat Or 1 coat of F-16 @ 125 µ DFT / coat	105-115 Or 190-200	For higher design temperatures, system as per Sr. No. c (1) of this table is applicable
b	External surfaces of bottom plate (soil side) for all storage tanks					
1	-45 to 80	SSPC-SP-10	1 coat of F-7 @ 125µ DFT/ coat	2 coats of F-7@ 125µ DFT/coat	375	F-7 should be suitable for immersion service of the products given
2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat	1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-

3	151 to 400	SSPC-SP-10	1 coat of F-16 @ 125 µ DFT /coat	1 coat of F-16 @ 125 µ DFT /coat	250	-
c	For underside of the bottom plate (in case tank is not lifted during PWHT)					
1	-180 to 650	For CS, SSPC SP 10 For SS, SSPC-SP-7 (15-25µ surface profile)	1 coat of inert polymeric matrix coating @ 125 µ	1 coats of inert polymeric matrix coating @ 125 µ	250	Note 2(c)

Notes

1. All paint coating application including primer for tankage shall be carried out at field after erection and completion of all welding.

2. For underside of bottom plate :

   a) Painting shall be carried out before laying of bottom plate for tanks with Non-Post Weld Heat Treatment (PWHT).

   b) For tanks with PWHT, painting shall be carried out after PWHT.

   c) In case tank is not lifted during PWHT then painting shall be applied before laying of bottom plate.

Caution: PWHT temperature shall not exceed 650 °C.

9.6 Internal coating systems for carbon steel and low alloy Storage Tanks

Sr. No.	Design Temp., °C	Surface Preparation	Coating system		Total DFT, µ (min.)	Remarks
			Primer	Finish Coat		
a	**Crude Oil, ATF, Turpentine Oil, Lubricating Oil & Vegetable Oil** Underside of external floating roof, top side & underside of internal floating roof, internal surface of cone roof, inside of bottom plate, Internal surfaces of Shell - including wetted and free board height, oil side surfaces of deck plates, oil side surface of pontoon of external floating roof, all outside surfaces of pontoon of internal floating roof, roof structures, structural steel, ladders and other CS internals					
1	-45 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240	-
b	**Petroleum Products & Intermediates like LDO, HSD , Gas Oil, Feeds of FCC-PC, FCC-LCO, VGO-HDT, ISOM, DHDT, Reformate, DCU, NHT & Gasoline, Naphtha, Isomerate & Kerosene** Underside of external floating roof, top side & underside of internal floating roof, internal surface of cone roof, inside of bottom plate, internal surfaces of bare shell for full height, underside of floating roof, oil side surfaces of deck plates, oil side surface of pontoon of external floating roof, all outside surfaces of pontoon of internal floating roof , support structures, ladders and other CS internals					
1	-45 to 45	SSPC-SP-10	1 coat of F-9 @ 75 µ DFT/coat	-	65-75	
2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240	-
c	**Potable Water, Raw Water & Fire Water** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-45 to 65	SSPC-SP-10	1 Coats of F-6A @ 100 µ DFT/coat;	2 Coats of F-6A @ 100µ DFT/ Coat	300	Note-1
d	**De-Mineralized (DM) Water** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-45 to 60	SSPC-SP-10	1 Coats of F-6B @ 100µ DFT/coat;	2 coats of F-6C @ 200µ DFT/ coat;	500	-
2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240	-
e	**Hydrochloric Acid (HCl) 10 %** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					

1	-45 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100µ DFT/ Coat	2 Coats of F-20 @ 500µ DFT/ Coat	1100	-
f	**Aggressive Solvents like Hexane, Hexene, Benzene, Xylene & Toluene** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-45 to 65	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	---	65-75	-
g	**Ethylene Glycol (EG) Tanks** Internal shell-full height, bottom plate, underside of roof and all accessories					
1	All	SSPC-SP-10	None	3 coats of vinyl chloride co-polymer @ 75µ /Coat; (3x75=225)	225	-
h	**Inside Pontoon and Inside of Double Deck of all Floating Roofs**					
1	-45 to 80	SSPC-SP-3	1 coat of F-8 @ 100µ DFT/coat	1 coat of F-8 @ 100µ DFT/coat	200	-
i	**Wet Slops, Amine Solutions, Sour Water , Water Draw Off** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	-45 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240	-
j	**Vacuum Residue, Fuel Oil , Dry Slop, Bitumen & Other High Temperature Hydrocarbon Liquids** Underside of floating roof, internal surface of cone roof, bottom plate, inside of bare shell – including wetted and non-wetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel and ladders					
1	Up to 150°C	SSPC-SP-10	-	1 coat of F-17 @ 375µ DFT/ coat;	375-475	-
k	**Alkalis upto 50 % Concentration** All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	2 Coats of F-6 A @ 100µ DFT/coat;	280-300	-

Notes

1. For Potable water tank lining, F-6 A shall be suitable for drinking water service and should have certification from competent authority like NSF International Standard NSF/ANSI-61 2004 or Water Regulations Advisory Scheme (WRAS), UK or Central food research Institute Mysore, India.

2. Coatings recommended in above table, shall be suitable for immersion in targeted service upto the mentioned design temperatures.

9.7 Coating systems for external side of underground carbon steel plant piping and underground Vessels

Sr. No.	Design Temp., °C	Surface Preparation & Shop Primer	Coating system		Total Final DFT, µ (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
a	**Underground carbon steel plant piping**					
1	25 to 65		SSPC-SP-10; 1 coat of synthetic fast drying primer @ 25µ DFT/ coat	1 layer of coal tar tape coating @ 2mm +1 coat of synthetic fast drying primer @ 25µ DFT/ coat + 1 layer of coal tar tape coating @ 2mm /layer as per EIL Std. Spec. 6-79-0011	-	Note 1
2	65 to 150	---	SSPC-SP-10; 1 coat of F-17 primer @ 400µ DFT/ coat	1 coat of F-17 intermediate coat @ 400µ DFT/coat	800	-
3	151 to 450	---	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	1 coat of F-16 finish coat @125µ DFT/ coat	250	This system is suitable up to 550 °C
b	**External side of uninsulated underground storage vessels**					
1	-45 to 80	SSPC-SP-10; 1 coat of F-7 @ 125µ DFT/ coat	---	2 coats of F-7 @ 125µ DFT/coat	375	-
2	81 to 150	SSPC-SP-10; 1 coat of F-17 primer @ 400µ DFT/ coat	---	1 coat of F-17 @ 400µ DFT/coat	800	-
3	151 to 400	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	---	1 coat of F-16 finish coat @125µ DFT/ coat	250	This system is suitable up to 550 °C

Notes:

1. Alternatively, 3LPE shop coated pipes conforming to DIN 30670 Type S-n up to maximum design temperature of 75°C is also acceptable. Fittings for 3LPE coated pipes, shall be coated with 1500 microns of Liquid Epoxy as per DIN EN 10289, Class C and type 3. Heat Shrink Sleeves shall be used for field joint coating of 3LPE coated pipes (Refer EIL Std. Spec. 6-71-0044 for details of specified field joint coating).

9.8 Coating System for Insulated CS, LTCS, Low Alloy Steel & Stainless Steels Surfaces

(Insulated Structures, Piping, Equipments, Storage vessels, tanks, Columns etc.)

Sr. No.	Design Temp., °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT, µ (min.)	Remarks
			Primer/ Intermediate	Finish Coat		
a	**Carbon steel, LTCS and Low Alloy Steel Piping, Storage tanks, Vessels, Equipments etc. (Note-1)**					
1	-45 to 125	SSPC-SP-10; 1coat of F-15 @ 75µ DFT/coat	-	2 coats of F-15 @ 75µ DFT/coat;	225	-
2	126 to 540	SSPC-SP-10; 2 coats of F-12@20µ DFT/coat	-	2 coat of F-12 @ 20µ DFT/coat;	80	Note-2
b	**Stainless Steel and Alloy-20 Piping, Vessels & Equipments (Note-1, 3)**					
1	-45 to 125	SSPC-SP-7 (15-25µ surface profile); 1 coat of F-15@ 75 µ DFT/coat	-	2 coat of F-15 @ 75 µ DFT/coat;	225	
2	126 to 550	SSPC-SP-7 (15-25µ surface profile); 1 coat of F-16 @ 125 µ DFT/coat	-	1 coat of F-16 @ 125 µ DFT/coat	250	
c	**Cyclic Service of Carbon Steel, LTCS, Alloy Steels & Stainless Steel (Note 4)**					
1	- 45 to 150	SSPC-SP-10 For CS, LTCS & Low Alloy Steel, SSPC-SP-7 for SS (15-25µ surface profile); 1 coat of F-15 @ 75 µ DFT/coat	-	2 coat of F-15 @ 75 µ DFT/coat;	225	Note-5

2	-180 to -45 and 150 to 650	SSPC-SP-10 For CS, LTCS & low Alloy Steel; SSPC-SP-7 for SS (15-25µ surface profile) ; 1 coats of inert polymeric matrix coating @ 125 µ	-	1 coats of inert polymeric matrix coating @ 125 µ	250	

Notes

1. Coating system for design temperature range not covered in Sr. No. a & Sr. No. b, shall be as per the Sr.No.c2.
2. Alternatively, for Tanks, Vessels & Equipments, thermally sprayed aluminium coating (TSAC) @ 300µ as per ANNEXURE-I is also acceptable.
3. The blast cleaning abrasives for SS and Alloy steel surfaces shall be Aluminium oxide grits/shots or garnet.
4. “Cyclic Service” is characterized by rapid temperature fluctuation.
5. Alternatively, for this temperature range, 1 coat of F-17 @ 300 µ is also acceptable.
6. No painting is required for insulated Monel, Incoloy and Nickel lines.

9.9 Internal Coating System for carbon steel components of coolers/ condensers for fresh water service

(Water boxes, channels, partition plates, end covers and tube sheets etc.)

Sr. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT, µ (min.)	Remarks
			Primer	Finish paint		
1	-45 to 80	SSPC-SP-10	1 coat of F-15 @ 80 microns	2 coats of F-15 @ 80µ DFT/coat;	240	-
2	80 to 140	SSPC-SP-10	---	1 coat of Glass Fibre Reinforced Novolac Epoxy	1500	-

Note: Above table is applicable in line with the data sheets of the respective exchangers.

9.10 Internal Coating System for galvanized or non-ferrous or stainless steel/ duplex stainless steel components of coolers/ condensers for fresh water service

Sl. No.	Design Temp., °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT (min.), µ	Remarks
			Primer	Finish paint		
1	-45 to 80	Sweep Blasting	1 coat of F-15 @ 80µ DFT/coat;	1 coat of F-15 @ 80µ DFT/coat;	160	-
2	80 to 140	Sweep Blasting	-	1 coat of Glass Fibre Reinforced Novolac Epoxy	1500	-

Note: Above table is applicable in line with the data sheets of the respective exchangers.

10.0 STORAGE

All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE – NO NAKED LIGHT – HIGHLY INFLAMABLE" shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

11.0 COLOUR CODE

The colour coding of OWNER is applicable. It is in the applicators/contractors scope to obtain confirmation for applicable colour coding from the OWNER.

In absence of any existing color coding scheme of the OWNER, Color Code scheme given in ANNEXURE-II shall be followed.

12.0 IDENTIFICATION OF COLUMNS, TANKS, VESSELS & PIPINGS etc.

12.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipe lines of more than one location as directed by Engineer-In-Charge; Size of letter printed shall be as below:

Column & Vessels	-	150mm (high)
Pump, compressor & other machinery	-	50mm (high)
Piping	-	40-150 mm

12.2 Identification of Storage Tanks

The storage tanks shall be marked as detailed in the drawing.

13.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

13.1 Following items shall be painted for camouflaging if required by the Client:

a. All Columns
b. All Tanks in Offsites
c. Large Vessels
d. Spheres

13.2 Two coats of selected finishing paint as per defense requirement shall be applied in a particular pattern as per 13.3 and as per the instructions of Engineer-In-Charge.

13.3 Method of Camouflaging

13.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matte finish).

Dark Green		Light Green		Dark Medium Brown
5	:	3	:	2

13.3.2 The patches should be asymmetrical and irregular.

13.3.3 The patches should be inclined at 30º to 60º to the horizontal.

13.3.4 The patches should be continuous where two surfaces meet at an angle.

13.3.5 The patches should not coincide with corners.

13.3.6 Slits and holes shall be painted in dark shades.

13.3.7 Width of patches should be 1 to 2 meters.

14.0 QUALITY CONTROL, INSPECTION AND TESTING

14.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable (see section 16.0).

14.2 The contractor must produce Test Certificate from Pre-Qualified Paint Manufacturer for various tests as detailed out in section 17.0 of this document. The Engineer-in-Charge shall have the right to test wet samples of paint from each batch at random for verifying quality of paint supplied. Contractor shall arrange to have such tests, when called for by Engineer-in-Charge, performed at his cost at any one of the NABL accredited laboratories under witness of NACE CIP Level-2 (min.) / Owner/ Owner's representative.

Samples for the test will be drawn at random in presence Engineer-in-Charge or his representations. Following tests to be carried out if called for by Engineer-in-Charge:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)
- Drying time (touch dry & full curing)
- Adhesion
- Flexibility
- Hardness
- Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

14.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

(a) Surface preparation
(b) Primer application
(c) Each coat of paint

14.4 **Surface preparation:** Following tests are to be carried out during surface preparation**.**

i) Test for presence of oil/ grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination:

- Visual inspection: Continue degreasing until all visible signs of contamination are removed.
- Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice

corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.
- Continue degreasing and inspection till test is passed.

ii) Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component atleast once per 200 m^2 of blasted surface and minimum of 3 checks per shift.

iii) Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m^2. Checks shall be done on each component atleast once per 200 m^2 of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.

iv) Blast Profile Measurement

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm^2 and average of measurements to be recorded and reported. If desired profile (35-50 µ or as recommended by paint manufacturer) is not achieved, blasting shall continue to get the required profile.

v) Test for Blasting Media (for every fresh batch of media and one random test during blasting):

- Blasting Media shall be visually inspected for absence of contamination and debris using 10X magnification.
- Inspection for the absence of oil contamination shall be conducted using following procedure:
  - Fill a small clean 200 ml bottle half full of abrasive.
  - Fill the bottle with potable water, cap and shake the bottle.
  - Inspect water for oil film/slick. If present, the blasting media is not to be used.
- Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.
- Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

vi) Test for Blasting Air (once daily before start of blasting and once at random during blasting):

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate, zinc rich epoxy or zinc phosphate etc. Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/ defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and

extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

14.5 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge. The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring dry film thickness of each coat, surface profile gauge for checking of surface profile, holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on MS test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

14.6 Inspection of finished coating: Inspection of applied coatings shall consist of measurement of the following:

i) Coating Dry Film Thickness Check: DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurement shall be as per SSPC-DA 2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.

ii) Adhesion Testing: Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D 6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel coupon coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m^2 of coated surface.

iii) Holiday Testing: Holiday testing shall be conducted in accordance with NACE SP 0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP 0188. Any holiday is unacceptable and should be marked and repaired immediately.

14.7 The contractor shall arrange for spot checking of paint materials for Specific gravity, glow time (ford cup) and spreading rate.

14.8 Final Inspection of coating system

A final inspection shall be conducted prior to the acceptance of the work. The coating contractor and the facility owner shall both be present and they shall sign an agreed inspection report. Such reports shall include:

General

- Names of the coating contractor and the responsible personnel
- Dates when work was performed

Coating Materials

- Information on coating materials being applied
- Condition of coating materials received

Environmental Conditions

- Weather and ambient conditions
- Coating periods

Surface Preparation

- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

Coating Application

- Equipment used
- Mixing procedure prior to application
- Coating application techniques used

Testing

- Type and calibration of inspection instruments used
- Type of quality control tests performed, and results

15.0 GUARANTEE

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

16.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/ SUB-CONTRACTOR

Painting contractor who is awarded any job for EIL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

17.0 QUALIFICATION/ ACCEPTANCE CRITERIA FOR COATING SYSTEM

17.1 Pre-Qualification of Paint Coating Manufacturer and Products

Paint Coating manufacture meeting the following requirements shall be considered for supply of their products:

- Manufacturer should have been in continuous business of paint coating formulation and manufacturer for at least past 5 years.
- Manufacturer should posses past experience of supplying his products to hydrocarbon, petrochemical, fertilizer. Chemical processing industry or offshore platforms in the past 5 years.
- Coating manufacturer should have supplied at least 10000 litre of an individual product to hydrocarbon, petrochemical, fertilizer, chemical processing industry or offshore platforms.
- The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should posses ISO 14000 certificate.
- The Quality control set up should be manned by qualified paint technologists whose bio data should be sent along with quality control organization chart.

CONTRACTOR shall procure the paint materials from the qualified manufacturer meeting above requirements and after obtaining prequalification testing approval as per requirements mentioned in clause 17.2 below.

17.2 Pre-Qualification Testing Procedure:

The paint manufacturer engaged by the mechanical contractor shall carry out the tests in reputed Government Laboratories (like National Test House Mumbai, National Test House Kolkata, Institute of Chemical Technology Mumbai, HBTI Kanpur, IICT Hyderabad) as a part of qualification. Paint manufacturer shall provide the paint samples to laboratory for testing of the parameters for each category of paint as mentioned in Clause 8.0 (Paint Materials Characteristics) and testing of Coating System properties as per Table given below. The testing laboratory will confirm the compliance of the paint material with respect to the acceptance criteria mentioned in this specification. Contractor shall furnish these test certificates along with all necessary supporting documents/information to Site-in-charge for approval/ acceptance. The paint manufacturer will be qualified and approved by Site-in-charge for supply of paints after review/assessment of the submissions made by the contractor. Test certificates which are more than 3 years old will not be considered. Paint manufacturers are advised to carryout pre-qualification testing prior to paints supply at site.

TABLE: PRE-QUALIFICATION TESTING

System No.	Coating System	Reference Clause	Total DFT, µ (Min.)
1.	F-9+P6+F6A/B+F2	Clause 9.3, Sr. No. 2 of table	345
2.	F12+F12+F12	Clause 9.3, Sr. No. 3 of table	60
3.	F15+F15+F15	Clause 9.5,	240

		Sr. No. b (2) of table	
4.	F16+F16	Clause 9.5, Sr. No. b (3) of table	250
5.	F17	Clause 9.6, Sr. No. j (1) of table	375
6.	F8+F8	Clause 9.6, Sr. No. h (1) of table	200
7.	F7+F7+F7	Clause 9.5, Sr. No. b (1) of table	375
8.	F-20	Clause 9.6, Sr. No. e (1) of table	1100
9.	F6B+F6C+F6C	Clause 9.6, Sr. No. d (1) of table	500
10.	Inert Polymeric Matrix	Clause 9.5, Sr. No. c (1) of table	250
11.	F6A+F6A+F6A	Clause 9.6, Sr. No. c (1) of table	300

Sr. No.	Test	For System Number	Duration	Acceptance Criteria
1.	Cyclic Test Salt Spray: 72 hrs. Drying in air: 16 hrs. UV-A340 nm weather meter: 80 hrs. One cycle: 168 hrs. (25 cycles at 168 hrs. each cycle) (ASTM D5894)	1	4200 hrs.	Shall pass. No chalking, cracking, flaking, blistering or peeling shall be observed.
2.	Chemical Resistance Test (ASTM D543)			
2a.	10% & 40% NaOH	3,5,8 & 11* *H_2SO_4 solution pH = 5.0 to 5.5 for system 11	1000 hrs.	Shall pass.
2b.	5% H_2SO_4		168 hrs.	No cracking, discoloration, blistering, peeling or softening of film shall be observed.
2c.	Xylene		4 weeks	
2d.	Acetone		4 weeks	
2e.	Ethanol		4 weeks	
2f.	Kerosene		4 weeks	

2g.	Sea water		2000 hrs.	
3.	Immersion in DM/DI water @ 90° (ASTM C868)	3,5 & 8	30 days	No softening, blistering or film damage.
4.	Resistance to DM water using water immersion. (ASTM D870)	9	2000 hrs.	Shall pass. No chalking, cracking, flaking, blistering or peeling.
5.	100% Humidity Test (ASTM D2247)	1 to 11 (except system-2)	1440 hrs.	Shall pass
6.	Dry Heat Resistance Test (ASTM D2485 method B at 540^0 C for system 2 and 550^0 C for system 4)	2 & 4	-	Shall pass the test. No peeling, cracking, blistering, abnormal discoloration or loss of adhesion.
7.	Thermal Shock Resistance Test; 5 cycles @ 30 minutes in furnace at 120 ^{0} C and 15 minutes in water after quenching in water for each cycle. (ASTM D2485 method A)	2,3,4 & 10 (For system-2, testing to be done after heating the panels at 175°C for 2 hrs.)	-	Shall pass
8.	Cathodic Disbondment Test (ASTM G8 @ 60°C)	3 & 5	-	Shall pass

Each coating product to be qualified shall be identified by the following:

1) Specific gravity of Base and curing agent (Ref. ISO 2811)
2) Ash content (ASTM D1650), volatile and non-volatile matters (ISO 3251) of each component

These identification tests of coating materials shall be carried out on the batch, which is used for the Pre-qualification testing and in the same reputed government laboratory.

17.3 Information to be furnished during delivery of paint materials:

CONTRACTOR along with delivery of paint material has to furnish following information from paint manufacturer to EIL for acceptance/approval of products:

a) Batch test certificates

Along with paint products delivery to site from the pre-qualified coating manufacturer, CONTRACTOR has to produce test certificate (from paint manufacturer) for each category of product for the following test items. All test results must mention clearly the batch no. and category of product tested. Tests shall be witnessed by NACE CIP Leve-2 (minimum) inspector. Tests to be conducted for following properties:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)

b) Product information sheet/ technical data sheet for each category of product

The contractor shall be fully responsible for the quality of the paints products as per prequalification testing. After the paint materials are supplied to site, the supplier shall organize random sampling and testing in a laboratory as per discretion of the Engineer-in-charge (refer clause 14.2). Failing to meet the specified quality requirements may cause rejection of the paint products.

18.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING

(Pre-Qualification tests (sec. 17.2), Batch testing (sec. 17.3) and Inspection testing (sec. 14.0))

18.1 Samples of coating materials should be submitted to the laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory.

18.2 All test panels should be prepared by testing laboratory. Surface preparation for a system shall be done in accordance with this specification. For individual products testing, minimum surface preparation shall be Sa 2.5. Colour photographs of test panels should be taken before and after the test and should be enclosed along with test report.

Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

18.3 Manufacturers should intimate EIL, details of sample submitted for testing, name of testing agency, date, and contact personnel of the testing agency.

ANNEXURE-I

SPECIFICATION FOR THERMALLY SPRAYED ALUMINIUM COATING (TSAC)

1.0 SCOPE

The following sections outlines the requirement of supply, application and testing of thermally sprayed aluminum coatings (TSAC) for corrosion protection of carbon steel piping and equipments with design temperature not exceeding 540 ^{0} C.

2.0 ITEMS TO BE THERMALLY SPRAYED

Steel Structures/equipments to be protected by TSAC shall be as specified in this specification. Structures, components thermally sprayed shall not have any uncoated area or shall not be in mechanically connected by flanges etc to any uncoated bare steel work. Such adjacent areas to TSA coated areas, if not coated by TSA shall have suitable paint coating system as per the standard specification.

3.0 TSAC REQUIREMENTS

3.1 Surface Preparation

All the parts to be sprayed shall be degreased according to SSPC-SP-1. The absence of oil and grease after degreasing shall be tested by method given elsewhere in the specification (Refer Sec. 6.7). Thereafter the surface to be abrasive blasted to white metal finish as per NACE 1/SSPC-SP-5 for marine and immersion service. Using SSPC VIS 1, it is to be visually assessed that the blast cleaned surface meets requirement of SSPC-SP-5. Thereafter clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on the blasted surface. Finally blasted surface shall be tested for presence of soluble salts as per method ISO 8502-9. Maximum allowable salt content shall be considered 50mg/m^2. (5 micrograms/cm^2) .In case salt content exceeds specified limit. The contaminated surface shall be cleaned by method as per Annex C of IS 12944-4 (Water Cleaning). After cleaning the surface shall be retested for salt content after drying. Testing shall be carried out at least on each component, once per 200 m^2 and a min of 3 times per shift during progress of work.

The blasting media shall be either chilled iron or angular steel grit as per SSPC-AB-3 of mesh size G-16 to G-40. Copper, Nickel slag, Garnet or Aluminum Oxide as abrasives will also be suitable having mesh size in the range of G16 to G24 (10-30 mesh), conforming to SSPC-AB-1. Mesh size shall be required as appropriate to the anchor tooth depth profile requirement and blasting equipment used. The blasted surface should be having angular profile depth not less than 65 microns with sharp angular shape but shall not exceed 85 microns. The profile depth shall be measured according to NACE standard RP 0287 (Replica Tape) or ASTM D 4417 method B (Profile depth gauge).

For manual blasting one profile depth measurement shall be taken every 10-20 m^2 of blasted surface. Surface preparation shall be completed in one abrasive blast cleaning operation wherever possible. If rust bloom (visual appearance of rust) appears on the blast cleaned surface before thermal spraying, the affected area shall be re-blasted to achieve specified degree of cleanliness after which only thermal spraying shall commence.

Air blasting pressure at nozzle shall be normally maintained at 100 psi. Air pressure and media size should be reduced and adjusted to preclude damage/distortion to thin gauge materials. Blasting time on work piece should be adjusted to only clean the surface and cut required anchor tooth with minimum loss of metal. Blast angle should be as close to perpendicular as possible but in no case greater than $\pm 30^{0}$ from perpendicular to work surface. Blasting media must be free of debris, excessive fines, and contaminants such as NaCl and sulfur salts (Ref. SEC 6.0 of this Spec). Blast cleaning shall not be performed when the surfaces to be blasted are wet or less than 5°C above dew point temperature or when the relative humidity in the vicinity of the work is greater than 90%.

3.1.1 Blasting Equipment

The TSAC applicator shall use mechanical (centrifugal wheel) or pressure pot blast cleaning equipment and procedures. Suction blasting equipment shall not be used. Sec 6.6.2 shall be used to validate clean and dry air.

3.1.2 Feed Stock

The feed stock shall be in the form of wire. The feed stock shall be 99.5% aluminum of commercial purity grade, its composition shall be in accordance with requirement of BS 1475 or ASTM B833 or ISO 209-1 type A1 (wrought aluminum and aluminum alloys, wire). Wire shall be supplied in protective wrapping indicating batch number and other details.

3.1.3 Thickness Requirement

The nominal thickness of finished TSAC shall be 300 microns having minimum value of 275 microns at low thickness areas (valleys) and not more than 325 microns at peak areas.

The finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge (Magnetic Gauge).

3.1.4 Coating Bond Strength Requirement

The TSAC coating shall have a minimum individual tensile-bond strength value of 1000 psi for flame sprayed and 1500 psi for arc sprayed coating with an average of 2000 psi for arc sprayed coatings. Minimum tensile bond strength should be achieved by proper anchor tooth profile of blasted surface, laying down the TSA thickness in multiple passes and carrying out TSA application under controlled environment

3.1.5 Porosity

All thermally sprayed metallic coatings will have porosity. For thermally sprayed aluminum coatings porosity shall not exceed 15% of total surface area for flame sprayed coating and 8% for arc spray coating.

4.0 THERMAL SPRAY APPLICATION PROCEDURE

Items in the atmospheric zone to be coated by TSA shall be applied by either Flame spray or Arc spray method only. For coating under insulation, application shall be by arc wire method.

4.1 Equipment Set Up

4.1.1 Thermal spray equipment shall be set up calibrated, operated (1) according to manufacturer instructions/technical manuals and also TSAC applicators refinement thereto and (2) as validated by Procedure Qualification (Sec 7.0 of this specification).

4.1.2 **Spray Parameters**

Spray parameters (see 4.1.3 below) and thickness of each crossing pass shall be set and shall be validated with bend test (See 6.5 of this Spec).

4.1.3 Spray Parameters

Spray Parameters	Method of Application	
Arc voltage	Arc wire Spray	Flame Wire Spray
	27 V	-
Air pressure	80 psi	80 psi
Steel surface cleanliness	NACE-1 white metal	NACE-1 white metal / or Near white metal
Steel surface profile	75 microns (minimum)	75 microns (min.)
Arc current	250-280A	-
Coating thickness	225 microns (nominal)	225 microns(Nominal)
Coating adhesion	> 1500 psi (Total coating),see 3.1.4	>1000 psi
Coating porosity	Less than 8%	Less than 15%.
Spray distance (spray Gun work piece)	6-8”	5-7”
Spray Pass width	40mm	20 mm

The above parameters to be validated with a bend test by the contractor before start of work (for details of bend test see Sec 6.5 of this Spec).

4.2 Post Blasting Substrate Condition and Thermal Spraying Period.

4.2.1 The steel surface temperature shall be at least 5°C above dew point of ambient air temperature.

Steel substrate surface temperature shall be recorded by with a contact pyrometer. Thermal spraying should commence within 15 minutes from the time of completion of blasting

4.2.2 **Holding Period**

Time between the completion of final anchor tooth blasting and completion of thermal spraying of blasted surface should be no more than four hours. If within this period rust bloom appears Sec 4.4.1 of this specification will apply.

4.3 Pre-Heating

For flame spraying, the initial starting area of 1-2 square feet to be preheated to approx.120^{0}C to prevent condensation of moisture in the flame on the substrate. For arc spraying the preheating is not required.

4.4 Thermal Spraying

Spraying should commence only after validation of equipment set up by procedure qualification test and spray parameter validation tests described in Sec 7.0 and 6.5 respectively. Thermal spraying must commence within 15 minutes from the time of completion of blast cleaning

The specified coating thickness shall be applied in several crossing passes. The coating bond strength is greater when the spray passes are kept thin. Laying down an excessively thick spray pass increases the internal stresses in TSAC and decreases the bond strength of total TSAC. The suitable thickness for crossing passes shall be determined by procedure qualification test described in Sec 7.0 of this specification.

For manual spraying, spraying to be done in perpendicular crossing passes to minimize thin spots in coating. Approx. 75-100 microns of TSAC shall be laid down in each pass.

The surface geometry of the item or area to be sprayed should be inspected before application. The spraying pass and sequence shall be planned according to following.

- Maintain Gun as close to perpendicular as possible and within ± 30° from perpendicular to the substrate.
- Maintain nominal standoff distance and spray pass width as given below:

Spray method	Standoff (Inches)	Spray pass width (Inches)
Arc Wire	6-8	1 ½(40mm)
Flame wire	5-7	¾(20mm)

4.4.1 **Rust Bloom** (Visual appearance of rust or Discoloration):

If Rust bloom appears on the blasted surface before thermal spraying, the affected area shall be re-blasted to achieve the specified level of cleanliness.

If Rust bloom in form of discoloration, or any blistering or a degraded coating appears at any time during application of TSAC, then spraying shall be stopped and acceptable sprayed area shall be marked off. The unsatisfactory areas shall be repaired to the required degree of surface cleanliness and profile.

Blast the edges of the TSAC to provide for 2-3” feathered area overlap of the new work into existing TSAC.

Then apply TSAC to the newly prepared surfaces and overlap the existing TSAC to the extent of feathered edge so that overlap is a consistent thickness.

4.4.2 **Masking**

Masking all those parts and surfaces which are not required to be thermally sprayed as instructed by purchaser should be inspected by applicator to ensure that they are properly marked and covered by purchaser.

Complex geometries (flanges, valve manifolds, intersections) shall be masked by applicator to minimize overspray i.e. TSAC applied outside spray parameters (primarily gun to substrate distance and spray angle).

4.4.3 **TSAC Finish**

The deposited TSAC shall be uniform without blisters, cracks, loose particles, or exposed steel as examined with 10 X magnification.

5.0 SEALER

Sealant shall be applied after satisfactory application of TSAC and completion of all testing and measurements of the finished TSAC as per Sec 6.0 of this specification.

For shop work Sealer shall be applied immediately after thermal spraying and for field work sealer shall be applied within 8 hours. The sealcoat shall be thin enough to penetrate into the body of TSAC.

The sealant shall be Silicone Alkyd Aluminium paint having DFT not more than 35-40 micron. Typically seal coat shall be applied at a spreading rate resulting in theoretical 38 microns DFT. The seal coat shall be applied in accordance with SSPC-PA 1 and the paint manufacturer instruction for sealing.

6.0 TESTING AND MEASUREMENT SCHEDULE

6.1 Surface Finish

That the blasted cleaned surface meets the required criteria (NACE 1/SSPC-SP 5) shall be visually inspected using SSPC-VIS 1. The clear cellophane-tape test as per ISO 8502-3 shall be used to confirm absence of dust or foreign debris on the cleaned surface. Checks shall be done on each component at least once per 200 m^2 of blasted surface and minimum of 3 checks per shift.

6.2 Blast Profile Measurement: (In-Process testing during actual production before application of TSA coating)

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm^2 and average of measurements to be recorded and reported.

If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

6.3 TSAC Thickness (In-Process Testing For finished coating during regular production)

6.3.1 TSAC finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge.

6.3.2 For flat surfaces, measurements shall be taken along a straight measurement line, one measurement line for every 15 m^2 of applied TSAC shall be selected along which 5 measurements to be taken at 25 mm internal and average to be reported.

6.3.3 For curved surface or complex geometry, 5 measurements shall be taken at a spot measuring 10 cm^2 in area. One spot to be taken for every 15 m^2 of applied TSAC area.

6.3.4 The TSAC thickness in surface changes or contour changes, welds and attachments shall be also measured and reported.

6.3.5 If TSAC is less than specified minimum thickness, apply additional TSAC until specified thickness range is achieved.

6.3.6 All locations and values of TSAC thickness measurements shall be recorded in Job Record (JR).

6.4 Tensile Bond Testing (In-Process testing for finished coating during regular production)

- Tensile Bond strength of the TSAC finish coat shall be determined according to ASTM D 4541 using a self-aligning adhesion tester.

- One measurement shall be made every 50 m^2. If tensile bond at any individual spot is less than 1000 psi for flame sprayed coating and 1500 psi for arc sprayed coating the degraded TSAC shall be completely removed and reapplied.

- The tensile bond portable test instrument to be calibrated according to ASTM C 633

6.5 Bend Tests

Bend test shall be carried out at beginning of each work shift. Bend tests shall also be conducted on sample coupons before start of thermal spraying work to qualify the following as mentioned earlier in this specification.

- To qualify spray parameters and thickness of each crossing pass.

6.5.1 **Test Procedure**

a) Five corrosion control steel coupons each of dimension 50 mm x 150 mm x 1.3 mm thick to be prepared.

b) Surface shall be prepared by dry abrasive blast cleaning as per this specification.

c) TSAC shall be applied as per specified thickness range. TSAC should be sprayed in crossing passes laying down approx. 75-100 microns in each pass.

d) TSAC applied coupons shall be bent 180° around a 13 mm diameter mandrel.

e) Bend test shall be considered passed if on bend radius there is

- No cracking or spalling or lifting by a knife blade from the substrate
- Only minor cracking that cannot be lifted from substrate with a knife blade.

f) Bend test fails if coating cracks with lifting from substrate.

6.6 Tests for blasting media, blasting air

6.6.1 Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

a) Inspection for the absence of oil contamination shall be conducted using following procedure :

- Fill a small clean 200 ml bottle half full of abrasive.
- Fill the bottle with potable water, cap and shake the bottle.
- Inspect water for oil film/slick. If present, the blasting media is not to be used.

b) Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

c) Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

6.6.2 Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

6.7 Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination.

a) Visual inspection - Continue degreasing until all visible signs of contamination are removed.

b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.

Continue degreasing and inspection till test is passed.

7.0 TSAC APPLICATOR QUALIFICATION

Following tests to be carried out as part of procedure qualification test for the applicator.

- Thickness measurement
- Coating bond strength
- Porosity test
- Bend strength

TSAC applicator's surface finishing and application process and equipment set up, calibration and operation shall be qualified by application of TSA on a reference sample which shall be used as a comparator to evaluate the suitability of application process. Only that applicator will be permitted to carry out the work when test specimens coated by the applicator meets the desired requirements as cited below.

The sample shall be made of a steel plate measuring approx. 18"x 18" x ¼" thick. If the actual work is less than ¼" thick then the sample to be made from material of representative thickness.

The surface preparation, TSAC application shall be made with actual field equipments and process/spray parameters and procedures as per the specification. The depth profile of blasted surface, TSAC coating thickness for each cross pass and total thickness range shall be as per specification.

The surface preparation and thermal spraying shall be carried out in representative environmental conditions spraying with makeshift enclosure.

7.1 After application of coating, thickness and tensile bond measurements shall be made in following manner.

- Divide the sample piece into four quadrants.
- Measure thickness along the diagonal line of each quadrant.
- Four each quadrant five in-line thickness measurements at 1" interval shall be done using SSPC-PA 2 type 2 fixed probe gauge. Thus a total of four "five in line" thickness measurements to be done for the whole sample.
- One tensile bond measurement using ASTM D 4541 type III or IV portable self-aligning test instrument to be done at centre of each quadrant. Total of 4 measurements for the sample.
- One porosity evaluation test by Metallographic examination shall be conducted to demonstrate the achievement of porosity within the limits specified. Sample shall be prepared for Metallographic examination as per ASTM E-3.
- The procedure shall be considered qualified if thickness and tensile-bond strength and porosity values meet the specification requirement.

7.2 Bend test: Bend test shall be carried out as detailed at sec. 6.5 of this specification.

Applicators thermal spray equipment set-up, operation and procedure of application including in-process QC checkpoints adopted during procedure qualification as described above should be always subsequently followed during entire duration of work.

8.0 DOCUMENTATION

The following information shall be provided by TSAC applicator before award of work.

- TSAC application process consisting of equipment capabilities and their technical parameters, feed stock material and source of procurement.
- Detailed application procedure and in-process quality control check points for (a) surface preparation (b) thermal spraying (c) seal coats.
- Type and specification of instruments to be deployed for measurement of blast profile depth, TSAC thickness and tensile bond.
- Paint manufacturer data sheet for the selected sealing coat to be applied.

9.0 RECORDS

- The TSAC applicator shall maintain job record to record production and QC information. All the results of the tests and quality control checks shall be entered in the record for each component/part thermally sprayed. All the result of tests (thickness, tensile bond, bend tests) and other validation tests (e.g. procedure qualification test, test for surface cleanliness after abrasive blasting, test for cleanliness of abrasives and air) shall also be recorded and duly signed by the Owner/ Owner's Representative.

- All the information mentioned in Sec 8.0 above should also form part of the Job record.

- Any modification affected after procedure qualification in the procedure, QC, spray parameter, equipment spec to the original information (submitted before award of the work) must also form part of Job record.

10.0 WARRANTY

The TSAC applicator shall warrant the quality of material used by providing the purchaser with a certificate of materials used to include

- Spray feed stock: Alloy type/designation, Lot Number, wire diameter, chemical analysis, name of supplier, manufacturer.

- Sealant: Name of manufacturer, application data sheet.

11.0 SAFETY

The TSAC applicator shall follow all safety procedures required by the purchaser/owner. Owner shall also give compliance requirement to be followed by applicator. The applicator shall follow all appropriate regulatory requirements.

12.0 CODES AND STANDARDS

This specification shall apply in case of conflict between specification and following applicable standards:

AWS C. 2.17	Recommended Practice for Electric arc Spray.
ASTM C 633	Test Method for Adhesive/Cohesive Strength of Flame Sprayed Coatings.
ASTM D 4285	Method for indicating Oil or Water in Compressed Air.
ASTM D 4417	Test Method for Field Measurement of Surface Profile of Blasted Steel.
BS 2569	Specification for Sprayed Metal Coating.
NACE Standard RP 0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape.
ASTM D 4541	Test method for Pull-Off Strength of Coating Using Portable Adhesion Testers.
ANSI/AWS C2.18	Guide for the Protection of Steel with Thermal Spray Coatings of Aluminum, Zinc and Their Alloys and Composites.
NACE No. 12/AWS C2.23M/SSPC-CS	Specification for the application of thermal spray coatings (Metallizing) of aluminum, zinc, and their alloys and composites for the corrosion protection of steel.

23.00	
SSPC Publication	The inspection of coatings and linings: A Handbook of Basic practice for Inspectors, Owners, and Specifiers.
SSPC-AB 1	Mineral and Slag Abrasives.
SSPC-AB 3	Ferrous Metallic Abrasives.
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel.
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages.
NACE No. 1/SSPC-SP 5	White Metal Blast Cleaning.
NACE No. 2/SSPC-SP 10	Near –White Metal Blast Cleaning.
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

ANNEXURE-II

COLOR CODE

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on these specified length to identify the particular service. Colour code is applicable for both unit and offsite pipes.

SR. No.	SERVICE	RECOMMNDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
HYDROCARBON LINES (UNINSULATED)				
1	CRUDE SOUR	Dark Admiralty grey with 1 orange band	7012	2011
2	CRUDE SWEET	Dark Admiralty grey with 1 red band	7012	3001
3	LUBE OILS	Dark Admiralty grey with 1 green band	7012	6010
4	FLARE LINES	Heat Resistant Aluminium	9006	
5	LPG	Orange with 1 oxide red band	2011	3009
6	PROPYLENE	Orange with 2 blue bands	2011	5013
7	NAPTHA	Orange with 1 green band	2011	6010
8	M.S.	Orange with 1 dark admiralty grey band	2011	7012
9	AV.GASOLINE (96 RON)	Orange with 1 band each of green, white and red bands	2011 / 6010	9010 / 3001
10	GASOLINE (regular, leaded)	Orange with 1 black band	2011	9005
11	GASOLINE (premium, leaded)	Orange with 1 blue band	2011	5013
12	GASOLINE (white)	Orange with 1 white band	2011	9010
13	GASOLINE (Aviation 100/130)	Orange with 1 red band	2011	3001
14	GASOLINE (Aviation 115/145)	Orange with 1 purple band	2011	4006
15	N-PENTANE	Orange with 2 blue bands	2011	5013
16	DIESEL OIL (White)	Oxide red with 1 white band	3009	9010
17	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009	1023
18	KEROSENE	Oxide red with 1 green band	3009	6010
19	HY.KEROSENE	Oxide red with 2 green bands	3009	6010
20	DISUFIDE OIL (EX-MEROX)	Oxide red with 1 black band	3009	9005
21	M.T.O	Oxide red with 3 green bands	3009	6010
22	DHPPA	Oxide red with 2 white bands	3009	9010
23	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
24	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
25	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
27	N-PARAFFIN	Oxide red with 1-blue band	3009	5013
28	HEAVY ALKYLATE	Oxide red with red band	3009	3001
29	BLOW DOWN, VAPOR LINE	Off white / Aluminum with 1-Brown band	9006	8004
30	BLOWDOWN	Off white / Aluminum with 2 brown bands	9006	8004
31	A.T.F.	Leaf brown with 1 white band	8003	9010
32	TOULENE	Leaf brown with 1 yellow band	8003	1023

33	BENZENE	Leaf brown with 1 green band	8003	6010
34	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
35	FUEL OIL	Black with 1 yellow band	9005	1023
36	FULE OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
37	ASPHALT	Black with 1 white band	9005	9010
38	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
39	SLOP AROMATICS	Black with 2 orange bands	9005	2011
	CHEMICAL LINES			
40	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
41	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
42	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
43	AMMONIA	Canary yellow with 1 blue band	1012	5013
44	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006
45	HEXAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005
46	ACID LINES	Golden Yellow with 1 red band	1004	3001
47	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
48	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
49	SOLVENT	Canary yellow with 1 green band	1012	6010
50	LCS	Canary yellow with 1 smoke grey	1012	7031
	WATER LINES			
51	RAW WATER	Sky blue with 1 black band	5015	9005
52	INDUSTRIAL WATER	Sky blue with 2 signal red band	5015	3001
53	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
54	DRINKING WATER	Sky blue with 1 green band	5015	6010
55	COOLING WATER	Sky blue with 1 light brown band	5015	1011
56	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001
57	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
58	DM WATER	Sky blue with 1 aluminum band	5015	9006
59	DM WATER ABOVE 150°F	Sky blue with 2 black bands	5015	9005
60	SOUR WATER	Sky blue with 2 yellow bands	5015	1013
61	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
62	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009
	FIRE PROTECTION SYSTEM (ABOVE GROUND)			
63	FIRE WATER FOAM & EXTINGUISHERS	Post office red	3002	
	AIR & OTHER GAS LINES (UNINSULATED)			
64	SERVICE AIR	Sea green with 1 signal red band	6018	3001
65	INSTRUMENT AIR	Sea green with 1 black band	6018	9005
66	NITROGEN	Sea green with 1 orange band	6018	2011
67	FREON	Sea green with 1 yellow band	6018	1023
68	CHLORINE	Canary yellow with 1 oxide band	1012	3009
69	SO_2	Canary yellow with 2 white bands	1012	9010
70	H_2S	Orange with 2 red oxide bands	2011	3009
71	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Orange with 2 signal red band	2011	3001

74	HYDROGEN	Orange with 1 light green band	2011	6021
STEAM AND CONDENSATE LINES (UNINSULATED)				
75	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023
76	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
77	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011
78	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Sky blue with 1 white band	5015	9010
80	CONDENSATE ABOVE 150°F	Sky blue with 3 oxide red band	5015	3009
81	BFW	Sky blue with 2 red bands	5015	3001
Note: For all insulated steam lines, the colour coding shall be follow as given for un-insulated lines with the specified length of color bands.				
INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	1Black ground colour with 1 yellow band in centre	9005	1023
83	IFO RETURN	Black ground colour with 1 green band in centre	9005	6010
84	HPS	Black ground colour with 1 red band in centre	9005	3001
85	BITUMEN	Black ground colour with 2 red bands in centre	9005	3001
86	CLO	Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 2 brown bands in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	1 Black ground colour with 1 blue band in centre	9005	5013
89	VR BH	1 Black ground colour with 2 blue bands in centre	9005	5013
90	VAC. SLOP	1 Black ground colour with 1 white band in centre	9005	9010
91	SLOP	1 Black ground colour with 1 orange band in centre	9005	2011
92	CRUDE SWEET	1 Dark admiralty grey ground colour with 1 red band in centre	7012	3001
93	CRUDE OUR	1 Dark admiralty grey ground colour with 1 orange band in centre	7012	2011
94	VGO / HCU	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
UNINSULATED EQUIPMENTS, TANKS AND STRUCTURES				
96	HEATER STRUCTURE	Steel grey	7011	
97	HEATER CASING	Heat resistant aluminium	9006	
98	VESSELS & COLUMNS	Aluminium	9006	
99	HYDROGEN BULLETS	Pink	3014	
100	LPG VESSELS	Oxide red	3009	
101	SO_2 VESSEL	Canary yellow	1012	
102	HEAT EXCHANGER	Heat resistant aluminium	9006	
103	FO TANK AND HOT TANKS	Black	9005	

104	ALL OTHER TANKS	Aluminum / Off white	9006
105	CAUSTIC / AMINE / ACID TANKS	Golden yellow	1004
106	SOUR WATER	Sky Blue	5015
107	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006
108	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012
109	PUMPS	Navy blue	5014
110	MOTORS & SWITCH GEAR	Bluish green	5024
111	HAND RAILING, MIDDLE RAIL, TOE PLATE, LADDER VERITAL POSTS, OVER HEAD MONORAIL, MONORAIL STOPPER PLATES, COKE CUTTING SYSTEM	Signal red	3001
112	STAIRCASE, LADDER, WALKWAYS, LADDER RUNGS, RAILING VERTICAL POSTS, CHEQUERED PLATE (BOTH FACES), GRATINGS	Black	9005
113	LOAD LIFTING EQUIPMENT	Leaf brown	8003
114	GANTRY GIRDER & MONORAIL	Dark Green	6009
115	EOT / HOT CRANES	Canary Yellow	1012
116	PIPE RACK STRUCTURALS, BUILDING STRUCTURALS, STEEL COLUMNS, BRACKETS, BEAMS, BRACINGS, ROOF TRUSSES, PURLINGS, SIDE GIRTS, LOUVERS, STRINGERS	Dark admiralty grey	7012
117	TRANSFORMERS & BATTERY ROOM STRUCTURALS	Dark admiralty grey	7012
118	ELECTRICAL MOTORS	Dark Blue (see Note)	5013
119	GENERAL STRUCTURE	Black	9005
	PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE		
120	IBR	Signal red	3001
121	9Cr-1Mo	Verdigris green	6021
122	5Cr-0.5Mo	Satin blue	5012
123	$2_{1/4}$Cr-1 Mo	Aircraft yellow	1026
124	$1_{1/4}$Cr-½ Mo	Traffic Yellow	1023
125	SS-304	Dark blue grey	5008
126	SS-316	Dark violet	4005
127	SS-321	Navy blue	5014

SAFETY COLOUR SCHEMES				
128	DANGEROUS OBSTRUCTION	Black and alert orange band	9005	2008
129	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008	

Notes:

- All LPG service PSVs shall be painted in Deep Blue (RAL 5014).
- All drains & Vents shall be painted in Main line colour.
- The colour code scheme is for identification of piping service group. It consists of a ground colour and 1 or more colour bands.
- Color code of electrical items shall be in-line with electrical deptt. specification.

Ground Colour

On uninsulated pipes, the entire pipe has to be painted in ground colour, and on metal cladded insulated lines, minimum 2M long portion should be painted.

Colour Bands

Location of colour bands:

- At Battery Limits
- Intersection points & change of direction points in piping
- Midway of piping section, near valves, across culverts
- At 50 M interval on long stretch pipes
- At starting and termination points.

Minimum width:

NB	Width
3” and below	75 mm
Above 3” to 6”	NB X 25 MM
Above 6” to 12”	NB X 18 MM
Above 12”	NB X 15 MM

For insulated pipes, NB indicates OD of the insulation.

Sequence:

Colour bands shall be arranged in sequence showing Table above and the sequence follows the direction of flow. The width of the 1st Band to 2nd band is 4:1,

Wherever deemed required by Process Department or Safety, pipes handling hazardous substances will be given hazard marking of 30 mm wide diagonal stripes of Black and Golden Yellow as per IS : 2379 or any other equivalent international standard.

Special Camouflage Painting for Uninsulated Crude and Product Storage Tanks.

Coating System shall be as per this specification.

Camouflage painting scheme for Defense requirement in irregular patches will be applied with 3-colours:

Dark Green	:	Light green	:	Medium Brown
5	:	3	:	2

- The patches shall be irregular and asymmetrical and inclined at 30 to 60 Degrees.
- Patches should be continuous at surface meeting lines / points.
- Slits / holes shall be painted in dark green shade.
- Width of patches shall be 1 to 2 meters.

Identification Markings on Equipment / Piping

Equipment tag Numbers shall be Stenciled / neatly painted using normal 'Arial' Lettering Style on all equipment and piping (Both insulated & uninsulated) after completion of all paint works. Lettering colour shall be either BLACK or WHITE, depending upon the background, so as to obtain good contrast.

Operations Group shall specify location.

Sizes shall be:

Columns, Vessels, Heaters:	150 mm
Pumps and other M/c	50 mm
Piping	OD/2 with Maximum 100 mm
Storage Tanks	(As per Drawings)

Colour Coding for Control Valve

a) Carbon steel body - Light grey

Alloy steel body - Canary yellow

Stainless steel body - Natural

b) The actuator of the Control valve shall be painted as:

Direct action (open on air failure) valves - Green

Reverse acting (close on air failure) valves - Red

The painting Status shall be comprehensively updated every 6 months for compliance

JOB SPECIFICATIONS

(ELECTRICAL)

FOR

CENTRIFUGAL COMPRESSORS (SPP)

(MR No. B378-101-KA-MR-5050)

PROJECT : PDH-PP PROJECT

OWNER : M/s GAIL, USAR

EPCC : ENGINEERS INDIA LTD.

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	09.06.2021	ISSUED WITH MR	CA	DA	SV
A	27.05.2021	ISSUED WITH MR	CA	DA	SV

GENERAL

1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the Centrifugal Compressors (SPP), PDH-PP Project of M/s GAIL. This job specification shall be read in conjunction with EIL standard specifications, data sheets and documents attached with the Material Requisition. In case of any conflict amongst various documents enclosed with MR, the most stringent requirement shall govern and Owner/EIL decision in this regards shall be final.

1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2.0 SCOPE & EXCLUSIONS

Refer scope & exclusions attached elsewhere in MR

3.0 UTILIZATION VOLTAGE

Utilization voltage for motor, anti-condensation heaters based on their ratings shall be as listed below:

a.) Motors rated above 160kW : 6.6 KV ± 6%

b.) Motors rated upto 160kW : 415V ± 6%

c.) Anti-condensation heaters : 240V ± 10%

4.0 SITE CONDITIONS

The equipment and the installation shall be suitable for continuous operation under the following site conditions:

Altitude above MSL : < 1000 m

Seismic Zone : As per IS-1893

Environment : Dusty, Tropical & Corrosive as in Hydrocarbon Industry

The temperature profiles at various locations are tabulated below:

Location	Maximum/ Minimum Ambient Temperature	Equipment design temperature (IS-9676)	Humidity
USAR	30.3 °C/ 22.7 °C	40 °C	90%

5.0 SPECIAL REQUIREMENTS

5.1 Motors shall fulfill the following requirements:-

5.1.1 HV motors (6.6 KV) for DOL start shall conform to EIL Specification 6-51-0031 and HV Motor data sheet no. B378-999-16-50-DS-3101.

5.1.2 MV motors (<1100V) for DOL start shall conform to EIL Specification 6-51-0064 and MV Motor data sheet no. B378-999-16-50-DS-6401.

5.1.3 The enclosure type / area classification for motors and their auxiliaries shall be as listed below:

S. No.	Tag No.	Enclosure Type	Area Classification
1.	101-KA-2002	Ex-de*/ Ex-p	Zone-2, IIC, Temp. Class T3
2.	AUXILARIES FOR 101-KA-2002	Ex-n#/ Ex-nA#	Zone-2, IIC, Temp. Class T3
3.	101-KA-2003	Ex-de*/ Ex-p	Zone-2, IIC, Temp. Class T3
4.	AUXILARIES FOR 101-KA-2003	Ex-n#/ Ex-nA#	Zone-2, IIC, Temp. Class T3

APPLICABLE FOR PSA FEED COMPRESSOR

* For all Ex-de equipment, main enclosure of the equipment shall be Ex-d certified and terminal box shall be Ex-e certified.

Ex-ec motors as per IS/IEC 60079-7 (2015) shall be acceptable subject to availability of statutory approvals.

5.1.4 Main compressor motor shall have minimum enclosure protection Ex – de/Ex-p and Ex-d motors shall meet the requirements of IS/ IEC 60079-1 whereas Ex-p motors shall meet the requirements of IS/ IEC 60079-2.

5.1.5 Auxiliary motors shall have minimum enclosure protection Ex – n and shall meet the requirements of IS/ IEC-60079-15.

5.1.6 All MV motors shall be IE3 type conforming to requirements of EIL standard specification 6-51-0064 and all operating parameters such as starting current, efficiency for all IE3 MV motors shall be in line with IS 12615 (2011).

5.1.7 The rated efficiency and the IE code shall be durably marked on the rating plate, for example "IE3– 94.0 %". Requirement of Gazette of India for IE-3 motors shall be duly complied as applicable.

5.1.8 All MV motors shall be provided with spreader box for smooth termination of power cables in the motor.

5.1.9 Please note that recommended range for the starting power factor of the motors shall be in range of 0.2 to 0.3.

5.1.10 Motors installed outdoors shall have GI canopy for additional weather protection

5.1.11 All motors shall have provision for double earthing.

5.1.12 All glands supplied with motors shall be of thread type 'ET'.

5.1.13 Space heater shall be supplied for motors rated 30 kW and above

5.1.14 Current transformers designed for installation in the neutral terminal box for differential protection of motors rated 1500kW and above shall be provided in line with 6-51-0031.

5.1.15 Trolley mounted pumps shall be powered from a nearby 5 pin socket supplied by client. Vendor to provide trolley mounted flame proof motors and their flameproof starters suitable for use in Zone-2, Gas group IIC, Temp class T3, with 30 meters of armored copper conductor trailing cable.

5.1.16 The trolley mounted pumps shall be complete with integral starters; connection between motor & starter shall be through armored copper conductor cable and shall have motor protections, other hardware & basic control/indications as shown in the data sheet B378-999-16-50-DS-1202.

5.1.17 Exact cable sizes of power and control cables shall be finalised during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.

5.1.18 All motors shall be supplied with cable entries duly sealed by weatherproof (IP-55) metallic sealing plugs in the respective terminal boxes i.e. main terminal box, space heater terminal box, any other terminal box, as required to render it weatherproof during transit and storage at site till installation and cable termination.

5.1.19 Cable glands to be supplied with the motor shall meet all the requirement of IS/IEC-60079-0.

5.1.20 Cable lug material shall be selected based on the application as under: -

Sr. No.	Description	Cable lug material
1.	Copper conductor cable & copper bus bar/ terminals	Tinned Copper
2.	Copper conductor cable & Aluminium bus bar/ terminals	Bi-metallic (Copper barrel with Aluminium palm)
3.	Aluminium conductor cable & Copper bus bar/ terminals	Bi-metallic (Aluminium barrel with tinned Copper palm)
4.	Aluminium conductor cable & Aluminium bus bar/ terminals	Aluminium

All lugs supplied shall be heavy duty long barrel type only.

5.1.21 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipment supplied with the main motor/pump, same shall be highlighted at the bid stage only.

5.2 LOCAL CONTROL STATION

5.2.1 Flameproof (Ex-d) local control panel suitable for gas group as indicated for motors and weatherproof (IP-65) for all motors, emergency stop push buttons & local control station for motors and emergency push buttons as required for plant operation and safety etc. shall be provided by the vendor.

5.2.2 Each motor shall have a separate push button station for motor start/stop in addition to local/remote, Auto/manual selector switch as per operation requirements. LCS for motors rated above 5.5 kW shall be provided with ammeter.

5.2.3 One number emergency stop push button station with ammeter (where applicable) shall be provided near each motor having control not in the vicinity. This push button shall be installed at an accessible place and clearly marked with suitable warning instructions.

5.2.4 Local control stations installed in outdoor area shall have GI canopy for additional weather protection.

5.2.5 Note that for DOL fed motors, Owner shall provide 1A CT signal from Owner's motor feeders for wiring ammeter in LCS.

5.2.6 All push button stations shall be provided with 2 nos. earthing lugs/studs

5.3 All the equipment indigenous and imported shall have a valid statutory approval of CCOE/PESO and copies of the same (CCOE/PESO) shall be furnished during detailed engineering stage which is mandatory as per local rules/regulations.

6.0 SPARES

For requirements of commissioning spares, mandatory spares and two year recommended spares for all electrical equipments, refer elsewhere in the MR

7.0 MAKES OF EQUIPMENT AND COMPONENTS

7.1 List of approved vendors for Electrical equipment/components is as mentioned elsewhere in the Master Vendor List, attached in the MR.

8.0 ATTACHMENTS

Sr. No.	Document Title	Document No.	Rev.
1.	Data Sheet – Contactor feeder for trolley mounted motor	B378-999-16-50-DS-1202	A
2.	Data Sheet – HV Motors - DOL	B378-999-16-50-DS-3101	C
3.	Data Sheet - Experience Record Proforma For FLP HV Motor	B378-999-16-50-DS-3103	A
4.	Data Sheet –MV Motors - DOL	B378-999-16-50-DS-6401	A
5.	Data Sheet – Load Data Format	B378-999-16-50-DS-9901	A
6.	Vendor Data Requirement	B378-101-16-50-VR-5040	A
7.	Vendor List (Electrical)	B378-101-16-50-VL-5040	A
8.	Job Specification (Electrical)	B378-101-16-50-SP-5040	A
9.	Specification for flameproof control stations.	6-51-006	6
10.	Specification for HV Induction Motors	6-51-0031	6
11.	Specification for Energy Efficient MV Induction Motors	6-51-0064	2
12.	Equipment earthing schedule	7-51-0116	7

Lube Oil Pump
(Horizontal-Centrifugal/Rotary)
(TYPICAL)

1	**GENERAL**									
2	Project:	**500 KTA PDH-PP PROJECT**				Job No.:	**B378**			
3	Owner:	**M/s GAIL (INDIA) LTD.**				Site:	**USAR**			
4	Purchaser:					Unit:	**PDH**		Unit No: **101**	
5	Item No.:					Service:	**Main & Auxiliary oil pump**			
6	No. Reqd.: **THREE**	Working: **ONE**		Standby: **TWO**		Parallel Operation Required:		☐ Yes	■ No	
7	Applicable to	■ Proposal	☐ Purchase				☐ As Built			
8	■ Scope option & Information specified by purchaser ☐ Information Reqd. from & option left to vendor. Vendor to cross ☒ the selected option.									
9	Driver: Working	**E. Motor**	Standby	**E. Motor**	Driver Supplied & Mounted By:		■ Pump Mfr.	☐ Other		
10	**OPERATING CONDITIONS**									
11	Liquid Handled	**Lube Oil**				Capacity (m³/hr): Min/Nor/Rated:				
12	Pumping Temp. (°C):	Normal		Max.		Discharge Pressure (kg/cm²,A):				
13	Specific Gravity at P.T./15°C:					Suction Pressure: Nor./ Max. (kg/cm²,A):				
14	Vapour Pressure at P.T. (kg/cm²,A):					Diff. Pressure (kg/cm²) @ Rated Capacity:				
15	Viscosity at P.T. (cP/~~cst~~):		Corr./Eros. By:			Diff. Head (m) @ Rated Capacity:				
16	Solids in suspension	☐ Yes ☐ No	Size:	%		NPSH Available (m):				
17	**MANUFACTURERS SPECIFICATIONS**									
18	Pump Manufacturer:					Model No.:				
19	**CONSTRUCTION**					**PERFORMANCE**				
20	Casing Mounting:	■ Centerline	☐ Foot	☐ Inline		Proposal Curve No.				
21	Casing Split:	☐ Axial	■ Radial			Visc. Corr. Factor:	C_η	C_Q	C_H	
22	Type:	☐ Single Volute	☐ Double Volute	☐ Diffuser		NPSH Reqd. (Water) (m):		F/L Speed (rpm):		
23	Casing Connection:	■ Vent	■ Drain	☐ Gauge		No. of stages:		Efficiency (%):		
24	Nozzles	Size	ANSI Rating	Facing	Position	Rated BKW(0% Tol.):	kW	Max.BKW rtd. Imp.:		
25	Suction		**300#**			BKW @ MCF(Δ=1.0):	kW	Rec. Driver Rating: (kW)		
26	Discharge		**300#**			Max.head rtd imp.(m):		Cap@ BEP(m³/hr):		
27	Imp. dia.(mm) Max:	Rated:	Min:	Type: **Closed**		MCF (m³/hr):Stable		Thermal		
28	Brg.: Type/No. Radial:	Thrust:	Lub: **Oil**			M.A.W.P @ °C /P.T./Design Temp.(kg/cm²,G):				
29	Cplg.:Make/Type:	**Fleximetl w spacer**	Nonspark Guard	■ Yes	☐ No	Hydrostatic Test pressure (kg/cm²,G):				
30	Driver Half cplg. mounted by:	■ Pump Mfr.	☐ Others			Rotation facing coupling end:		☐ CW	☐ CCW	
31	Packing Type:	Size:	No. of rings:			Seal flush/ Quench plan:	**11/61**	Material:		
32	Mech. Seal:	Model:	API Code:			Ext. seal flush fluid:		LPM: @	Kg/cm²G/ EC	
33	Base Plate Drain Rim Type :	■ Yes ☐ No	Fdn. Bolts:	■	☐ No	Seal Barrier fluid:		LPM: @	Kg/cm²G/ EC	
34	Throat Bush:	■ Yes ☐ No	Matl.:	Bal. Device:	☐ ☐ No	Ext. quench fluid:		LPM: @	Kg/cm²G/ EC	
35	Materials (API-610 Matl. Class):	**S-8**	MOC	ASTM Grades		C.W. Plan :		LPM: @	Kg/cm²G/ EC	
36	I - Cast Iron (Ductile)	Casing	**S**			Weight(kg): Pump+Base+Coupling:			Driver:	
37	B – Bronze	Impeller	**L**			**AUXILIARY PIPING INTERFACE CONNECTIONS**				
38	S - Carbon Steel	Inner Case parts				(All interface conn.shall be termntd.with a flng. block valves)				
39	C - 11-13% Chr. Stl.	Sleeve Packed	**---**				**Size**	**Rating(ANSI)**	**Facing**	
40	h – Hardened	Sleeve Seal	**L**			Lantern Ring Inlet/Outlet				
41	f – Faced	Casing ring	)H-BHN	**Lhf**		Ext. Seal flush fluid Inlet/Outlet				
42	K -SS 304	Impeller ring	50(min)	**Lhf**		Seal Quench fluid Inlet				
43	L -SS 316	Shaft	**X**			Seal pot vent/ drain				
44	X - AISI 410	Throttle Bush				Casing vent/ drain				
45	Y	Throat Bush	**L**			C.W Inlet/ Outlet				
46	Z	Balance Drum				Base plate drain (only flanged)				
47	■ Driver suitable for Pump starting with open Disc. Valve condition.					Casing steam jacket				
48	**INSPECTION & TESTS (EACH PUMP)**									
49		Witness	Observe				Witness	Observe		
50	■ Shop Test / Inspection	☐	☐	■ NPSH As Reqd. ☐■ Per Spec. ☐ Mandatory			■	☐		
51	■ Material Certificates	☐	☐	■ Dismantle Insp. & Re-assembly after Test			■	☐		
52	■ Hydrostatic	■	☐	■ Unitisation/Dimensional Check			■	☐		
53	■ Performance/Sound Level	■	☐	■ Check for direction of rotation of pump & driver.			■	☐		
54	**Applicable Specification: API Std. 610, 11 th Edition**									
55	**REMARKS:-** 1) Max. allowable casing working pressure shall not be less than ________ kg/cm²g @ ___ °C.									
56	2) Down Stream Design Pressure is ____kg/cm²g. Maximum shut-off, considering max suction pressure, including all tolerances shall not exceed this value.									
57	3) Both main & standby pump shall be identical in design, construction, speed,etc.									
58	4) Vendor shall fill in all the data for LOP & submit to EIL approval during detailed engg. stage									
59	5) ***NOTE: In case the offered Lube Oil Pump is of Rotary type use sheet 2 of 3 and 3 of 3.***									
60	6) Vendor to provide general reference list to establish field proven experience of the offered pump model.									

1	**GENERAL**							
2	Project:	**500 KTA PDH-PP PROJECT**		Job No.	**B378**			
3	Owner:	**M/s GAIL (INDIA) LTD.**		Site	**USAR**			
4	Purchaser:			Unit	**PDH**	Unit No.: **101**		
5	Item No.:			Service :	**Main & Auxiliary oil pump**			
6	No. Required: **Three** Working: **One**		Stand by:**Two**	Driver:	Working: **E. MOTOR**	Stand by: **E. MOTOR**		
7	Applicable to	■ Proposals		☐ Purchase		☐As Built		
8	■ Scope Option & Information specified by Purchaser ☐ Information required from & options left to vendor. Vendor to cross [☒] the selected Option							
9	Manufacturer:			Size &Type:		Model:		
10	**OPERATING CONDITIONS**							
11	■ Liquid: **Lube Oil**			☐ Rated Capacity at PT (m^3/hr):		(@ Min. viscosity)		
12	☐ Pumping Temperature (°C) (Max / Min):			☐ Capacity (m^3/hr): (@ Max. viscosity)				
13	☐ Specific Gravity at PT:			☐ Discharge Pressure (kg/cm², a) (Rated):				
14	☐Vapour Pressure at PT (kg/cm², a):			☐ Suction Pressure (kg/cm², a) (Rated):				
15	☐ Viscosity at PT (Cp/Cst) (Min / Max):			☐ Differential Pressure (kg/cm², a):				
16	☐ Corrosion Erosion caused by:			☐ NPSH available (m):				
17	☐ Presence of Solids:			☐ Jacketing / Tracing Required	☐ Steam	☐ Electric		
18								
19	**SITE / INSTALLATION / UTILITY DATA (Rem 4)**							
20	Location: ■ Indoor	☐ Outdoor w/w/o roof		☐ Heated	■ Unheated			
21	Site Temperature (°C):	Max:	Min:	☐ Elect. Area Hazard:	Div:	Class:	Group:	
22	☐ Available Steam Pr. (kg/cm²g):		Min:	Nor:	Max:			
23		Temperature (EC)	Min:	Nor:	Max:			
24								
25								
26	**APPLICABLE CODES & STANDARDS**							
27	**APPLICABLE CODES & STANDARDS: API STANDARD 676, 3rd edition**							
28	**PERFORMANCE**							
29	☐ Rated Capacity (m^3/hr)	@ min. viscosity:		☐ Direction of Rotation from Coupling End	☐ CW	☐ CCW		
30	☐ Pump (rpm)	@ max. viscosity:		☐ Relief Valve Set Pressure (kg/cm², g):				
31	☐ NPSH Required (m):			☐ Relief Valve Acc. Pressure (kg/cm², g):				
32	☐ Rated speed (rpm):			☐ BKW @ Max Viscosity (kW):				
33	☐ Displacement (m^3/hr):			☐ BKW @ Relief Valve Setting (kW):				
34	☐ Volumetric efficiency (%):			☐ BKW at accumulation Pr.:				
35	☐ Mechanical Efficiency (%):			☐ Motor Rating (kW):				
36	☐ Overall Efficiency (%):			☐ Allowable Speed (rpm)	Max:	Min:		
37								
38								
39	**CONSTRUCTON FEATURES**							
40	**Nozzles**	**Size**	**Rating/Facing**	**Position**	**Nozzles**	**Size**		
41	Suction				Jacket Inlet			
42	Discharge				Jacket Outlet			
43	Vent				C.W Supply			
44	Drain				C.W Return			
45	Gland / Flush				Steam Quenching			
46	**PUMP TYPE:** ■ Gear	OR	■ Screw		☐ Sliding Vane			
47	☐ External Gear	☐ Internal Gear			Gear Type	☐ Spur Gear	☐ Helical Gear	
48	☐ Twin Screw	☐ Triple Screw	☐ Progressive Cavity					
49	Rotor Mount: ■ Between Brg.	☐ Overhung			☐ Packing:		☐No. Of Rings:	
50	■ Relief Valve: ☐ Built In	■ Ext.			Steam Jacketing: ☐ Casing	☐ Stuffing Box	☐ None	
51	☐ Timing Gears: ☐ Yes	☐ No			■ Mechanical Seals:			
52	☐ **Bearing (Make/Model):**				☐ Manufacturer and Model:			
53	☐ **Lubrication Type for Bearing:**				☐ Mech. Seal API Code:	■ API 610 Seal Flush Plan:		
54	☐ Pumped Fluid	☐ Ring Oil	☐ Oil Mist		Piping for Seal Flush & Quench furnished by:			
55	☐ External	☐ Oil Flood	☐ Grease		■ Pump Vendor	☐ Others		
56	☐ Maximum Allowable Working Pressure (kg/cm², g):				☐ Piping for Cooling / Heating furnished by:			
57	☐ Hydrostatic Test Pressure (kg/cm², g):				☐ Pump Vendor	☐ Others		
58	☐ Steam Jacket Design Pressure (kg/cm², g):							
59								
60								
61								

62							
63	**MATERIALS**						
64	■ Stator Body / Casing: **CS**			■ Sleeve(s): **SS316**			
65	☐ Stator Liner / Insert:			■ Bearing Housing: **CS OR CI**			
66	☐ End Plates:			☐ Timing Gears:			
67	■ Rotor(s): **NITRIDED ALLOY STEEL**			■ Mounting / Base Plate: **MS**			
68	☐ Vanes:			☐ Discharge Piping:			
69	☐ Shaft:			☐ Gland(s):			
70	☐ Packing: Mech. Seal Faces: **C Vs. WC**			■ Relief Valve: Body: **CS** Trim: **SS316**			
71							
72							
73	**INSPECTION & TESTING**						
74	**Description**	**Required**	**Witnessed**	**Description**	**Required**	**Witnessed**	
75	Shop Inspection	■	☐	Performance Test	■	■	
76	Material Certificates	■	☐	NPSH Test (if reqd.)	■	■	
77	Hydrostatic test (Casing & Jacket)	■	■	R.V Set Functional Test	■	■	
78	Rotor Dyn. Balancing (Observed)	■	☐	Dismantle Inspection	■	■	
79	Mechanical Run	■	■				
80							
81							
82	**DRIVER**						
83	■ Type of Driver: ■ Elec. Motor			☐ Steam Turbine ☐ Other:			
84	■Driver Supplied & mounted by Pump Manufacturer			☐ Driver Supplied and mounted by other			
85	☐ Driver kW:			☐ Speed (rpm):			
86							
87							
88	**DRIVE MECHANISM**						
89	■ Direct Coupled ☐ V- Belt ☐ Variable Speed ☐ Gear ☐ Gear Make:						
90	☐ Coupling Make: ☐ Coupling Type: ☐ Coupling Guard (Non-sparking type)						
91							
92							
93							
94	■ By Pump Manufacturer ■ Common Base plate for pump driver, auxiliaries						
95	■ Drain rim type ☐ Drip tray type ☐ Overall Size (lxbxh) (mm):						
96							
97							
98	**WEIGHT**						
99	☐ Pump only (kg): ☐ Driver (kg): ☐ Gear Box (kg):						
100	☐ Base plate (kg): ☐ Misc. (kg): ☐ Total Weight (kg):						
101							
102	**REMARKS:**						
103	1. Equipment Manufacturer to supply his standard design with respect to pump sealing.						
104	2. Pump casing design pressure shall not be less than kg/cm² @ ˚C.						
105	3. Refer Site & Utility data enclosed in Process Specoification.						
106	4. Driver rating shall be suitable for start-up & operation of pump at max. viscosity of lube oil(heater out of operation)						
107	5. Both main & standby pump shall be identical in design, construction ,speed etc.						
108	6. Driver shall be suitable for auto-start.						
109	7. Vendor to provide general reference list to establish field proven experience of the offered pump model.						
110	8. The motor nameplate rating shall be atleast 110% of the power corresponding to relief valve set pressure at maximum specified						
111	Viscosity						
112	9. Pump shall be selected for the maximum capacity at minimum viscosity and the maximum differential pressure.						
113	10. NPSH test shall be carried out when the difference between NPSHA and NPSHR is less than or equal to 1m.						
114	***NOTE: In case the offered Lube Oil Pump is of Centrifugal type use sheet 1of 3.***						

12/06/21	**A**	**MK**	**JSD**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

1	**GENERAL**										
2	Project:	**500 KTA PDH-PP PROJECT**				Job No.:	**B378**				
3	Owner:	**M/s GAIL (INDIA) LTD.**				Site:	**USAR**				
4	Purchaser:					Unit:	**PDH**	Unit No: **101**			
5	Item No.:					Service:	**Emergency oil pump**				
6	No. Reqd.: **ONE**	Working:	Standby: **ONE**			Parallel Operation Required:	☐ Yes	■ No			
7	Applicable to	■ Proposal	☐ Purchase			☐ As Built					
8	■ Scope option & Information specified by purchaser ☐ Information Reqd. from & option left to vendor. Vendor to cross ☒ the selected option.										
9	Driver: Working		Standby	**E. Motor**		Driver Supplied & Mounted By:	■ Pump Mfr.	☐ Other			
10	**OPERATING CONDITIONS**										
11	Liquid Handled	**Lube Oil**				Capacity (m³/hr): Min/Nor/Rated:					
12	Pumping Temp. (°C):	Normal		Max.		Discharge Pressure (kg/cm²,A):					
13	Specific Gravity at P.T./15°C:					Suction Pressure: Nor./ Max. (kg/cm²,A):					
14	Vapour Pressure at P.T. (kg/cm²,A):					Diff. Pressure (kg/cm²) @ Rated Capacity:					
15	Viscosity at P.T. (cP/~~cst~~):		Corr./Eros. By:			Diff. Head (m) @ Rated Capacity:					
16	Solids in suspension	☐ Yes	☐ No	Size:	%	NPSH Available (m):					
17	**MANUFACTURERS SPECIFICATIONS**										
18	Pump Manufacturer:					Model No.:					
19	**CONSTRUCTION**					**PERFORMANCE**					
20	Casing Mounting:	■ **Centerline**	☐ Foot	☐ Inline		Proposal Curve No.					
21	Casing Split:	☐ Axial	■ Radial			Visc. Corr. Factor:	C_{η}		C_Q		C_H
22	Type:	☐ Single Volute	☐ Double Volute	☐ Diffuser		NPSH Reqd. (Water) (m):			F/L Speed (rpm):		
23	Casing Connection:	■ Vent	■ Drain	☐ Gauge		No. of stages:			Efficiency (%):		
24	Nozzles	Size	ANSI Rating	Facing	Position	Rated BKW(0% Tol.):	kW		Max.BKW rtd. Imp.:		
25	Suction		**300#**			BKW @ MCF(Δ=1.0):	kW		Rec. Driver Rating: (kW)		
26	Discharge		**300#**			Max.head rtd imp.(m):			Cap@ BEP(m³/hr):		
27	Imp. dia.(mm) Max:	Rated:	Min:	Type:	**Closed**	MCF (m³/hr):Stable			Thermal		
28	Brg.: Type/No. Radial:	Thrust:	Lub: **Oil**			M.A.W.P @ °C /P.T./Design Temp.(kg/cm²,G):					
29	Cplg.:Make/Type:	**Fleximetl w spacer**	Nonspark Guard	■ Yes	☐ No	Hydrostatic Test pressure (kg/cm²,G):					
30	Driver Half cplg. mounted by:	■ Pump Mfr.	☐ Others			Rotation facing coupling end:			☐ CW	☐ CCW	
31	Packing Type:	Size:		No. of rings:		Seal flush/ Quench plan:	**11/61**		Material:		
32	Mech. Seal:	Model:		API Code:		Ext. seal flush fluid:			LPM:	@	Kg/cm²G/ EC
33	Base Plate Drain Rim Type :	■ Yes	☐ No	Fdn. Bolts:	■ ☐ No	Seal Barrier fluid:			LPM:	@	Kg/cm²G/ EC
34	Throat Bush:	■ Yes	☐ No	Matl.:	Bal. Device: ☐ ☐ No	Ext. quench fluid:			LPM:	@	Kg/cm²G/ EC
35	Materials (API-610 Matl. Class):	**S-8**	MOC	ASTM Grades		C.W. Plan :			LPM:	@	Kg/cm²G/ EC
36	I - Cast Iron (Ductile)	Casing	**S**			Weight(kg): Pump+Base+Coupling:			Driver:		
37	B – Bronze	Impeller	**L**			**AUXILIARY PIPING INTERFACE CONNECTIONS**					
38	S - Carbon Steel	Inner Case parts				(All interface conn.shall be termntd.with a flng. block valves)					
39	C - 11-13% Chr. Stl.	Sleeve Packed	**---**				**Size**		**Rating(ANSI)**	**Facing**	
40	h – Hardened	Sleeve Seal	**L**			Lantern Ring Inlet/Outlet					
41	f – Faced	Casing ring	)H-BHN	**Lhf**		Ext. Seal flush fluid Inlet/Outlet					
42	K -SS 304	Impeller ring	50(min)	**Lhf**		Seal Quench fluid Inlet					
43	L -SS 316	Shaft	**X**			Seal pot vent/ drain					
44	X - AISI 410	Throttle Bush				Casing vent/ drain					
45	Y	Throat Bush	**L**			C.W Inlet/ Outlet					
46	Z	Balance Drum				Base plate drain (only flanged)					
47	■ Driver suitable for Pump starting with open Disc. Valve condition.					Casing steam jacket					
48	**INSPECTION & TESTS (EACH PUMP)**										
49		Witness	Observe				Witness	Observe			
50	■ Shop Test / Inspection	☐	☐	■ NPSH As Reqd. ☐■ Per Spec. ☐ Mandatory			■	☐			
51	■ Material Certificates	☐	☐	■ Dismantle Insp. & Re-assembly after Test			■	☐			
52	■ Hydrostatic	■	☐	■ Unitisation/Dimensional Check			■	☐			
53	■ Performance/Sound Level	■	☐	■ Check for direction of rotation of pump & driver.			■	☐			
54	**Applicable Specification: API Std. 610, 11 th Edition**										
55	**REMARKS:-** 1) Max. allowable casing working pressure shall not be less than ________ kg/cm²g @ ____ °C.										
56	2) Down Stream Design Pressure is _____kg/cm²g. Maximum shut-off, considering max suction pressure, including all tolerances shall not exceed this value.										
57	3) Vendor shall fill in all the data for LOP & submit to EIL approval during detailed engg. stage										
58	4) ***NOTE: In case the offered Lube Oil Pump is of Rotary type use sheet 2 of 3 and 3 of 3.***										
59	5) Vendor to provide general reference list to establish field proven experience of the offered pump model.										
60											

1	**GENERAL**							
2	Project:	**500 KTA PDH-PP PROJECT**		Job No.	**B378**			
3	Owner:	**M/s GAIL (INDIA) LTD.**		Site	**USAR**			
4	Purchaser:			Unit	**PDH**	Unit No.: **101**		
5	Item No.:			Service :	**Emergency oil pump**			
6	No. Required: **Three** Working: **One**	Stand by:**Two**		Driver:	Working:	Stand by:		
7	Applicable to	■ Proposals		☐ Purchase		☐As Built		
8	■ Scope Option & Information specified by Purchaser ☐ Information required from & options left to vendor. Vendor to cross [☒] the selected Option							
9	Manufacturer:			Size &Type:		Model:		
10	**OPERATING CONDITIONS**							
11	■ Liquid: **Lube Oil**			☐ Rated Capacity at PT (m^3/hr):	(@ Min. viscosity)			
12	☐ Pumping Temperature (˚C) (Max / Min):			☐ Capacity (m^3/hr): (@ Max. viscosity)				
13	☐ Specific Gravity at PT:			☐ Discharge Pressure (kg/cm^2, a) (Rated):				
14	☐Vapour Pressure at PT (kg/cm^2, a):			☐ Suction Pressure (kg/cm^2, a) (Rated):				
15	☐ Viscosity at PT (Cp/Cst) (Min / Max):			☐ Differential Pressure (kg/cm^2, a):				
16	☐ Corrosion Erosion caused by:			☐ NPSH available (m):				
17	☐ Presence of Solids:			☐ Jacketing / Tracing Required	☐ Steam	☐ Electric		
18								
19	**SITE / INSTALLATION / UTILITY DATA (Rem 4)**							
20	Location: ■ Indoor	☐ Outdoor w/w/o roof		☐ Heated	■ Unheated			
21	Site Temperature (˚C):	Max:	Min:	☐ Elect. Area Hazard:	Div:	Class:	Group:	
22	☐ Available Steam Pr. (kg/cm^2g):		Min:	Nor:	Max:			
23		Temperature (EC)	Min:	Nor:	M3ax:			
24								
25								
26	**APPLICABLE CODES & STANDARDS**							
27	**APPLICABLE CODES & STANDARDS: API STANDARD 676, 3rd edition**							
28	**PERFORMANCE**							
29	☐ Rated Capacity (m^3/hr)	@ min. viscosity:		☐ Direction of Rotation from Coupling End	☐ CW	☐ CCW		
30	☐ Pump (rpm)	@ max. viscosity:		☐ Relief Valve Set Pressure (kg/cm^2, g):				
31	☐ NPSH Required (m):			☐ Relief Valve Acc. Pressure (kg/cm^2, g):				
32	☐ Rated speed (rpm):			☐ BKW @ Max Viscosity (kW):				
33	☐ Displacement (m^3/hr):			☐ BKW @ Relief Valve Setting (kW):				
34	☐ Volumetric efficiency (%):			☐ BKW at accumulation Pr.:				
35	☐ Mechanical Efficiency (%):			☐ Motor Rating (kW):				
36	☐ Overall Efficiency (%):			☐ Allowable Speed (rpm)	Max:	Min:		
37								
38								
39	**CONSTRUCTON FEATURES**							
40	**Nozzles**	**Size**	**Rating/Facing**	**Position**	**Nozzles**	**Size**		
41	Suction				Jacket Inlet			
42	Discharge				Jacket Outlet			
43	Vent				C.W Supply			
44	Drain				C.W Return			
45	Gland / Flush				Steam Quenching			
46	**PUMP TYPE:** ■ Gear	OR	■ Screw		☐ Sliding Vane			
47	☐ External Gear	☐ Internal Gear			Gear Type	☐ Spur Gear	☐ Helical Gear	
48	☐ Twin Screw	☐ Triple Screw	☐ Progressive Cavity					
49	Rotor Mount: ■ Between Brg.	☐ Overhung			☐ Packing:	☐No. Of Rings:		
50	■ Relief Valve: ☐ Built In	■ Ext.			Steam Jacketing: ☐ Casing	☐ Stuffing Box	☐ None	
51	☐ Timing Gears: ☐ Yes	☐ No			■ Mechanical Seals:			
52	☐ **Bearing (Make/Model):**				☐ Manufacturer and Model:			
53	☐ **Lubrication Type for Bearing:**				☐ Mech. Seal API Code:	■ API 610 Seal Flush Plan:		
54	☐ Pumped Fluid	☐ Ring Oil	☐ Oil Mist		Piping for Seal Flush & Quench furnished by:			
55	☐ External	☐ Oil Flood	☐ Grease		■ Pump Vendor	☐ Others		
56	☐ Maximum Allowable Working Pressure (kg/cm^2, g):				☐ Piping for Cooling / Heating furnished by:			
57	☐ Hydrostatic Test Pressure (kg/cm^2, g):				☐ Pump Vendor	☐ Others		
58	☐ Steam Jacket Design Pressure (kg/cm^2, g):							
59								
60								
61								
62								

63	**MATERIALS**					
64	■ Stator Body / Casing: **CS**			■ Sleeve(s): **SS316**		
65	☐ Stator Liner / Insert:			■ Bearing Housing: **CS OR CI**		
66	☐ End Plates:			☐ Timing Gears:		
67	■ Rotor(s): **NITRIDED ALLOY STEEL**			■ Mounting / Base Plate: **MS**		
68	☐ Vanes:			☐ Discharge Piping:		
69	☐ Shaft:			☐ Gland(s):		
70	☐ Packing: Mech. Seal Faces: **C Vs. WC**			■ Relief Valve: Body: **CS** Trim: **SS316**		
71						
72						
73	**INSPECTION & TESTING**					
74	**Description**	**Required**	**Witnessed**	**Description**	**Required**	**Witnessed**
75	Shop Inspection	■	☐	Performance Test	■	■
76	Material Certificates	■	☐	NPSH Test (if reqd.)	■	■
77	Hydrostatic test (Casing & Jacket)	■	■	R.V Set Functional Test	■	■
78	Rotor Dyn. Balancing (Observed)	■	☐	Dismantle Inspection	■	■
79	Mechanical Run	■	■			
80						
81						
82	**DRIVER**					
83	■ Type of Driver: ■ Elec. Motor			☐ Steam Turbine ☐ Other:		
84	■Driver Supplied & mounted by Pump Manufacturer			☐ Driver Supplied and mounted by other		
85	☐ Driver kW:			☐ Speed (rpm):		
86						
87						
88	**DRIVE MECHANISM**					
89	■ Direct Coupled ☐ V- Belt ☐ Variable Speed ☐ Gear ☐ Gear Make:					
90	☐ Coupling Make: ☐ Coupling Type: ☐ Coupling Guard (Non-sparking type)					
91						
92						
93						
94	■ By Pump Manufacturer ■ Common Base plate for pump driver, auxiliaries					
95	■ Drain rim type ☐ Drip tray type ☐ Overall Size (lxbxh) (mm):					
96						
97						
98	**WEIGHT**					
99	☐ Pump only (kg): ☐ Driver (kg): ☐ Gear Box (kg):					
100	☐ Base plate (kg): ☐ Misc. (kg): ☐ Total Weight (kg):					
101						
102	**REMARKS:**					
103	1. Equipment Manufacturer to supply his standard design with respect to pump sealing.					
104	2. Pump casing design pressure shall not be less than kg/cm² @ ˚C.					
105	3. Refer Site & Utility data enclosed in Process Specification.					
106	4. Driver rating shall be suitable for start-up & operation of pump at max. viscosity of lube oil(heater out of operation)					
107	6. Driver shall be suitable for auto-start.					
108	7. Vendor to provide general reference list to establish field proven experience of the offered pump model.					
109	8. The motor nameplate rating shall be atleast 110% of the power corresponding to relief valve set pressure at maximum specified					
110	Viscosity					
111	9. Pump shall be selected for the maximum capacity at minimum viscosity and the maximum differential pressure.					
112	10. NPSH test shall be carried out when the difference between NPSHA and NPSHR is less than or equal to 1m.					
113	***NOTE: In case the offered Lube Oil Pump is of Centrifugal type use sheet 1of 3.***					
114						
115						
116						

12/06/21	**A**	**MK**	**JSD**
Date	**Rev**	**Job Engineer**	**Rev. & Approved By**

Project	EPCM Consultancy Services for 500 KTA PDH-PP Project		**Client**	GAIL - CORPORATE OFFICE	
Unit	Utilities and offsites	**Location**	**Job No.**	B378	**Unit No.** 999

PURCHASER'S DATA

A.	**Site Conditions**		
1.	Maximum Ambient Temperature	°C	42
2.	Minimum Ambient Temperature	°C	12
3.	Design Ambient Temperature	°C	40
4.	Relative Humidity	%	90
5.	Altitude	mm	less than 1000
6.	Environment:		Corrosive
B.	**Technical particulars**		
1.	Motor Tag no.:		
2.	Driven Equipment name:		
3.	Voltage:	V	415 +/- 6 %
4.	Phase:		Three
5.	Frequency:	Hz	50 +/- 3 %
6.	Fault level:	kA	
7.	Method of starting:		D.O.L
8.	Winding Connection:		Delta
9.	No of Terminals:		6
10.	Cable size:	mm^2	During Detailed Engg.
11.	Cable type:		Al./Cu. Cond, XLPE insulated
12.	Temperature rise:	°C	80
13.	Cooling:		IC411
14.	Insulation class:		F
15.	Temperature rise Limited to insulation class		B
16.	Hazardous area classification:		Refer Job Specification
17.	Dust classification		Refer Job Specification
18.	Gas group:		Refer Job Specification
19.	Dust Group		Refer Job Specification
20.	Type of explosion protection:		Refer Job Specification
21.	Prestart purging for Ex(n) motor		Not Required
22.	Type of ingress protection:		IP 55
23.	Color shade:		632 as per IS 5
24.	Thermisters:		Not Required
25.	RTD:		Not Required
26.	BTD:		Not Required
27.	RTD/BTD monitoring device:		Not Required
28.	Applicable specification:		EIL Spec. 6-51-0064
29.	Efficiency:		IE 3

DRIVEN EQUIPMENT MANUFACTURER's DATA

1.	Suggested motor rating:	kW	
2.	Manufacturer:		
3.	BkW at Full load:	kW	
4.	kW:at end of Curve	kW	

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
A	02-NOV-2020	ISSUED WITH MR/ TENDER	JAYENDRA L CHAUHAN	JAYENDRA L CHAUHAN	SHALINI VERMA

Project	EPCM Consultancy Services for 500 KTA PDH-PP Project		**Client**	GAIL - CORPORATE OFFICE	
Unit	Utilities and offsites	**Location**	**Job No.**	B378	**Unit No.** 999

5.	Speed:	RPM	
6.	Rotation of eqpt. from coupling end:		
7.	Driven equipment:		
8.	Coupling type:		
9.	Torque required starting	mkg	
	Torque required Maximum	mkg	
10.	GD2 of eqpt including flywheel	kgm²	
	excluding flywheel:	kgm²	
11.	thrust Up:	kg	
	thrust Down:	kg	
12.	Starting condition:		

MOTOR MANUFACTURER's DATA

1.	Rating:	kW	
2.	Manufacturer:		
3.	No. of poles:		
4.	Frame designation:		
5.	Full load speed:	RPM	
6.	Mounting:		
7.	Full load torque (FLT):	mkg	
8.	Starting torque:	% of FLT	
9.	Break down or pull out torque:	% of FLT	
10.	Full load current (FLC):	A	
11.	Starting current at 100% voltage:	% of FLC	
12.	Rotation viewed from coupling end:		
13.	Starting time at 75% voltage:	sec.	
	100% voltage:	sec.	
14.	Locked rotor withstand time (cold/hot) at,		
	75% voltage	sec.	
	100% voltage:	sec.	
15.	Time (Te) for Increased Safety Motor at 100% Voltag	sec.	
16.	Heating/Cooling Time Const. (min.)	min	
17.	Space heater - voltage & power:		
18.	Efficiency at 75% Load:	%	
	100% Load: voltage:	%	
19.	Power factor at 75%/ Load:		
	100% Load:		
	starting		
20.	Moment of inertia, GD2:	kgm²	
21.	NDE bearing type & no		
22.	DE bearing type & no.:		
23.	Type of lubrication:		
24.	Weight of motor:	kg	

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
A	02-NOV-2020	ISSUED WITH MR/ TENDER	JAYENDRA L CHAUHAN	JAYENDRA L CHAUHAN	SHALINI VERMA

Project	EPCM Consultancy Services for 500 KTA PDH-PP Project		**Client**	GAIL - CORPORATE OFFICE	
Unit	Utilities and offsites	**Location**	**Job No.**	B378	**Unit No.** 999

25.	Thermisters, quantity	no.	
	make: type:		
26.	RTD, quantity:	no.	
	make: type:		
27.	BTD, quantity	no.	
	make: type:		
28.	Shaft voltage:	V	
29.	Critical speed, 1st/2nd stage:	RPM	
30.	Canopy:		

Notes

1 Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
2 GI canopy shall be provided for all outdoor motors.
3 For Approved makes of motors refer else where in the MR/Tender/Package
4 Starting time calculations shall be based on operating conditions specified on Material Requisition eg. open valve ccondition/closed valve condition, at no load/full load, as applicable.

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VENDOR LIST

(INSTRUMENTATION)

FOR

Propylene Refrigerant Compressor (101-KA-5001)

FOR

GAIL (INDIA) LIMITED – USAR

MR No: B378-101-KA-MR-5040

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	02.07.21	Revised & Re-Issued for Bids	GS	IJS	KS
A	14.06.21	Issued for Bids	GS	IJS	KS

Vendor list provided in the MR is for the Make only, and not for any specific Model. For any instrumentation item, the offered model for the same must meet the specifications and proven track record (PTR) requirement, as explained elsewhere.

Instrument Sub-vendor shall meet the requirement conditions of EIL approval for the Project Approved Vendor List. The EIL approval conditions are available with the Sub-Vendors. Contractor shall follow the approval requirement.

For Instruments / items not covered in the vendor list, Contractor shall get approval for the vendors proposed, prior to the placement of order.

Sr No.	VENDOR NAME
FIELD TRANSMITTERS	
1.	ENDRESS + HAUSER WETZER INDIA PVT LTD
2.	ABB INDIA LTD (BANGALORE)
3.	ABB AUTOMATION PRODUCTS GMBH
4.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
5.	ENDRESS+HAUSER (I) AUTO. INSTR. PVT. LTD
6.	EMERSON PROCES MGMT ASIA PACIFIC PTE LTD
7.	ENDRESS+HAUSER WETZER GMBH+ CO.KG
8.	ENDRESS+HAUSER GMBH+CO. KG
9.	FUJI ELECTRIC SYSTEMS CO. LTD
10.	HONEYWELL AUTOMATION INDIA LTD.
11.	HONEYWELL INC.
12.	YOKOGAWA INDIA LIMITED
13.	YOKOGAWA ELECTRIC CORPORATION
SPECIAL LEVEL INSTRUMENTS (GUIDED WAVE RADAR TYPE)	
1.	KROHNE S.A.S.
2.	ABB INC
3.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
4.	ENDRESS+HAUSER (I) AUTO. INSTR. PVT. LTD
5.	ENDRESS+HAUSER GMBH+CO. KG
6.	L & J TECHNOLOGIES
7.	MAGNETROL INTERNATIONAL N.V
8.	VEGA GRIESHABER KG
MAGNETIC LEVEL INSTRUMENTS	
1.	KROHNE S.A.S.
2.	GAUGES BOURDON (I) PVT LTD (GEN. INST)
3.	ABB INC
4.	BLISS ANAND PVT LTD
5.	CHEMTROLS SAMIL (INDIA) PVT LTD
6.	CESARE BONNETTI S.P.A.
7.	KLINGER SPA
8.	MAGNETROL INTERNATIONAL N.V
9.	NIHON KLINGAGE CO LTD
10.	PUNE TECHTROL PVT LTD
11.	SIGMA INSTRUMENTS CO
12.	SHRIDHAN AUTOMATION PVT LTD
13.	V AUTOMAT & INSTRUMENTS PVT LTD
LOOP POWERED INDICATORS	
1.	ENDRESS + HAUSER WETZER INDIA PVT LTD
2.	BEKA ASSOCIATES LTD
3.	EMERSON PROCESS MANAGEMENT INDIA PVT LTD

4.	ENDRESS+HAUSER WETZER GMBH+ CO.KG
5.	HONEYWELL AUTOMATION INDIA LTD.
6.	MTL INSTRUMENTS PVT LTD
7.	YOKOGAWA INDIA LIMITED
PRESSURE GAUGES	
1	PRECISION MASS PRODUCTS PVT. LTD.
2	BAUMER TECHNOLOGIES INDIA PVT.LTD(W058)
3	BADOTHERM PROCESS INSTRUMENTS B.V.
4	FORBES MARSHALL (HYD) PVT. LTD
5	GAUGES BOURDON (I) PVT. LTD. (GEN.INST)
6	H GURU INSTRUMENTS (SOUTH INDIA) PVT. LTD
7	H.GURU INDUSTRIES
8	MANOMETER (INDIA) PVT. LTD.
9	THERMAL INSTRUMENT (I) P LTD (GEN.INST.)
10	WIKA INSTRUMENTS INDIA PVT LTD
11	WALCHANDNAGAR INDUSTRIES LTD(TIWAC DIVN)
12	WIKA ALEXANDER WIEGAND & CO GMBH
DIFFERENTIAL PRESSURE GAUGE	
1	BAUMER TECHNOLOGIES INDIA PVT.LTD
2	FORBES MARSHALL (HYD) PVT. LTD
3	GAUGES BOURDON (I) PVT. LTD. (GEN.INST)
4	HIRLEKAR PRECISION ENGINEERING PVT LTD
5	SWITZER PROCESS INSTRUMENTS PVT. LTD.
6	WIKA INSTRUMENTS INDIA PVT LTD
TEMPERATURE GAUGE (BI-METALLIC, FILLED SYSTEM)	
1	PRECISION MASS PRODUCTS PVT. LTD.
2	BAUMER TECHNOLOGIES INDIA PVT.LTD
3	BADOTHERM PROCESS INSTRUMENTS B.V.
4	FORBES MARSHALL (HYD) PVT. LTD
5	GAUGES BOURDON (I) PVT. LTD. (GEN.INST)
6	H GURU INSTRUMENTS(SOUTH INDIA)PVT. LTD
7	H.GURU INDUSTRIES
8	THERMAL INSTRUMENT (I) P LTD (GEN.INST.)
9	WIKA INSTRUMENTS INDIA PVT LTD
10	WALCHANDNAGAR INDUSTRIES LTD(TIWAC DIVN)
11	WIKA ALEXANDER WIEGAND & CO GMBH
TEMPERATURE ELEMENTS AND THERMOWELLS	
1	GAUGES BOURDON (I) PVT LTD (GEN. INST)
2	TOSHNIWAL INDUSTRIES PVT LTD
3	ALTOP INDUSTRIES LTD.
4	ABB AUTOMATION LTD
5	BAUMER TECHNOLOGIES INDIA PVT.LTD
6	DETRIV INSTRUMENTATION & ELECTRONICS LTD
7	DAILY THERMETRICS CORPORATION
8	GAYESCO-WIKA USA, LP
9	PYRO-ELECTRIC INSTRUMENTS GOA PVT LTD
10	TEMP-TECH
11	TEMPSENS INSTRUMENTS INDIA PVT LTD
12	TECHNO INSTRUMENTS
13	THERMAL INSTRUMENT (I) P LTD (GEN.INST.)
14	THERMO ELECTRIC CO. INC.
15	TM TECNOMATIC SPA
16	THERMO-COUPLE PRODUCTS CO
17	THERMO-ELECTRA B.V.

18	WIKA INSTRUMENTS INDIA PVT LTD
19	WIKA ALEXANDER WIEGAND & CO GMBH
PRESSURE RELIEF VALVES	
1	UNI KLINGER LIMITED
2	ANDERSON GREENWOOD CROSBY
3	AST APPARECCHI DI SICUREZZA E TENUTA SPA
4	BHEL (TRICHY)
5	BLISS ANAND PVT LTD
6	CURTISS WRIGHT FLOW CONTROL CORPORATION
7	DRESSER INC.
8	FAINGER LESER VALVES (P) LTD
9	INSTRUMENTATION LTD. (PALGHAT)
10	LESER GMBH & CO. KG
11	NIRMAL INDUSTRIAL CONTROL PVT. LTD.
12	NAKAKITA SEISAKUSHO CO LTD
13	ANDERSON GREENWOOD CROSBY SANMAR LIMITED
14	TRILLIUM FLOW TECHNOLOGIES INDIA PRIVATE LIMITED
CONTROL VALVES	
1	BELLINO SRL
2	ARCA REGLER GMBH
3	AST APPARECCHI DI SICUREZZA E TENUTA SPA
4	CONTINENTAL VALVE LTD
5	CCI VALVE TECHNOLOGY GMBH
6	GE OIL & GAS INDIA PVT. LTD.
7	DRESSER PRODUITS INDUSTRIELS
8	EMERSON PROCESS MANGMNT CHENNAI PVT. LTD.
9	FORBES MARSHALL ARCA P LTD
10	FLOWSERVE INDIA CONTROL PVT LTD-BANGALOR
11	FLOWSERVE PTE LTD
12	INSTRUMENTATION LTD. (PALGHAT)
13	KOSO INDIA PVT LTD
14	KENT INTROL UK LTD
15	MASCOT VALVES PVT LIMITED (FMLY VALFLO)
16	KSB MIL CONTROLS LIMITED
17	MOTOYAMA ENGG WORKS LTD
18	SEVERN GLOCON INDIA PVT LTD
19	SAMSON CONTROLS PVT LTD
20	SEVERN GLOCON LTD
21	SAMSON AG MESS-UND REGELTECHNIK
22	SPX VALVES & CONTROLS (FORMERLY DEZURIK)
23	WEIR VALVES & CONTROLS UK LTD
CONTROL VALVE POSITIONER	
1	FLOWSERVE INDIA CONTROL PVT LTD-BANGALOR
2	SAMSON CONTROLS PVT LTD
SELF ACTUATED PRESSURE CONTROL VALVES	
1	GE OIL & GAS INDIA PVT. LTD.
2	DRESSER PRODUITS INDUSTRIELS
3	ESME VALVES LTD.
4	EMERSON PROCES MGMT ASIA PACIFIC PTE LTD
5	KSB MIL CONTROLS LIMITED
6	NIRMAL INDUSTRIAL CONTROL PVT. LTD.
7	RICHARDS INDUSTRIALS, INC.
8	SAMSON CONTROLS PVT LTD
9	EMERSONPROCESSMANAGEMENT CHENNAI PVT LTD

10	SAMSON AG MESS-UND REGELTECHNIK
SOLENOID VALVES (SOV)	
1	ROTEX AUTOMATION LTD
2	AVCON CONTROLS PVT. LTD.
3	ASCO NUMATICS (INDIA) P. LIMITED
4	ASCO JOUCOMATIC LTD
5	ALCON ALEXANDER CONTROLS LIMITED
6	ASCO JOUCOMATIC SA
7	HERION WERKE
8	PRECISION INSTRUMENT COMPANY
9	ROTEX AUTOMATION LTD
10	SCHRADER DUNCAN LIMITED
11	THOMPSON VALVES LTD
12	VERSA BV
INTERFACE DEVICES (Barriers, proximity switches, converters, etc)	
1	PEPPERL + FUCHS ASIA PTE. LTD.
2	PEPPERL + FUCHS, INC.
3	CAMILLE BAUER MESSINSTRUMENTE AG
4	GM INTERNATIONAL SRL
5	HANS TURCK GMBH & CO. KG
6	IFM ELECTRONIC GMBH
7	MTL INSTRUMENTS PVT LTD
8	OSNA ELECTRONICS PVT LTD
9	PEPPERL + FUCHS GMBH
10	R STAHL SCHALTGERATE GMBH
AIR FILTER REGULATOR (AFR)	
1	DIVYA CONTROL ELEMENTS PVT LTD
2	JANATICS INDIA PVT LTD
3	MARSH BELLOFRAM
4	PLACKA INSTRUMENTS INDIA P LTD
5	SHAVO NORGREN (I) PVT LTD
6	SCHRADER DUNCAN LIMITED
7	SHAH PNEUMATICS
8	THOMPSON VALVES LTD
9	VELJAN HYDRAIR PVT LTD
ORIFICE PLATES & FLANGES	
1	CAMERON CANADA CORPORATION
2	CANALTA CONTROLS LIMITED
3	HYDROPNEUMATICS PVT. LTD
4	DYNAFLUID VALVES AND FLOW CONTROLS P LTD
5	CHEMTROLS SAMIL (INDIA) PVT LTD
6	COMFIT & VALVES PVT. LTD.
7	EMERSON PROCESS MANAGEMENT ASIA PACIFIC PTE LTD
8	EUREKA INDUSTRIAL EQUIPMENTS (P) LTD.
9	GURU NANAK ENGG WORKS
10	JAV FORGINGS & ENGINEERINGS PRIVATE LIMITED
11	MICRO PRECISION PRODUCTS PVT LTD
12	MINCO (INDIA) PVT LTD (GEN. INST.)
13	MINCO (I) FLOW ELEMENT P. LTD. (GIC CO.)
14	PETROL VALVES SRL
15	PIETRO FIORENTINI SPA
16	STAR-MECH CONTROLS (INDIA) PVT LTD
17	TEMP-TECH
18	TM TECNOMATIC SPA

RESTRICTION ORIFICE	
1	CAMERON CANADA CORPORATION
2	CANALTA CONTROLS LIMITED
3	HYDROPNEUMATICS PVT. LTD
4	DYNAFLUID VALVES AND FLOW CONTROLS P LTD
5	CHEMTROLS SAMIL (INDIA) PVT LTD
6	COMFIT & VALVES PVT. LTD.
7	EMERSON PROCESS MANAGEMENT ASIA PACIFIC PTE LTD
8	EUREKA INDUSTRIAL EQUIPMENTS (P) LTD.
9	GURU NANAK ENGG WORKS
10	JAV FORGINGS & ENGINEERINGS PRIVATE LIMITED
11	MICRO PRECISION PRODUCTS PVT LTD
12	MINCO (INDIA) PVT LTD (GEN. INST.)
13	MINCO (I) FLOW ELEMENT P. LTD. (GIC CO.)
14	PETROL VALVES SRL
15	PIETRO FIORENTINI SPA
16	STAR-MECH CONTROLS (INDIA) PVT LTD
17	TEMP-TECH
18	TM TECNOMATIC SPA
LOCAL CONTROL PANEL	
1	CONTROL SYSTEMS ENGINEERS
2	ACCUSONIC CONTROLS PVT LTD
3	DRESSER RAND INDIA PVT LTD
4	ELECTRONIC CORPORATION OF INDIA LTD.
5	ELECTRONIC INSTRMNTATION & CONTROL P LTD
6	INDUSTRIAL CONTROLS & APPLIANCES PVT LTD
7	IRIS AUTOMATION PVT LTD
8	POSITRONICS PVT LTD
9	PRIMA AUTOMATION INDIA PVT LTD
10	PYROTECH ELECTRONICS PVT LTD
11	RADHA KRISHNA CONTROLS
SIGNAL CABLES	
1	LEONI CABLE SOLUTIONS(INDIA) PVT LTD.
2	LAPP INDIA PVT LTD
3	KEI INDUSTRIES LIMITED
4	POLYCAB INDIA LIMITED
5	CORDS CABLE INDUSTRIES LTD
6	THERMO CABLES LTD.
7	TEMPSENS INSTRUMENTS (I) PVT. LTD.
8	POLYCAB INDIA LIMITED
9	PARAMOUNT COMMUNICATIONS LTD
10	ASSOCIATED CABLES PVT LTD
11	ASSOCIATED FLEXIBLES & WIRES [P] LTD
12	CMI LIMITED
13	CORDS CABLE INDUSTRIES LTD
14	DELTON CABLES LIMITED
15	ELKAY TELELINKS LTD.
16	HAVELLS INDIA LTD
17	KEI INDUSTRIES LIMITED
18	KEC INETRNATIONAL – MYSORE
19	LEONI KERPEN GMBH
20	SUYOG ELECTRICALS LTD
21	THERMO CABLES LTD

22	T C COMMUNICATION PVT. LTD.
23	UDEY PYROCABLES PVT. LTD.
THERMO COUPLE EXTN.CABLES	
1	KEI INDUSTRIES LIMITED
2	CORDS CABLE INDUSTRIES LTD
3	THERMO CABLES LTD.
4	TEMPSENS INSTRUMENTS (I) PVT. LTD.
5	PARAMOUNT COMMUNICATIONS LTD
6	ASSOCIATED CABLES PVT LTD
7	ASSOCIATED FLEXIBLES & WIRES [P] LTD
8	CORDS CABLE INDUSTRIES LTD
9	DELTON CABLES LIMITED
10	KEI INDUSTRIES LIMITED
11	THERMO CABLES LTD
12	T C COMMUNICATION PVT. LTD.
13	UDEY PYROCABLES PVT. LTD.
TUBE FITTINGS	
1	SWAGELOK COMPANY
2	FITOK INCORPORATED
3	WESMEC ENGINEERING PRIVATE LIMITED
4	PRECISION ENGINEERING INDUSTRIES
5	HAVI ENGINEERING INDIA PVT LTD
6	MET-LOK VALVES AND FITTINGS
7	PANAM ENGINEERS LIMITED
8	ASTEC VALVES & FITTINGS PVT. LTD.
9	ARYA CRAFTS & ENGINEERING PVT LTD
10	COMFIT & VALVES PVT. LTD.
11	CIRCOR INSTR. TECHNOLOGIES INC
12	EXCELSIOR ENGG. WORKS
13	EXCEL HYDRO PNEUMATICS PVT LTD
14	FLUID CONTROLS PVT LTD
15	HAM-LET (ISRAEL-CANADA) LTD.
16	MULTIMETAL INDUSTRIES
17	PRECISION ENGINEERING INDUSTRIES
18	PRIME ENGINEERS
19	PARKER HANNIFIN CORPORATION
20	RELIANCE ENGINEERING & ELECTRICALS CORPN
21	SEALEXCEL (INDIA) PVT. LTD.
22	SWASTIK ENGINEERING WORKS
23	SSP FITTINGS CORPORATION
24	TK FUJIKIN CORPORATION
INSTRUMENT TUBING	
1	HEAVY METAL & TUBES (INDIA) PRIVATE LTD
2	JINDAL SAW LTD (NASHIK WORKS)
3	RATNAMI METALS AND TUBES LTD
4	REMI EDELSTAHL TUBULARS LTD
5	SHUBHLAXMI METALS AND TUBES PVT. LTD
6	TK FUJIKIN CORPORATION
INSTRUMENT VALVES AND MANIFOLDS	
1	SWAGELOK LIMITED
2	SWAGELOK COMPANY
3	WESMEC ENGINEERING PRIVATE LIMITED
4	PRECISION ENGINEERING INDUSTRIES
5	HAVI ENGINEERING INDIA PVT LTD

6	MET-LOK VALVES AND FITTINGS
7	PANAM ENGINEERS LIMITED
8	ASTEC VALVES & FITTINGS PVT. LTD.
9	ARYA CRAFTS & ENGINEERING PVT LTD
10	ANDERSON GREENWOOD CROSBY
11	BAUMER TECHNOLOGIES INDIA PVT.LTD
12	COMFIT & VALVES PVT. LTD.
13	CIRCOR INSTR. TECHNOLOGIES INC
14	EXCELSIOR ENGG. WORKS
15	EXCEL HYDRO PNEUMATICS PVT LTD
16	FLUID CONTROLS PVT LTD
17	HAM-LET (ISRAEL-CANADA) LTD.
18	MICRO PRECISION PRODUCTS PVT LTD
19	PRECISION ENGINEERING INDUSTRIES
20	PRIME ENGINEERS
21	PARKER HANNIFIN CORPORATION
22	SWASTIK ENGINEERING WORKS
23	TK FUJIKIN CORPORATION
JUNCTION BOX	
1	BALIGA LIGHTING EQUIPMENTS (P) LIMITED
2	FLEXPRO ELECTRICALS PVT LTD
3	FLAMEPROOF EQUIPMENTS PVT.LTD
4	FCG POWER INDUSTRIES PVT LTD
5	FCG POWER INDUSTRIES PVT LTD
6	FCG FLAMPROOF CONTROL GEARS P. LTD
7	PEPPERL & FUCHS MANUFACTURING (INDIA) PRIVATE LIMITED
8	KAYSONS TECHNO EQUIPMENTS PVT. LTD.
9	R STAHL PVT LTD
10	SUDHIR SWITCHGEARS PVT LTD
11	PHOENIX MECANO INDIA PVT. LTD.
CABLE GLANDS	
1	BALIGA LIGHTING EQUIPMENTS (P) LIMITED
2	COMET BRASS PRODUCTS
3	COMET INDUSTRIALS
4	FLEXPRO ELECTRICALS PVT LTD
5	FLAMEPROOF EQUIPMENTS PVT.LTD
6	FCG POWER INDUSTRIES PVT LTD
7	FCG POWER INDUSTRIES PVT LTD
8	FCG FLAMPROOF CONTROL GEARS P. LTD
9	KAYSONS TECHNO EQUIPMENTS PVT. LTD.
10	SUDHIR SWITCHGEARS PVT LTD
11	STANDARD METAL INDUSTRIES
12	CMP PRODUCTS LIMITED
13	METAL CRAFT INDUSTRIES
14	AKSHAR BRASS INDUSTRIES
PUSH BUTTONS AND LAMPS	
1	BCH ELECTRIC LTD
2	C & S ELECTRIC LTD
3	ESSEN DEINKI
4	HOTLINE SWITCHGEAR & CONTROLS
5	LARSEN & TOUBRO LTD-POWAI
6	PRECIFINE PRODUCTS PVT. LTD.
7	SIEMENS LIMITED
8	SHRI TULSI SWITCHGEARS PVT LTD

9	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD
10	TEKNIC ELECTRIC (I) PVT. LTD.
MACHINE MONITORING SYSTEMS	
1	PROGNOST SYSTEMS GMBH
2	MEGGIT SA
3	GE OIL & GAS INDIA PVT. LTD.
4	ROCKWELL AUTOMATION INDIA PVT LTD
5	SHINKAWA ELECTRIC COMPANY LTD.
OPTICAL FIBRE CABLE & ASSOC. ITEM	
1	APAR INDUSTRIES LTD
2	AKSH OPTIFIBRE LIMITED
3	BIRLA CABLE LIMITED
4	HIMACHAL FUTIRISTIC COMMUNICATIONS LTD.
5	KEC INETRNATIONAL – MYSORE
6	KABEL RHEYDT
7	PIRELLI CAVI SPA
8	WEST COAST PAPER MILLS LIMITED (DIVISION: WEST COAST OPTILINKS)
9	U M CABLES LTD
10	VINDHYA TELELINKS LIMITED
FIELDBUS SIGNAL CABLE	
1	LAPP INDIA PVT LTD
2	CORDS CABLE INDUSTRIES LTD
3	ASSOCIATED FLEXIBLES & WIRES [P] LTD
4	BELDEN INC
5	CORDS CABLE INDUSTRIES LTD
6	LEONI KERPEN GMBH
7	SUYOG ELECTRICALS LTD
8	THERMO CABLES LTD
ON-OFF VALVES	
1	VALVTECHNOLOGIES INC.
2	VELAN INC
3	BRAY CONTROLS INDIA PVT LTD
4	NELES INDIA PRIVATE LIMITED
5	ADVANCE VALVES PVT LTD.
6	CONTINENTAL VALVE LTD
7	CAMERON ITALY SRL
8	EL-O-MATIC INDIA (PVT) LTD
9	FLOWSERVE INDIA CONTROL PVT LTD-BANGALOR
10	FLOWSERVE PTE LTD
11	ITALVALV S.N.C
12	KOSO INDIA PVT. LIMITED
13	KITAMURA VALVE MANUFACTURING CO LTD
14	KITZ CORPORATION OF EUROPE S.A.
15	L & T VALVES LIMITED
16	MICROFINISH VALVES PVT LIMITED
17	MOTOYAMA ENGG WORKS LTD
18	ORTON S.R.L
19	PIBIVIESSE S. R. L.
20	PERRIN GMBH
21	NELES INDIA PRIVATE LIMITED
22	SAMSON CONTROLS PVT LTD
23	SAMSON AG MESS-UND REGELTECHNIK
24	SPX VALVES & CONTROLS (FORMERLY DEZURIK)

25	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
26	TYCO VALVES & CONTROLS
27	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
28	TRILLIUM FLOW TECHNOLOGIES INDIA PRIVATE LIMITED
29	WEIR VALVES & CONTROLS UK LTD
FLOW ELEMENTS (VENTURI, FLOW NOZZLES)	
1	HYDROPNEUMATICS PVT. LTD
2	DYNAFLUID VALVES AND FLOW CONTROLS P LTD
3	CHEMTROLS SAMIL (INDIA) PVT LTD
4	JAV FORGINGS & ENGINEERINGS PRIVATE LIMITED
5	MICRO PRECISION PRODUCTS PVT LTD
6	MINCO (INDIA) PVT LTD (GEN. INST.)
7	MINCO (I) FLOW ELEMENT P. LTD. (GIC CO.)
8	STAR-MECH CONTROLS (INDIA) PVT LTD
9	TM TECNOMATIC SPA
VARIABLE AREA FLOW METERS	
1	ALFLOW GLASS EQUIPMENTS
2	ASA SPA
3	ABB AUTOMATION PRODUCTS GMBH
4	BROOKS INSTRUMENT
5	EUREKA INDUSTRIAL EQUIPMENTS (P) LTD.
6	HEINRICHS MESSTECHNIK GMBH
7	INSTRUMENTATION ENGINEERS PVT. LTD.
8	KROHNE MARSHALL PVT. LTD
9	KROHNE MESSTECHNIK GMBH & CO KG
10	PLACKA INSTRUMENTS INDIA P LTD
11	ROTA YOKOGAWA GMBH & CO. KG
12	TOKYO KEISO CO LTD
13	YOKOGAWA INDIA LIMITED
TANK LEVEL INSTRUMENT (RADAR, ULTRASONIC)	
1	KROHNE S.A.S.
2	AMETEK DREXELBROOK
3	EMERSON PROCESS MANAGEMENT INDIA PVT LTD
4	ENDRESS+HAUSER (I) AUTO. INSTR. PVT. LTD
5	ENRAF B.V. (GR. COMPANY OF HONEYWELL)
6	ENDRESS+HAUSER GMBH+CO. KG
7	HAWK MEASUREMENT SYSTEM PTY LTD
8	L & J TECHNOLOGIES
9	MAGNETROL INTERNATIONAL N.V
10	MOBREY LTD
11	ROSEMOUNT TANK RADAR AB
12	SIEMENS AG
13	VEGA GRIESHABER KG
RUPTURE DISCS	
1	BS & B SAFETY SYSTEMS (INDIA) LTD
2	BS&B SAFETY SYSTEMS INC
3	ELFAB HUGHES LTD
4	FIKE CORPORATION-USA
5	OKLAHOMA SAFETY EQUIPMENTS CO. INC.
6	REMBE GMBH SAFETY+CONTROL
7	SAFETY SYSTEMS UK LTD (MARSTON DIVN)
WATER IN OIL ANALYZER	
1	ESSIFLO
2	ROX-R WATER CUT

3	AGAR
SPECIAL CONTROL VALVES-MIXED	
1	GE OIL & GAS INDIA PVT. LTD
2	DRESSER PRODUITS INDUSTRIELS
3	EMERSON PROCESS MANGMNT CHENNAI PVT. LTD
4	EMERSON PROCES MGMT ASIA PACIFIC PTE LTD
5	FLOWSERVE INDIA CONTROL PVT LTD-BANGALOR
6	FLOWSERVE PTE LTD
7	ITALVALV S.N.C
8	KOSO INDIA PVT. LIMITED
9	KITAMURA VALVE MANUFACTURING CO LTD
10	KSB MIL CONTROLS LIMITED
11	MOTOYAMA ENGG WORKS LTD
12	SAMSON AG MESS-UND REGELTECHNIK
13	SPX VALVES & CONTROLS (FORMERLY DEZURIK)
14	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED
15	TYCO VALVES & CONTROLS
16	WEIR VALVES & CONTROLS UK LTD
ALARM ANNUNCIATORS	
1.	ELECTRONIC CORPORATION OF INDIA LTD.
2.	INSTALARM INSTRUMENTS PVT LTD.
3.	IDEC IZUMI CORPORATION
4.	MTL INSTRUMENTS PVT LTD
5.	MINILEC (INDIA) PVT LTD
6.	PROCON INSTRUMENTATION PVT LTD
7.	RONAN ENGINEERING COMPANY
ANTI-SURGE AND PERFORMANCE CONTROL SYSTEM	
1.	CCC (COMPRESSOR CONTROLS CORPORATION) or Equivalent
PRDS & DESUPERHEATERS	
1.	BELLINO SRL
2.	ARCA REGLER GMBH
3.	BOMAFA SPECIAL VALVE SOLUTIONS PVT. LTD
4.	CIRCOR FLOW TECHNOLOGIES INDIA PVT LTD
5.	FORBES MARSHALL ARCA P LTD.
6.	HOLTER REGELARMATURE N GMBH &CO.KG
7.	IMTECH SYSTEMS BV
8.	KOSO INDIA PVT LTD
9.	MASCOT VALVES PVT LIMITED (FMLY VALFLO)
10.	SAMSON AG MESS-UND REGELTECHNIK
11.	SPX VALVES & CONTROLS
12.	WEIR VALVES & CONTROLS UK LTD

	BHEL RC PURAM HYDERABAD-32	**STANDARD QUALITY PLAN**		QP. NO.: HYQA/SQP/TC/1617/14	
		Product : AC Induction Motor	BHEL SPEC: TC54370, TC54373	REV NO: 00	22.03.2017
				PAGE 1 OF 4	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	***RAW MATERIALS & BOUGHT OUT ITEMS***												
1.1	Motor Frame	Chemical composition & Mechanical Properties.	Major	Chem., Mech.	1/lot	Manufacturer's Standard / Applicable IS Std./ BHEL Specs / Approved Drawings / Approved Data Sheets		TC	√	2		1	
1.2	Copper wire enameled round copper wire	Overall Diameter	Major	Measurement	Sampling	Manufacturer's Standard / Applicable IS Std./ BHEL Specs / Approved Drawings / Approved Data Sheets		TC	√	2		1	
		Elongation	Major	Mechanical	-do-								
		Mandrel winding test	Major	Mechanical	-do-								
		Peel test	Major	Mechanical	-do-								
		Cut through test	Major	Electrical	-do-								
		Heat shock test	Major	Electrical	-do-								
		Springiness	Major	Mechanical	-do-								
		Abrasion test	Major	Mechanical	-do-								
		Continuity test	Major	Electrical	-do-								
		BDV Test	Major	Electrical	-do-								
1.3	Steel Shaft	Dimensional Conformity of OD	Major	Measurement	1/lot	Manufacturer's Standard / Applicable IS Std./ BHEL Specs / Approved Drawings / Approved Data Sheets		TC	√	2		1	
		Surface finish	Major	Visual	100%								
		Internal Defects	Major	UT	-do-								
		Chemical composition & Mechanical Properties.	Major	Chem., Mech.	1/lot								
1.4	Bearings	Make, Model	Major	Review	100%	BHEL Specs / Approved Drawings / Approved Data Sheets		TC/COC/ Manufacturer's catalogue	√	2		1	

LEGEND:
WPS – WELDING PROCEDURE SPECIFICATION PQR – PROCEDURE QUALIFICATION RECORD
WPQ – WELDER'S PERFORMANCE QUALIFICATION
P: - PERFORM, W: - WITNESS V: - VERFICATION,
1: - BHEL /NOMMNATED INSPECTION AGENCY
2: - MANUFACTURER / VENDOR/SUB CONTRACTOR
* D: RECORDS IDENTIFIED WITH TICK(✓) SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION..

PREPARED BY

Sachin Katiyar

Sachin Katiyar
Engineer / QA

APPROVED BY

D. S. Satpute
AGM / QA

	BHEL RC PURAM HYDERABAD-32	STANDARD QUALITY PLAN		QP. NO.: HYQA/SQP/TC/1617/14	
		Product : AC Induction Motor	BHEL SPEC: TC54370, TC54373	REV NO: 00	22.03.2017
				PAGE 2 OF 4	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS
2.0	**INPROCESS INSPECTION**												
2.1	Availability of All documents under approval category	All drawings, data sheets	Major	Review	100%	Approved. Drawing/ Data Sheet / BHEL Spec.		-		2		1	
2.2	Rotor	Dynamic Balancing	Major	Mechanical	100%	ISO 1940	ISO 1940 Gr. 2.5	IR	√	2		1	
2.3	Assembly stage	Completeness, Dimensions Correctness of General assembly, cable entry, TB location, Fan and Cover (as applicable)	Major	Visual & Measurement	100%	Approved. Drawing/ Data Sheet / BHEL Spec.		IR	√	2	1		
3.0	**FINAL INSPECTION & TESTING**												
3.1	Routine Tests	Measurement of winding resistance	Critical	Electrical	100%	IS:325: 1996 Cl. 22.3.2 / IEC 60034-2 / Approved. Data Sheet / BHEL Spec.		TC	√	2	1		
		Measurement of Insulation Resistance before & after HV Test		Electrical									
		HV Test		Electrical									
		Locked Rotor Test		Electrical									
		Reduced Voltage Running Up Test		Electrical									
		No Load Test, DOR		Electrical									
		Test for Vibrations severity of motor		Mechanical		IS 12075 / IEC 60034-14.		TC	√	2	1		
		Noise Level Measurement		Mechanical		IS12065 (latest) /IEC60034		TC	√	2	1		

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BHEL RC PURAM HYDERABAD-32	STANDARD QUALITY PLAN		QP. NO.: HYQA/SQP/TC/1617/14	
	Product : AC Induction Motor	BHEL SPEC: TC54370, TC54373	REV NO: 00	22.03.2017
			PAGE 3 OF 4	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS
3.2	Type Tests	Routine test as mentioned above	Critical	Electrical	One per similar rating & type	IS:325: 1996 Cl. 22.3.2 / IEC 60034-2 / BHEL Spec.		TC	√	2		1	
		Temperature rise test		Electrical									
		Momentary over load test		Electrical									
		Over speed test		Electrical									
		Pull out Torque		Electrical									
		Performance Test 1. Voltage 2. Full load current 3. Full load Speed &slip 4. Efficiency shall be tested on 100%, 75%, 50% load		Electrical									
		Degree of Protection	Major	Review		BHEL Specification / Approved Drawings / Data Sheets							
4.0	**PRESERVATION & PACKING**												
4.1	Preservation and Protection		Major	Visual	100%	BHEL Specification			√	2		1	
4.2	Painting	Finish, Shade, DFT	Major	Visual	100%	BHEL Specification / Approved Drawings/Data Sheets			√	2		1	
4.3	Rating Plate and Marking		Major	Visual	100%	BHEL Specification			√	2		1	
4.4	Packing & Case Marking		Major	Visual	100%	BHEL Specification			√	2		1	

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APPROVED BY

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	BHEL RC PURAM HYDERABAD-32	**STANDARD QUALITY PLAN**		QP. NO.: HYQA/SQP/TC/1617/14	
		Product : AC Induction Motor	BHEL SPEC: TC54370, TC54373	REV NO: 00	22.03.2017
				PAGE 4 OF 4	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
									D	P	W	V	

NOTES:

1. This QP should be read along with BHEL Spec, BHEL drawings / approved drawings, data sheet, BOM and PO.
2. Latest revisions of specification / drawings as per P.O., approved drawings & bill of materials are applicable.
3. Any other tests/ checks indicated in specification, P.O., or drawing & any additional checks envisaged by BHEL/TPI to ensure workmanship, finish, aesthetics, etc. shall also be conducted and witnessed/verified by BHEL /TPI / customer as required.
4. All test certificates/ reports reviewed and certified by BHEL/TPI shall be submitted to BHEL as documentation package.
5. Drawing / Data Sheet shall prevail over Quality Plan in case of any contradiction between Quality Plan and Drawing / Data Sheet.
6. **Any project / customer specific requirement, like QP approval & Customer/Consultant Inspection, which shall be notified have to be fulfilled by the vendor at the time of execution of order.**
7. **This QP shall not be applicable to the orders for which QP approval & Inspection by customer/consultant is required.**
8. Requirement of carrying out the type tests and other tests shall be as per BHEL spec/ approved drawing.
9. **This SQP is not applicable for vendors supplying this item for the first time to BHEL.**
10. This SQP is not applicable for NTPC Projects. Separate QAP needs to be submitted by Vendor for QAP approval by NTPC.

MTC – Mill Test Certificate ***TC – Test Certificate*** ***IR – Inspection Report*** ***COC – Certificate of Conformity***
TPIA – Third Party Inspection Agency appointed by BHEL. ***PO – Purchase Order***

LEGEND: WPS – WELDING PROCEDURE SPECIFICATION PQR – PROCEDURE QUALIFICATION RECORD WPQ – WELDER'S PERFORMANCE QUALIFICATION P: - PERFORM, W: - WITNESS V: - VERFICATION, 1: - BHEL /NOMMNATED INSPECTION AGENCY 2: - MANUFACTURER / VENDOR/SUB CONTRACTOR * D: RECORDS IDENTIFIED WITH TICK(✓) SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION..	PREPARED BY **Sachin Katiyar** **Engineer / QA**	APPROVED BY **D. S. Satpute** **AGM / QA**

BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD	STANDARD QUALITY PLAN FOR VENDOR ITEMS ITEM: OIL CONSOLE FOR BARRING GEAR BHEL SPEC: TC64015, TC54015	QP. NO: HYQA/SQP/TC/1718/07 Rev. No. : 00 DATE: 07.10.17 VALID UPTO: 06.10.19 PAGE 1 OF 3

Sl No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	*D	Agency			Remarks
										P	W	V	
1.0	**RAW MATERIALS & BOUGHT OUT ITEMS**												
1.1	Oil Pump	Material Test Certificate	Major	Verification	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	MTC	√	2	-	1	
		Performance Test	Major	Test	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	-	1	
1.2	Electric Motor	Routine Test	Major	Routine Test	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	-	1	
		Type Test	Major	Type Test	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	-	1	
1.3	Valves & Piping	Material Test Certificate	Major	Verification	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	MTC	√	2	-	1	
1.4	Pressure Gauge	Calibration, Functional	Major	Verification	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	-	1	
1.5	Relief Valve	Calibration, Functional	Major	Verification	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	-	1	
1.6	Coupling, Coupling Guard, Base Plate	Certificate of Conformity	Major	Verification	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	-	1	

LEGEND:
P: - PERFORM, W: - WITNESS , V: - VERFICATION,
INDICATING 1: - BHEL / BHEL NOMMNATED INSPECTION AGENCY, 2: - VENDOR / SUB VENDOR AS APPROPRIATE AGAINST EACH COMPONENT / CHARACTERISTICS UNDER THE COLUMNS P, W & V.
* D: RECORDS IDENTIFIED WITH TICK (✓) SHALL BE ESSENTIALLY INCLUDED IN QA DOCUMENTATION.

PREPARED BY	REVIEWED BY	APPROVED BY
Sachin Katiyar Engineer / QA	D. S. Satpute AGM / QA	D. S. Satpute AGM / QA

BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD	STANDARD QUALITY PLAN FOR VENDOR ITEMS ITEM: OIL CONSOLE FOR BARRING GEAR BHEL SPEC: TC64015, TC54015	QP. NO: HYQA/SQP/TC/1718/07 Rev. No. : 00 DATE: 07.10.17 VALID UPTO: 06.10.19 PAGE 2 OF 3

Sl No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	*D	Agency			Remarks
										P	W	V	
2.0	**INPROCESS INSPECTION**												
2.1	Welding	Availability of WPS, PQR, WQR	Major	Review	100%	ASME code	ASME code			2		1	
2.2		Visual Inspection of all welds	Major	Visual	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	IR	√	2		1	
2.3		RT on Butt Welds, LPI on Fillet Welds	Major	NDT	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	NDT Report	√	2		1	
3.0	**FINAL INSPECTION & TESTING**												
3.1	Oil Console Barring Gear Assembly	Visual, Dimensional & completeness wrt Drg/BOM.	Major	Visual & measrt.	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	IR	√	2	1		
3.2		Leakage Test	Critical	Hydraulic Test	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	1		
3.3		Functional Test	Critical	Testing	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	TC	√	2	1		
4.0	**PAINTING, PRESERVATION & PACKING**												
4.0	Painting	Colour Shade, Painting Thickness	Major	Visual & measrt.	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet	IR	√	2		1	

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PREPARED BY	REVIEWED BY	APPROVED BY
Sachin Katiyar Engineer / QA	D. S. Satpute AGM / QA	D. S. Satpute AGM / QA

	BHARAT HEAVY ELECTRICALS LIMITED R.C.PURAM, HYDERABAD	STANDARD QUALITY PLAN FOR VENDOR ITEMS ITEM: OIL CONSOLE FOR BARRING GEAR BHEL SPEC: TC64015, TC54015	QP. NO: HYQA/SQP/TC/1718/07 Rev. No. : 00 DATE: 07.10.17 VALID UPTO: 06.10.19 PAGE 3 OF 3

Sl No	Component & Operations	Characteristics	Class	Type Of Check	Quantum Of Check	Ref Document	Acceptance Norms	Format Of Record	*D	Agency P	Agency W	Agency V	Remarks
5.0	Marking, Preservation	Visual	Major	Visual	100%	BHEL Spec./ Approved Drg. / Data Sheet	BHEL Spec./ Approved Drg. / Data Sheet			2		1	

NOTES:

1. Spares procured along with main equipment/item shall be inspected for relevant / applicable checks as indicated in the SQP.
2. Pre-despatch inspection photographs of the equipment/item shall be included in Quality documentation.
3. This QP should be read along with BHEL Spec, BHEL drawings / approved drawings, data sheet, BOM and PO.
4. Latest revisions of specification / drawings as per P.O., approved drawings & bill of materials are applicable.
5. Any other tests/ checks indicated in specification, P.O., or drawing & any additional checks envisaged by BHEL/TPIA to ensure workmanship, finish, aesthetics, etc. shall also be conducted and witnessed/verified by BHEL /TPIA / customer as required.
6. All test certificates/ reports reviewed and certified by BHEL/TPIA shall be submitted to BHEL as documentation package.
7. Drawing / Data Sheet shall prevail over Quality Plan in case of any contradiction between Quality Plan and Drawing / Data Sheet.
8. Any project / customer specific requirement, like QP approval & Customer/Consultant Inspection, which shall be notified have to be fulfilled by the vendor at the time of execution of order.
9. This QP shall not be applicable to the orders for which QP approval & Inspection by customer/consultant is required.
10. This SQP is not applicable for vendors supplying this item for the first time to BHEL.

ABBREVIATIONS:		
MTC – MILL TEST CERTIFICATE	MPI - MAGENTIC PARTICLE INSPECTION	TC – TEST CERTIFICATE
HT – HEAT TREATMENT	UT - ULTRASONIC TEST	TPIA - THIRD PARTY INSPECTION AGENCY APPOINTED BY BHEL.
IR - INSPECTION REPORT	RT – RADIOGRAPHY TEST	COC – CERTIFICATE OF CONFORMITY
MEASRT - MEASUREMENT	WPS – WELDING PROCEDURE SPECIFICATION	PQR – WELDING PROCESS QUALIFICATION RECORD
WQR – WELDER QUALIFICATION RECORDS	PO – PURCHASE ORDER	LPI – LIQUID PENETRANT INSPECTION

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3/2 EXPLOSION PROOF SOLENOID VALVE – UNIVERSAL TYPE

(Medium pressure 0 to 100 bar)
(For Internal Reference only)
Remove this preface sheet before issuing to supplier.

DESIGNATION (eg) : 3/2 Explosion proof solenoid valve universal type suitable for 110 V DC power supply, to this standard shall be designated as follow :

ON THE DRAWINGS :

Material specification column : TC 51108
Description : 3/2 EXPF SOL VALVE 110 V
Material code column : TC 9751108020

ON THE INDENTS :

Material specification column : TC 51108
Description column : 3/2 Explosion proof
Solenoid valve – Universal type – 110 VDC.
Material code column : TC 9751108020.

ON ENQUIRES AND PURCHASE ORDERS : A copy of this standard shall be enclosed without preface sheet.

NOTE : For placing order for 3/2 Ex. Pf solenoid valve suitable 110 V DC supply, the order description shall be as follows :
ORDER NO. 2413602. 1580
Herion – 3/2 Way valve (Universal)
Voltage : 110 VDC
BHEL Code : TC 9751108020

3/2 EXPLOSION PROOF SOLENOID VALVE – UNIVERSAL TYPE

(Medium pressure 0 to 100 bar)

1.0 : **SCOPE :** This standard specifies the requirements of 3/2 explosion proof solenoid valve – Universal type, used in hydraulic circuit of a Electro hydraulic barring device of Industrial turbo sets.

2.0 : **TECHNICAL REQUIREMENTS :**

2.1	Type of Valve	:	Universal.
2.2	Symbol	:	Pressure connection at 1 , 2 , 3 .

2.3 : **VALVE SPECIFLICATIONS :**

2. 3. 1	Medium	:	Hydraulic oil <5 deg E.
2. 3. 2	Nominal diameter (ND)	:	12 mm.
2. 3. 3	Size of connection	:	R ½" - Female.
2. 3. 4	Operating pressure	:	0 to 100 bar.
2. 3. 5	Flow factor Kv (Q in m3/hr)	:	1.13 for passage 1 - 2 1.27 for passage 2 – 3
2. 3. 7	No. of operations (per min).	:	50
2. 3. 8	Body material	:	1.4571 as per DIN Standard
2. 3. 9	Seat seal material	:	Steel (SS)
2. 3. 10:	Weight	:	4.2 Kgs.

2.4 : **SOLENOID SPECIFICATIONS :**

2. 4. 1	Power Input	:	42 W for DC solenoids 50 VA when starting 50 VA during operation for AC solenoid.
2. 4. 2	Duty	:	Continuous.
2. 4. 3	Protection class acc. to DIN 40050.	:	IP 63.
2. 4. 4	Permissible relative air humidity	:	< 80%
2. 4. 5	Ambient temperature	:	-5 to 40 deg C
2. 4. 6	Medium temperature	:	-10 to +60 deg C
2. 4. 7	Sum ambient temp. + medt. max.	:	80 deg C
2. 4. 8	Weight	:	4.7 Kgs.
2. 4. 9	Bore	:	43 mm.

2. 4.10 : Construction of Solenoid : Solenoid protection class (sch) d (Ex) d3n G5, with terminal in housing, cable entry to DIN 22419, PTB No . III B/E 17878. BVS No . T 5047. (Built in rectifier for AC voltage solenoids).

3.0 : **SPARE PARTS :** The offer shall accompany with quotation for recommended spare parts for 2 years operation.

4.0 : **TEST & GUARANTEE CERTIFICATES :**

4.1 : **TEST CERTIFICATES :** 3 copies of certificates of explosion proof housing as per Clause 2 .4.9 shall be supplied for each item of the consignment quoting BHEL standard number, purchase order number and manufactures identification serial number . Functional test (Type/Routine) certificates are to be furnished as per manufacturer's practice.

4.2 : **GUARANTEE CERTIFICATE :** A guarantee certificate for 24 months of trouble free performance from the date of shipment or 12 months from date of commissioning whichever is earlier shall be supplied.

5.0 : **DOCUMENTS :** The descriptive leaflets/ catalogues giving full sectional details of the directional valve offered shall be furnished along with the offer and also with the consignment.
15 prints and one reproduceable copy of operating , trouble shooting and maintenance manuals shall be supplied within 4 weeks after placement of order.

6.0 : **MARKING :**

6.1 : **NAME PLATE DETAILS :** The name plate details of the 3/2 solenoid valve shall contain the following information.

a) Manufacturers identification serial number.
b) Type/Model number.
c) Operating pressure range.
d) Solenoid protection class.
e) Supply voltage.
f) Power consumption.

6.2 : A tag bearing relevant 12 digit material code of BHEL shall be attached for each consignment.

6.3 : The following details shall be marked on the packing case.

a) Manufacturer's Name

b) BHEL Order Number.

c) BHEL Standard Number TC 51108.

7.0 : Painting, Preservation and packing as per manufacturer's practice.

8.0 : **SUPPLY VOLTAGE :**

Sl. No.	Supply Voltage	Old Code New Code	Equipment model of M/s Herion Werke, WG.
01	220V DC	D 116160340 TC9751103012	Order No. 2413607. 1580 Herion-3/2 way valve (Universal) Voltage : 220 V DC.
02	110V DC	D 116160250 TC9751108020	Order No. 2413607. 1580 Herion -3/2 way valve (Universal) Voltage : 110 V DC
03	24V DC	D 116160260 TC9751108039	Order No. 2413607. 1580 Herion -3/2 way valve (Universal) Voltage : 24 V DC
04	48V DC	D 116160350 TC9751108047	Order No. 2413607. 1580 Herion -3/2 way valve (Universal) Voltage : 48 V DC
05	240V DC 50 HZ, single phase.	D 116160360 TC9751108055	Order No. 2413607. 1581 Herion -3/2 way valve (Universal) Voltage : 240 V AC, 50 HZ, 1ph.
06	220V AC 50 HZ, single phase.	D 116160370 TC9751108063	Order No. 2413607. 1581 Herion -3/2 way valve (Universal) Voltage : 220 V AC, 50 HZ, 1ph.
07	110V AC 50 HZ, single phase.	D 116160380 TC9751108071	Order No. 2413607. 1581 Herion -3/2 way valve (Universal) Voltage : 110 V AC, 50 HZ, 1ph.
08	24V AC 50 HZ, single phase.	D 116160390 TC9751108080	Order No. 2413607. 1581 Herion -3/2 way valve (Universal) Voltage : 24 V AC, 50 HZ, 1ph.

RECORD OF REVISIONS

REV. NO.	DATE	REVISION DETAILS	REVISED	APPROVED
02	6/95	GEN. REVISED	A.GUPTA	ACH

1. BHEL Standard specifications to be followed: **TC 6 4015 Rev 01,**

2. BHEL Standard drawing number to be followed **1-307-04-00004 Rev 00**

3. **GENERAL NOTES:**

3.1. Final documentation as per clause 7.1 B of a & b of BHEL specification TC 6 4015 Rev 01 shall also be furnished in C.D compatible for using Auto cad (Latest).

3.2 O & M manuals shall also be furnished in C.D compatible for using in MS WORD (Latest).

3.3 Clause 3.2.1 b) of purchase specification TC64015 Rev 01 shall be read as Ex proof (E Ex"d") type motor and it is in console vendor's scope of supply. Please refer purchase specification TC54197 Var 39 of Explosion proof (E Ex"d") motor.
Motor requirement shall be as per relevant motor enquiry specification and Annex-I to purchase spec TC54197; For make of motor refer Annex-I to TC54197 only.

3.4 3/2 Solenoid valve as per clause 3.2.3 of purchase specification TC64015 Rev 01 & it is in Console vendor scope of supply. The purchase specification TC51108 is to be considered. The voltage shall be as per our enquiry.
Solenoid valve shall be as per relevant SOV enquiry specification and Annex-I to purchase spec TC54197; For make of SOV refer Annex-I to TC54197 only.

3.5 Motor data sheet shall be as per Customer / Consultant data sheet & the same shall be attached along with our enquiry.

3.6 Oil Console for Barring Gear Vendor has to procure the Sub delivery items like Motor & Solenoid Valve from Customer Approved Vendors only mentioned in the Annexure (If Applicable).

3.7 Vendor to submit the duly signed & stamped Annexure I to TC54197 during offer(If applicable)

3.8 **For the make of Pump, Pressure Gauge and its special requirement, refer Annex-I to purchase spec TC54197.**

11	SP PRESSURE GAUGE FOR OCBG - SS316 (10% SUBJECT TO MINIMUM 2 NO. OF EACH TYPE)	**TC9754015112**
10	3/2 EX PROOF SOLENOID VALVE,110VAC Exd SIL-2 T3, SS316 Body	**TC9754015104**
09	OCBG,2LPM,100KG/CM2(G) With IIC 415VAC Motor, SOV 110VAC Exd SIL-2 T3, SS316 Body	**TC9754015090**
08	3/2 EX PROOF SOLENOID VALVE,24VDC	**TC9754015082**
07	3/2 EX PROOF SOLENOID VALVE,110VAC	**TC9754015074**
06	OCBG,2LPM,100KG/CM2(G)415VAC,IIC,24VDC	**TC9754015066**
05	OCBG,2LPM,100KG/CM2(G)415VAC,IIC,110VDC	**TC9754015058**
04	OCBG,2LPM,100KG/CM2(G)415VAC,IIC,110VAC	**TC9754015040**
03	OCBG,2LPM,100KG/CM2(G)415VAC,IIC,230VAC	**TC9754015031**
02	OCBG,2LPM,100KG/CM2(G) WITH IIC MOTOR Voltage:400VAC	**TC9754015023**
01	OCBG,2LPM,100KG/CM2(G) WITH IIC MOTOR Voltage:415VAC	**TC9754015015**
VAR No	**Description**	**Material code**

REF-DOC

RECORD OF REVISIONS.

Rev. No	Date	Revision Details	Revised	Approved
00	17.04.09	First issue.		
01	11.02.10	Variant 02 added	MVS Raju	RA Krishnan
02	21.07.13	Variant 03 to Variant 06 added & Generally Revised	M S Kumar	M V S Raju
03	25.08.15	Variant 07 Added	M S Kumar	M V S Raju
04	24.02.18	Variant 08 Added & clause 3.7 added Variant 09 & 10 Added	Sunil B Jiwtode	P S V S K

EXPLOSION PROOF SQ. CAGE INDUCTION A.C MOTORS TYPE: E. Ex. d-IIC, T3

1.0.0 DESIGN PHILOSOPHY / CRITERIA – GENERAL:

Selection of rotating equipment shall be based upon the following consideration.
Suitability of the specified duty conditions
Standard models under vendor's regular range of manufacture.
Proven track record in similar service.
Optimum operating and maintenance costs.
Maximum interchangeability of parts.
Ease of operation and maintenance.

2.0.0 THE ORDER OF PRECEDENCE IS TO BE FOLLOWED:

Customer standard specification.
Project specific motor data sheet
BHEL Specification TC54370/TC54373 (Latest)(Based on energy efficiency class)
Engineering design basis.
Applicable codes, standards
For design aspects not specifically covered by data sheets, specifications, codes and standards or regulations, the design shall be based on good engineering practices.

Vendor shall make all possible efforts to comply strictly with the requirements of this design basis. In case deviation is considered essential by the vendor (after exhausting all possible efforts), these shall be clearly brought out and consolidated under technical exception chapter at offer stage. However vendor specific deviation (if any) to applicable codes / specifications shall be subject to Consultant/Customer's approval during detail engineering.
The motors shall be energy efficient type

3.0.0	Reference Codes	:	As per relevant national and international standards, IS - 2148, IS - 5571, IS – 325, IEC 60034.
4.0.0	Particular Requirement	:	Motor shall comply with Customer motor specification enclosed along with Enquiry & Project specific motor data sheet for the requirements not covered in this specification. For efficiency class of motor, refer BHEL Specification TC54370/TC54373 (latest) attached as applicable. -- **(R10)**

5.0.0	Area of classification	:	Zone 1, Gas group IIC, Temperature class T3 according to IEC 79 / IS 6381.
6.0.0	Type of motor	:	Squirrel cage induction. Continuous duty (S1)
7.0.0	KW Rating	:	As per enquiry.
8.0.0	Speed	:	As per enquiry.
9.0.0	Construction shape	:	As per enquiry.
10.0.0	Voltage	:	415 V ±10% AC Fault level 35 MVA (50KA) for 415 V system and the fault duration shall be taken as 0.25 seconds for motors rated 55KW & above. For motors below 55KW, the fault energy to be considered shall depend upon the back-up fuse rating.
11.0.0	Frequency	:	50 Hz ± 5%
12.0.0	Combined Voltage and Frequency variation	:	±10%
13.0.0	No of phases / connections / No of terminals.	:	3 / delta / 6
14.0.0	Type of starting	:	Direct on line
15.0.0	Enclosure and execution	:	IP 55, TEFC,(Explosion proof)EEx de IIC T3.
16.0.0	Terminal box inlet type	:	Flame proof double compression cable glands shall be supplied along with motor
17.0.0	Direction of rotation	:	Bi – directional
18.0.0	Space heater	:	Suitable to 240V, Single phase AC (For more than 22 KW Rating)

21.0 **INSPECTION & TESTING** : According to relevant IS Codes.
M/s Lloyds is the approved Inspection agency, if the item is procuring from imported organization. The Inspection charges shall be included in main equipment price.

22.0 **MOTOR MAIN TERMINAL BOX:**

a) Fault level rating for at least 0.25 Seconds. : See clause 10 of this specification

b) Protection : IP 55 Explosion proof E Ex-de IIC T3

c) Cable connection(Cable gland size) : As per project specific datasheet or the value will be provided during detailed engineering. Vendor to provide the same.

23.0 **OTHER REQUIREMENTS** :

a) All hardware like nuts, screws shall be zinc plated / electro galvanized.
b) Locked rotor withstand time (Hot) is not less than 8 seconds. Locked rotor Withstand time (Cold) is not less than 10 seconds.
c) Facility terminate fourth core of cable in motor Terminal box to be provided
d) Supplier shall include in the offer the spare parts for commissioning & shall be Quote separately the spare parts for two years operation.
e) Starting time of motor shall be less than its locked rotor withstand time (Hot)
f) Dimensional drawings and shaft end details shall accompany the offer.
g) Vendor to furnish type test certificate and flame proof / Explosion proof requirement for the motor and terminal box from approving authorities (**CMRS, BASEEFA, PTB, UL**) complying also to the requirement of **IIC** (**H_2** gas group)
h) Vendor is to furnished quality plan along with offer.

26.0 **LIST OF ENCLOSURES** : 1.Customer standard specification
2.Project specific motor data sheet &
3. BHEL Specification TC54175 (Latest)
4.Refer project specific Annexures to Specification(If applicable)

27.0 **SPECIAL NOTES** :

1. Motor dimensional and cross sectional drawings shall also be furnished in C.D compatible for using in Acad
2. O & M Manuals shall also be furnished in C.D compatible for using in MS-WORD
3.Vendor to submit the filled in Annex-I(TDS) &Annex-II(Price format, while quoting offer

28.0 **OPTIONAL REQUIREMENTS:**

The following spares shall be offered in separate price bid along with offer.

- Spare set of bearings (DE & NDE)
- Spare cooling fan

29.0 DOCUMENTATION :

29.1 **ALONG WITH OFFER : (2 Sets of documents)**

- Overall dimensional drawing and wiring diagrams
- Completely filled Vendor's motor data sheet (As per Customer project oriented motor data sheet.)
- Terminal box detail drawings.
- Torque Vs Speed curves.
- Starting curve Vs Time curve including thermal limit curve
- Factory inspection & test form.
- Type test certificates with respect to area classification.
- Quality plan as followed in vendor's works

29.2 **AFTER PLACEMENT OF ORDER: (3Sets of documents)**

- Overall dimensional drawing and wiring diagrams for approval
- Cross sectional drawing of the motor showing recommended spare parts.
- Completely filled Vendor's motor data sheet (As per Customer project oriented motor data sheet.)for approval
- Terminal box detail drawings.
- Torque Vs Speed curves.
- Starting curve Vs Time curve including thermal limit curve
- Type test certificates with respect to area classification.
- Quality plan as followed in vendor's works
- Operation, Instruction and Maintenance manuals

29.3 **DOCUMENT TO BE SEND AFTER APPROVAL:**

The following documents are to be supplied in 2 hard copies & 1 soft copy
Final Overall dimensional drawing of the motor
- Final Cross-sectional drawing of the motor
- Final completely filled Vendor's motor data sheet (As per Customer project oriented motor data sheet - Final Motor characteristic curves
- Operation, Instruction and Maintenance manuals

29.4 **ALONG WITH CONSIGNMENT:**

- Operation, Instruction and Maintenance manuals (2 Hard copies & 1 Soft Copy)
- Test and Guarantee certificates (6 Copies)

62	30	1450	SET OF BEARING(DE+NDE)FOR 30KW AC MOTOR	B3	**TC9754197628**
61	30	1450	SET OF TER.STUD/BLOCK FOR 30KW AC MOTOR	B3	**TC9754197610**
60	22	2950	SP.SET-JUNCT. BOX&CABLE GLANDS OF22KW M	B3	**TC9754197601**
59	22	2950	SP.SET OF COOLING FAN FOR 22KW MOTOR	B3	**TC9754197598**
58	22	2950	SP.INNER&OUTER COVER OF DE+NDE BEARING	B3	**TC9754197580**
57	22	2950	SP.SETOF GREASE,NIPPLE & PLUG FOR22KW MOTOR.	B3	**TC9754197571**
56	22	2950	SETOF BEARING(DE+NDE)ACCESSORIES OF22KW	B3	**TC9754197563**
55	37	1450	Sp set of Terminal /Bushing (Terminal Box Cover with Screws & Terminal Block) for LOP motor 37KW & 415V	B3	**TC9754197555**
54	37	1450	Sp set of brgs (NDE+DE) for LOP motor 37KW & 415V	B3	**TC9754197547**
53	37	2900	Horizontal Foot mounted Explosion proof (E.Ex(d), Zone-2 Gas group: IIC) sq. cage AC induction motor, 37KW, 415V	B3	**TC9754197539**
52	30	2900	Sp set of Terminal /Bushing (Terminal Box Cover with Screws & Terminal Block) for LOP motor 30KW & 415V	B3	**TC9754197520**
51	30	2900	Sp set of brgs (NDE+DE) for LOP motor 30KW & 415V	B3	**TC9754197512**
50	30	2900	Horizontal Foot mounted Explosion proof (E.Ex(d), Zone-2 Gas group: IIC) sq. cage AC induction motor, 30KW, 415V	B3	**TC9754197504**
49	22	1450	Sp set of Terminal /Bushing for LOP motor 22KW & 415V	B3	**TC9754197490**
48	22	1450	Sp set of brgs (NDE+DE) for LOP motor 22KW & 415V	B3	**TC9754197482**
47	7.5	2900	Vertical Flange Mounted Explosion Proof (Ex"d", Gas group IIC) sq. cage A.C Induction Motor,415 V	V1	**TC9754197474**
46	11	1450	Vertical Flange Mounted Explosion Proof (Ex"d", Gas group IIC) sq. cage A.C Induction Motor,415 V	V1	**TC9754197466**
45	22	1450	Horizontal Foot mounted Explosion proof (E. Ex(d), Gas group: IIC) sq. cage AC induction motor. Voltage 415V. The motor cable gland & terminal box is to be designed to suit the existing cable size of 3CX120A2FY. The motor frame size 180 is to be offered by vendor as much as possible. Vendor shall comply wih M/s Jacobs datasheet No: TCEG-MCN1003-LOPDM-DS as enclosed in Enquiry	B3	**TC9754197458**
Var.	**KW**	**RPM**	**Description**	**Co. shape**	**Material code**

44	7.5	2900	Horizontal Foot mounted Explosion proof (EEx(d), Gas group:IIC) sq. cage AC induction motor. Voltage:400V	B3	**TC9754197440**
43	0.75	1450		B3	**TC9754197431**
42	0.75	1450		B5	**TC9754197423**
41	1.1	1450		B3	**TC9754197415**
40	11	2900	Sp set of brgs (NDE+DE) for CEP motor,415V	V1	**TC9754197407**
39	5.5	2900	Sp cooling fan for EOP motor,415V	B3	**TC9754197393**
38	5.5	2900	Sp set of brgs (NDE+DE) for EOP motor,415V	B3	**TC9754197385**
37	18.5	1450	Sp set of brgs (NDE+DE) for LOP motor,415V	B3	**TC9754197377**
36	22	2900	Horizontal Foot mounted Explosion proof (EEx(de), Gas group:IIC) sq. cage AC induction motor,415V	B3	**TC9754197369**
35	18.5	2900		B3	**TC9754197350**
34	15	2900		B3	**TC9754197342**
33	11	2900		B3	**TC9754197334**
32	7.5	2900		B3	**TC9754197326**
31	5.5	2900		B3	**TC9754197318**
30	3.7	2900		B3	**TC9754197300**
29	110	1450		B3	**TC9754197296**
28	100	1450		B3	**TC9754197288**
27	90	1450		B3	**TC9754197270**
26	75	1450		B3	**TC9754197261**
25	55	1450		B3	**TC9754197253**
24	45	1450		B3	**TC9754197245**
23	37	1450		B3	**TC9754197237**
22	30	1450		B3	**TC9754197229**
21	22	1450		B3	**TC9754197210**
20	18.5	1450		B3	**TC9754197202**
19	15	1450		B3	**TC9754197199**
18	11.0	1450		B3	**TC9754197180**
17	7.5	1450		B3	**TC9754197172**
16	5.5	1450		B3	**TC9754197164**
15	3.7	1450		B3	**TC9754197156**
14	1.1	1450		B3	**TC9754197148**
13	0.75	1450		B3	**TC9754197130**
12	0.37	1450		B3	**TC9754197121**
11	0.75	1450	Hor. Foot/flg mounted Ex. proof (EEx (d), Gas group:IIC) sq. cage AC motor,415V	B5	**TC9754197113**
10	90	2900	Vertical Flange mounted Explosion proof (Ex(d), Gas group:IIC) sq. cage A.C induction motor,415V.	V1	**TC9754197105**
09	75	2900		V1	**TC9754197091**
08	55	2900		V1	**TC9754197083**
07	45	2900		V1	**TC9754197075**
06	37	2900		V1	**TC9754197067**
05	30	2900		V1	**TC9754197059**
04	22	2900		V1	**TC9754197040**
03	15	2900		V1	**TC9754197032**
02	18.5	2900		V1	**TC9754197024**
01	11	2900		V1	**TC9754197016**
Var.	**KW**	**RPM**	**Description**	**Co. shape**	**Material code**

RECORD OF REVISIONS

Rev. No	Date	Revision Details	Revised	Approved
00.	18.02.08	FIRST ISSUE	-	-
01	19.04.08	Var. nos. added in variant table	MVS Raju	KK Rao
02	11.02.10	Var. nos. added upto 39	MVS Raju	RA Krishnan
03	13.05.10	Var. nos. added upto 43	MVS Raju	RA Krishnan
04	15.12.10	Var. no. 44 added.	MVS Raju	RA Krishnan
05	15.03.12	Var. no. 45 added.	M.S. Kumar	MVS Raju
06	27.08.15	Clause 26 point 4 Addedd	M S KUMAR	M V S RAJU
07	07.09.15	Variant 46 Added	M.S.KUMAR	M.V.S.RAJU
08	09.09.15	Clause 22.0 & 27.0 Added	M S Kumar	M V S Raju
09	29.10.15	Variant 47 Added	M S Kumar	M V S Raju
10	24.07.17	Marked as R10 & Variants added upto 62	Anshul Gupta	SUNIL

SQUIRREL CAGE INDUCTION MOTORS IE-3 (Premium Efficiency Class)

(For BFP Drive Turbine)

1. SCOPE:

This standard specifies the requirements of the 3-phase medium voltage squirrel cage Induction motors used for driving Centrifugal / Screw / Gear pumps of lube oil systems of Industrial Turbo sets and BFP drives.

2. TECHNICAL REQUIREMENTS:

2.1 General:

The squirrel cage induction motors shall be of horizontal foot mounted (B3) type or Vertical flange mounted (V1) type construction as per enquiry suitable for bi-directional rotation. Unless otherwise specified the motors are of type IP55 enclosure (as per IS: 4691 & IEC60034-05) with class 'B' insulation and continuous duty (S1). Class 'F' insulation is also accepted with temperature rise limited to class 'B'. The motors shall be suitable for 100% humid (at 40 deg C), salty tropical conditions and highly polluted environment.

2.2 Design Standards:

The motors shall conform to relevant latest amendments of National and International Codes and standards, especially the Indian Statutory Regulations.

- Performance : IS 325 & IS 8789 & IEC:60034
- Dimensions : IS 1231 / IS 2223
- Enclosure and protection : IS 4691 / IEC:60034-05
- Tropicalizing treatment : IS 3202
- Energy Efficient motors : IS 12615 / IEC:60034-30
- Method of Cooling : IS 6362 / (Equivalent IEC: 60034 Std.)

2.3 Design and Constructional Features:

2.3.1 Motors shall work satisfactorily for following supply conditions:

Variation of supply voltage from rated voltage : ± 10%
Variation of supply frequency from rated frequency : + 3% to - 5%
Combined voltage and frequency variation : ± 10%

2.3.2 The Voltage level of motors shall be as follows: (unless otherwise specified)
Up to 200 kW: 3 Phase 415V AC

2.3.3 Rated frequency: 50 Hz

2.3.4 The ambient temperature is 50°C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration unless otherwise specified.

2.3.5 TEMPERATURE RISE 70°C by resistance method for both thermal class 130(B) & 155(F) insulation.

2.3.6 Continuous duty LT motors up to 160 KW Output rating (at 50°C ambient temperatures), shall be Energy Efficient motors, Efficiency class of Premium efficiency (IE3) as per IEC: 60034-30 unless otherwise specified.

2.3.7 Winding and Insulation shall be Non-hygroscopic, oil resistant, and flame resistant.

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

2.3.9 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.

2.3.10 The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.

2.3.11 The starting time of the motor shall be less than 3 secs.

2.312 The motor shall be totally enclosed fan cooled (TEFC) unless otherwise specified.

2.4 Performance:

2.4.1 Motor shall be suitable for DOL starting.

2.4.2 The motor shall be capable of start & operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminal.

2.4.3 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. Starting torque should not be less than 120% of FLT. The pullout torque at the rated voltage shall be not less than 205% of the full load torque with no negative tolerance. Unless otherwise agreed, the pullout torque shall not exceed 300% of the rated load torque.

2.4.4 Fault capacity of the system to which motor is connected is about 45 kA RMS 1 second.

2.4.5 Noise level for all the motors shall be limited to 85dB (A) at distance of 1 m as per IS12065 (latest) /IEC60034.

2.4.6 Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment.

2.4.7 The spacing between gland plate & center of terminal stud shall be as per Table-1.

2.4.8 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.

2.4.9 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance)

a) Below 110 kW: 10.0

(b) From 110 kW & up to 200 kW: 9.0

2.4.10 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

2.4.11 The starting voltage requirement shall be 85% for motors below 110KW rating and 80% from 110KW to 200KW.

2.5 ACCESSORIES:

Terminals and Terminal box:

2.5.1 All the six terminals should be brought out on the terminal block, which shall be provided with connecting strips and shall amply be rated.

2.5.2 The terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees and location is to be midway on right hand side when viewed from coupling end.

2.5.3 The terminals shall be clearly marked R.Y.B.

2.5.4 The terminal box shall be furnished completely with nickel coated brass double compression glands for termination.

2.5.5 Grounding pads shall be as per relevant standards.

2.5.6 The degree of protection shall be IP55 as per IS4601 & IEC60034-05

2.6 Suitable single phase AC (240 V) space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Space heaters shall be wired up to separate terminal box complete with removable gland plate and suitable terminals & glands for connections of cable & temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals shall also be provided.

2.7 Lower capacity motors (less than 30kW) where separate Anti condensation heaters are not provided, two phases of the winding will be subjected to 240V AC, 50HZ supply continuously whenever the motor is switched off to avoid any ingress of moisture. The supplier in the offer in this regard shall bring out any limitations. For LV Motors: Two point five (2.5) mm2, two (2) core copper conductor PVC insulated, armoured & FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 Part-I).

2.8 RATING PLATES

A rating plate of non-corrosive material upon which shall be engraved Manufacturer's name, Motor type, Motor model, Serial no. of motor, Rating, Voltage, Speed in RPM, Type of duty, Full load current in Amps, type of protection and efficiency class (IE3 / IE4).

These rating plates shall be of White non-hygroscopic material with engraved black lettering.

Stainless steel name plate as per IS 325 (Latest) /IEC 60034 (latest).

2.9 PROTECTION AND PRESERVATIVE COATING REQUIREMENTS:

2.9.1 All coated surfaces shall be protected against abrasion impact, discoloration any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. The shaft ends of motor shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted due to exposure to whether, should also be properly treated and protected in a suitable manner. All primers / paints / coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be.

2.9.2 Preservative shop coating:

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces that will not be easily accessible after the shop assembly shall be treated before-hand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and pre heated in the shop. The surfaces that are to be finish painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.

All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of Customer / BHEL.

2.10 PAINT AND FINISH

Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting, and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of RAL 5012 blue paint unless otherwise specified.

Material shall be properly packed to withstand mechanical damage and rust during transit.

2.11 The motor winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the winding shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

2.12 Cooling fan hub shall be threaded for withdrawing.

2.13 Drain plug shall be provided at the bottom of the starter frame.

2.14 The following **cable sizes** shall be considered for selecting suitable cable glands, unless otherwise specified.

Up to 3.7 KW - 3C x 2.5 mm^2 multi stand cu. conductor armored cable.

Above 3.7 KW up to 11KW - 3C x 10 mm^2 Multi stand Al. conductor, Armored cable

Above 11 KW up to 26KW - 3C x 25 mm^2 Multi stand Al. conductor, Armored cable.

Above 26 KW up to 37KW - 3Cx50 mm^2 Multi stand Al. conductor, Armored cable.

Above 37 KW up to 55KW - 3Cx95 mm^2 Multi stand Al. conductor, Armored cable.

Above 55 KW up to 75KW - 3Cx150 mm^2 Multi stand Al. conductor, Armored cable.

Above 75 KW up to 150KW -2x 3Cx185 mm^2 Multi stand Al. conductor, Armored cable.

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 cable as per IS:1554 Part-I).

For space heater 2Cx6 mm^2 Aluminum conductor, Armored cable

Special sizes if any will be as per our enquiry.

- For NTPC:

90 kW AC motor: 1x3C x 150sq mm

2.15 Bearing & Lubrication:

Motors shall have greased lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum life of 5 Years (40000 hours) at rated operating conditions. Unless otherwise specified the bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Vertical motors shall be provided with thrust bearings suitable for the load imposed by the driven equipment. In cases such as pumps for hot liquids where the driven machine operates at high temperatures, a shaft-mounted fan shall cool bearings. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven object by conduction or convection. For motors operating in hazardous areas fans shall be of an anti-static non-sparking material.

Bearings shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust or moisture e.g. labyrinth seal. Where grease nipples are provided, these shall be associated, where necessary with appropriately located relief devices, which ensure passage of grease through the bearing. Pre-lubricated sealed bearings may be considered provided full guarantee is given for 4 to 5 years of trouble free service without the necessity of re-lubrication.

2.16 Cooling system:

All motors shall be self-ventilated, fan cooled (TEFC). Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reserve the fan without effecting the balancing of the motor.

Motor shall be capable of 5 equal spaced cold starts per hour under normal conditions, 3 starts in quick succession from cold condition and two hot start in succession with motor initially at normal running condition.

2.17 **ROTOR:**

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life of the bearings. The accepted values of peak-to-peak vibration amplitudes for a motor at rated voltage and speed on a machined surface bedplate with the motor leveled and with a half-key or coupling fitted shall not exceed those given in IS-12075 (latest).

2.18 Grounding

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.

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.

3. TESTS CERTIFICATE:

3 copies of performance test certificate of motor shall be supplied for each item of the consignment quoting BHEL Standard number, purchase order number and manufacturer's identification serial number.

4. GUARANTEE CERTIFICATE:

4.1 A guarantee certificate for 24 months of trouble free performance from the date of shipment or 18 months from the date of commissioning whichever is earlier shall be supplied.

4.2 If any mal-performance or defects occur during the guarantee period, the vendor shall make all necessary alteration, repairs and replacement free of charge.

5. SCOPE OF SUPPLY:

5.1 Main Supply

5.1.1 Motor with suitable double compression cable glands, lugs and along with shaft keys.

5.1.2 Space heater & RTD for motors with separate terminal box of rating 30 KW and above.

5.2 1 Set of commissioning spares (DE &NDE Bearings) items- Separate Purchase Requisitions is raised if required.

5.3 3 years Normal Operational spares (optional price shall be quoted for validity of 2 years) - Separate Purchase Requisitions will be raised as and when required.

5.3.1 Terminal Box.

5.3.2 Cooling Fan with End shield Cover

5.3.3 DE and NDE side Bearings

6. TESTS:

6.1 Each motor shall be Routine tested in accordance with IEC 60034-2 latest in presence of purchaser's representative.

Type test of similar frame size motor to be produced at the time of inspection. Tests on completely assembled motor shall be carried out in the presence of BHEL / Customer representative. The results shall be tabulated and signed by both vendor and BHEL / Customer representatives. **Though the motors shall be accepted on the basis of the satisfactory result of the tests at the vendor's works, it shall not absolve the vendor from liability regarding the proper functioning of motor coupled to the driven equipment at BHEL works or at sites.**

6.2 LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last eight (8) years.

6.3 These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last eight (8) years from the date of ordering, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.

1. <u>Type tests</u>

i. No load saturation and loss curves up to approximately 115% of rated voltage.
ii. Momentary overload test.
iii. Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., core temp., coolant flow and its temperature 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.iv. Surge withstand test on the sample coil after placing it in stator core at (4U + 5 KV) and with at least five impulse of 1.2/50 micro sec. wave, for HV motors only,where U is the line to line voltage in kV.

v. Surge-withstand test with 0.3/3 micro sec. wave on each type of 6.6/11 kV motor coils with at least five such impulses, followed by one minute power frequency high voltage test on turn to turn insulation, after cutting the coil and bringing out the turns suitably. The power frequency test voltage shall be decided during detailed engineering.
vi. Dimensions (for motors covered by IS 1231:1974 and IS 2223:1983 only).
vii. Measurement of resistance of windings of stator and wound rotor.
viii. Reduced voltage running up test at no load (for squirrel cage motors up to 37kw

only).

ix. Full load test to determine efficiency, power factor and slip.

x. Insulation resistance test.

xi. Test for vibration severity of motor.

xii. Test for noise levels of motor.

xiii. Test for degree of protection by enclosure.

xiv. Temperature rise test at limiting values of voltage and frequency variations.

xv. Over speed test.

2. Routine Tests

The following shall constitute the routine tests.

i. Insulation resistance test

ii. Measurement of resistance of windings of stator and wound rotor.

iii. No load test

iv. Locked rotor readings of voltage, current and power input at a suitable reduced voltage

v. Reduced voltage running up test (for squirrel cage motor) vi. Open circuit voltage ratio of stator and rotor windings (for slip ring motors);rotor;

vii. High voltage test

7. DOCUMENTATION:

7.1 All the drawings/ documents submitted by the vendor during detailed engineering stage shall be stamped “For Approval” or For Information” prior to submission. After the approval of the drawing, further work by the vendor shall be in strict accordance with these approved drawings and no deviations shall be permitted without the written approval of customer.

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

7.3 LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

- All the motors shall be tested in accordance of IEC 60034-2
- The following type test reports shall be submitted for each type and rating of

LT motor of above 50 KW only

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip.
5. Temperature rise test.
6. Momentary excess torque test.
7. High voltage test.
8. Test for vibration severity of motor.
9. Test for noise levels of motor (Shall be limited to 85 dB (A) until otherwise specified)
10. Test for degree of protection
11. Over - speed test.
12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1.

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

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

7.4 NUMBER OF DOCUMENTS TO BE SUBMITTED:-

- Drawings, Data sheets, Curves for Information /approval .....3 prints (1 soft copy).
- Final Drawings, Data sheets, Curves for Information / approval .... 3 Prints.
- Performance and functional guarantee test reports .... 3 prints
- O&M manual with project drawings, data sheets, performance and functional guarantee test reports ..... 10 Prints & 1 CD

8. DRAWINGS, DATA TO BE FURNISHED

8.1 Documents to be sent along with offer (2 copies)

(Without following data, offers will not be considered)

8.1.1 The descriptive leaflets / catalogues giving full sectional details of the item.
8.1.2 Motor Overall dimensional drawing along with terminal box details.
8.1.3 Motor cross-sectional drawing showing spare part details.
8.1.4 Filled in motor data sheets as per NTPC format (Page 12 to 15)
8.1.5 Characteristics curve of motor.
8.1.6 Speed torque characteristic curve of motor along with GD^2 Value.
8.1.7 Quality plan
8.1.8 Type test Certificates of similar frame size

8.2 DOCUMENTS TO BE SENT AFTER PLACEMENT OF ORDER FOR APPROVAL
(3 Hard Copies + 1 Soft copy)

8.2.1 Motor Overall dimensional drawing along with terminal box details.
8.2.2 Motor cross-sectional drawing showing spare part details.
8.2.3 Filled in motor data sheets as per NTPC format (Page 12 to 15)
8.2.4 Characteristics curve of motor
8.2.5 Speed torque characteristic curve of motor along with GD^2 value
8.2.6 Quality plan
8.2.7 Type test Certificates of similar frame size

8.3 DOCUMENT TO BE SUBMITTED AFTER FINAL APPROVAL

8.3.1 Material test certificates.
8.3.2 Guarantee certificates
8.3.3 Motor Overall dimensional drawing.
8.3.4 Filled in motor data sheets.
8.3.4 Quality plan.
8.3.7 Type test report

8.4 DOCUMENT TO BE SUBMITTED ALONG WITH CONSIGNMENT

8.3.1 Material test certificates.
8.3.2 Performance test certificates & Performance curve.
8.3.3 Guarantee certificates
8.3.4 Motor Overall dimensional drawing.
8.3.5 Filled in motor data sheets.
8.3.6 Quality plan.
8.3.7 Type test reports
8.3.8 O&M Manual

9. SPECIAL NOTES:

9.1 Final documents shall be furnished in CD for using in MS – word, AutoCAD & PDF.
9.2 Before forwarding the drawings and documents, vendor shall ensure that the following information is properly entered in each drawing.
9.2.1 Name of the equipment
9.2.2 Equipment tag number
9.2.3 Name of the project
9.2.4 Client / Customer
9.2.5 Drawing / Document title
9.2.6 Drawing / Document number.
9.2.7 Revision and date.
9.2.8 The manufacturer's serial no. shall be marked at suitable location.
9.2.9 A tag number bearing the relevant 12 digit material code shall be attached for each item.

10. **REFERENCE**

- IS 325: THREE-PHASE INDUCTION MOTORS
- IS 8789: Values of performance characteristics for three-phase induction motors(up to 37 kw)
- IEC:60034: Rotating electrical machines
- IS 1231: Dimensions of Three-phase Foot-mounted Induction Motors
- IS 2223: Dimensions of flange mounted ac induction motors
- IS 4691: Degrees of protection provided by enclosure for rotating electrical machinery
- IS 3202: Code of practice for climate proofing of electrical equipment
- IS 12615, Energy Efficient Induction Motors - Three Phase Squirrel Cage
- IEC:60034-30: Rotating electrical machines - Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code)
- IS 6362: Designation of methods of cooling of rotating electrical machines

11. **TABLE 1:**

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS:

S.N.	Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm
1	UP to 3 KW	As per manufacturer's practice.
2	Above 3 KW - up to 7 KW	85
3	Above 7 KW - up to 13 KW	115
4	Above 13 KW - up to 24 KW	167
5	Above 24 KW - up to 37 KW	196
6	Above 37 KW - up to 55 KW	249
7	Above 55 KW - up to 90 KW	277
8	Above 90 KW - up to 125 KW	331
9	Above 125 KW-up to 200 KW	203

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:

S.N.	Motor MCR in KW	Clearance
1	UP to 110 KW	10mm
2	Above 110 KW and up to 150 KW	12.5mm
3	Above 150 KW	19mm

12. **DATA SHEET** (NTPC FORMAT)**:**

DE-1	LT MOTORS	

A.	**GENERAL**	
1.	Manufacturer & Country of origin.	
2.	Equipment driven by motor	
3.	Motor type	
4.	Quantity	
B.	**DESIGN AND PERFORMANCE DATA**	
1.	Frame size	
2.	Type of duty	S1
3.	Type of enclosure /Method of cooling/ Degree of protection	
4.	Applicable standard to which motor generally conforms	
5.	Efficiency class as per IS 12615 (latest) / IEC 60034-30 (latest)	IE3 (default)
6.	(a)Whether motor is flame proof	Yes/No
	(b)If yes, the gas group to which it conforms as per IS:2148	
7.	Type of mounting	
8.	Direction of rotation as viewed from DE END	Bi-directional
9.	Standard continuous rating at 40 deg. C ambient temperature as per Indian Standard (KW)	
10.	Deaerated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
11.	Maximum continuous load demand of driven equipment in KW	
12.	Rated Voltage (volts)	415
13.	Permissible variation of :	
	a. Voltage (Volts)	±10
	b. Frequency (Hz)	±5
	c. Combined voltage and frequency	±10
14.	Rated speed at rated voltage and frequency(RPM)	
15.	At rated Voltage and frequency:	
	a. Full load current	
	b. No load current	
16.	Power Factor at	
	a. 100% load	
	b. NO load	
	c. Starting.	
17.	Efficiency at rated voltage and frequency,	
	a.100% load	
	b. 75% load	

	c. 50% load	
18.	Starting current (amps) at	
	a. 100 % voltage	
	b. 85% voltage	
	c. 80% voltage	
19.	Minimum permissible starting Voltage (Volts)	
20.	Starting time with minimum permissible voltage	
	a. Without driven equipment coupled	
	b. With driven equipment coupled	
21.	Safe stall time with 100% and 110% of rated voltage	
	a. From hot condition	
	b. From cold condition	
22.	Torques :	
	a. Starting torque at min. permissible voltage (kg-mtr.)	
	b. Pull up torque at rated voltage.	
	c. Pull out torque	
	d. Min accelerating torque (kg-m) available at lowest permissible starting voltage	
	e. Rated torque (kg-m)	
23.	Stator winding resistance per phase (ohms at 20 Deg.C.)	
24.	GD^2 value of motors	
25.	No of permissible successive starts when motor is in hot	
26.	Locked Rotor KVA Input	
27.	Locked Rotor KVA/KW	
28.	Vibration limit :Velocity (mm/s)	
29.	Noise level limit (dBA)	
C.	**CONSTRUCTIONAL FEATURES**	
1.	Stator winding insulation	
	a. Class & Type	

	b. Winding Insulation Process	
	c. Tropicalised (Yes/No)	Yes
	d. Temperature rise over specified maximum ambient temperature of 50 deg C	
	e. Method of temperature measurement	
	f. Stator winding connection	
2.	Main Terminal Box	
	a. Type	
	b. Location(viewed from NDE side)	
	c. Entry of cables(bottom/side)	
	d. Recommended cable size (To be matched with cable size envisaged by owner)	
	e. Fault level (MVA),Fault level duration(sec)	50kA RMS for 0.25 sec
	f. Cable glands & lugs details (shall be suitable for power cable)	
3.	Type of DE/NDE Bearing	
4.	Motor Paint shade	RAL5012(Blue)
5.	Weight of	
	a. Motor stator (KG)	
	b. Motor Rotor (KG)	
	c. Total weight (KG)	
D.	**List of accessories.**	
1.	Space Heaters (Nos./Power in watts/supply voltage)	
2.	Terminal Box for Space Heater (Yes/No)	yes
3.	Speed switch (Yes/No) No of contacts and contact ratings of speed switch	
4.	Insulation of bearing (Yes/No)	
5.	Noise reducer(Yes/No)	
6.	Grounding pads	
	i) No and size on motor body	
	ii) Nos on terminal Box	
7.	Any other fitments	

E.	List of curves.	
1.	Torque speed characteristic of the motor	
2.	Thermal withstand characteristic	
3.	Starting. current Vs. Time	
4.	Starting. current Vs speed	
5.	P.F. and Effi. Vs Load	

13. **VARIANT TABLE:**

Var. No.	Description	Material code
01	TEFC SQ. CAGE HOR FOOT MOUNTED (B3) A.C IND. MOTOR FOR L.O.P. RATING: 90 KW, 415 VAC, 1450 RPM EFFICENCY AS PER IE3 IEC60034-30, SCOPE AS PER CLAUSE 5.1, NTPC Project	**TC9754373019**
02	SPARE SET OF BEARINGS (DE+NDE) FOR 90 KW A.C MOTOR- COMMISSIONING SPARE	**TC9754373027**
03	SPARE COOLING FAN FOR 90 KW A.C.MOTOR	**TC9754373035**
04	TERMINAL PLATE FOR IE3 90KW MOTOR	**TC9754373043**
05	SPACE HEATER FOR 90KW IE3 MOTOR	**TC9754373051**
06	TEFC SQ. CAGE HOR FOOT MOUNTED (B3) A.C IND. MOTOR FOR L.O.P. RATING: 110 KW, 415 VAC, 2900 RPM EFFICENCY AS PER IE3 IEC60034-30, SCOPE AS PER CLAUSE 5.1	**TC9754373060**
07	IE3 TEFC(B3)AC IND MTR,90KW,415VAC,2900	**TC9754373078**
08	IE3 TEFC(B3)AC IND MTR,75KW,415VAC,1450	**TC9754373086**

RECORD OF REVISIONS

Rev. No.	Date	Revision Details	Revised By	Approved By
00	01.07.14	First Issue		
01	20.06.16	First revision	Anshul	M.V.S.Raju
02	19.05.17	Second revision	Anshul	Sunil Jiwtode
03	16.12.17	Third revision , Var 08 added	Anshul	Sunil Jiwtode

PRODUCT STANDARD
INDUSTRIAL TURBINES & COMPRESSORS

SPECIFICATION FOR OIL CONSOLE FOR BARRING GEAR

1.0 GENERAL

1.1 SCOPE

This specification is intended to cover the minimum requirements of design, manufacture, assembly, functional testing at manufacturers works, delivery at BHEL works, properly packed of an oil console required for Barring device of Industrial drive turbines.

1.2 INSTALLATION

The unit shall be suitable for outdoor installation, under roof.

1.3 As far as construction materials are concerned, copper and copper alloys are not allowed at all.

2.0 DESIGN

2.1 The oil console is required for supplying pressurised oil to Barring device of Industrial drive turbine. The system shall handle Turbine oil grade 'Servoprime 46' of IOC make. The following are the system parameters.

Type of Fluid : Servoprime 46 of IOC.
Specific gravity - 0.88
Kinematic Viscosity - 30 cst at 40°C

Maximum operating pressure : 100 kg/cm^2
Design pressure : 110 kg/cm^2
Working temperature : 50°C

2.2 The graphical schematic of oil console and proposed general arrangement drawing is shown in the enclosed BHEL drg. 130704 00004. The general arrangement drawing is furnished for vendors guidance only. However the vendor can make his own arrangement which should be compact and such arrangement is subject to the approval of BHEL.

3.0 SPECIFICATION, CODES & STANDARDS

3.1 The oil console components and piping shall be supplied in accordance with relevant national and International standards.

3.2 Job technical specifications

3.2.1 Gear pump with electric motor (Pos 1 of drg)

a) Pump specification

Fluid handled	: Servoprime 46 of IOC Kinematic viscosity 30 cst at 40°C. Specific gravity - 0.88
Discharge quantity	: 2.0 litres per minute.
Suction pressure	: 2.5 to 3.5 kg/cm^2 gauge.
Discharge pressure	: 100 Kg/cm^2 gauge.
Built in Relief valve	: YES.

b) Motor Specification

Power consumption & rating of motor	: To be furnished by supplier (Motor is to be rated for power absorbed by pump for oil viscosity of 70 cst plus 25% more and rounded off to the nearest standard motor model.
Location	: Outdoor in hot humid climate.
Motor type	: Horizontal foot mounted squirrel cage induction motor.

Supply voltage and frequency	: 415V, 3 ph, 50Hz solidly earthed.
Supply voltage and frequency variations	: Voltage ±10% , frequency ±5% combined voltage and frequency ±10%
Type of starting	: Direct on line.
Minimum voltage at starting to bring equipment upto rated speed	: 80% rated voltage.
Enclosure and execution.	: IP-55 TEFC ~~(Non-sparking)~~ Increased Safety Ex'e' G3 as per VDE 0171
Insulation class	: "F" with over temperatures of class "B".
Cable gland inlet type	: Explosion proof, Double compression cable glands (included in vendors scope of supply).
Performance characteristic	: To suit driven equipment.
Grounding	: 2 Nos. earthing studs on motor body and 1 No. inside terminal box.
Test according to	: Relevant IS standards.
Particular requirements	: ~~Motors shall comply with – SPG.EL.RMA.2 Section 1,2 & 3.~~
Max. and Min. ambient temperatures	: 50/4 °C
Relative humidity	: 87% at 39°C
Area	: Zone-II hazardous area, apparatus grouping II A, II B and II C gases. Temperature class T3 as per IEC
Testing	: As per relevent IS codes. - Routine test is to be conducted. Type test certificates are to be furnished
Fault level	: 35 MVA for 0.25 sec
No of cold starts	: 5 starts per hour equally spaced
No of hot starts	: 3 starts per hour equally spaced.

c) Scope of supply: Completely assembled pump with motor as follows.

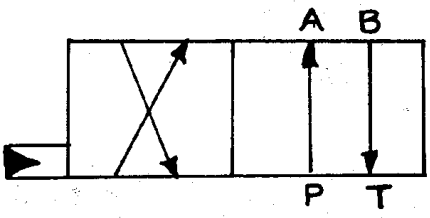
- Pump with built in relief valve.
- Motor with suitable cable glands.
- Flexible coupling of spacer type (Lovejoy)
- Coupling gauard in spark proof construction.
- Common base plate on which pump and motor are assembled.

d) Acceptable motor makes : - NGEF
- Bharat Bijlee
- Siemens India
- Kirloskar electric co.
- Crompton greaves.

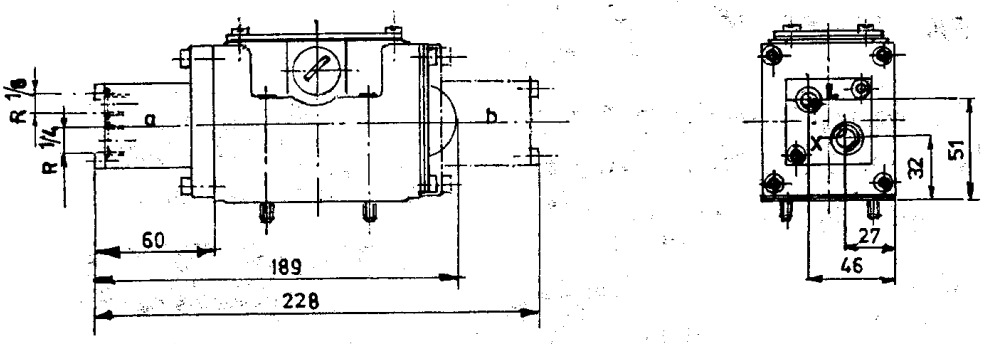
However motor make will be specified in P.O out of the above make.

3.2.2 4/2 - Way Direction control valve (Pos. No. 2 of drg)

- Graphic symbol:



Overall dimensions



Actuation : Hydraulic

Equivalent model : S10 E00 G02 0 00130V of Herion, WG (5202086)

Mounting : Bolted on Sub-plate and sealed by O-Rings (DIN 2434 and CETOP)
- Type PS10G4001000 (2855400) of Herion, WG or equivalent.

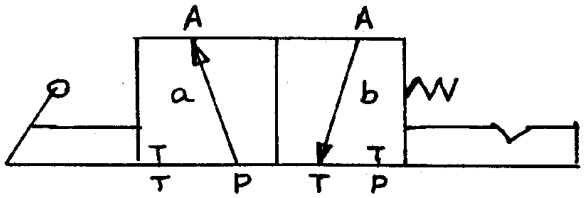
Operating pressures at
ports P,A,B,T : Upto 315 bar.
At port L : Upto 100 bar.
Fluid temperature : 50°C max.
Viscosity : 30 cst
Control pressure range : 5 to 315 bar.

3.2.3 3/2 Solenoid valve - Explosion proof design (Pos.3 of drg.)

- Please refer enclosed BHEL Spec. TC 5 1108
- The solenoid shall be supplied complete with explosion proof cable gland.
- Power supply to solenoid : 115V, 1 phase, 50Hz AC.
- Equivalent Herion model : 2413602.1581

3.2.4 3/2 Way hand operated control valve (Pos.4 of drg)

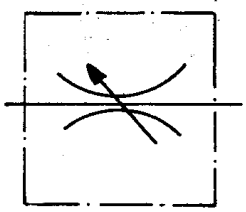
Graphic Symbol



Operating pressure : 100 kg/cm^{2}g
Design pressure : 125 kg/cm^{2}g
Mounting : Bolted on subplate and sealed by O Rings.

3.2.5 Throttle valve:(position 5 of drg).

Graphic Symbol



Mounting : In line
End connection : Screwed G3/8" - Female
Function : For providing speed control and shutt off.

Special requirement : 'Colorflow' color bands for fast accurate setting.

Material of construction : Stainless steel
Operating pressure : 100 kg/cm^2
Design pressure : 125 kg/cm^2

3.2.6 Ball valves (Pos.6 of drg)

- Operating pressure : 100 kg/cm^2
- Design pressure : 125 kg/cm^2
- Body, ball and stem material : A1S1 316 stainless steel
- Valve shall be Quarter turn type.
- End connections : Screwed BSP.
- Valve body shall be hydrostatically tested for 1.5 times design pressure and seats shall be tested to the operating pressure.

3.2.7 Pressure gauge (Pos.7 of drg)

Make : Bells controls Ltd. or A.N. Instruments.
Mounting : Direct mounting
Dial size : 100 mm
Accuracy : ±1% of FSD
Range : 0 to 160 kg/cm^2
Connection location : Bottom
Process connection. : 1/2" NPT-M
Case & Bezel : Diecast aluminium alloy heavily enamelled black and stoved.
Bourdon : A1S1 316 SS
Movement assembly : Stainless steel A1S1 316/304.

3.2.8 Piping

Complete piping shall be of stainless steel material confirming ASTM A312 - TP 321. The maximum working pressure is 100 kg/cm^2 and the design pressure is 110 kg/cm^2. The pipe thicknesses mentioned in the General arrangement drg is for guidance only. Vendor

is to check the thicknesses for the above design conditions and if required higher thickness pipes are to be adopted. Hydraulic test is to be conducted at 1.5 times the design pressure.

3.3 Exceptions

Purchaser will assume that proposals meet all the requirements stated herein except for Bidder's specific written exceptions.

4.0 DESCRIPTION OF SUPPLY

4.1 The oil console shall be supplied as per BHEL drg. 130704 00004 enclosed to this specification.

4.2 The scope of supply shall include but not limited to the following.

4.2.1 Gear pump complete with ~~non-sparking~~ Increased Safety type AC motor drive and built-in relief valve - 1 No. 1

4.2.2 4/2 Way valve - 1 No.

4.2.3 3/2 Solenoid valve - explosion proof design - 1 No. (Free issue from BHEL - Not in vendors scope) 1

4.2.4 3/2 hand operated valve - 1 No.

4.2.5 Throttle valve -1No.

4.2.6 Ball valves - 2 Nos.

4.2.7 Pressure gauge - 1 No.

4.2.8 Complete piping made of stainless steel to ASTM A312-TP 321.

4.2.9 Any other equipment explicitly not mentioned but required for system operation.

4.3 ~~In case the vendor can not supply explosion proof solenoid valve as per the specifications, then this aspect should be clearly brought out in the offer so that BHEL will arrange this material as 'Free issue' item to vendor for mounting in the console at vendors works.~~ The complete oil console shall be tested along with the solenoid valve at vendors works. 1

5.0 SPARE PARTS FOR ERECTION / COMMISSIONING AND TWO YEARS OPERATION

Bidder shall furnish Quotations separately as follows along with the bid.

1) Recommended spares for erection and commissioning.
2) Recommended spares for 2 years operation.

6.0 INSPECTION AND TESTS

6.1 All the equipment shall be subject to inspection and witnessed tests by BHEL inspector.

6.2 The bidder shall notify the purchaser no less than 15 days before the oil console, will be ready for inspection/Testing.

6.3 The schedule of Quality checks are given in separate sheets enclosed to this specification.

6.4 The functional test of oil console shall be conducted using turbine oil 'Servoprime 46' of IOC. While doing functional testing performance of the pump also shall be established. The solenoid valve shall be powered as per the relevant voltage specified elsewhere and should be functionally tested. The 3/2 hand operated valve, 4/2 - Way valve, Throttle valve, Ball valve etc shall be tested during functional testing of oil console.

7.0 DATA, DRAWINGS AND DOCUMENTS

7.1 The vendor shall supply the following data, drawings and documents.

A. Along with Quotation

a) General arrangement drg of oil console showing overall dimensions fixing details and weight of the console.
b) Technical literature/catalogues of all component including overall dimensions.
c) Performance curve of pump.
d) Motor data sheet as per enclosed BHEL format.

B. After award of contract

a) Final general arrangement drawing.
b) Cross-sectional drawing of pump identifying spare parts.
c) Test and inspection reports as per schedule of Quality checks.
d) Instruction, service and maintenance manuals.
e) Guarantee certificate.
f) Motor data sheets ✓

8.0 GAURANTEE

A gaurantee certificate for 24 months of trouble free performance from the date of shipment or 18 months from the date of commissioning whichever is earlier shall be furnished.

9.0 PREPARATION FOR DELIVERY

9.1 Preservation, packaging & packing - shall be accomplished in accordance with acceptable commercial practices. The vendor shall make shipment in single consignment with the requirement of safety transit, available modes of transportation. It shall be vendors responsibility to assure that all equipment will arrive at destination in an undamaged condition and ready for intended use.

9.2 Marking

9.2.1 Name plates and Product markings

Ecuipment supplied shall bear at a visible point on the unit, a metal name plate of corrosion resistant material bearing the manufacturer's name, the unit item number, equipment title, manufacturers serial number and the main parameters of equipment.

9.2.2 The manufacturer's identification serial number shall be mentioned in test/inspection and gaurantee certificates pertaining to it.

9.2.3 A tag bearing 12 digit material code of BHEL shall be attached to oil console.

9.2.4 The following details shall be marked on packing case,

1. Manufacturer's Name
2. BHEL Order Number
3. BHEL Material code number.

10. REJECTION

Equipment or parts thereof and materials entering therein, indicating irremediable or injurious defects, improper fabrication, excessive repairs or that is not in accordance with the requirements of this specification shall be subject to rejection. They shall also be subject to rejection if such conditions are discovered after acceptance of the items at manufacturer's works.

PREPARED 22/12/88

SCHEDULE OF QUALITY CHECKS FOR OIL CONSOLE FOR BARRING DEVICE

		S	B	
1.0	**Oil Pumps**			
1.1	Performance test	3	1	
1.2	Material certification	3	2	
2.0	**Electric Motors**			
2.1	Routine tests	3	2	
2.2	~~Non-sparking~~ Increased Safety certification	4	2	Δ
3.0	**4/2 Way control valve, 3/2 hand operated valve, Ball valve, Throttle valve.**			
3.1	Material certificates	3	2	
4.0	3/2 Solenoid valve → Not applicable			Δ
4.1	Material certificates	3	2	
4.2	Explosion proof certification.	4	2	
5.0	**SS Piping**			
5.1	Material certificates	3	2	
6.0	**Oil console Assembly**			
6.1	Functional Testing	3	1	
6.2	Hydraulic Test	3	~~2~~ 1	Δ

Agency

S - Supplier
B - BHEL or BHEL authorised inspector.

Type Of Inspection

1. Witnessed.
2. Review of certificates.
3. Certified check by manufacturer
4. CMRS - Dhanbad, certificate/Authority specified in BHEL Specification.