NUCLEAR POWER CORPORATION OF INDIA LIMITED

(A Govt. of India Enterprise)

PROJECT : KAIGA ATOMIC POWER PROJECT UNIT 5&6

SPECIFICATION NO. : KAIGA-5&6/PP/PC- E/ 76121

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TECHNICAL SPECIFICATION

ON

DOUBLE GIRDER EOT CRANE ABOVE 100T

(TURBINE HALL CRANES)

BHARAT HEAVY ELECTRICALS LTD.				**NPCIL'S ACCEPTANCE**			
	NAME	**SIGN**	**DATE**		**NAME**	**SIGN**	**DATE**
PREPARED BY	**DSR**		**15/07/24**	**CHECKED BY**			
CHECKED BY	RR		**15/07/24**	**REVIEWED BY**			
REVIEWED BY	RR		**15/07/24**	**APPROVED BY**			
APPROVED BY	**SKB**		**15/07/24**				

(For Revisions See Revision Control Sheet)

FILE NAME: KAIGA-5&6/PP/PC- E - 76121_R0

REVISION CONTROL SHEET

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DG EOT CRANE ABOVE 100T

REV. NO. DATE	DESCRIPTION OF REVISION	BHEL			NPCIL		
		REVISED BY	REVWD BY	APPD BY	CHECKD BY	REVWD BY	APPD BY

BHEL - REVISION RECORD SHEET

BHEL/PE-TS-488-501-A501

REV. NO. DATE	DESCRIPTION OF REVISION	BHEL			REMARK
		REVISED BY	REVWD BY	APPD BY	

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NPCIL PROPERITARY

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PROJECT INFORMATION

1.1	OWNER / PURCHASER	: NUCLEAR POWER CORPORATION OF INDIA LTD
1.2	ENGINEER	: EXECUTIVE DIRECTOR (PROCUREMENT)
1.3	Project Title	: 2x700 MWe PHWR – KAIGA-5&6 ATOMIC POWER PROJECT
1.4	Location	:KAIGA, UTTARA KANNADA DISDRICT, KARNATAKA
1.5	Elevation (RL)	: RL +32m to +46m
1.6	Nearest Railway Stations	: KARWAR (Konkan Railway)
1.7	Name of Railway Stations	: KARWAR (Konkan Railway)
1.8	Ambient Air Temperatures	
a)	Maximum dry bulb temperature	: +41.6 deg C,
b)	Minimum dry bulb temperature	: 10.9 deg C,
c)	Design temperature for electrical equipment /devices	: +50 deg C
1.9	Relative Humidity	
a)	Maximum during monsoon	: 99.9%
b)	Minimum (design)	: 3%
1.10	Air Quality	: Air quality is clean and free from chemical pollutants.
1.11	Rainfall	
	Annual Average	: 3649.31 mm
	Highest annual rainfall	: 4695.1 mm in 1988
	Lowest annual rainfall	: 2345.3 mm in 2016
	Period	: Year 1987-2017
1.12	Wind Pressure:	
a)		
	Height above mean ground level, m	Design Wind Speed m/sec
	@ 10 M	5.0
	@ 100 M	13.8
	The assessment of wind loads based on the above basic wind speed shall be done as specified in IS: 875	
b)	Wind direction	: Predominantly W, SW, NE & E with respect to true North
1.13	Transport	: Rail & Road
1.14	Rail / Road access	: About 53 km from Karwar (Konkan Railway) Station and NH 10 passes through Karwar
1.15	SEISMOLOGY	: Zone III as per IS1893-2002 part I
1.16	Auxiliary Power	: Auxiliary electrical equipment to be supplied against this specification shall be suitable for operation on the following supply systems

a)	For AC motors 200 kW and above	: 6600 Volts, 3 phase, 50 Hz, non-effectively earthed with following supply variations*
b)	For AC motors below 200 kW	: 415 V, 3 phase, 3 wire, 50Hz effectively earthed with following supply variations*
c)	Construction supply	: 415 V, 3 phase, 4 wire, 50 Hz, AC supply effectively earthed, one feeder supplied to the VENDOR at one point, as determined by the PURCHASER near the Sub-station, with following supply variations *
d)	Panel Lighting fixtures, Space heaters	: 240 V, 1 phase, 2 wire, 50 Hz, AC supply with neutral lead earthed, with following supply variations*
e)	DC motors control and protective devices	: 220 V, 2 wire, unearthed DC supply from Station Battery /Battery Charger, with a supply variation of (-) 20% to (+) 10% of rated voltage.
f)	Instrumentation controls & annunciation	: i) (+) 24V DC centre tap grounded supply for general control purpose. ii) 240V AC, 1 phase, 2 wire, 50 Hz, uninterruptible power supply source (UPS).
	NOTES: *Supply Variations	
i)	Variation of supply voltage	: (±) 10%
ii)	Variation in supply frequency	: (±) 5%
iii)	Combined voltage and frequency variation	: (±) 10%

1.0.0. SCOPE OF WORK

1.1.0. SCOPE OF SUPPLY

1.1.1. This specification includes, but not limited to SUPPLY PART, SERVICE PART & MANDATORY SPARES comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles fill of lubricants & consumables along with spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, erection & commissioning, trial run at site and carrying out load/overload tests at site & final handing over to end customer in flawless condition of crane(s) for project and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order for following EOT cranes:

i) 2 Nos. 125/25T capacity Double girder EOT Cranes for TB building

ii) 2 Nos. 25T capacity double girder Aux. EOT Cranes for TB building

Any equipment / accessories not specified in the specification but required to make the EOT crane complete for efficient operation shall also be under the bidder's scope of work.

1.1.2. Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

1.1.3. EOT shall consist of but not limited to the following:

I. Box type girder, end carriages and trolley frame.
II. Long travel runway rail with machined clamps, bolts, and nuts, end stops with spring/rubber buffers and wheel stops.
III. Trolley runway rails with machined clamps, bolts, and nuts, end stops with spring/rubber buffers and wheel stops.
IV. Lifting hook, wire ropes, rope drum, sheaves, equalizing sheaves and bottom block and top block assemblies.
V. Totally enclosed gearboxes.
VI. Drive motors with variable voltage variable frequency drives for all motions.
VII. Brakes (all motions) for fail-safe operation.
VIII. Remote control as specified in data sheet.

IX. Cradles & slings
X. PVC insulated shrouded type DSL with copper conductor and spring-loaded current collectors with fixtures.
XI. Flexible trailing cable system mounted on retracting support for hoist drives and for cross travel motion.
XII. Controllers, resistors, control panel and distribution panel.
XIII. Necessary cabling.
XIV. Protection devices and indicating devices such as limit switches, resistors, insulators, safety switches, etc.
XV. Load cells for each crane
XVI. Lighting fixtures and accessories for cranes.
XVII. Earthing of all electrical equipment in crane.
XVIII. Maintenance and repair platform with hand railing on both sides of bridge girders for the full span length.
XIX. Protective guards, necessary fasteners, screws and other fixtures.
XX. Supply of adequate quantity of consumables required for the job at site.
XXI. Initial fill of various lubricants
XXII. One (1) lot of essential spares for five (5) years of trouble-free operation.
XXIII. One (1) lot of start-up spares required during erection, testing, trial operation and commissioning.
XXIV. One (1) set of all required maintenance tools and tackles.
XXV. List of essential spares, start-up spare & maintenance spare

1.1.6 Erection and Commissioning spares

The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. Fill of lubricants; oil etc. till commissioning of the cranes shall also be supplied by the bidder.

1.1.7 Any supplies/services mentioned in GCC, SCC as relevant to the package

1.2.0 Services to be provided by the bidder

1.2.1. Packing, forwarding and transportation to site

1.2.2. Development of storage space including ward & watch of the equipment and handling at site.

1.2.3 Unloading, storage and handling at site.

The Bidder shall provide means for all unloading and reloading for all consignments of plant; both during transport to Site and on the Site. Consignments shall be unloaded immediately on arrival at Site. The Bidder is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc. The following parts shall be stored inside enclosed warehouses:

Bolts, pins, packing, tools, insulation materials, electrical parts with electrical devices attached, electric motors and excitation equipment, instruments, welding material and equipment, all small parts and all parts of the crane which already have been finally painted. If large parts are stored in the open air, they shall be provided with weather resistant and fire & resistant covers. Electrical parts, which are not packed in heavy duty polyethylene foil and those so packed, but whose packing has been damaged shall be kept in suitable places from the moment of storage to the moment of installation. All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the station shall be protected from weather or humidity. All the equipment shall be stored as per standard storage and preservation instructions etc. of the suppliers.

1.2.4 Arranging test load at site

Collecting the test load at site within a radius of 1-2 KM from owner's storage to final testing bed of crane shall be under bidder's scope of work. Test load in the form of rolled steel, plates, girder, angle etc., as available at the site shall be made available by the purchaser. The test load shall be put back to the place from where it was lifted by the vendor, after the load testing. Load testing sling, cradles and any other item required by the vendor during the load testing shall be arranged by the vendor at no extra cost to the purchaser.

1.2.5 Erection and Commissioning

1.2.6 Demonstration / Load test at bidder's Works and at site.

1.2.7 Obtaining clearance and acceptance certificate from the concerned competent

Authority after site test and as and when required as per Government Norms /Statutory body till the time of final handling over to Customer. Necessary fees/expenditure as required shall be borne by the supplier.

1.2.9 Any service mentioned in GCC & SCC as relevant to the package

2.0.0. **Works Excluded**

Supply feeder and cable from feeder / MCC to isolating switch.

Gantry girder

Dead load for load/ overload testing at site

Space for storage.

Exclusion, if any, mentioned in GCC, SCC.

SYSTEM DESCRIPTION

The material handling systems shall be designed to meet the safety requirements of AERB Factory rules 1996.

The cranes shall be designed as per IS 3177-2020 for all load combinations. The system equipment shall be designed to limit noise levels as specified, to a maximum of 90 db, measured at a distance of 1.0 m from the source in any direction.

EQUIPMENT SELECTION & DESCRIPTION:

BRIDGE GIRDER

The crane bridge shall be of double girder box type. The size of girder and strength of the plate used shall be such that it has enough strength to carry the rated load without causing undue stress or deflection as per IS 807. The design should ensure that deflections in the steel structure do not affect the drive-unit alignment. Each girder shall carry a rail on which a wheeled trolley shall run. The closed box sections of crane shall have breathing holes for venting. The material of construction of the girder shall be mentioned in the detail drawing to be prepared by crane vendor after placement of order and it shall be subjected to approval of purchaser. Any subsequent change, in the material of construction from the approved drawing, by the Vendor will need approval of NPCIL.

END CARRIAGE

End carriages connected with bridge girder at the both ends shall be made from structural steel and it shall be designed as per IS 807/800 for the rated load on the crane. End carriage design shall be such that it facilitates easy removal of the wheels for maintenance. Suitable jacking pads shall be provided for maintenance and easy removal of crane wheels. The wheels shall be double flanged machined on their treads to match the runway rail section. Wheel base and structural frame of the end carriages shall be designed and connected with bridge girder in such a way that the equipment remains square and skewness is prevented. The material of construction of end carriage shall be mentioned in the detail drawing to be prepared by crane vendor after placement of order and it shall be subjected to approval of purchaser. Any change in the material of construction from the drawing shall be done with the prior approval of purchaser

ROPE DRUM

Rope drum shall be either fabricated or seamless pipe of required diameter and thickness to withstand the rated load. It shall be designed as per IS 3177. Drums shall have machined groove, right and left of a proper size for the rope used. Grooving shall be of adequate length, to handle entire rope required to make the specified lift plus the two dead laps at each anchor point, without overlapping, as per IS 3177. The allowable stress on rope drum should be as per IS 800 / IS 807. In case of welded drum, same shall be stress relieved. The material of construction shall be mentioned in the detail drawing to be prepared by crane vendor after placement of order and it shall be subjected to approval of purchaser

WIRE ROPE

Wire ropes shall be extra flexible with well lubricated hemp core having six (6) strands of thirty-seven (37) or thirty-six (36) wires per strand of adequate strength as per the loading on the rope with a factor of safety as per relevant IS. Wire ropes shall be of Right Hand Ordinary (RHO) lay construction. The rope shall be fastened to the drum with an anchor having strength equal to that of the rope. Three such ropes anchors shall be provided at spacing of 120º on circumference of rope drum at both ends of rope. The rope fastening at the swinging end shall be aligned so as to prevent rope coming off its reeving.

Rope shall be of sufficient length so that three (3) full laps remain on the drum at extreme low position of the hook. Reverse bends or cross bends and bird caging shall be avoided.

The breaking loads for the hoist ropes shall not be less than the factor specified in IS 3177. The load shall include rated load on hooks, weight of the bottom block and the weight of rope.

TOP AND BOTTOM BLOCKS

These shall be fabricated from plates of required thickness. Head blocks assembly shall be designed to maintain a vertical load balance about the centre of lift from load block Sheaves and equalizing sheaves, if provided, shall be as per relevant IS and it shall be designed for the rated load. These shall be equipped with anti-friction bearings. Grooves shall be machined to proper shape for the rope used. The material of construction shall be required to be mentioned in the drawing by the crane vendor and it would be subjected to approval by purchaser

Maximum fleet angle from drum to lead sheave in the load block or in between individual sheaves shall not exceed the IS specified value except at highest elevation the fleet angle may increase slightly.

GEARS

All gears and pinion for the cranes shall be forged rolled bar. The material of construction shall be either low carbon steel or medium carbon alloy steel and suitably heat treated as per the hardness and HP requirement. All gears and pinions shall be hardened suitably to meet the design requirement shall conform to IS 4460. The material of construction, hardness values of gears & pinion, method of heat treatment, HP rating of gear box shall be mentioned in the drawing by crane vendor for approval of purchaser. Split gears shall not be used. Gears and pinions shall be pressed on and keyed to shafts. All gears and pinions shall be totally enclosed type up to last stage of reduction in all Motions and shall be enclosed in fabricated steel gear boxes which shall be dust proof and firmly sealed to prevent oil leakages. Gear boxes shall have covers split horizontally and arranged such that top half can be removed for inspection. The gear boxes shall be fitted with bolted type machined inspection covers. Cast steel cartridge

housings shall be provided for carrying roller bearings. It shall be provided suitable method for indicating oil level. No overhanging gears shall be used. Drain plugs shall be provided on all gear boxes. Lifting lugs shall be provided for handling purposes.

All the gear boxes shall be provided with lube oil gears. Vertical gear boxes shall be provided with lube pumps.

SHAFTS, AXLES, COUPLINGS, KEYS AND SPLINES

Shafts and axles shall be of forged /rolled steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported. Shafts shall, as far as possible, be furnished straight. If shouldered, these

shall be provided with fillets of ample radius or shall be tapered to avoid loss of strength and stress concentration. These shall be designed considering allowances for keys and splines. The material of construction of shaft and axle shall be mentioned in the technical bid for evaluation. All couplings shall be of forged steel and shall be designed to suit the maximum torque that may be transmitted.

Keys and keyways shall conform to relevant IS specification. Splines and serrations shall be of involute or straight sided form and shall comply with relevant IS specification. All accessible shaft shall be properly guarded.

LIFTING HOOKS

The lifting hooks shall be as per relevant IS based on the capacity, for all cranes. All the hooks shall be solid, forged, heat treated, of rugged construction and provided with a standard type safety latch. Lifting hooks shall have swivels and operate on thrust bearings with hardened races. Lock to prevent hook from swivelling shall be provided.

WHEELS AND RAILS

Bridge and trolley track wheels shall be of forged straight tread or cast steel, in case of under slung cranes with tapered tread as per IS:3177. The hardness of the wheel rim shall be as per IS: 3177. The wheels shall be mounted in such a manner as to facilitate easy removal and placement. The material of construction, the hardness value and heat treatment method shall be mentioned in drawings for purchaser's approval.

The wheel diameter and rail sizes shall be suitably selected so as to meet the requirements of wheel loading for the specified duty class of crane. The rail fasteners with suitable washers shall be used to ensure full contact with the rail flanges. The bridge and trolley track wheel bearings shall be anti-friction roller bearing and shall be mounted on specially designed bearing support blocks of L type design (commonly known as L type bearing housings).

The wheel boxes shall have hinge at one end and a special spring at the other end to ensure all wheels have equal load at all times. Run way rail both CT and LT shall be designed as per IS 3443. It shall have adequate strength and rigidity. Rail clamps and other accessories shall also be provided.

Square bar sections can be used for smaller capacity crane subjected to condition that it withstands the required loading. The crane vendor is to submit the necessary design calculation in support of this for approval of purchaser. I beam section shall be used for under slung crane for LT and CT movement. The strength, size and rigidity of the selected section shall be as per IS 807/800.

BUFFERS, STOPS AND SWEEPS

Spring or hydraulic buffers shall be provided on the trolley and end carriage. Suitable end stops welded to the bridge girder shall be provided to limit mechanically the movement of trolley/ bridge at the end of travel.

Trolley wheel stops shall be welded at the end of rail and radius of the stops shall match with radius of the wheel to prevent trolley from running off the track. Wheel stops shall also be provided on long travel girder to prevent the end carriage from running off the LT girder.

Sweeps shall be attached to the end carriages and to the trolley, to remove foreign material from the rails.

GUARDS

All exposed couplings, shafts, gear wheels, pinions, drives etc. shall be safely encased and guarded. The sheaves of hook blocks shall be guarded to prevent trapping of hand in between a sheave and the in-running rope.

LUBRICATION

Centralised grease lubrication unit with hand operated grease pump shall be provided for anti-friction bearings. One unit shall be provided on bridge platform for line shaft anti-friction bearings and another unit shall be provided on trolley for top sheave and drum anti-friction bearings. All other anti-friction bearings shall be lubricated manually by hand operated grease pump through respective grease nipples.

Accessibility should be such that parts may be safely lubricated from the walkways or ladders. A steel box with hinged cover shall be provided. It shall be conveniently located and permanently fastened to the bridge girder side of the walkway for storing of tools, oil can, grease and waste. It contains proper tools necessary for minor repairs and maintenance work. Oil-grease collection tray shall be provided for the hoisting arrangement in the trolley to prevent spillage

WALKWAYS AND LADDERS

Safe means of access shall be provided to all places where maintenance/ inspection works are required to be carried out. Access walkways of minimum 750 mm clear inside width with hand railings on both sides of bridge girders for the full span length for inspection and maintenance of the crane shall be provided. Walkways shall be of chequered plate or non-slip steel surface of minimum 6 mm thickness. Walkways shall be of rigid construction and be designed to sustain a distributed live load of adequate rating.

All the platforms shall be complete with hand railings, posts and toe plate all around. The hand railings shall consist of 32 mm NB pipe in two tiers. Top pipe shall be at about 1 m and middle pipe shall be at about 450 mm height from the walkway platform level. Posts shall be spaced at 1.5 m maximum centres. Toe plate shall be 8 mm thick and shall project 100 mm above the walkway platform.

Ladder shall be provided to reach the cabin, If applicable, and girder rail level from the runway girder level. Ladder shall be 450 mm clear in width with 20 mm diameter rungs spaced at 300 mm centres and shall be equipped with safety cage. Ladder shall be provided at two suitable locations.

Necessary ladders shall be provided for easy access to all areas of the crane for operation and maintenance consideration.

SEISMIC DESIGN

Crane shall be designed for earthquake conditions as given in respective data sheet. Also bridge and trolley shall be designed to remain in place on their respective runways with their wheels prevented from leaving the tracks during seismic event.

The structured equipment shall be designed for seismic category-I. The bridge and the trolley with load on the hook shall be designed for SSE and OBE as per Floor Response Spectra furnished by the Purchaser.

Following are the minimum safety features, which shall be provided to prevent occurrence of accident due to derailment of crane, fall of load etc. in the event of earthquake:

1) End carriage and trolley shall be provided with earth quake lug on both the sides to prevent derailment of carriage / trolley during the seismic event. Gap between cross travel rail and bottom of trolley frame and also gap between long travel rail and bottom of end carriage shall be kept minimum possible to limit their drop-in case of failure of wheel, axle and bearing.

2) Suitable parking lugs shall be provided for locking the trolley and the crane when crane is not required for a longer period of time. Such clamps shall be designed to hold the crane in place during earthquake. Normal thruster brake used for LT and CT brakes can be qualified for this purpose if earth quake load is not high enough to open.

ELECTRICAL REQUIREMENTS

The cranes and its electrical requirements shall be designed for indoor use and based on the environment in which they are to be installed. On any point for which specific provisions are not made in this part of the specifications, appropriate Indian or British Standards shall be used.

POWER SUPPLY

Crane electrical equipment's except motors shall be designed for the power supply of 415 + 10% V, 3-phase, 3-wre, 50 Hz + 5%. AC. Motors shall be designed to 415 + 6% V, 3 –phase, 3 – wire, 50 Hz + 3%. as per relevant IS code and suitable for VVVF drive.

The power supply for the crane will be made available at a point near operating floor. Vendor shall provide an isolation switch at this point. The vendor's scope of supply shall commence from this isolation switch and includes crane electrical as elaborated here after. Transformers to step down the voltage and rectifiers, as necessary shall be furnished by the vendor. Following voltages are recommended to be used in the crane.

415 V, 3 phase 50 Hz AC	Motors, electro hydraulic thrustors, VVVF Drives
240 V, 50 Hz AC, Single Phase, 2 wire, Neutral Earthed	Panel Lighting Fixtures, Space heaters
110 V, Single phase, 50 Hz AC	Control circuit
24 V, Single phase 50 Hz AC	Hand lamp socket outlets and motor heating through winding.
Supply variations of AC System	
i) Variation of Supply Voltage	±10%
ii) Variation of Supply Frequency	±5%
iii) Combined Voltage & Frequency variation (arithmetic addition)	±10%
iv) Voltage unbalance	±3%
v) AC Supply Voltage harmonic	±5%

One secondary terminal of all the transformers shall be earthed.

POWER CONDUCTOR

Runway conductors shall be PVC insulated shrouded type copper conductor DSL. Spring loaded current collectors with fixtures shall be provided. Sufficient allowance shall be kept for wear and tear while selecting the runway conductors. The vendor shall also provide the flexible cable for the purpose of feeding power supply points from the runway conductors.

Necessary insulators, supporting brackets, etc. shall be furnished for support of runway conductor. Supporting brackets fabricated from MS shall be properly painted in order to prevent corrosion. Runway conductors should have sufficient spacing to avoid sparking and should not cause significant deflection.

The power conductors for power supply to crane shall comprise of four numbers of PVC shrouded copper bus bars for carrying 3 phase power & one number earth connection.

The size of bus bar shall be so selected to suit the total current requirement of EOT cranes. The sizing calculation is subjected to the approval of the purchaser. The necessary voltage drop shall be considered while selecting the bus bar sizes.

DSL indication lamps shall be provided on both ends of the DSL for each phase.

CROSS CONDUCTORS ON BRIDGE

For bridge conductors, flexible trailing cable systems mounted on retracting supporting system shall be supplied. The conductor shall consist of EPR insulated multi-conductor copper cables with permanent termination on the bridge and on the trolley. The flexible trailing cable shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cables. Consideration shall be given to the inclusion of spare conductors or provision for the later additional conductors.

INSULATION

The power cables from isolation switch to DSL shall be of 1100 V grade armoured XLPE insulated and PVC FRLS sheathed stranded copper conductor and for flexible cables PCP or EPR insulation shall be used. Other power cabling may be unarmoured.

POWER COLLECTOR

Power Collectors shall be suitable for copper conductor DSL and shall have adequate area and contact pressure for rated current. It should not cause sparking due to minor deflection of the power conductor in the middle of support.

Spacing between power collectors shall be such as to provide sufficient quenching area for sparks coming out from collector surfaces.

ELECTRIC MOTORS

The motors of the NPCIL approved make shall be provided. Motors shall be as per IS 12615, duty type S4 with CDF 40%, 150 starts / hour. Motors for long travel and cross travel, main and auxiliary hoist shall be totally enclosed, squirrel cage induction motors. Motors shall be suitable for operation with VVVF drive for crane duty, frequent reversal, braking and acceleration. The motors shall be totally enclosed fan cooled conforming to enclosure IP 55 and cooling IC 411 .

However, these motors need not be operated at those conditions. Motors shall be offered with class "F" insulation and temperature rise shall be limited to that of class "B" insulation (taking ambient temperature of 50 deg C). Terminal Box of Motor shall be of IP 55. The motor shall be designed for high starting and pull out torque and the same shall not be less than 200% of full load torque. Motors shall be connected to the shaft by means of a flexible coupling. The type and rating are to be decided on the basis of load transmitted and is subjected to the approval of purchaser. Wherever the motor name plate is not visible, a plate with duplicate information shall be provided where it can be readily seen. Name plates shall not be removed from the motors. In addition, condition laid down in PC-E-501&502. Motor data sheet for all motors shall be submitted to PURCHSER for approval before start of manufacturing of motor by motor vendor in the format given in the Annexure-B of specification PB-E-293. Type test certificates for same frame size motors for all motors shall be submitted for review at the time of inspection. Selected frame size rating shall be more than 110% of the computed kilowatt of the respective motors.

BRAKES

I) Hoisting braking system shall include two mechanical holding brakes, of Electro- Hydro-Thruster (EHT) for all industrial type cranes. The holding brakes shall be applied when power is off. Whenever power control brake malfunction and result in over speed during lowering, the holding brakes shall be automatically activated to switch off the power supply.

II) Each holding brake shall be designed to have torque rating not less than 150% of the full load Motor Torque. Manual operation of holding brakes shall be provided for hoisting to use during emergency conditions.

iii) For cross travel and long travel, one EHT brake shall be provided for industrial crane and for single failure proof cranes two EHT shall be provided. These brakes are designed to hold 1.25 times full load torque.

iv) Except power control brake for hoisting, all the brakes shall be of "fail-safe" design and they operate automatically in case of power failure. All brakes should have weather-proof enclosures. Brake linings shall not be subject to more than 80% of rated lining temperature. Adequate heat dissipation from the brake shall be ensured so that no damage occurs if the lowering velocity is permitted to increase excessively.

v) The mechanical holding brakes shall be of adequate capacity and their controls shall provide positive/reliable means to stop and hold the hoisting drums to withstand the full load torque of the driving motor

LIMIT SWITCHES

All the limit switches shall have min. IP55 class of enclosure. The contacts shall be rated for 10A, 500 VAC and min. 720 operation/hour.

Limit Switches for Hoist Motion and Auxiliary Hoist motion

The hoist motion shall be fitted with rotary geared limit switch, coupled to hoist drum. The limit switch shall have 2 contacts to operate for over hoisting and lowering position. Also, additional 2 contacts shall be provided for slow down to the creep speed in each direction as a safety measure. All the contacts shall be self-resetting by operating the crane in opposite direction.

Gravity limit switch

Rotary limit switch shall be backed by manual reset type gravity limit switch the limit switch is provided with counter weight which is lifted with wire rope to prevent over hoist position the

contacts of the gravity limit switch shall be wired in the circuit of main contactor to disconnect entire crane supply.

Limit switches for cross traverse motion & long travel motion

Trolley and Long Travel motion shall be provided each with 2 nos. lever type shunt limit switches for extreme traveling position in both directions. Additional limit switches for slow down the speed to creep speed shall also be provided in both the directions. Activation of slow down limit switches restricts the motion speed to creep speed. All limit switches shall be self-resetting by operating the motion in the reverse direction by spring action. The limit switch shall operate when it reaches a predetermined position when the lever is moved over a projecting member fixed to the girder/gantry. The limit switches shall be rugged and totally enclosed type with properly designed actuators and shall be readily accessible for adjustment and repair.

CONTROLLERS

i) All the motors of the crane shall be controlled by VVVF drives.

ii) The hoist and auxiliary hoist notions shall be provided with 4-wire pulse encoder feedback of minimum 1200 PPR.

iii) Independent VVVF drives shall be provided to control each crane motion. If two motors are provided for long travel motion they may be controlled by common drive with an overload relays in each motor circuit.

iv) All the master controllers shall be provided with zero position interlock. This shall be wired in the circuit of main contactor to ensure that the levers of all the master controller are in zero position during initial start-up of crane.

v) Relays and controllers in motion circuits shall be suitable for start-stop operation of around 150 times per hour.

ELECTRICAL PROTECTIONS

i) Start push button of the main supply shall be wired in series with the off-position contacts of all the controllers, thus requiring that all controller circuits are in „Off" position before the main supply contactor can be switched on.

ii) Under voltage interlock shall be provided to operate the main supply contactor and open the main contactor contacts and its holding contact.

iii) Hoisting motion shall be provided with encoder for speed feedback signal to drive to prevent any free fall conditions.

iv) All the motions of the crane shall be provided with over load protection. If VVVF drive has this provision no separate relay is required.

v) A timer protection shall be provided as an additional safety feature to engage the brake after certain time against the drive brake control contact failure.

EMERGENCY STOP PUSH BUTTONS

Emergency push button is to be provided in the pendent to stop the operation of the crane in any emergency situation. The switch will cut off the main supply on its actuation. Fire extinguishers (one no. in each place) shall be provided on trolley, in electrical cabinet and in operator's cabin (if applicable).

DOOR INTERLOCK FOR PANELS

Panel incoming switch-fuse unit or MCCBs shall be provided with drive interlocking so that the panel door shall be closed if the incoming supply is on. Padlocking facility shall be provided to lock the incoming switch-fuse uriit in OFF position while repair work is going on.

CRANE CONTROL EQUIPMENT

All control equipment for the crane shall be housed in totally enclosed weatherproof, insulated cabinets mounted on the crane, sheet steel cabinets. Separate panels shall be provided for the following:

Main power panel comprising the following:

- 415 V, 3 pole gang operated, manual air break isolating switch together with a set
- of three (3) suitably rated HRC fuses for the incoming power supply to the crane
- Red and green indicating lamps with series resistors to indicate „ON" and „OFF"
- conditions of the main power.
- Suitably rated 415V / 110 V single phase transformer for the crane control supply
- 110 V double pole, air break isolating switch across the primary and secondary
- of the control transformer
- Set of HRC fuses across the primary/ secondary of the control transformer
- 415 V / 240 V single phase, lighting transformer to supply the crane lighting
- loads receptacles and space heaters.
- 415 V double pole air break isolating switch together with suitably rated HRC
- fuses on the primary side of the lighting transformer and MCB for loads.
- 415 V / 24 V single phase, control transformer of suitable rating with double
- pole air break isolating switch together with suitably rated HRC fuses on the
- primary and secondary side of the transformer to supply the hand lamp and
- heating of motors through winding.
- Small wiring up to terminal blocks
- 415 V triple pole main contactor (IS class AC4) for controlling the incoming
- power supply, together with „START" and „STOP" push buttons.
- Space heaters with thermostat shall be provided for control panel heating in order
- to eliminate moisture.
- Separate panels for housing the control gear comprising VVVF drive, contactors,
- timers, isolators switches, HRC fuses, moulded case circuit breakers all brought
- up to terminal blocks, etc. inside the panel and push buttons, indicating lamps,
- operating handles, etc. brought out on the panel door shall be provided to add
- motion.
- 415 V triple pole air break isolating switch and fuse for each motor serving as
- drive for all driven on the crane.
- 415 V triple pole main contactor (IS class AC4) for controlling the incoming
- power supply, together with „START" and „STOP" push buttons.
- Power on indicating lamp.
- On / off/ drive trip indication lamps shall be provided.

CONTACTOR

Contactors shall be of heavy duty and suitable for frequent operation. Contactors shall be of AC4 duty type. Contactor coil shall be of impregnated type and temperature rise of coil for repeated operation should not exceed the permissible limit of class of insulation. Contactors current rating shall be at least 25% higher than the maximum current rating of motors being controlled.

CONTROL SWITCHES

Control switches for crane and hoist motions with more than one speed shall be spring return rotary switches fitted with piston grip handles of approved make. Switches for motions having single speeds and for stopping and reset may be of push button type, of approved make.

FUSE DISCONNECT SWITCHES

A fuse disconnect switch for crane shall be provided for installation at floor level in a location to be determined later. The switch shall be installed in a dust tight metal enclosure. The switch shall be capable of being locked in the open position and fuses shall have an interrupting capacity of not less than 35 MVA. The continuous current carrying capacity of the switch shall not be less than the short time ampere rating of the main line contactor

RECEPTACLES

Three, 3 pin, 240 V, 15 A and three 3 pin, 24 V (for hand lamp) single phase, polarized interlocked power receptacles shall be provided, one each located at the control cabinet and others at suitable locations like middle of the crane bridge etc. A hand lamp along with sufficient length of cable with a plug shall also be provided for each crane.

LIGHTING AND MISCELLANEOUS ACCESSORIES

Lighting shall be provided in staircases, platforms & working area including trolley areas. The minimum 100 lux level shall be achieved in working area. 100W lamps with Bulkhead fittings shall be used for staircases whereas 40 W LED shall be used in platforms and working area.
whereas 18W-20W LED Tube fittings shall be used in operator's cabin, platforms and working area. 4 Nos. of approx. 370W LED lamps complete with control gears continuously under the bridge for illumination of working zone.

VARIABLE VOLTAGE VARIABLE FREQUENCY (VVVF) DRIVES

The design, material, construction, manufacture, inspection, testing and performance of AC drives shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to IEC 146 or equivalent and the latest applicable standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. Equipment/ system shall conform to the latest applicable standards. The drives shall be selected such that the de-rated current rating (50ºC) shall be more than the rated full load current of the respective motor.

PENDANT CONTROL STATION

Cranes shall be provided with pendent control system. This shall be of movable type as per the data sheet of individual crane. This shall be operated at a height of 1m from the floor level. The pendent switches shall be capable of withstanding rough handling without being damaged and the cover shall be effectively secured. Means shall be provided to prevent inadvertent operation

from the floor while maintenance work is being carried out on the crane. An isolator fitted on the crane bridge which cannot be operated from the floor will comply with this requirement. The control push buttons in the pendent shall automatically return to the "OFF" position immediately after they are released. One key operated switch shall be provided to switch off control power when the crane is not in use. The weight of the pendent shall be supported independently by means of dog chain. If the pendent enclosure is of metal the same shall be effectively earthed. Indicating lamp shall be provided on the pendant to indicate the availability of power.

RADIO REMOTE CONTROL (RRC)

Radio remote control is required as per the data sheets of individual crane. Range of control for receiver shall be over the span of 100 m to make the unit free from noise and jamming, proper safety system shall be provided. The unit shall be maintenance free from dust accumulation. No interfacing panel is provided by Purchaser. Output relays of radio remote system directly operate the contactors in various control panels of different motions. Any surge suppressors, if required, shall be provided in receiver panel. Receiver on Panel shall be IP55, powder coated with shade 631 as per IS-5. Flexible antenna integral with receiver (detachable) shall be housed on the bridge. Frequency allocation shall be arranged by vendor Scope of Supply: 1-set consisting of transmitter, receiver with antenna & 2- Sets of batteries, 1-battery charger, commissioning of unit at customer's site.

OPERATOR's CABIN

The requirement of cabin/ pendent is specified in the data sheet of the crane. The operator's cabin shall be open type and suitable for indoor service. The cabin shall be fixed type fitted below the bottom level of the crane girder. The cabin shall have ample space for mounting of all control panels and adequate clearance for the safety of operator and maintenance personnel. The main control panel and associated resistors may be located outside the cabin on the trolley or bridge platform with adequate clearance for the safety of operator and maintenance personnel. The platform shall be of a non-slip surface and cabin. Size shall not be less than 2.5 m x 1.85 m x 2.0 m clear height

The cabin shall be provided with a swing way operator's seat and a protected ladder to access the crane walkway. It shall be adequately illuminated. The cabin and its access ladder shall be so arranged as to prevent personnel from making accidental contact with runway conductors. A permanent frame indicating complete instructions covering the crane operation, maintenance and lubrication shall be mounted in the cabin for convenient reference. A non-oscillating ventilation fan of 240 V AC, single phase and with suitable guard shall be provided in the cabin. The fan shall have 300 mm sweep and equipped with toggle switch and an independent regulator. The cabin shall be fitted with a 300 mm diameter hand operated brass gong. The gong shall be securely suspended outside the cabin and operated by the cabin driver through a hammer tied by a flexible steel wire. In addition to this an electrical horn shall be provided and mounted on underside of the cabin, operated by foot switches as and when required by the operator. Horn shall be of heavy-duty howler to produce 95 db. at 3.5 m, double bell projector suitable for 240V AC operation. A single 3 Kg CO_2 type fire extinguisher conforming to IS 2878 and with TAC/LPA approval shall be provided in the cabin. Some of the crane are provided with both cabin/pendent and radio control systems. They are to be provided with mutually exclusive interlocks to operate only one at a time. Also, authorisation for shifting controls from cabin control/pendent to remote

radio control shall be provided in the control cabin only. The protection from interference from other radio-controlled systems is to be provided as indicated in IS 3177.

WIRING

The vendor shall furnish and install all power, control and auxiliary circuit wiring of the equipment and panels. The wiring shall be complete in all respects to ensure the proper functioning of the equipment.

Power wiring to any motor shall be done with 1100 V grade HRPVC insulated and PVC FRLS overall sheathed, insulated copper conductor cables of suitable sizes. Minimum size of cable for power wiring shall not be less than 4 sq. mm size for copper conductor cable.

All control wiring shall be done with 650 V PVC insulated copper conductor cable of minimum cross section 2.5 sq. mm. For selecting the rating of the cables for wiring, consideration shall be given to the duty of the motor, ambient temperature, grouping or disposition of the cables, voltage drop etc. Each motor shall be wired up independently. Power and control wiring shall be effectively separated. For control panel wiring, each wire shall be identified at both ends in accordance with vendor's wiring diagram. All wiring termination to the panel shall be made with clamp type connection block. Screw type terminals with screw directly impinging on conductor are not acceptable. Multi-way terminal block completes with screws, nuts, washers and marking strips shall be furnished for terminating the panel wiring and outgoing panels. Terrninal blocks for control cables will be of Elmex type. In no case, shall more than one wire be connected to any terminal ways. If necessary, a number of terminals shall be jumpered together to provide the wiring points. At least 25% spare terminal blocks shall be provided in each control panel. Each of the terminal blocks shall be identified in accordance with vendor's wiring

GROUNDING

The crane structure motor frame and metal cases of all electrical equipment including metal conductors or cable guards shall be effectively connected to earth complying with Indian Electricity rules. Motors shall have connection to main earthing conductor with the following sizes of lead of GI strip of following size:

Motors above 30kw – 35x6 GI FLAT (2 leads)

Motors 30kw or less – 25x3 GI FLAT (2 leads)

Panels - 35x6 GI FLAT (2 leads)

Push button station / Marshalling box / JBs – 8 SWG GI wire (2 leads)

If any equipment is connected to the supply by flexible cable, the cable shall have additional core for earthing the equipment. Purchaser will arrange to connect the station ground riser to runway rails and earthing runway conductor. Two grounding points for the crane shall be ensured by taking one earth connection from the runway conductor through collector and the other from the runway rails through the carbon brushes and rails. Rails shall be connected by GI strip for electrical continuity. All current carrying equipment shall be grounded at two point. Panel doors shall be grounded with a flexible wire.

PAINTING

Before packing and dispatch, all crane structures/parts/equipment/components of mechanical and electrical parts shall be thoroughly cleaned by sand blasting or shot blasting (except machined surfaces) to remove all dirt, grease, scale and rust and painted with two coats of epoxy finished paint. Total DFT shall not be less than 250 microns. Structural portions of the cranes hall

be painted with Light Orange (557) all the machined surfaces shall be coated with anti-rust black compound. Electrical component shall be epoxy based painting of Air Craft Grey Shade No. 693 all the interior of panel shall be coated with epoxy based brilliant white shade. Alternatively, powder coating is acceptable for panel. In such cases, the DFT shall not be less than 50 microns.

INSPECTION AND TESTING

The Vendor shall conduct all tests required to ensure that the equipment and material furnished shall conform to the relevant standards/ Manufacturer's standard practice.

Performance test, load test and overload test shall be conducted in the Manufacturer's shop as per approved procedure and QAP in presence of Purchaser's representative

- All the crane components and materials used in manufacturing the crane shall be subjected to testing as per the manufacturer's standard QAP. However major components and materials used to manufacture various assemblies shall be tested as per the approved QAP. Vendor shall prepare a QAP in-line with the indicative QAP attached in Annexure–2 suiting to their manufacturing procedure and shall obtain the purchasers approval before start of manufacturing.
- Inspection to be carried out as per approved QAP. Supplier shall prepare QAP based on the indicative QAP attached as annexure-2, for approval of purchaser.
- Manufacturing, fabrication, NDT and shop test procedures to be submitted for approval.
- The Purchaser's representative shall be given full access to the shop in which the equipment is being manufactured or tested and all test records shall be made available to Purchaser. A final inspection will be done by the Purchaser's representative before the dispatch of the equipment. Final tests of the complete units shall be carried out in the presence of the Purchaser's representative. If not otherwise specified in Indicative QAP, the inspection and testing requirements escribed in this section shall hold good. Else, enclosed Indicative QAP shall govern.
- The Supplier shall provide the facility for inspection to ensure that quality of workmanship in his works and of his Sub-Contractor, compliances with drawings,
- identity and acceptability of all materials, parts and equipment. He shall conduct
- all tests required as per approved QAP to ensure that the equipment and material
- furnished conforms to the requirements of the approved QAP. All tests and test
- procedure proposed by the Manufacturer shall be submitted to the Purchaser for
- his prior approval. The Purchaser shall be notified well in advance of the
- inspection requirement as per QAP, particularly for hold points/witness points.
- All material used for manufacture of the equipment covered under this
- specification shall be of tested quality. Relevant test certificates shall be made
- available to the Purchaser before the final shop inspection. In case the relevant
- correlating test certificates are not available, the Supplier shall arrange to carry out
- the necessary tests required as per the QAP at his cost. Parts found unsatisfactory
- as to workmanship or material, shall be removed by the Contractor and replaced by parts which are satisfactory.
- No welding or repairs shall be carried out without prior permission of the Purchaser.
- Performance test, load test and over load test shall be conducted in shop for each of the hoists in accordance with relevant approved procedure.
- After all the individual cranes components are cleared by NPCIL QS, the vendor shall arrange for crane complete assembly and shall conduct the following tests.

- The long travel in full/partial and span including the splice joint shall be erected either indoor or outdoor as may be convenient.
- Shop tests for ensuring proper functioning of machinery and components, shall be conducted as per approved procedure.
- The deflection of the girder shall not be more than as specified in IS 807. The vendor shall also carry out performance tests for the following.
- Speed, current, voltage and wattage shall be recorded for individual motions at no load, full load and shall be recorded in the format of approved load test Procedure.
- Functional test of control panel by simulating working conditions.
- Insulation resistance test.
- High voltage at 2.5 KV for one minute.

After erection of the crane with all components including limit switches and erection of rail at site, manufacturer shall perform load test, performance test and over load test for the crane.

DANGER BOARDS/ RATING PLATE/ CAPACITY PLATE

Danger boards having information written in Hindi, English and regional language shall be provided on all electrical equipment with a voltage of 415 V and above. The boards shall have the skull and cross bones danger sign together with the inscription DANGER 415 VOLTS and the corresponding translations inscribed in white letters on a red back ground.

All the major equipment's like gear box etc. shall have rating plates as per manufacturers standard showing the equipment name rating, vendors component number, if any etc.

Plate showing the capacity of the crane, crane Tag No. as specified in our data sheet shall be provided on the bridge on both the sides of the crane in readable font size from the operating floor.

For all major equipment, the VENDOR shall provide appropriate structural steel members/bracket for mounting various handling devices which are necessary for the component's erection and maintenance

Technical Data Sheet of EOT Crane

S.N.	Description	Technical Particulars	
1.0	**Design, fabrication and testing of the crane confirm to standard / code number**	IS: 3177-2020 & IS 807-2006	
2.0	**Number of crane/s**	2Nos. 125/25T EOT Crane in Turbine Hall (One per Unit) 2Nos. 25T Auxiliary EOT Crane in Turbine Hall (One per Unit)	
3.0	**Crane classification**	M5 (Mechanical and Electrical)	
4.0	**Suitable for outdoor or indoor duty**	Indoor	
5.0	**Capacity (T)**	**TG CRANE**	**AUX. TG CRANE**
5.1	**Main hoist**		
	Rated SWL – tones	125	25
	Test load SWL – tones	(125% of SWL)	
5.2	**Aux. Hoists**		
	Rated SWL – tones	25	NA
	Test load SWL – tones	(125% of SWL)	
6.0	**Span**	As per attached crane clearance diagram	
7.0	**Operation from**	Operator Cabin + RRC + Pendent push button	Pendent push button + RRC
8.0	**Crane Performance**		
8.1	**Crane speed with full load**		
	Main Hoist (M/Min.)	2.0	2.0
	Aux. Hoist (M/Min.)	4.0	NA
	Crab travelling speed (CT motion) (M/Min.)	6.0	6.0
	Crane travelling speed (LT motion) (M/Min.)	8.0	10.0
	Creep speed M/Min	@ 10% of main speed for all the motions through VVVF drive	
8.2	**Lift in Meters**		
	Main Hoist	As per Crane Clearance Diagram	

	Aux Hoist	As per Crane Clearance Diagram		
8.3	**Hook Approaches**	As per Crane Clearance Diagram		
8.4	**Hand rail pipes**	32 mm NB having top and bottom rail at height of about 1100 mm and 450 mm and vertical post spacing not exceeding 1500 mm with provision of kick plate (100 mm high and 8 mm thick)		
9.0	**Component Detail**			
9.1	**Trolley**			
	Type	Fabricated		
	Method of fabrication	Welded		
	Material conforming to IS:	IS: 2062 Gr.BR		
9.2	**Rope drums**			
	Material	As per IS 3177 - 2020		
	Numbers provided	One for each hoist		
	Type of grooves	Identical Right hand and Left hand		
	Flange /Flangeless	Flanged		
9.3	**Rope details**			
	Standard	IS:2266		
	Construction	Extra flexible plough steel / 6 x 36 or 6x37 construction		
	Factor of safety	As per IS 3177-2020	As per IS 3177-2020	
	Type of core	Steel	Steel	
9.4	**Sheaves details**			
	Material	As per IS: 3177- 2020		
	Type of guards provided	Fabricated from rolled steel plate		
9.5	**Coupling & Shafting**			
9.5.1	**Coupling details (between motor and gear box)**	Main Hoist	Cross Travel	Long Travel
	Type	As per IS 3177 - 2020		
	Guards and Enclosures	Provided		
9.5.2	**Coupling details (gear box and wheels)**	Cross Travel	Long Travel	
	Type	As per IS 3177 - 2020		
	Guards and Enclosures	Provided		
9.5.3	**Coupling details (gear box and rope drum)**	Main Hoist		
	Type	As per IS 3177 - 2020		

	Guards and Enclosures	Provided	
9.5.4	**Shafting (Output)**		
	Factor of Safety	As per IS: 3177 - 2020	
	Arrangement of Lubrication	Centralized lubrication System	
	Type of Lubricant	Grease	
9.6	**Gear box details**		
A.0	**Hoist Motions**	MH	MH Micro
	Type of mounting of gear box	Horizontal / Vertical	
	Classification	Suitable for M5 duty	
	Type of gears	Helical / Spur	NA
	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication/ Vertical gearbox shall be provided with lube pump	
	Difference in Gear and pinion hardness	Min 20 BHN	
	Material (Gear/pinions)	As per IS: 3177 -2020	
	Casings	Fabricated IS: 2062 Gr BR	
B.0	**Travel Motions**	CT	LT
	Type of mounting gear box	Horizontal / Vertical	
	Classification	M5 duty	
	Type of gears	Helical/Spur	Helical/Spur
	Type of lubrication (grease / splash / pump lubrication)	Splash Lubrication/ Vertical gearbox shall be provided with lube pump	
	Difference in Gear and pinion hardness	Min 20 BHN	
	Materials (gear / pinions)	As per IS: 3177-2020	
	Casings	Fabricated IS: 2062 Gr BR	
9.7	**Wheels details**	Cross travel	Long travel
	Material	As per IS: 3177-2020	
	Hardness	As per IS: 3177-2020	
	Type	Double Flanged	
	Specification conforming to	IS: 3177-2020	
	Arrangement of lubrication	Grease	

9.8	**Lifting hooks**		
	Type	**125T Hook** - Ram shorn, shank with safety latch swivelling type as per latest edition of IS: 5749 **Other Hook** - Plain with safety latch swivelling type as per latest edition of IS: 15560	
	Material	**125T Hook** - Class 2 as per IS 1875:1992 (re affirmed 2004) for hooks conforming to IS: 5749 **Other Hook** - As per IS: 15560	
9.9	**Brakes**		
A.0	**Hoist Motions**	DOUBLE GIRDER CRANE	
	Type of brake	AC Electro-Hydraulic Thruster operated	
	Number provided	2	
	Braking capacity	150%	
B.0	**Travel Motions**		
		CT	LT
	Type of brake	AC Electro-Hydraulic Thruster operated/ DCEM	AC Electro-Hydraulic Thruster operated / DCEM
	Number provided	For 125T – 1 +1 For 25T – 1 ACEHT	For 125T – 1 +1 / Per Motor For 25T – 1 ACEHT
	Braking capacity	125%	
9.10	**Bearings**		
	Type	Antifriction ball / roller bearing	
	Method of lubrication	Grease lubrication	
	Bearing life	10,000 working hours.	
9.11	**Bridge girder**		
	Type & Quantity	Box type / ISMB, Material: IS 2062	
	Vertical Deflection	As per IS 807	
	Type of connection to end carriage	By fitted bolts	
9.12	**Rails-Bridge girder**		
	Type / section	Rails sections as per IS: 3443 / End clamping	
	Standard conforming to	IS: 3443	
	Material	50C12 or 55C11	
10.0	**Motors**	Suitable for ambient temperature of 50 deg. C	
10.1	**Hoist Motions**	MH	MICRO

	Type	Squirrel Cage, suitable for Inverter duty	NA	
	Cooling	IC411	IC411	NA
	Nurnbers furnished	1	1	NA
	Voltage, phase and frequency	3 Ph., 3 wire, 415V + 6%, 50 Hz + 3%		
	Class of protection	IP – 55		
	Rated capacity (KW)	The motor shall be suitable for 150 starts / hr. and 40% CDF. Motor nameplate rating at 50 deg. C shall have Motor rating will be calculated keeping margin of 10% over the computed KW.		
	Duty	S4, 40 % CDF		
	Class of insulation	Class 'F' for sq. cage motors with temp rise limited to that of class B		
	Number of starts/ hour	150 starts / hr.		
	Pull out torque	The pull-out torque of the motor will not be less than 200 % of the full load torque.		
10.2	**Travel Motions**	CT	LT	Micro
	Type	Squirrel Cage, suitable for Inverter duty	Squirrel Cage, suitable for Inverter duty	NA
	Cooling	IC411	IC411	NA
	Numbers furnished	1	2	NA
	Voltage, phase and frequency	3 Ph., 3 wire, 415V + 6%, 50 Hz + 3%		
	Class of protection	IP – 55		
	Rated capacity (KW)	The motor shall be suitable for 150 starts / hr and 40% CDF. Motor nameplate rating at 50 deg. C shall have Motor rating will be calculated keeping margin of 10% over the computed KW.		
	Duty	S4, 40 % CDF		
	Class of insulation	Class 'F' for sq. cage motors with temperature rise limited to that of class B		
	Number of starts/ hour	150 starts / hr		
	Space heater requirement	For motors above 30 KW rating		
	Pull out torque	The pull-out torque of the motor will not be less than 200 % of the full load torque.		

11.0	**Limit switches**	Main hoist	Cross Travel & Long Travel	
	Type	Rotary gear (screw type) + Gravity	Lever type (one way/ two way)	
	Nurnber provided	1 + 1	1 + 1	2/1
	Control voltage/ Enclosure	110 V/ IP 55		
12.0	**Power conductors (DSL)**	DSL indicating lamp shall be provided at both ends		
	Type	LT: PVC shrouded Cu conductor bus bar. CT: Flexible trailing cable mounting on retracting support (Festoon type) EPR insulated type/ Drag Chain Type		
	Length	Suitable for entire bay length		
13.0	**Control panel**			
	Material	Rolled sheet steel Min. 2mm size		
	Degree of Protection	IP 54		
	Illumination	Internal illumination with florescent lamp		
14.0	**Cable**	Power	Control	
	Material	Copper	Copper	
	Size	Min. 2.5 mm2	Min. 2.5 mm2	
	Type	XLPE FRLS	PVC FRLS	
	Voltage grade	1100 V		
	Voltage drop	Cable from main isolating switch (1.5M above operating floor) to motor terminal shall be so sized that the voltage drop does not exceed 3% of rated voltage.		
15.0	**Power Supply**	415 V, 3 phase, 4 wire supply at operating floor at centre of bay length.		
16.0	**Illumination**			
	Over Bridge	4 nos. 18-20 W LED Tube fittings		
	Under bridge	4 nos.370 W LED Lamps		
	For inspection of crane components	One (1) portable 40W hand lamp with min. half span length flexible cable for inspection of crane components		
17.0	Buffer	Cross Travel	Long Travel	
	Nurnber	4	4	
	Type	Spring buffer		

18.0	**Type of platform required on the bridge**	Chequered plate platform 6 mm thick as per IS :3502
	Length	Full span length
	Type of access from gantry girder level to crane bridge	Rung ladder at ends from gantry girder level walkway to crane bridges walkway
	Type of access to maintenance cage from crane bridges walkway	Rung ladder
	Provided at both ends	Yes
19.0	**Master Controllers**	
	Voltage & current rating	415 V/10 A
	Location	In Cabin
20.0	**Fire Extinguisher**	
	Type and size	4.5 kg, CO2 type
	Numbers & Location	**For 125T Crane** - One no. in Cabin and Three on bridge for Main TG Crane **For 25T Crane** - Two on bridge
21.0	**Load Cell**	One no for each crane (Display Type)
22.0	**Type of control for Hoists/ CT/LT operation**	Through VVVF drive
23.0	**Sweep**	Sweep shall be attached to the end carriages and to the trolley to remove foreign materials from the rails.
24.0	**EARTHQUAKE LUG AND PARKING LOCK provided**	Yes.
25.0	**SEISMIC DESIGN**	AS per IS 1893

QAP EOT Cranes

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
1A	MATERIAL STRUCTURAL RAW MATERIALS										
1	Bridge Girder End Carriages Trolley frame.	M.S. As per IS 2062 Gr. A/B	Physical(Tensile test & bend test)	Major	Material Specification IS - 2062	Material Specification IS - 2062	T. C.	3	2,1	1, 2	Refer note No.1 Plates used for construction of main frame of Box Girder, End Carriage, Trolley Box are only to be offered for inspection.
			Chemical	Major	DO	DO	T. C.	3	-	1, 2	Note: Above 25mm thk. plate U.T. Required.

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
2	Rope Drum	M S As per IS 2062 Gr. A/B ASTM -106 Gr B	Physical(Tensile test & bend test)	Major	IS-2062 Gr. A /B ASTM 106 Gr.B	IS-2062 Gr. A /B ASTM 106 Gr.B	T. C.	3	2,1	1, 2	Refer note No.1
			Chemical	Major		DO	TC	3		1,2	
			Ultrasonic Testing	Major	Approved test procedure	Approved test procedure	IR	3	2,1	1, 2	.
			(if fabricated from plate above 25 mm thick)								

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
3	Gears, Pinion, CT shaft & o/p shaft	As per manuf c-uring drawing / manuf c-uring Specification	Physical(Tensile test Chemical	Major	Material Specification	Material Specification	T. C.	3	2,1	1, 2	
			UT After Proof machining	Major	NPC approved procedure	NPC approved procedure	I.R.	3	2,1	1, 2	At random (10%) UT Witness for gears, pinions
			Hardness after H T	Major	As per relevent standard	As per relevent standard	I.R	3	2,1 10%	1,2	At random (10%) hardness test witness.
3a	Wheels LT & CT	As per manuf act -	Physical(Tensile test	Major	Material	Material	T. C.	3	2,1	1, 2	
		uring drawin	Chemical		specification	Specification	T. C.	3	-	1, 2	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
		g/									
		Matl Specification	Ultrasonic testing after proof machining	Critical	As per appd. test procedure	As per appd. Test procedure	I. R.	3	2,1 10%	1, 2	
4	Pulleys (sheaves)	IS-1030 / M.S. as per IS 2062 Gr.A/B	Physical(Tensile test)	Major	Material specification	Material specification	T. C.	3	2	1, 2	Refer note No.1
			Chemical		Material specification	Material specification	T. C.	3	-	1, 2	
5	Hooks & Nut	Forged steel	a) Chemic	Major	Material Spec.	Material Spec.	T. C.	3	-	2, 1	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
		as	al								
		per IS - 1875 Class - 2	b) Ultrasonic Test	Critical	Material	Material	T. C.	3	1,2	2, 1	
			c) Physical after heat treatment	Critical	Material Specification	Material Specification	T. C.	3	1,2	2, 1	
			d)Proof Load test as per IS 5749/ IS 15560	Major	As per IS 5749/ IS - 15560	As per IS 5749 /IS - 15560	I. R	3	1, 2	2, 1	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
			e) Magnetic Particle test before & After Proof load test	Major	As per NPCL approved proc.	As per NPCL approved proc.	I. R	3	1, 2	2, 1	CHP for MPI after proof load test MPI before proof load test will not be witnessed by NPCIL , however. Vendor will witness the same.
6	Trunnion (Cross head)	Forged steel as per IS - 1875 Cl-2	Physical	Critical	Material Spec.	Material Spec.	T. C.	3	2	1, 2	
			Chemical	Major	Material Spec.	Material Spec.	T. C.	2	-	1, 2	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
			Ultrasonic testing	Major	As per appd procedure	As per appd procedure	I. R	2	1, 2	1, 2	
7	Wire rope	IS 2266 size as per drawing	Breaking load test	Critical	IS-2266	IS-2266	T. C.	3	1, 2	1, 2	If mfgr's T.C correlation with the reel no of wire rope drum is possible, breaking load test not required. Otherwise samples to be identified and tested for Breaking load.

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
8	Rails – CT & LT	As per IS 3443 IS 2062 Gr. A/B	Chemical Hardness	Major	As per IS 3443 IS 2062 Gr. A/B	As per IS 3443 IS 2062 Gr. A/B	T.C. / I. R.	3 2	2,1 10%	1, 2	
1B	**IN PROCESS INSPECTION - FABRICATION OF ITEMS**										
1	WELDING (a) Welding Procedure/ PerformanceQualification	--	Test as per ASME Sec. IX	Major	Appro. WPS & PQR	As per ASME Sec. IX	WPS/WPQ/PQR report	2	-	1	In case qualified welder already available and doing the same job regularly requalification not required WPS & PQR to be approved by

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
											NPCIL.
2	(a) Welding joints of box, girders, rope drums, pulleys (if fabricated),Trolley frame & End carriages										
	(I) Fillet weld	--	D P Test	Minor	As per appd. Procedure	As per appd. Procedure	I. R	3	1,2 10%	1, 2	At Random DP test witness by NPCIL on final pass 100% witness by Vendor.
	(ii) Butt welds (Load bearing member)	--	RT& DP	Major	As per appd. Procedure	As per appd. Procedure	RT Films IR	3	2,1 10%	1, 2	Radiographs will be reviewed by NPCIL . DP test will be

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
											witnessed by Vendor on 100%
	(iii) Stress relieving only for rope drums (if fabricated from plates) & gear box casings	–	--	Major	As per approved proc.	As per approved proc.	HT Chart	3	-	2, 1	Review of HT Chart
1 C	**Machining of items**										

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
1	Gears and Pinions	Material as per drawing/ Specification	MPI / DP Test	Major	As per approved Procedure	As per approved Procedure	I. R	3	2,1 10%	2, 1	
2	Wheels	As per drawing	Hardness	Major	–	–	I.R	2	2,1 10%	1, 2	At random (10%) hardness test witness.
3	Gear box Casing (Casing Material)	M S as per IS - 2062 Gr. A/B	Stress Relieving	Major	As per Mfg drawing / approved Procedure	As per Mfg drawing / approved Procedure	I. R.	3	-	2, 1	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
		Weld joints	DP	Major	As per approved Procedure	As per appr'd Procedure	I.R.	3	2	2,1	
II	Electrical Items (a) Motors -	IS 325	Type & Routine test	Major	Data sheet	IS 325	T C	3	2	1, 2	
	b) Brakes	IS 3177	Performance	Major	catalogue	catalogue	T. C	3	-	2, 1	
	c) Cables	IS 9968 / IS 1554	Verification of type & ratings	Major	As per cable schedule	As per IS 9968 / IS 1554	T. C.	3	-	2, 1	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
	d) Control panels, VVVF panels & pendant	As per Mfg's standard	Continuity test, Painting DFT, IR, HV test, functional test incl. Sequential operational test	Major	Approved drawing	As per manufacturer's standard	I. R.	3	2,1	1, 2	CHP FOR HV&IR Test.
	e) Limit Switch	–	Performance test	--	Catalogue	As per mfg. standard	T. C.	3, 2	-	1, 2	
	f) Runway Conductors (DSL)	–	HV, IR	Minor		As per manufacturer's standar	I. R	3	-	1, 2	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
						d					
	g) Radio Remote Control	As per Mfg"s std	Performance test	Minor	Catalogue	As per Mfg"s Std	I. R	3	-	1, 2	License for radio frequency shall be submitted
III	**Assembly**										
1	Girder & End Carriages with LT wheels after assembly		Dimensions of structural assembly & skew	Major	G A Drawing	As per approved drawing / IS 3177 / Mfg"s std	I. R.	2	1, 2	1, 2	Dimensions as per Approved GAs are only to be measured.

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
2	CT & LT Wheel Alignment		CT wheel gauge base, water level	Major	G A Drawing / Crab sub assembly drg	As per drawing / IS 3177 / Mfg"s std	I. R.	2	1, 2	1, 2	
IV	**Operational test and Load test at Manufacturer's works**					As per drawing /					
1	Load & Over Load Test		As per approved procedure	Major	As per approved procedur	IS 3177 / Mfg"s standard	I. R	2	1, 2	1, 2	

Sl No	Component & Operation	Material Specification	Characteristics of checks	Classification	Reference Documents	Acceptance Norms	Format of Record	Agency			REMARKS
								P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
2	Painting		Visual		As per Speci / procedur			2	2	1 , 2	
V	History Document							2	-	1, 2	First copy to be approved by NPCIL QS.
1 : NPCIL VENDOR				2 : CRANE MANUFACTURER							3 : SUB
P : PERFORAMANCE AGENCY, AGENCY				W : WITNESSING AGENCY,							V : VERIFYING
T.C. TEST CERTIFICATE, INSPECTION REPORT				T.R. : TEST REPORT,							I.R. :
C.H.P.: CUSTOMER HOLD POINT - CUSTOMER IS NPCIL											

Note 1: In absence of co-relating Mill Test Certificate, NPCIL approved lab test TC of sample identified by NPCIL QS will have to be submitted.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: DOUBLE GRIDER EOT CRANES

SCOPE OF VENDOR: SUPPLY , ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

S. NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 4W) supply feeder only up to isolating switches for cranes. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel.
2	Power cables, control cables, screened control cables and any special cables (if required) between equipment supplied by vendor.	Vendor	Vendor	Cable from supply feeder to isolating switch shall be in BHEL scope.
3	Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).	Vendor	Vendor	
4	Equipment Earthing	Vendor	Vendor	All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL.
5	Motors	Vendor	Vendor	
6	Cable glands and lugs for equipment supplied by vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

1.0 SCOPE

This specification covers the technical requirements for design, manufacture, inspection, testing, supply and guarantee of Medium voltage induction Motors of capacity greater than 50kW.

2.0 STANDARDS

The motors shall conform to the latest editions of the following standards unless specified otherwise in this specification.

IS	325	:	Three-phase induction motors - Specification
IS	12075	:	Mechanical vibration of rotating electrical machines with shaft heights 56mm and higher- Measurement, evaluation and limits of vibration severity
IS	14578	:	Three-phase induction motors for use in nuclear power plants - Specification
IS	12615	:	Energy efficient induction motors - Three phase squirrel cage
IS	9283	:	Motors for submersible pump sets - Specification
IS	15881	:	Three phase cage induction motor specifically designed for IGBT converter supply - Specification
IEC	60034	:	Rotating Electrical Machines

In case of conflicts, requirements stated in this specification shall govern.

3.0 OPERATING CONDITIONS

3.1 Motors shall be suitable for continuous operation under the following operating conditions:

1.	Ambient temperature at the location of motor	50^0 C
2.	Site altitude	Less than 1000mtrs
3.	Humidity	90% at 40^0 C
4.	Rated voltage and its variation	415V+/-10%
5.	Rated frequency and its variation	50Hz+/-5%
6.	Number of Phases	3
7.	Combined variation	10%
8.	Unbalance in supply voltage	3%
9.	Permissible harmonics in the supply voltage	5%
10.	Method of power supply system grounding	Effectively grounded system.

11.	Power supply voltages for auxiliaries	(a) 240V AC, 50Hz, 1-Phase for space heater. (b) 240V AC, 50Hz, 1-Phase or 24V DC for instrumentation and Controls.
12.	Temperature rise of motor winding under normal operating conditions of voltage and frequency (Measured by winding resistance)	70^0 C (except submersible & canned motor pump set)
13.	Temperature rise of motor winding under extreme conditions of voltage and frequency (Measured by winding resistance)	80^0 C (except submersible & canned motor pump set)
14.	Seismic requirements	If specified in Annexure-A, total assembly consisting of motor and driven equipment shall be qualified and documented to prove its capability to withstand specified seismic accelerations.
15.	Radiation dose for which motors located inside the reactor building required to be designed.	As specified in Annexure-A
16	External over pressure for motors inside reactor building during reactor building pressure test.	Motors and their auxiliaries shall withstand satisfactorily external pressure specified in Annexure-A

4.0 DESIGN REQUIREMENTS

4.1 General

4.1.1 Motors shall be designed, manufactured, inspected, tested and equipped with accessories in accordance with this specification, Annexure-A, Annexure-C, Annexure-D, Annexure-E and the applicable standards. Materials and components not specifically stated in this specification and which are necessary for meeting the operational and or performance requirements of this specification should be included in the scope of supply.

4.1.2 Design and manufacture of the motors shall be coordinated with the requirements of the driven equipment. The motor manufacturer shall co-operate fully with the Purchaser and the manufacturer of the driven equipment by furnishing required information for proper assembly and operation of the unit as a whole and to offer

a motor suitable for the driven equipment duty and application. Typically, the details that may have to be exchanged between the driven equipment vendor and the motor vendor would include:

i) A copy of this specification including annexure-A, Load Torque vs Speed characteristics, load GD^2, rated speed, number of starts/restarts, operating duty, load on bearings, mounting, provisions to be made by the motor vendor for ensuring proper coupling, instrumentation, location etc.

ii) A fully dimensioned outline drawing of the motor, shaft, mounting details and motor terminal box arrangement.

iii) Technical particulars and characteristic curves as asked in Annexure 'B' of this specification.

iv) If specified, submitting all details that are required by agency performing seismic analysis of motor and the driven equipment as a single unit.

4.1.3 When motors are purchased with the driven equipment, driven equipment supplier shall be responsible to the Purchaser for coordinating with the motor manufacturer for supply of required motors and accessories as per this specification and for satisfactory operation of complete unit.

4.1.4 Where the quantity is more then one, similar parts shall be physically and technically interchangeable between the motors.

4.1.5 All motors (other than canned & submersible pump motor) up to and including 132kW rating shall be of efficiency class IE3 of IS-12615 (2011) and efficiency class of motors beyond 132kW shall be as given in Annexure-A.

4.1.6 Motors if powered through electronic Pulse Width Modulated or any similar variable speed drives shall be suitably designed to take in to account harmonics and voltage surges generated by such drives. Suitability of the motor for operation with such drives shall be confirmed. CONTRACTOR shall coordinate between the drive vendor and the motor vendor so as to ensure total compatibility.

4.2 **Rotor**

4.2.1 The squirrel cage rotor design shall provide a rigid cage construction with aluminum die cast rotor. Alternatively, rotor with copper bars firmly wedged in slots and solidly bonded by brazing to the copper end rings is also acceptable. Brazing and brazing procedures shall be qualified in accordance with acceptable standards. The end ring assembly shall be such that it is free to move with the expansion of the bars without distortion. The rotor cage shall be designed to

operate satisfactorily under specified repetitive starting and load cycles. The rotor end lamination shall be rigidly fixed to prevent flaring.

4.2.2 Rotor shaft shall be of forged material. The shaft shall be ultrasonically tested as per Purchaser's specification No-PP-P-2012 and after final machining, dye penetrant tested as per PP-P-2396. Acceptance norms for defects in shafts shall be as per the PP-P-2012 and PP-P-2396 specifications.

4.2.3 Internal and external fans shall be metallic.

4.3 **Stator (except submersible & canned motor pump set)**

4.3.1 Motor shall be insulated to minimum class 'F' insulation with temperature rise limited to class B. The insulation system shall be of proven design and shall have high dielectric strength, high mechanical strength and long life.

4.3.2 Insulation system of the motor shall be vacuum impregnated. The whole assembly of stator winding and overhang shall be vacuum impregnated in resin/ varnish and heat cured.

4.3.3 The supplier shall describe insulation and insulation treatment and its capacity to meet the operating requirements specified.

4.3.4 Motor core and winding shall be protection against (a) tropical weather conditions (b) fungus growth and moisture (c) oil (d) abrasive and conducting dust and chemical fumes that are likely to be encountered in and around the power plant area. For this purpose manufacturer shall provide non-hygroscopic & non-digestible (to fungus/mold) insulation material and suitable gel coating .

4.3.5 Insulation at joints in the motor winding such as at coil connection etc shall be to the same level as that of complete motor. Additionally, joints should have minimum resistance and mechanically strong. Joints shall be braced to withstand various stresses likely to encounter during their service. Joints in stator windings shall be brazed in accordance with a qualified brazing procedure and a qualified brazer shall perform brazing. The brazing procedure and brazer qualification shall be performed in accordance with acceptable standards for brazing.

4.3.6 Overhang portion shall be adequately braced to withstand forces due to repeated restarts and fast transfer voltage conditions. The supports for the overhang portion shall be of non-magnetic material.

4.3.7 Motors located inside the reactor building shall be provided with insulation systems, wires, leads, terminal supports, gaskets, seals, lubricating oil or grease etc capable of withstanding specified level of radiation dose during its service life.

4.3.8 Stator windings shall be of insulated copper conductors.

4.4 **Resistance Temperature Detectors (RTD)**

4.4.1 Motors shall be provided with minimum of 2 RTDs per phase suitably distributed in the winding and terminated in a separate terminal box.

4.4.2 RTDs shall be 3-wire, duplex type or 5-wire simplex type.

4.4.3 One 3-wire, duplex RTD shall be embedded in each bearing respectively.

4.4.4 RTDs shall be platinum, having a D.C. resistance of 100 ohms at 0 Deg.C.

4.4.5 The RTDs shall comply with the latest editions of IS-2848

4.4.6 RTD insulation shall be minimum class-F. Winding RTDs shall be insulated from winding voltages. Teflon insulation and sleeving near terminal box is acceptable. RTD leads shall be shielded.

4.5 **Enclosure**

4.5.1 Type of enclosure shall be as specified in the specific requirements sheet (Annexure 'A').

4.5.2 Motors shall be self-ventilated unless otherwise specified.

4.5.3 All outdoor motors shall be provided with aluminum cover (Painted) to protect it and its terminal boxes from rainwater.

4.6 **Frame, End-shields, Fans and other fabricated parts**

4.6.1 These components of the motor shall be of rigid fabricated steel, cast steel or spheroidal cast iron. In case of alternatives, specific mention of the same shall be made in the offer indicating complete chemical and physical properties of material. However, use of such material is permitted only after obtaining Purchaser's approval against a specific request of vendor for use of such alternate material.

4.6.2 Weld joints involved in fabrication of motor frame, end shields etc shall be performed according to a qualified welding procedure and shall be performed by a qualified welder.

4.6.3 Welding Procedure Specification and Performance Qualification Procedure shall be as per ASME Boiler and Pressure Vessel code Section–IX. Weld surfaces shall

be subjected to NDT as per QAP and criteria for acceptance/rejection shall be as per PP-P-2396.

4.7 **Terminal Boxes (except submersible motor pump set)**

4.7.1 For all motors, separate terminal boxes shall be provided for each of the following.

i) Stator leads
ii) Space heaters
iii) Temperature detectors
iv) Instruments

4.7.2 Terminal boxes shall be fabricated from steel plates. The stator leads shall be brought into the power terminal box as an insulated cable through a suitable insulating barrier and terminated in clamp or compression type terminals.

4.7.3 Terminal boxes shall be sealed from the motor enclosure so as to prevent entry of dust and moisture from the motor.

4.7.4 Power terminal boxes for motors above 75kW ratings shall be suitable for withstanding fault current level of 50 kA fed by the network (to which the motor is connected) for 0.25 seconds (with out any back up HRC fuses).

4.7.5 Power terminal boxes complete with cable end box for motors above 75kW ratings shall be designed and tested at system voltage and 50 kA current level to prove compliance with the following requirements of this specification:

4.7.6 Following tests shall be made: (a) A three phase, through fault current test; the test shall not result in any mechanical or electrical damage to the terminal box and (b) An internal three phase to earth short circuit test (fault is created by using appropriate size wires between three phases and earth); the test shall not result in any external damage to power terminal box other than rupturing of pressure relief device but there might be damages to the parts inside the terminal box.

4.7.7 Terminal boxes shall generally be suitable for top, bottom or side entry of cables and shall be provided with **EPDM/XLPE** gaskets on all bolted jointed to provide a degree of protection equal to IP 55. The terminal boxes shall be suitable for terminating the purchaser's cables as specified in Annexure -'A'. For single core power cables, the gland-plate shall be of non-magnetic steel.

4.7.8 Special care shall be taken in designing the terminal box for Purchaser's power cables so as to allow sufficient space for bending of cables and adequate electrical clearances. Phase to earth clearance inside the terminal box shall be minimum 25mm (after termination of purchaser's cable of specified size) and minimum

creepage distance over the surface of bushings and surfaces resistant to tracking shall be 25mm.

4.7.9 Terminal box shall be provided with two numbers of M-12 bolts with nuts for grounding.

4.7.10 Terminals for RTDs and BTDs provided for motors located in reactor building shall be of plug-in type quick disconnecting type of connectors of approved make and type.

4.7.11 Supply and mounting of cable glands required for power and control cables are not in the scope of this specification and same shall be provided by the Purchaser. Adequate size of undrilled gland plates shall be provided to facilitate termination of cables.

4.7.12 External connections between RTDs, BTDs and other instruments to their respective terminal boxes shall be made through metallic flexible conduits. Such conduits shall be adequately supported using removable metallic clamps.

4.7.13 Instruments and accessories shall be provided with engraved labels made of aluminum and the same shall be properly fixed.

4.8 **Bearings and Bearing Housing**

4.8.1 Motor bearings shall be constructed so as to exclude dirt and water and to prevent lubricant from reaching the windings. Grease lubricated bearings shall have easily accessible grease nipples to facilitate greasing operations. The bearing assembly shall be provided with grease relief device such that when the motor runs at rated speed any surplus grease is automatically ejected out of the motor casing to a separate container.

4.8.2 Vertical motors shall be provided with single or double (as required) thrust and guide bearings.

4.8.3 Ball and roller bearings shall have a minimum calculated L10 basic rating life of 40,000 running hours and Sleeve bearings shall have a minimum life of 100,000 hours of operation, after considering (a) all the forces that normally occur and (b) seismic forces. Motor manufacturer shall obtain from the driven equipment manufacturer all necessary details required for selection of bearing and in consultation with the bearing vendor, select suitable bearings. Complete details regarding selection and technical particulars of bearings provided shall be submitted to the Purchaser after placement of order.

4.8.4 Operating temperature of bearings under all conditions shall be within the limits prescribed by the bearing manufacturer. Oil vapour (if any) generated during the

operation of motor shall be suitably collected and directed away from the windings and let out in a controlled manner to avoid any condensation on windings and fire hazard.

4.8.5 The bearings lubricating oil system shall preferably be such that no external forced oil to maintain required oil supply or water to keep bearings temperatures within design limits are necessary.

4.8.6 Bearings shall be designed to permit motor running in either forward or reverse directions as required by the driven equipment.

4.8.7 Lubricant shall be selected for prolonged storage and use of the motor in a tropical climate and shall contain corrosion and oxidation inhibitors and anti foaming agents. Grease shall have suitable bleeding characteristics to minimize setting. Data regarding suggested regreasing intervals should be furnished in the offer. In case of reactor building motors, which are required to operate following the Loss of Coolant Accident (LOCA) and, or Main Steam Line Break (MSLB), bearing lubricant shall be capable of withstanding pressure and temperature conditions prevailing at the location during and subsequent to LOCA and, or MSLB as specified so as to ensure operability of motor under these conditions.

4.8.8 When the motor shaft is not located axially by its own bearing, it shall be permanently marked to indicate its running position and the extent of float in either direction.

4.9 **Balancing and Vibration**

4.9.1 Vibrations in all the three directions for horizontal motors shall be within the limits specified in IS-12075. For vertical motors the measured values shall not exceed the limits at the bottom bearings. Tests for measuring amplitudes and velocity of vibration on all directions shall be carried out in the presence of Purchaser's representatives on all motors. Test data with test diagram showing amplitudes and velocity of vibration at various locations shall be submitted along with test reports.

4.9.2 Balancing of rotor with all components mounted shall be carried out at rated RPM or as permitted by the standards. Facility should be provided for trim balancing of motor at site. A chart indicating the details of balancing weights added and their locations shall be enclosed as a part of test reports. Balancing shall be to grade Gr 2.5 according to ISO 1940. Dynamic balancing of rotor for submersible motor pump set shall be as per IS 9283. Report shall be a part of Routine test reports.

4.9.3 Components such as fan, coupling etc., that are to be mounted on the shaft shall be individually balanced to enable future replacements.

4.9.4 Weights added for the purpose of balancing shall be free of defects and shall be firmly fixed such that there is no displacement while in service.

4.10 **Grounding**

4.10.1 For all motors, a non-corrodible terminals shall be provided at two locations on the motor frame and each shall have a threaded hole of M12 size and shall be provided with suitable bolts, nuts, washers and spring washers. The threaded hole shall be of sufficient depth to ensure adequate electrical contact between external connector and motor frame. Separate earthing terminals of M12 size shall be provided for the power terminal box.

4.10.2 Gasketted joints shall be provided with metallic by pass connections of adequate size to ensure earth continuity.

4.11 **Space Heaters (except submersible & canned motor pump set)**

4.11.1 Motors shall be provided with space heaters of adequate capacity to maintain motor internal temperature above the dew point to prevent moisture condensation when the motor is not in service. The heaters shall be mounted inside the motor in accessible place so that their removal and replacement is a simple operation. Space heaters shall be rated for 240 volts, single phase, 50 cycles and shall be located in lower part of motor.

4.12 **Couplings**

4.12.1 Driven equipment manufacturer shall work out details of coupling arrangement. Motor manufacturer shall provide necessary information to the driven equipment supplier and meet the requirements of the driven equipment manufacturer.

4.13 **Direction of Rotation**

4.13.1 Direction of rotation shall be as required by the driven equipment and the same shall be indicated in drawings, documents and motor frame.

4.13.2 As specified in Annexure-A, a mechanical device to prevent reverse rotation shall be provided. The rating of mechanical reverse rotation stop shall be such that it can prevent reverse rotation when the torque in the reverse direction is not greater than 100% of rated torque of the motor in the forward direction.

4.14 **Mounting and Dowelling**

Mounting arrangement shall be matched with the requirements of the driven equipment.

4.15 **Lifting facility**

Motors shall be provided with adequately designed eyebolts, lugs or other devices to facilitate safe lifting operations.

4.16 **Drain Plugs**

Motors shall have drain plugs to permit removal of water accumulated inside the motor.

4.17 **Base Frames**

When a motor is supplied with driven equipment having common base frame, the supplier of the driven equipment shall determine that such base frame is adequately braced to keep vibration and misalignment within permissible limits. Driven equipment supplier shall be responsible for supply of all required mounting arrangements considering the motor and driven equipment assembly.

4.18 **Name plate and Diagram of Connections**

Each motor shall have a nameplate showing all the particulars specified in relevant clause of IS-325. In addition, the nameplate shall also indicate (a) the type of bearings used for motor and the details of recommended lubricant, (b) Re-lubrication quantity & interval, (c) Limit and conditions of successive starts

5.0 **PERFORMANCE REQUIREMENTS**

5.1 **Starting Duty**:

5.1.1 The motors shall be capable of two successive restarts coupled to its driven equipment with coasting to rest between starts under both cold and hot conditions and a third restart shall be feasible after 20 minutes. The motor shall further be capable of three equally time spaced starts per hour under normal service conditions. In case of motors for cranes which are subjected to repeated starting, stopping, reversing etc., the starting duty shall be commensurate with the requirements of the driven equipment.

5.1.2 Motors shall be designed for direct on line, full voltage starting and shall withstand all stresses and give satisfactory performance when started with their driven equipment connected under all operating conditions specified for the driven equipment. The end windings of stator, and rotor shall be adequately braced and supported to cater to the different starting duty conditions. The total number of starts during the design life of motor shall be commensurate with the

requirements of driven equipment and taking into account the design life of motor.

5.1.3 Motors shall be capable to starting and accelerating the driven equipment satisfactorily at a minimum voltage of 80% of the nominal voltage at the motor terminals.

5.2 **Locked Rotor current for squirrel cage rotor**

5.2.1 For all motors (except canned and submersible pump motor set) up to & including 132kW rating, locked rotor current shall be as per particular efficiency class given in the relevant Indian Standards (tolerance as per IS). For motors above 132kW, locked rotor current shall be as given in Annexure-A.

5.3 **Fast Bus Transfer**:

5.3.1 Motors and the driven equipment shall be capable of withstanding the voltage torque stresses and forces developed due to the vector difference between the motor residual voltage and the incoming supply voltage during fast change over of the supply. The drive train of the motor and the driven equipment and motor winding shall be adequately designed to withstand mechanical forces developed during such conditions.

5.4 **Pull out:**

5.4.1 Motor shall not pull out of step when the supply voltage drops to 70% of the rated motor voltage for a short duration of 25 cycles during full load operation of motor. To meet this requirement, the pull out torque of the motor at rated voltage shall be at least 200% of full load torque.

5.5 **Over speed**:

5.5.1 Motors shall be capable of withstanding without mechanical damage, at least 120% of rated speed or as imposed by the driven equipment, whichever is higher.

5.6 **Other requirement**:

5.6.1 Motors shall be capable of satisfactory operation at full load without injurious heating when the motor terminal voltage is at 80% of rated voltage for ten minutes. Motors shall be capable of withstanding 160% rated torque for 15 and 10 seconds for normal and submersible motor pump set respectively.

5.6.2 In all cases involving typical centrifugal pumps, compressors etc. the acceleration time of motor at 80% terminal voltage shall not be greater than the locked rotor withstand time under hot condition at 100% voltage The safe stall time of the

motor shall be such that taking in to account the accelerating time of the motor with the driven equipment and specified number of hot and cold starts, adequate margin exists and the motor remains safe. The permissible stator and rotor temperatures for the purpose of calculating safe stall times shall be limited to 185^0 C and 300^0 C for stator with copper conductors insulated with class-F insulation and with aluminum die cast rotor respectively. In case of rotor with copper bars temperature limit shall be 400^0 C.

5.6.3 If called for in Annexure-A, driven equipment vendor by analysis of complete assembly of motor, coupling, driven equipment and mounting arrangements shall qualify that motor and the driven equipment assembly would continue to perform intended function during and after subjected to specified level of earthquake with out any deterioration in the performance.

5.6.4 Motors provided with power supplies from variable frequency drives shall be suitably designed and tested to take care of effects of such power supplies on motor performance.

6.0 SPARE PARTS

The supplier shall recommend spares that are required for 5 years operation and required to be stocked for maintenance purpose. However, as a minimum, supplier shall furnish prices for the following in his tender.

i) One set of complete bearing assembly for drive and non-drive end bearings
ii) One set of space heaters.
iii) Seals and other materials that require periodic replacement.
iv) Bearing & Winding RTDs, one of each type.

All the spares to be supplied should be physically and technically interchangeable with similar components already installed/in use.

7.0 INSPECTION AND TESTS

7.1 All routine tests mentioned as given in Annexure-C shall be conducted **on all motors** by the manufacturer at his work and test certificates shall be furnished to the Purchaser's representative (QA) for review & acceptance. The cost for the same shall be included in the equipment prices.

7.2 On one typical motor of each design, test reports for all type tests as given in Annexure-C shall be submitted for purchaser's review. In case type test reports are not acceptable to the Purchaser, type tests shall be performed at no extra cost to the Purchaser and without affecting the delivery period. Type test certificates shall be submitted for review and approval of the Purchaser. Type test reports

shall not be earlier than 5 years from the date of purchase order. Any special test and or qualification tests if specified in Annexure-A, same shall be performed in accordance with approved procedure and test reports shall be submitted after qualification. Cost of type testing shall be included in the equipment prices. Price for special tests if any specified in Annexure-A shall be separately indicated and are payable only if tests are conducted and results are acceptable.

7.3 The supplier shall be responsible and shall provide for and perform all the necessary tests, compile reports, documents, arrange inspection and testing to ensure that the material, equipment and workmanship are in accordance with the stipulation detailed in the QAP attached with this specification. All inspection and test reports and reports reviewed shall form part of end documentation.

7.4 The Purchaser or his authorised representative shall at all reasonable times have access to those parts of the supplier's or sub-supplier's works concerned with the manufacture of the motor for the purpose of witnessing tests and ascertaining compliance with the requirements of this specification. The Purchaser shall also have the right to conduct at his expense any additional tests or inspection he deems necessary.

7.5 Supplier shall furnish material specification test certificates as required in the QAP and shall be in a position to co-relate these certificates with the actual material used for the motors.

7.6 After receipt of the Purchase order, the supplier shall furnish to the Purchaser a detailed schedule of manufacture and delivery to enable Purchaser's inspector to plan visits to the manufacturer's works for inspection during different stages of manufacture, which shall be as per detailed quality assurance plan attached as Annexure 'C'. The supplier will be required to develop a quality control plan in line with the requirements indicated in Annexure 'C' and submit the QAP for approval by Purchaser.

7.7 The contractor shall supply to Purchaser's representative a complete set of detailed fabrication drawings which will be used in the inspection during manufacture, which will be retained at the factory and returned after completion of the contract.

7.8 All repairs and rework shall be informed to the Purchaser and his approval taken before proceeding further. All such repair work shall be documented and where desired by the Purchaser, photographic records shall be maintained. These documents shall be included in end documents.

8.0 PAINTING AND PACKING:

8.1 The 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. The painting system shall be having primer based on inorganic Ethyl zinc silicate (for RB motors)/zinc phosphate and compatible with epoxy paint system and top coats of epoxy paint to shade 631 of IS-5.

8.2 All materials/ spares that have limited shelf life shall be marked with expiry date in bold to indicate their storage conditions.

8.3 The motor shall be packed for dispatch to project site in strong wooden crates. The following information shall be clearly given on each box.

a) Purchaser

b) Purchaser order number

c) Equipment code number, if any.

d) List of contents of each package

e) Storage instructions

8.4 The packing should incorporate measures to prevent damage to motor winding, bearing and shaft due to jerks and shocks during transit. The packing should afford reasonable protection against ingress of rainwater.

9.0 **DRAWINGS AND DOCUMENTS**:

9.1 Within 4 weeks of placement of purchase order, the supplier shall furnish for Purchaser's approval following drawings:

a) Drawings showing overall dimensions and all other essential dimensions along with cross-sectional views and motor data sheets as per the format in Annexure-B.

b) Detailed drawing for terminal boxes, clearance, conductor termination, cable gland and degree of protection should also be marked on this drawing.

c) Drawing showing conductor details in slots, thickness & materials of insulation and conductor cross section should also be shown and detailed write up on the insulation system provided for the motor winding.

d) All details submitted to the driven equipment supplier for the purpose of seismic qualification of the driven equipment and the motor assembly, application check for the motor to confirm suitability of the motor to the requirements of driven equipment.

9.2 Supplier shall take up manufacture after the Purchaser has approved the drawings.

9.3 Three prints of all drawings and documents should be submitted for approval. After execution of the order, three sets of documents/drawings in hard copies and two sets of CDs with all scanned copies of documents, drawings, data sheets, quality documents, test reports and characteristic curves shall be supplied.

9.4 Following characteristic curves shall be supplied:

9.4.1 Torque Vs speed curves for the motor superimposed with load torque vs speed characteristics.

9.4.2 Starting current Vs time and speed

9.4.3 Power factor, efficiency, load current Vs Load

9.4.4 Thermal withstand characteristics for motor under cold and Hot conditions

9.4.5 Negative sequence current capability curve

9.4.6 Residual voltage Vs time

10.0 INSTRUCTION MANUALS

10.1 Supplier shall furnish three copies of instruction manuals and two CDs with completely scanned copies of documents covering storage, installation, detailed assembly, disassembly procedures, operation and maintenance of the motors. Installation instructions shall include procedure for checking alignment of motor shaft, coupling and base. Instruction shall also cover lubricating details including recommended inspection and replacement schedules, quantity of lubricant required and specifications for the lubricant and its equivalent. Instruction manual shall include one set of all approved drawings, a complete part list, descriptive literature for all components such as Heat exchangers, RTDs, fans, filters, space heaters etc and complete details of motor in Annexure- B as per requirement.

10.2 In addition, three copies of the above instruction manual shall be supplied with each motor.

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Motor Tag Nos:
Quantity:
Project Title:

	Process Group	Electrical Design Group
Prepared by		
Reviewed by		
Approved by		

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Sl.No.	Particulars	
1.0	**SPECIAL SITE CONDITIONS**	
1.1	Type of environment (corrosive/non-corrosive)	
1.2	Location (indoors/outdoors)	
1.3	Hazardous condition	
1.4	Type of starter if any	
1.5	Whether motor is supplied from variable frequency variable voltage drives or similar such electronic drive?	
2.0	**GENERAL**	
2.1	Application/Driven equipment	
2.2	Type of motor (SCR/SR)	
2.3	Type of submersible motor pump set, (Wet Type/Resin Filled/Sealed)	
2.4	Efficiency class of motor above 132kW (IE2/IE3/any other class) (For motors up to & including 132kW, efficiency class shall be IE3)	
2.5	Nature of application of the motor (Motor is safety related / Motor is not safety related but critical / General Purpose.)	
2.6	Lower critical speed of motor	>130% of rated speed
2.7	Length of cable for submersible motor pump set, (m)	
2.8	Permissible voltage drop of 15m cable length for submersible motor pump set	≤1% of rated voltage
3.0	**RATING**	Driven equipment vendor to select the rating considering all operating conditions and provide a minimum margin of 10%
4.0	**DUTY**	
4.1	Type of duty (S1 to S8)	
5.0	**STARTING**	
5.1	Method of starting	
5.2	Number of successive starts with full load followed by next start after 20 minutes. (a) In cold condition (b) In hot condition.	 Minimum 2 Minimum 2
5.3	No. of equally spread starts per hour.	Minimum 3
5.4	Permissible starting current as % of full load current for motors above 132kW	

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	(For motors up to & including 132kW, starting current shall be as per IS)	
6.0	**INSULATION**	
6.1	Class of insulation for stator winding	Minimum Class-F
7.0	**ENCLOSURE**	
7.1	Type of enclosure.	
7.2	Degree of protection.	
7.3	Type of cooling	
8.0	**TERMINAL BOXES**	
8.1	Whether power terminal box is required to withstand 50 kA for 0.25s?, (Yes/No)	
8.2	No. of cable entries.	
8.3	Power cable size and type.	
8.4	Separate terminal box required for: Stator phase terminals, (Yes/No) Space heater terminals, (Yes/No) Winding RTD's terminals, (Yes/No) Bearing RTD's terminals, (Yes/No)	
8.5	Size of cable for space heater external connection	2.5 sq.mm Cu. conductor, 2 core HRPVC/XLPE cable or as required.
8.6	Size of cable for RTD and BTD external connection.	
8.7	Location of terminal boxes when viewed from non driving end of the motor	Left / Right / Top
9.0	**BEARINGS**	
9.1	Type of bearings	
9.2	Type of lubrication	
9.3	Expected re-lubrication interval, (Hours)	
9.4	Bearing cooling	
10	**Inspection plugs for air gap measurement required? , (Yes/No)**	
11	**Whether reverse rotation stop is required? , (Yes/No)**	
12.0	**INSPECTION, TESTING AND QUALIFICATION**	
12.1	Inspection as detailed in the specification and typical QAP attached as annexure-C required? , (Yes/No)	
12.2	Acceptance criteria for NDT as per applicable standards as follows:	

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	i)	Liquid penetrant inspection	As per PP-P-2396
	ii)	Ultrasonic inspection	As per PP-P-2012
12.3	Whether NDT specifications (PP-P-2012 & PP-P-2396) attached as a part of this tender package.		Yes/No
12.4	Whether seismic qualification of complete motor and driven equipment assembly along with all accessories and auxiliaries required to be performed? If yes, identify operability/structural integrity requirements under SSE and OBE.		<table><tr><th>Seismic Level</th><th>Structual integrity</th><th>Operability</th></tr><tr><td>SSE</td><td></td><td></td></tr><tr><td>OBE</td><td></td><td></td></tr></table>
12.5	Whether any special tests other than those indicated in the specifications / Indian Standards are required to be performed? If so, indicate details.		
13	**Special Requirements for Reactor building motors**		
13.1.	Whether motor is required to be qualified for operation during and following LOCA/MSLB? (Yes/No*)		
13.1.1	If LOCA/MSLB (accident condition) qualification is required, are the pressure and temperature transient curves enclosed? (Yes/No*)		
13.1.2	Tag number of motor required to be qualified for LOCA/MSLB		
13.1.3	Cumulative radiation dose under normal and accident conditions, (MRad)		
13.2	Whether motor insulating materials, auxiliaries, gaskets, lubricants, terminal blocks etc required to withstand radiation and operate satisfactorily? (Yes/No*)		
13.2.1	Cumulative radiation dose under normal conditions, (MRad)		
13.3	Tag number of motor for which radiation qualification is required but LOCA/MSLB qualification is not required		
13.4	Expected external over pressure likely to be experienced by motors and their accessories during reactor building pressure test.		

* Detailed procedure shall be worked out by the Contractor and subjected to review and approval of Purchaser.

NUCLEAR POWER CORPORATION OF INDIA LIMITED	
ANNEXURE-B TO PC-E-502 FORMAT FOR SUBMISSION OF TECHNICAL PARTICULARS FOR MEDIUM VOLTAGE INDUCTION MOTORS OF CAPACITY GREATER THAN 50kW FOR 700MWe (To be filled in by Motor Manufacturer and submitted through driven equipment Manufacturer/Package Contractor)	**Project : 700MWe** **Page : 1 of 9**

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1.	Name and address of Motor Manufacturer		:	
2.	Name and address of driven equipment manufacturer		:	
3.	Name and address of Package contractor		:	
4.	References		:	
	i)	NPCIL's Purchaser Order No.	:	
	ii)	Package Contractor's Purchase Order No.	:	
	iii)	Driven Equipment Supplier's Purchase Order No	:	
	iv)	Work Order Number of Motor Manufacturer	:	
5.	NPCIL Document No.		:	
6.	Rev. No. & Date		:	
7.	Motor Tag Nos.		:	
8.	Quantity		:	
9.	Project Title		:	
10.	Contents		:	
	i)	Motor data sheets	:	Sheet 1 to 9
	ii)	Motor & load Torque v/s Speed Curves	:	Sheet 10
	iii)	Performance Curves	:	Sheet 11
	iv)	Current and speed v/s starting time	:	Sheet 12
	v)	Thermal withstand characteristics	:	Sheet 13
	vi)	Negative sequence current withstand capability curve	:	Sheet 14
	v)	Residual voltage Vs time characteristics	:	Sheet 15

	Motor Manufacturer	Driven Equipment Supplier	Package Contractor
Prepared by			
Reviewed by			
Approved by			

Motor manufacturer's name and address	**Date of issue, Rev No**

NUCLEAR POWER CORPORATION OF INDIA LIMITED	
ANNEXURE-B TO PC-E-502 FORMAT FOR SUBMISSION OF TECHNICAL PARTICULARS FOR MEDIUM VOLTAGE INDUCTION MOTORS OF CAPACITY GREATER THAN 50kW FOR 700MWe (To be filled in by Motor Manufacturer and submitted through driven equipment Manufacturer/Package Contractor)	**Project : 700MWe** **Page : 2 of 9**

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Sl. No.	Particulars		
1.0	**Guaranteed operating conditions for the motor**		
1.1	Ambient temperature, (^{0}C)		
1.2	Altitude, M		
1.3	Humidity at 40^{0}C, (%)		
1.4	Type of environment, (corrosive/non-corrosive)		
1.5	Location, (indoors/outdoors)		
1.6	Hazardous condition, (Yes/No)		
1.7	Rated voltage & its variations, (V)		
1.8	Rated frequency & its variations, (Hz)		
1.9	Permissible un-balance in supply voltage, (%)		
1.10	Permissible harmonic content in supply voltage, (%)		
1.11	Combined voltage & frequency variations, (%)		
1.12	Number of phases		
1.13	Method of system grounding.		
1.14	Seismic capability: if specified in the annexure-A, whether qualification of motor and the driven equipment assembly along with accessories and auxiliaries included in the scope of the tender? Indicate proposed method of qualification.		
1.15	Radiation withstand capability of complete motor		
1.16	Auxiliary power supply requirements		
	i)	For auxiliaries	
	ii)	For space heaters	
	iii)	For instrumentation & control	
1.17	Whether the motors are adequately designed to operate satisfactorily when supplied with power supply from electronic drives intended to be used for the driven equipment?		
2.0	**GENERAL**		
2.1	Application/Driven equipment		
2.2	Method and type of coupling to driven equipment.		
2.3	Type of motor (SCR/SR)		
2.4	Frame size		
2.5	Mounting		
2.6	Single shaft / double shaft extension.		
2.7	Direction of rotation (viewed from drive end)		
2.8	Rotation – uni /bi-directional		
2.9	Reverse rotation stop provided?		
2.10	Applicable standards/codes.		

Motor manufacturer's name and address	**Date of issue, Rev No**

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Sl. No.	Particulars		
2.11	Stator winding connection*		
2.12	Winding resistance per phase*		
3.0	**RATING**		
3.1	Rated output (kW)		
3.2	Rated speed (RPM)/Synchronous speed (RPM)		
3.3	kW actually required by the drive equipment under specified operating conditions		
4.0	**DUTY**		
4.1	Type of duty		
5.0	**STARTING**		
5.1	Method of starting		
5.2	Starting current (% of full load current)		
5.2.1	At rated voltage		
	a)	Including I.S. tolerance*	
	b)	Excluding I.S. tolerance* (Committed value)	
5.2.2	At 80% voltage		
	a)	Including I.S. tolerance*	
	b)	Excluding I.S. tolerance* (Committed value)	
5.3	Minimum voltage required for starting, (% of rated voltage)		
5.4	Starting time with DOL starting with driven equipment coupled		
	a)	At rated voltage, (sec)	
	b)	At 80% voltage*, (sec)	
5.5	Permissible No. of successive starts on full load		
5.5.1	In cold condition		
5.5.2	In hot condition.		
5.6	No. of equally spread starts per hour		
6.0	**INSULATION**		
6.1	Class of insulation for stator and rotor (in case of SR motor)		
6.2	Permissible temperature rise (by resistance method)		
	a)	Under normal conditions, (^{0}C)	
	b)	Under extreme voltage conditions (90/110% of rated voltage whichever is severe), (^{0}C)	
6.3	Tropical Treatment of motor		
6.3.1	Material of insulation		
6.3.2	Treatment of insulation, stator and rotor core for anti-fungal growth		
6.4	Radiation withstand capability of insulation system and other materials used in the motor (If specified, only for motors		

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Sl. No.	Particulars		
	located in the reactor building)		
7.0	**COSTRUCTION & MATERIALS.**		
7.1	Degree of protection provided by the enclosure		
7.2	Enclosure type (Fabricated type/ casting)		
7.3	Enclosure material grade for		
	a)	Frame	
	b)	End shields	
	c)	Power terminal box	
	d)	Bearing housing	
	e)	Gaskets	
7.4	Material for stator conductors		
7.5	Material for rotor bars, (Cu/Al)		
7.6	Material for short circuiting rings (if provided)		
7.7	Material for retaining rings (if provided)		
7.8	Heat loss to environment for the purpose of ventilation design*, (kW)		
7.9	Type of cooling		
7.10	Painting		
7.10.1	Primer (Based on Inorganic Ethyl zinc silicate/zinc phosphate compatible with epoxy paint system?), (Yes/No & Type)		
7.10.2	Finish Coats (Epoxy based?), (Yes/No, If No then indicate details)		
8.0	**TERMINAL BOXES**		
8.1	Type of main terminal Box		
8.2	Fault withstand capacity at rated voltage and its duration for		(kA)
	a)	Internal faults, (sec)	
	b)	External faults, (sec)	
8.3	Max. cable size suitable for the terminal box/Actual cable size (sqmm.)*		
8.4	Size of T. Box (inside dimensions)*		
8.5	Degree of protection for T. Box enclosure.		
8.6	No. of cable entries.		
8.7	No. of terminals for main winding*		
8.8	Size of connections from windings to terminals*, (sqmm & Cu/Al)		
8.9	Details of type test certificates to prove the capability of motor power terminal box to prove its capability to meet requirements stated in this specification, (NPCIL document number for Type		

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Sl. No.	Particulars		
	test report)		
8.10	Separate terminal box provided for:		
	a)	Stator phase terminals, (Yes/No)	
	b)	Rotor phase terminals, (Yes/No)	
	c)	For forming star connections, (Yes/No)	
	e)	Space heater terminals, (Yes/No)	
	f)	Winding RTD's terminals, (Yes/No)	
	g)	Bearing RTD's terminals, (Yes/No)	
8.13	Direction of cable entry		
8.14	Double compression Cable gland for T. Boxes provided? , (Yes/No)		
8.15	Size of cable gland plate suitable for		
	a)	Motor cable	
	b)	Space heater cable	
	c)	RTD cable	
8.16	Plug-in terminals for RTDs provided? , (Yes/No)		
8.17	Cable type & length for submersible motor pump set		
9	**BEARINGS**		
9.1	Type of bearing		
9.2	D.E bearing number and make.		
9.3	N.D.E bearing number and make		
9.4	Standard L10 life of bearing, (hrs)		
9.5	Type and grade of lubricant		
9.6	Quantity of lubricant required*, (grams)		
9.7	Bearing end play (mm)* Axial Radial		
9.8	Thrust bearing losses*		
9.9	Regressing interval, (hrs)		
9.10	Maximum permissible bearing temperature, (^{0}C) DE NDE		
9.11	Whether bearings are designed considering all loads expected during all operating conditions including seismic conditions (if specified) of the driven equipment?		
9.12	Whether bearings are designed for operation during and after LOCA/MSLB (only if the requirement is specified)		
10.	**ACCESSORIES**		
10.1	Temperature detectors in windings, (No. & Type)		

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Sl. No.	Particulars		
10.2	Temperature detectors in bearings, (No. & Type)		
10.3	Space – heaters		
	a)	Voltage, (V)	
	b)	Wattage/ space heater*, (W)	
	c)	Nos. proposed to be used*	
	d)	Location*	
	e)	Expected temperature of in side air above the outside ambient air temperature*, (^{0}C)	
11	**WEIGHT AND MOMENT OF INERTIA**		
11.1	Weight of stator (Kg.)*		
11.2	Weight of rotor (Kg.)*		
11.3	Total weight of motor (Kg.)*		
11.4	Shipping weight of motor (Kg.)*		
11.5	Shipping dimensions LXBXH*, (mm)		
11.6	Rotor GD^2 (Kgm^2) *		
11.7	GD^2 of driven equipment referred to motor speed (kgm^2) *		
12	**PERFORMANCE**		
12.1	Full load current (amps)		
12.2	No load current. (amps)		
12.3	Full load speed (rpm)		
12.4	No load speed (rpm)		
12.5	Efficiency At full load (%) At 75% load (%)* At 50% load (%)*		
12.6	Power factor At full load At 75% load* At 50% load*		
12.7	Noise pressure level of motor at 1.0 m at no load db (A)		
12.8	Velocity of vibration at		
	a)	No load (microns), mm/s	
	b)	With load (microns), mm/s	
12.9	Critical speed (rpm)		
	a)	Lower	
12.10	Safe stall time in secs. At 80% & 100% voltages		
	i)	When motor is at rated operating temperature	
	ii)	When motor is at ambient temp.	

Motor manufacturer's name and address	**Date of issue, Rev No**

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Sl. No.	Particulars		
	iii)	Limiting stator and rotor temp. considered to determine stall time, (^{0}C)	
12.11	The maximum number of starts permissible per year		
12.12	a)	Stator thermal time constant.	
	b)	Stator cooling time constant	
12.13	Overload capacity		
12.14	Torque		
12.14.1	Torque at full load		
12.14.2	Starting torque (% of full load torque) At rated voltage At 80% voltage		
12.14.3	Pull-out torque (% of full load torque) at rated voltage		
12.14.4	Pull-up torque (% of full load torque) at rated voltage		
13.0	**CONNECTIONS**		
13.1	Stator		
13.2	Number of connections brought out		
14.0	**INSPECTION**		
14.1	Customer inspection in works as specified detailed in QAP agreed?, (Yes/No)		
14.2	NDT as per applicable Annexures will be done as follows on shafts, welds etc:		
	i)	Liquid penetrant inspection, (Yes/No)	
	ii)	Ultrasonic inspection, (Yes/No)	
14.3	Welding procedure and welder qualification as specified agreed? , (Yes/No)		
14.4	Brazing procedure qualification and brazer qualification agreed for brazing of stator connections and rotor bars with end rings? , (Yes/No)		
14.5	Performance of all routine tests as specified agreed? , (Yes/No)		
14.6	Performance of all type tests as specified agreed? , (Yes/No)		
14.7	Whether full compliance to QAP attached as Annexure agreed? , (Yes/No)		
14.8	Whether full compliance to PC-E-502 and Annexure-A agreed? , (Yes/No, if No, enclose clause wise deviations)		
15.0	**DRAWINGS, CATALOGUES, DATA SHEETS**		
15.1	Descriptive pamphlets for the offered motor enclosed? , (Yes/No, If No, to be supplied along with equipment)		

Motor manufacturer's name and address	**Date of issue, Rev No**

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Sl. No.	Particulars		
15.2	Details of reverse rotation stop enclosed? * , (Yes/No)		
15.3	Torque vs. speed characteristics curve at rated voltage and frequency		
	a)	For motor*, (Sheet/Drawing No. Reference)	
	b)	For driven equipment*, (Sheet/Drawing No. Reference)	
15.4	Current vs. speed characteristic curve at rated voltage and frequency during acceleration*, (Sheet/Drawing No. Reference)		
15.5	Thermal withstand characteristic curve and data in digital form for		
	a)	Hot condition*, (Sheet/Drawing No. Reference)	
	b)	Cold condition*, (Sheet/Drawing No. Reference)	
15.6	Current vs. time characteristic curve during acceleration*, (Sheet/Drawing No. Reference)		
15.7	Negative sequence current capability curve*, (Sheet/Drawing No. Reference)		
15.8	Efficiency. Power factor, speed and current vs. load characteristics*, (Sheet/Drawing No. Reference)		
15.9	Dimensional drawing showing cross sectional view and identification of components and their material specification, typical stator slot and rotor bar, shaft, fan, bearings etc*, (Sheet/Drawing No. Reference)		
15.10	Dimensional drawing of the terminal boxes showing dimensions, permissible cable size, degree of protection, type test numbers, materials of fabrication, etc and the method of terminating the purchaser's incoming cables*, (Drawing No. Reference)		
15.11	Type test certificates to prove the specified fault withstand capability of power terminal box for both (a) internal faults and (b) external faults, (NPCIL Document No. for type test report)		
16.0	**Additional Technical Particulars For Induction Motors In Reactor Building**		
16.1	Applicable standards		
16.2	Is the motor designed to operate under normal and Loss of coolant accident (LOCA) / MSLB conditions, (Normal condition/Normal and Accidental condition.)		
16.3	Capability of the motor to withstand specified radiation levels (NPCIL document no. for test certificate)		
16.4	List of materials used and their radiation withstand capability:		
16.4.1	Stator conductor, (MRad)		

Motor manufacturer's name and address	**Date of issue, Rev No**

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Sl. No.	Particulars	
16.4.2	Slot liner, (MRad)	
16.4.3	Slot wedge, (MRad)	
16.4.4	End connections, (MRad)	
16.4.5	Over hang portion, (MRad)	
16.4.6	Varnish for impregnation, (MRad)	
16.4.7	Gaskets, (MRad)	
16.4.8	Lubricants, (MRad)	
16.4.9	Motor terminals, (MRad)	
16.4.10	Control wires and accessories, (MRad)	
16.5	Capability of the motor to continuously operate under the specified accident conditions viz. temperature, pressure and relative humidity, (Test certificate to be submitted or type test shall be performed as per approved procedure)	

Note:

1. All data sheets and characteristic curves should be strictly in the above format in A4 and A3 size sheets respectively with continuous page numbers, properly bound and provided with a cover sheet indicating names and signatures of persons responsible for preparation, checking, approving of documents at motor manufacturer, driven equipment vendor, EPC contractor etc before submission to the Purchaser. Document shall have Purchaser's purchase order reference, EPC contractor's purchase order reference and driven equipment vendor's purchase order reference, Purchaser's project identification, Motor tag numbers, revision number, date of revision etc on the cover sheet.

2. All drawings shall be in A3 size sheets and shall indicate Purchaser's project identification, motor tag numbers, purchase order numbers etc.

3. Items marked * can be submitted after placement of order and after completion of detailed engineering.

4. The vendor shall attach sheet nos 10 to 15 referred in clause no 10 in this document or as separate document.

NUCLEAR POWER CORPORATION OF INDIA LIMITED

QUALITY ASSURANCE PLAN FOR 415V MOTORS OF RATING GREATER THAN 50kW

Scope and Purpose:

This document indicates the requirements expected from the package contractor/manufacturer of motors. Subsequent to the placement of Purchase Order, contractor/manufacturer shall submit for purchaser's approval a quality assurance plan in line with this document incorporating specific document numbers for "format of records", "acceptance norms" and "reference documents.If requried by the purchaser, reference documents indicated shall be shown before approval of QAP.

QAP NO: PC-E-502/Annex-C.

DATE: November, 2016

LEGEND

R: Review H: Hold P: Perform W: Witness 1: NPCIL 2: Package Contractor

3: Motor Manufacturer/External lab/Manufacturer's Sub;contractor

Manufacturer reference documents to be detailed here

AD: NPCIL Approved Document such as Tender Document, Purchase order, Drawings & Test Procedures

TR: Test Report

PS : Plant Standards

H: Customer's Hold Point (Customer is NPCIL)

W: Witness (After lapse of due notice of 2 weeks time to NPCIL, manufacturer may proceed with manufacturing/next stage)

IS: Indian Standards

IEC : International Electrotechnical Commission standards

IEEE: Institute of Electronics and Electrical Engineers standards

NOTES:

* Wherever V & W are both indicated , NPCIL QS to witness test or review TRs at NPCIL's choice.

* **TRs not more than five year old from date of purchase order may be reviewed for acceptance. Otherwise, test shall be carried out at no extra cost to NPCIL and within the committed delivery schedule.**

* Minor: The characteristic of a component, process or operation whose failure neither materially reduce the usability of the product in operation, nor does it affect the aesthetic aspects.

* Major: The characteristic of a component, process or operation whose failure may cause operation failure which cannot be readily corrected at site or cause substandard performance, increased erection and maintenance cost, reduced life or seriously affect aesthetics or ergonomics.

* Critical: The characteristics of a component, process or operation failure of which will surely cause operating failure or intermittent troubles which is difficult to rectify at site or render the unit unfit for use or safety hazards.

* ''Failure '' of a characteristic means failure to meet the 'acceptance norms '.
* Sampling: Generally in accordance with IS:2500. If 100% "witness" is carried out by "Package contractor", NPCIL will witness on sample basis, or if 100% "witness" is carried out by "Motor Manufacturer", "Package contractor" will witness on sample basis.

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
1	**BOUGHT OUT ITEMS**												
1.1	Enamelled, copper conductor Class F for temp. class 155 deg. C	a) Overall Dimensions	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			TC to be furnished batchwise
		b) Bare conductor dimension	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		c) Increase in dimension due to insulation coverage	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		d) Chemical composition	Major	Chemical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		e) Flexibility	Major	Mechanical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		f) Cure test	Major	Physical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		g) Electrical strength proof voltage test	Major	Electrical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		h) BDV Test at 155 deg. C.	Major	Electrical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		I) Resistivity	Major	Electrical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
1.2	Electrolytic tough pitch high conductivity copper (for rotor copper bars - if provided)	a) Tensille Strength	Major	Mechanical	1sample/ lot	PS	PS	TR	1, 2	3			TC to be furnished batchwise.
		b) Elongation	Major	Mechanical	1sample/ lot	PS	PS	TR	1, 2	3			
		c) Hardness	Major	Mechanical	1sample/ lot	PS	PS	TR	1, 2	3			
		d) Chemical Comp.	Major	Chemical	1sample/ lot	PS	PS	TR	1, 2	3			
		e) Resistivity	Major	Electrical	1sample/ lot	PS	PS	TR	1, 2	3			
		f) Free from surface defects	Major	Visual	1sample/ lot	PS	PS	TR	1, 2	3			
		g) Dimensions	Major	Mechanical	3samples /lot	Manufacturing Drgs.	Manufacturing Drgs.	TR	1, 2	3			
		h) DP test	Major	NDT	3samples /lot	PP-P-2396	PP-P-2396	TR	1, 2	3			

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY R	AGENCY P	AGENCY W	AGENCY H	REMARKS
1.3	Forged Short circuting ring. (if copper rotor bars are provided)	a) Chemical comp.	Major	Chemical	1sample/ lot	PS	PS	TR	1, 2	3			TC to be furnished batchwise.
		b) Tensile strength	Major	Mechanical	1sample/ lot	PS	PS	TR	1, 2	3			
		c) Elongation	Major	Mechanical	1sample/ lot	PS	PS	TR	1, 2	3			
		d) Conductivity	Major	Electrical	1sample/ lot	PS	PS	TR	1, 2	3			
		e) Dimensions	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1, 2	3			
		f) Visual inspection of cracks and blow holes	Major	Visual	100%	PS	PS	TR	1, 2	3			
		g) DP test	Critical	NDT	100%	PP-E-1209	PP-E-1209	TR	1, 2	3			
1.4	Insulating Material/Tapes	a) Dimensions	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			TC to be furnished batchwise.
		b) Chem. comp.	Major	Chemical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		c) Heat aging test	Major	Thermal	1sample/ lot	IS/PS	IS/PS	TR	1,2	3			
		d) BDV	Major	Electrical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
1.5	Impregnating Varnish / Resins	a) Packing viscosity	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			TC to be furnished batchwise.
		b) Non volatile content	Major	Chemical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		c) Drying in thin layer	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		d) Curing in thick layer	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		e) Stability of varnish/resin in open vessel	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		f) Effect of varnish on enamelled copper wire	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		g) Electric strength at 155 deg. C.	Major	Electrical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		h) Electric strength at Room Temperature	Major	Electrical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		i) Volume resistivity	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
1.6	Shaft material	a) Chemical comp.	Major	Chemical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		b) Hardness	Major	Mechanical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		c) Yield strength	Major	Mechanical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		d) Tensile strength	Major	Mechanical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		e) Elongation	Major	Mechanical	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		f) Grain size	Major	Measurement	1sample/ lot	IS/PS	IS/PS	TR	1, 2	3			
		g) Ultrasonic test	Critical	NDT	100%	PP-P-2012	PP-P-2012	TR	1	3	2		
1.7	Stamping Steel material	a) Specific core loss	Major	Electrical	1sample / lot	IS/PS	IS/PS	TR	1,2	3			TC to be furnished batchwise.
		b) Magnetisation (Permeability)	Major	Electrical	1sample / lot	IS/PS	IS/PS	TR	1, 2	3			
		c) Insulation resistance	Major	Electrical	1sample / lot	IS/PS	IS/PS	TR	1, 2	3			
		d) Stacking factor	Major	Mechanical	1sample / lot	IS/PS	IS/PS	TR	1, 2	3			
		e) Type of coating	Major	Mechanical	1sample / lot	IS/PS	IS/PS	TR	1, 2	3			
		f) Thickness	Major	Measurement	1sample / lot	IS/PS	IS/PS	TR	1, 2	3			
		g) Thickness of coating	Major	Measurement	1sample / lot	IS/PS	IS/PS	TR	1, 2	3			
1.9	Steel plates (For stator frames and end shields)	a) Thickness	Major	Measurement	1sample / lot	Mfg Drg	Mfg Drg		1.2	3			TC to be furnished batchwise.
		b) Chemical comp.	Major	Chemical	1sample / lot	IS/PS	IS/PS	PS	1.2	3			
		c) Tensile strength	Major	Mechanical	1sample / lot	IS/PS	IS/PS	PS	1.2	3			
		d) Yield strength	Major	Mechanical	1sample / lot	IS/PS	IS/PS	PS	1.2	3			
		e) Elongation	Major	Mechanical	1sample / lot	IS/PS	IS/PS	PS	1.2	3			
1.10	Stator frame and end shields - Castings	a) Dimensions	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1, 2	3			
		b) Chemical comp.	Major	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) Mechanical Properties.	Major	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
		d) Casting Quality	Critical	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
1.11	Fans (fabricated)	a) Dimensions	Major	Measurement	100%	IS/PS	IS/PS		1, 2	3			
		b) Visual check	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) D.P. test on major weld joints (as per drawing)	Critical	NDT	100%	PP-P-2396	PP-P-2396	TR	1	3	2		
1.12	Bearing housings	a) Visual checks	Major	Visual	100%	IS/PS	IS/PS	TR	1	3			
		b) Dimensions	Major	Measurement	100%	IS/PS	IS/PS	TR	1	3			
		c) DP test on load bearing surfaces	Critical	NDT	100%	PP-P-2396	PP-P-2396	TR	1	3	2		
1.13	Power Terminal Box	a) Visual check	Major	Visual	100%	Test Report	Test Report	TR	1	3	2		Review of type test report.
		b) Review of type test reports	Major	Review	Sample	Test Report	Test Report	PS	1, 2	3		1	
		c) Compliance to type tested terminal boxes	Major	Review	Sample	Test Report	Test Report	PS	1, 2	3		1	
1.14	RTD & BTD	a) Temperature calibration	Major	Measurement	1sample /lot	IS/PS	IS/PS	TR	1,2	3			
		b) Dimension	Major	Measurement	1sample /lot	IS/PS	IS/PS	TR	1,2	3			
		c) Accuracy	Critical	Measurement	1sample /lot	IS/PS	IS/PS	TR	1,2	3			
		d) HV test	Major	Electrical	1sample /lot	IS/PS	IS/PS	TR	1, 2	3			
1.15	Space heaters	a) Verification of name plate details	Minor	Visual	100%	IS/PS	IS/PS		1, 2	3			
		b) High voltage test	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) Insulation resistance measurement	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
2	**INPROCESS INSPECTION**												
2.1.1	Fabricated / Cast frame/end shields	a) Blow holes/cracks	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			Welding to be done by Manufacturer qualified welders based on qualified procedures.
		b) Stress relieving	Major	Physical	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) D.P. Test on weld joints of load bearing areas (as per the drawing)	Critical	NDT	100%	PP-P-2396	PP-P-2396	TR	1	3	2		
		d) Dimensions	Major	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
2.1.2	Machined frame and endshields.	a) Surface finish	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			Welding to be done by Manufacturer qualified welders based on qualified procedures.
		b) Measurement of run out/concentricity/PCD	Critical	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) D.P. Test on load bearing areas (as per drawing)	Critical	NDT	100%	PP-P-2396	PP-P-2396	TR	1	3	2		
		d) Dimensions	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1	3			
2.1.3	Machined bearing housing	a) Surface finish	Minor	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
		b) Dimensions	Minor	Visual	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1, 2	3			
2.2	Rotor												

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY R	AGENCY P	AGENCY W	AGENCY H	REMARKS
2.2.2	Machined Shaft	a) Dimensions	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1, 2	3			
		b) Surface finish	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) D.P. Test on load bearing areas and shaft extension	Major	NDT	100%	PP-P-2396	PP-P-2396	TR	1	3	2		
2.2.3	Die Cast aluminum Rotor (for die cast rotors only)	a) Blow holes/cracks	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
		b) Chemical Composition	Major	Chemical	1sample /lot	IS/PS	IS/PS	TR	1, 2	3			
2.2.4	Brazed Rotor (for Copper rotors only)	a) D.P. Test on brazed joints	Critical	NDT	100%	PP-P-2396	PP-P-2396	TR	1	3	2		Brazing to be done by qualified brazers based on qualified procedures.
2.2.5	Rotor assembly complete	a) Major dimensions	Major	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
		b) Dynamic balancing of rotor	Critical	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
		c)Runouts on bearing step and shaft extension	Major	Measurement	100%	IS/PS	IS/PS	TR	1, 2	3			
2.3	STATOR							PS					
2.3.1	Stator Coils	a) Dimension checks	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1.2	3			
		b) No. of turns	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1, 2	3			
		b) Visual check	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) Inter turn test (Surge Comparison	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
2.3.2	Stator core (Before coil insertion)	a) Core length	Major	Measurement	100%	Manufacturing Drgs.	Manufacturing Drgs.	TR	1.2	3			
		d) Visual check	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
2.3.3	Wound Stator (before impregnation)	a) Visual check	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
		b) Resistance	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) Insulation resistance	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		d) Placement of RTD's	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
		e) IR and resistance of RTD's	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		f) Interturn voltage test	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		g) HV test	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		h) Bracing of wdg. Overhang	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
2.3.4	Impregnation (VPI)	Process parameters	Major	Visual	100%	IS/PS	IS/PS	TR	1, 2	3			
2.3.5	Wound stator (after impregnation)	a) Resistance	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		b) Insulation resistance	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		c) HV test	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		d) Polarity	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
		e) IR, resistance & HV test on RTD's	Major	Electrical	100%	IS/PS	IS/PS	TR	1, 2	3			
3	**TESTS**												
3.1	Completed Motor	a) Air Gap	Major	Measuring stator ID and rotor OD	100%	Manufacturing Drgs.	Manufacturing Drgs.	Test Report		3	1, 2		1 sample/rating shall be witnessed by 1, 2
		b) Mounting and over all diemensions including TB	Major	Mechanical	100%	Approved GA Drg.	Approved GA Drg.	Test Report		3	1, 2		
		c) Runout of shaft extension, spigot and flange	Major	Mechanical	100%	Approved GA Drg.	Approved GA Drg.	Test Report		3	1, 2		

QUALITY ASSURANCE PLAN

415V INDUCTION MOTORS ABOVE 50kW

SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
3.2	Routine Tests	a) IR of winding before and after HV test	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		b) HV test	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		c) Resistance measurement	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		d) IR, HV on space heater and winding RTD	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		e) Phase sequence & direction of rotation	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		f) Locked rotor test	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		g) Reduced voltage running test on no load	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		h) No load test	Major	Electrical	100%	IS/PS	IS/PS	Test Report		3	1, 2		
		i) Completeness along with dimensional checks	Major	Visual	100%	Approved GA Drg.	Approved GA Drg.	Test Report		3	1, 2		
		j) Vibration test	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		k) Terminal marking and rating plate details	Major	Visual	100%	Approved GA Drg.	Approved GA Drg.	Test Report		3	1, 2		
3.3	Type Tests (In addition to all tests mentioned in routine test)	a) Temp. rise test at approx + 10% or -10% of rated voltage, whichever is severe	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		Test to be perofmed only if suitable type test certificate for identical motor design is not available. If test is conducted, the same shall be offered for witness by 1, 2.
		b) Temp. rise test at rated voltage	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		b) Load test and derivation of performance data corresponding to 50%, 75% and 100% load at rated voltage	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		c) Operation of motor on full load at 70% voltage 10 sec. & 80% voltage for 10 min.	Major	Electrical	Similar motor	AD	AD	Test Report		3	1, 2		
		d) Test for degree of protection by enclosures of motor and terminal boxes	Major	Mechanical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		e) Noise level	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		f) Vibration test	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		g) Overspeed test	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		

		QUALITY ASSURANCE PLAN 415V INDUCTION MOTORS ABOVE 50kW											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY				REMARKS
									R	P	W	H	
		h) Starting current & starting torque at reduced voltage	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		i) Momentary overload test	Major	Electrical	Similar motor	IS/IEC	IS/IEC	Test Report		3	1, 2		
		j) Review/approval of all type test reports	Major	Review	100%	Test Report	Test Report	Test Report	1, 2	3		1	
4.0	Pre despatch Inspection	a) Painting finish	Major	Visual	100%	Approved GA Drg.	Approved GA Drg.	TR		3	1, 2		
		b) Review of end documents & issue of shipping release	Major	Review of all doc. For each motor	100%	Approved documents	Approved documents	TR		3	1, 2	1	
5.0	If specified in Annexure-A, special tests required to demonstrate capability of motors to perform in the anticipated ambient conditions due to radiation, LOCA and MSLB, shall be performed in accordance with an approved procedure and reports submitted to NPCIL.												

1.0 SCOPE

This specification covers the technical requirements for design, manufacture, inspection, testing, supply and guarantee of Medium voltage induction Motors of capacity equal to or less than 50kW.

2.0 STANDARDS

The motors shall conform to the latest editions of the following standards unless specified otherwise in this specification.

IS	325	:	Three-phase induction motors - Specification
IS	14578	:	Three-phase induction motors for use in nuclear power plants - Specification
IS	12615	:	Energy efficient induction motors - Three phase squirrel cage
IS	12075	:	Mechanical vibration of rotating electrical machines with shaft heights 56mm and higher- Measurement, evaluation and limits of vibration severity
IS	9283	:	Motors for submersible pump sets - Specification
IS	15881	:	Three phase cage induction motor specifically designed for IGBT converter supply - Specification

In case of conflicts, requirements stated in this specification shall govern.

3.0 OPERATING CONDITIONS

3.1 Motors shall be suitable for continuous operation under the following operating conditions:

1.	Ambient temperature at the location of motor	50^0 C
2.	Site altitude	Less than 1000mtrs
3.	Humidity	90% at 40^0 C
4.	Rated voltage and its variation	415V+/-10%
5.	Rated frequency and its variation	50Hz+/-5%
6.	Number of Phases	3
7.	Combined variation	10%
8.	Unbalance in supply voltage	3%
9.	Permissible harmonics in the supply voltage	5%
10.	Method of power supply system grounding	Effectively grounded system.

11.	Power supply voltages for auxiliaries	(a) 240V AC, 50Hz, 1-Phase for space heater. (b) 240V AC, 50Hz, 1-Phase or 24V DC for instrumentation and Controls.
12.	Temperature rise of motor winding under normal operating conditions of voltage and frequency (By winding resistance method)	70^0C (except submersible motor pump set)
13.	Temperature rise of motor winding under extreme conditions of voltage and frequency (By winding resistance method).	80^0C (except submersible motor pump set)
14.	Seismic requirements	If specified in annexure-A, total assembly shall be qualified and documented to prove its capability to withstand specified seismic accelerations.
15.	Radiation dose for which motors located inside the reactor building required to be designed.	As specified in Annexure-A
16	External over pressure for motors inside reactor building during reactor building pressure test.	Motors and their auxiliaries shall withstand satisfactorily external pressure specified in annexure-A

4.0 DESIGN REQUIREMENTS

4.1 General

4.1.1 Motors shall be designed, manufactured, inspected and equipped with accessories in accordance with this specification, Annexure-A and the applicable standards. Materials and components not specifically stated in this specification and which are necessary for meeting the operational and or performance requirements of this specification should be included in the scope of supply.

4.1.2 Design and manufacture of the motors shall be coordinated with the requirements of the driven equipment. The motor manufacturer shall co-operate fully with the Purchaser and the manufacturer of the driven equipment by furnishing required information for proper assembly and operation of the unit as a whole and to offer a motor suitable for the driven equipment duty and application. Typically, the

details that may have to be exchanged between the driven equipment vendor and the motor vendor would include:

i) A copy of this specification including Annexure-A, Load Torque vs Speed characteristics, load GD^2, rated speed, number of starts/restarts, operating duty, load on bearings, mounting, provisions to be made by the motor vendor for ensuring proper coupling, instrumentation, location etc

ii) A fully dimensioned outline drawing of the motor, shaft, mounting details and its terminal box arrangement.

iii) Technical particulars and characteristic curves as asked in Annexure 'B' of this specification.

iv) If specified, submitting all details that are required by the agency performing seismic analysis of motor and the driven equipment as a single unit.

4.1.3 When motors are purchased with the driven equipment, driven equipment supplier shall be responsible to the Purchaser for coordinating with the motor manufacturer for supply of required motors and accessories as per this specification and for satisfactory operation of complete unit.

4.1.4 Where the quantity is more than one, similar parts shall be physically and technically interchangeable between the motors.

4.1.5 Design, manufacture, inspection, testing, qualification and performance of motors shall be in accordance with the particulars specified in Annexure-A to this specification.

4.1.6 Minimum efficiency of motors shall be as per relevant Indian Standards (IS) and efficiency class shall be as given in Annexure-A. Starting current shall be limited as per the particular efficiency class given in the relevant Indian Standards (tolerance as per IS) unless otherwise specified.

4.1.7 Motors if powered through electronic Pulse Width Modulated or any similar variable speed drives shall be suitably designed to take in to account harmonics and voltage surges generated by such drives. Suitability of the motor for operation with such drives shall be confirmed. CONTRACTOR shall coordinate between the drive vendor and the motor vendor so as to ensure total compatibility.

4.2 **Rotor**

4.2.1 The squirrel cage rotor design shall provide a rigid cage construction with aluminum die cast rotor. Alternatively, rotor with copper bars firmly wedged in slots and solidly bonded by brazing to the copper end rings is also acceptable. Brazing and brazing procedures shall be qualified in accordance with acceptable standards. The end ring assembly shall be such that it is free to move with the expansion of the bars without distortion. The rotor cage shall be designed to operate satisfactorily under specified repetitive starting and load cycles. The rotor end lamination shall be rigidly fixed to prevent flaring.

4.2.2 Slip ring motors shall be provided with class-F insulated copper conductor winding and processed in vacuum with Class-F varnish or resin. The temperature rise limits shall correspond to class-B limits. The overhang portion of windings shall be provided with strong supporting arrangement to prevent it's flaring due to action of centrifugal forces during operation and over speeding conditions. Slip ring motors shall be provided with slip ring and brush gear. The design of slip ring and brush gear shall be proven, rugged, non-hygroscopic, anti-tracking and shall have excellent stability at high temperature.

4.3 **Stator (except submersible motor pump set)**

4.3.1 Motor shall be insulated to class 'F' insulation with temperature rise limited to class B. The insulation system shall be of proven design and shall have high dielectric strength, high mechanical strength and long life.

4.3.2 Complete assembly of stator winding and overhang shall be impregnated in resin/ varnish using Vapour Pressure Impregnation (VPI).

4.3.3 The supplier shall describe the insulation and insulation treatment and its capacity to meet the operating requirements specified.

4.3.4 Motor core and winding shall be protected against (a) tropical weather conditions (b) fungus growth and moisture (c) oil (d) abrasive and conducting dust and chemical fumes that are likely to be encountered in and around the power plant area. For this purpose manufacturer shall provide non-hygroscopic & non-digestible (to fungus/mold) insulation material and suitable gel coating.

4.3.5 Overhang portion shall be adequately braced to withstand forces due to repeated restarts and fast transfer voltage conditions. The supports for the overhang portion shall be of non-magnetic material.

4.3.6 Motors located inside the reactor building shall be provided with insulation systems, terminal supports, gaskets, seals, lubricating oil or grease etc capable of withstanding specified level of radiation dose during its service life.

4.3.7 Stator windings shall be of insulated copper conductors.

4.4 **Enclosure**

4.4.1 Motors shall be provided with enclosure providing a degree of protection not less than IP 44 unless other wise specified in Annexure-A. For submersible pump motors, the degree of protection provided by enclosures shall be minimum IP-68.

4.4.2 Motors shall be self-ventilated unless otherwise specified. All out door motors shall be provided with a suitable canopy to prevent rainwater from entering motor and terminal boxes.

4.5 **Frame, End-shields, Fans and other fabricated parts**

4.5.1 Frame, end shields etc of the motor shall be of cast steel or cast iron grade FG 200 or aluminium alloy or better. Incase of alternatives, it shall be made in the offer indicating complete chemical and physical properties of material. However, use of such material is permitted only after obtaining Purchaser's approval against a specific request of vendor for use of such alternate material.

4.6 **Terminal Boxes (except submersible motor pump set)**

4.6.1 Terminal boxes for motors greater than 15kW shall be provided with clearances between phases and phase to earth greater than or equal to 25mm. Terminal boxes for motors less than or equal to 15kW shall be provided with clearances as per applicable standards. Adequate space shall be provided for easy termination of Purchaser's cable.

4.6.2 Terminal boxes shall be suitable for top and bottom or side entry of cables and shall be provided with **EPDM/XLPE** gaskets on all bolted joints to provide a degree of protection equal to IP 55. The terminal boxes shall be suitable for terminating the purchaser's cables as specified in Annexure 'A'.

4.6.3 Supply and mounting of cable glands required for power and control cables are not in the scope of this specification and same shall be provided by the Purchaser. Adequate size of undrilled gland plates shall be provided to facilitate termination of cables.

4.6.4 Motors rated above 30kW shall be provided with auxiliary terminal box for connection to the space heater of the motor.

4.7 **Bearings and Bearing Housing**

4.7.1 Motor bearings shall be constructed so as to exclude dirt and water and to prevent lubricant from reaching the windings. Grease lubricated bearings shall have easily accessible grease nipples to facilitate greasing operations. The bearing assembly shall be provided with grease relief device such that when the motor runs at rated speed any surplus grease is automatically ejected out of the motor casing to a separate container. Alternately, self-lubricated bearings may be used.

4.7.2 Vertical motors shall be provided with single or double (as required) thrust and guide bearings.

4.7.3 Ball and roller bearings shall have a minimum calculated L10 basic rating life of 40,000 running hours and Sleeve bearings shall have a minimum life of 100,000 hours of operation, after considering (a) all the forces that normally occur and (b) seismic forces. Motor manufacturer shall obtain from the driven equipment manufacturer all necessary details required for selection of bearing and in consultation with the bearing vendor, select suitable bearings. Complete details regarding selection and technical particulars of bearings provided shall be submitted to the Purchaser after placement of order.

4.7.4 Operating temperature of bearings under all conditions shall be within the limits prescribed by the bearing manufacturer.

4.7.5 Bearings shall be designed to permit motor running in either forward or reverse directions as required by the driven equipment.

4.7.6 Lubricant shall be selected for prolonged storage and use of the motor in a tropical climate and shall contain corrosion and oxidation inhibitors and anti foaming agents. Grease shall have suitable bleeding characteristics to minimize setting. Data regarding suggested re greasing intervals shall be furnished in the offer. In case of reactor building motors, which are required to operate following Loss of Coolant Accident (LOCA)/ Main Steam Line Break (MSLB), bearing lubricant shall be capable of withstanding pressure and temperature conditions prevailing at the location during and subsequent to LOCA/MSLB.

4.8 **Balancing and Vibration**

4.8.1 Vibrations in all the three directions for horizontal motors shall be within the limits specified in IS-12075. For vertical motors the measured values shall not exceed the limits at the bottom bearings. Type test certificate/report for amplitudes and velocity of vibration in all directions shall be submitted for Purchaser's review/acceptance.

4.8.2 Balancing of rotor with all components mounted shall be carried out at rated RPM or as permitted by the standards. Balancing shall be to grade Gr 2.5 according to ISO 1940. Dynamic balancing of rotor for submersible motor pump set shall be as per IS 9283. Report shall form part of Routine test reports.

4.9 **Grounding**

4.9.1 Provision shall be made on the motors for connecting Purchaser's grounding conductors.

4.10 **Space Heaters (except submersible motor pump set)**

4.10.1 Motors of capacity greater than 30kW (except submersible motor pump set) shall be provided with space heaters of adequate capacity to maintain motor internal temperature above the dew point to prevent moisture condensation when the motor is not in service. The heaters shall be mounted inside the motor in accessible place so that their removal and replacement is a simple operation. Space heaters shall be rated for 240 volts, single phase, 50 Hz operation and shall be located in lower part of motor.

4.11 **Couplings**

4.11.1 Driven equipment manufacturer shall work out details of coupling arrangement. Motor manufacturer shall provide necessary information to the driven equipment supplier and meet the requirements of the driven equipment manufacturer.

4.12 **Direction of Rotation**

4.12.1 Direction of rotation shall be as required by the driven equipment and the same shall be indicated in drawings, documents and motor frame.

4.12.2 If specified in Annexure-A, a mechanical device to prevent reverse rotation shall be provided. The rating of mechanical reverse rotation stop shall be such that it can prevent reverse rotation when the torque in the reverse direction is not greater than 100% of rated torque of the motor in the forward direction.

4.13 **Mounting and Dowelling**

Mounting arrangement shall be matched with the requirements of the driven equipment.

4.14 **Lifting facility**

Motors shall be provided with adequately designed eyebolts, lugs or other devices to facilitate safe lifting operations.

4.15 **Drain Plugs**

Motors should have drain plugs to permit removal of water accumulated inside the motor.

4.16 **Base Frames**

When a motor is supplied with driven equipment having common base frame, the supplier of the driven equipment shall determine that such base frame is adequately braced to keep vibration and misalignment within permissible limits. Driven equipment supplier shall be responsible for supply of all required mounting arrangements considering the motor and driven equipment assembly.

4.17 **Name plate and Diagram of Connections**

Each motor shall have a nameplate showing all the particulars specified in relevant clause of IS-325. In addition, the nameplate shall also indicate (a) the type of bearings used for motor, (b) details of recommended lubricant and (c) Re-lubrication interval & quantity

5.0 PERFORMANCE REQUIREMENTS

5.1 **Starting Duty**

5.1.1 The motors shall be capable of two successive restarts coupled to its driven equipment with coasting to rest between starts under both cold and hot conditions and a third restart shall be feasible after 20 minutes. The motor shall further be capable of three equally time spaced starts per hour under normal service conditions. In case of motors for valve actuators, cranes, lifts, hoists etc which are subjected to repeated starting, stopping, reversing etc, the starting duty shall be commensurate with the requirements of the driven equipment.

5.1.2 Motors shall be designed for direct on line, full voltage starting and shall withstand all stresses and give satisfactory performance when started with their driven equipment connected under all operating conditions specified for the driven equipment. The complete rotating system of motor and driven equipment and end windings of stator, and rotor shall be adequately designed to cater to the different starting duty conditions etc. The total number of starts during the design

life of motor shall be commensurate with the requirements of driven equipment and taking into account design life of motor.

5.1.3 Motor shall be capable to starting and accelerating the driven equipment satisfactorily at a minimum voltage of 80% of the nominal voltage at the motor terminals.

5.2 **Locked Rotor current for squirrel cage rotor**

Locked rotor current shall be as per the values given in Indian Standard for the required efficiency class (Tolerance shall be as per standard) unless otherwise specified.

5.3 **Fast Bus Transfer**

Motors and driven equipment shall be capable of withstanding the voltage torque stresses and forces developed due to the vector difference between the motor residual voltage and the incoming supply voltage during fast changeover of the supply. Motor winding shall be adequately braced to withstand mechanical forces developed during such conditions.

5.4 **Pull out:**

Motor shall not pull out of step when the supply voltage drops to 70% of the rated motor voltage for a short duration of 25 cycles during full load operation of motor. To meet this requirement, the pull out torque of the motor at rated voltage shall be at least 200% of full load torque.

5.5 **Over speed**

The motors shall be capable of withstanding without mechanical damage, at least 120% of rated speed or as imposed by the driven equipment, whichever is higher.

5.6 **Other requirements**

5.6.1 Motors shall be capable of satisfactory operation at full load without injurious heating when the motor terminal voltage is at 80% of rated voltage for ten minutes. Motors shall be capable of withstanding 160% rated torque for 15 and 10 seconds for normal motors and submersible motor pump set respectively.

5.6.2 In all cases involving centrifugal pumps, compressors, fans etc. the acceleration time of motor at 80% terminal voltage shall not be greater than the locked rotor withstand time under hot condition at 100% voltage. The safe stall time of the motor shall be such that taking in to account the accelerating time of the motor

with the driven equipment and specified number of hot and cold starts, adequate margin exists and the motor remains safe. The permissible stator and rotor temperatures for the purpose of calculating safe stall times shall be limited to 185^0 C for stator with class-F insulation and 300^0C for aluminum die cast rotor or 400^0C for rotors with copper bars.

5.6.3 If specified in Annexure-A, driven equipment vendor by analysis of complete assembly of motor, coupling, driven equipment and mounting arrangements shall qualify that motor and the driven equipment assembly would continue to perform intended function during and after subjected to specified level of earthquake with out any deterioration in the performance.

5.6.4 Motors provided with power supplies from variable frequency drives shall be suitably designed and tested to take care of effects of such power supplies on motor performance.

6.0 SPARES

The supplier shall recommend spares that are required for 5 years operation and required to be stocked for maintenance purpose. However, as a minimum, supplier shall furnish prices for the following in his tender.

i) One set of complete bearing assembly for drive and non-drive end bearings.
ii) One complete motor.
iii) One set of space heaters; wherever motors are provided with space heaters.
iv) Seals and other materials that require periodic replacement (if provided).

All spares to be supplied should be physically and technically interchangeable with similar components already installed/in use.

7.0 INSPECTION AND TESTS

7.1 All routine tests mentioned in IS-325/9283 shall be conducted **on all motors** by the manufacturer at his work in the presence of main contractor and/or purchaser's representative. Inspection call for routine tests shall be given two weeks in advance from date of commencement of routine tests as witness point. After lapse of the notice time, manufacturer can proceed with the routine tests. Routine test certificates shall be furnished to the Purchaser's representative (QA) for review & acceptance. Cost for the same shall be included in the equipment prices.

7.2 Test certificates for type tests performed on identical motors as per IS 325/9283 shall be submitted along with the documents and data sheets for review and approval of the Purchaser. In case type test reports are not acceptable to the

Purchaser, type tests shall be performed at no extra cost to the Purchaser and with out affecting the delivery period. Type test reports shall not be earlier than 5 years from the date of purchase order. Test certificates shall be submitted for review and approval of the Purchaser. Any special tests and qualification tests if specified in Annexure-A shall be performed in accordance with an approved test procedure and test reports submitted after due qualification. Special & qualification tests shall be conducted in presence of purchaser's representative Charges for special tests shall be indicated separately and shall be payable if tests are conducted and results are acceptable.

7.3 The Purchaser or his authorised representative shall at all reasonable times have access to those parts of the supplier' s or sub-supplier's works concerned with the manufacture of the motor for the purpose of witnessing tests and ascertaining compliance with the requirements of this specification. The Purchaser shall also have the right to conduct at his expense any additional tests or inspection he deems necessary.

7.4 The contractor shall supply to Purchaser's representative a complete set of detailed fabrication drawings which will be used in the inspection during manufacture, which will be retained at the factory and returned after completion of the contract.

7.5 All repairs and rework shall be informed to the Purchaser and his approval in writing taken before proceeding further. All such repair work shall be documented and photographic records shall be maintained. These documents shall be included in end documents.

8.0 PAINTING AND PACKING:

8.1 The 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. The painting system shall be having a primer based on inorganic Ethyl zinc silicate (for RB motors)/ zinc phosphate and compatible with epoxy paint system and top coats of epoxy paint system to shade 631 of IS-5 or RAL-7032.

8.2 All materials/ spares that have limited shelf life shall be marked with expiry date in bold to indicate their storage conditions.

8.3 The motor shall be packed for dispatch to project site in strong wooden crates. The following information shall be clearly given on each box.

a) Purchaser

b) Purchaser order number

c) Equipment code number, if any.

d) List of contents of each package

e) Storage instructions

8.4 The packing should incorporate measures to prevent damage to motor winding, bearing and shaft due to jerks and shocks during transit. The packing should afford reasonable protection against ingress of rainwater.

9.0 DRAWINGS AND DOCUMENTS

9.1 Within 4 weeks of placement of purchase order, the supplier shall furnish for Purchaser's approval following drawings:

a) Drawings showing overall dimensions and all other essential dimensions along with cross-sectional views and data sheets as given in Annexure-B.

b) Detailed drawing for terminal boxes, clearance, conductor termination, cable gland and degree of protection should also be marked on this drawing.

c) Write up on the insulation system provided for the motor winding as part of motor datasheet.

d) All details submitted to the driven equipment supplier for the purpose of seismic qualification of the driven equipment and the motor assembly, application check for the motor to confirm suitability of the motor to the requirements of driven equipment.

9.2 Supplier shall take up manufacture after the Purchaser has approved the drawings.

9.3 Three prints of all drawings and documents shall be submitted for approval. After execution of the order, three sets of hard copies of drawings and documents and two sets of CDs with all scanned copies of documents, drawings, data sheets and characteristic curves and routine and type test reports including reports of special tests if performed shall be supplied.

9.4 Following characteristic curves shall be supplied:

9.4.1 Torque v/s speed curves for the motor superimposed with load torque vs speed characteristics.

9.4.2 Starting current v/s time

9.4.3 Power factor, efficiency, load current v/s Load

9.4.4 Thermal withstand characteristics for motor under cold and hot conditions.

10.0 INSTRUCTION MANUALS

10.1 Supplier shall furnish three hard copies of instruction manuals and two CDs with completely scanned copies of documents covering storage, installation, detailed assembly, disassembly procedures, operation and maintenance of the motors. Installation instructions shall include procedure for checking alignment of motor shaft, coupling and base. Instruction shall also cover lubricating details including recommended inspection and replacement schedules, quantity of lubricant required and specifications for the lubricant and its equivalent. Instruction manual shall include one set of all approved drawings, a complete part list, descriptive literature for all components such as space heaters etc and complete details of motor in Annexure - B as per requirement.

10.2 In addition, three copies of the above instruction manual shall be supplied with each motor.

Sl.No.	Particulars	
1.0	**SPECIAL SITE CONDITIONS**	
1.1	Type of environment (corrosive/non-corrosive)	
1.2	Location (indoors/outdoors)	
1.3	Hazardous condition.	
1.4	Whether the Motor is supplied from variable frequency variable voltage drives or similar such electronic drives (Yes, the motor shall be designed adequately to take in to account voltage output from such drives / No, the motor is provided with normal power supply)	
2.0	**GENERAL**	
2.1	Application/Driven equipment	
2.2	Type of motor (SCR/SR)	
2.3	Type of submersible motor pump set, (Wet Type/Resin Filled/Sealed)	
2.4	Efficiency class of motor (IE1/IE2/IE3/any other class)	
2.5	Nature of application of the motor (Motor is safety related/Motor is not safety related but critical/General)	
2.6	Lower critical speed of motor	>130% of rated speed
2.7	Length of cable for submersible motor pump set, (m)	
2.8	Permissible voltage drop of 15m cable length for submersible motor pump set	≤1% of rated voltage
3.0	**RATING**	Driven equipment vendor to select the rating considering all operating conditions and provide a minimum margin of 10%
4.0	**DUTY**	
4.1	Type of duty (S1 to S8)	
5.0	**STARTING**	
5.1	Method of starting	
5.2	Number of successive starts on full load followed by next start after 20 minutes. (A) In cold condition (B) In hot condition.	 Minimum 2 Minimum 2
5.3	No. of equally spread starts per hour.	Minimum 3

6.0	**INSULATION**	
6.1	Class of insulation for stator/Rotor winding	Minimum Class-F
7.0	**ENCLOSURE**	
7.1	Type of enclosure.	
7.2	Degree of protection.	
7.3	Type of cooling	
8.0	**TERMINAL BOXES**	
8.1	No. of cable entries.	
8.2	Power cable size and type.	
8.3	Separate terminal box required for: Stator phase terminals (Yes/No) Rotor phase terminals (Yes/No) Space heater terminals (Yes/No)	
8.4	Size of cable for space heater external connection	2.5 sq.mm Cu. conductor, 2 core HRPVC/XLPE cable or as required.
8.5	Location of terminal boxes when viewed from non driving end of the motor	Left / Right / top
9.0	**BEARINGS**	
9.1	Type of bearings	
9.2	Type of lubrication	
9.3	Expected re-lubrication interval	
10.0	**INSPECTION AND TESTING**	
10.1	Whether any special tests other than those indicated in the specifications and Indian Standards are required to be performed? (Yes/No) If so, indicate details.	
10.2	Whether seismic qualification of motor and its driven equipment required to be performed? If yes, identify operability / structural integrity requirements under SSE and OBE.	
11	**Special Requirements for Reactor building motors**	
11.1.	Whether motor is required to be qualified for operation during and following LOCA/MSLB? (Yes/No*)	
11.2	If LOCA/MSLB qualification is required, are the corresponding pressure and temperature transient curves enclosed? (Yes/No)	
11.3	Cumulative radiation dose under normal and accident conditions.	

11.4	Motor tag number for which LOCA/MSLB qualification is required.	
11.5	Whether motor insulating materials, gaskets, lubricants etc required to withstand radiation and operate satisfactorily under normal conditions? (Yes/No)	
11.6	Cumulative radiation dose under normal conditions	
11.7	Whether motor is required to be qualified to withstand radiation under normal conditions? (Yes/No)	
11.8	Tag numbers of motors for which radiation qualification for normal conditions is required but LOCA and MSLB qualification is not required	
11.9	Expected external over pressure likely to be experienced by motors and their accessories during reactor building pressure test.	

* Detailed procedure shall be worked out by the Contractor and subjected to review and approval of Purchaser.

NUCLEAR POWER CORPORATION OF INDIA LIMITED	
ANNEXURE-B TO PC-E-501 FORMAT FOR SUBMISSION OF TECHNICAL PARTICULARS FOR MEDIUM VOLTAGE INDUCTION MOTORS EQUAL OR LESS THAN 50kW FOR 700MWe (To be filled in by Motor Manufacturer and submitted through driven equipment Manufacturer / Package Contractor)	**Project: 700MWe** **Page : 1 of 8**

1.	Name and address of Motor Manufacturer		:	
2.	Name and address of driven equipment manufacturer		:	
3.	Name and address of Package contractor		:	
4.	References		:	
	i)	NPCIL's Purchaser Order No.	:	
	ii)	Package Contractor's Purchase Order No.	:	
	iii)	Driven Equipment Supplier's Purchase Order No	:	
	iv)	Work Order Number of Motor Manufacturer	:	
5.	NPCIL Document No.		:	
6.	Rev. No. & Date		:	
7.	Motor Tag Nos.		:	
8.	Quantity		:	
9.	Project Title		:	
10.	Contents		:	
	i)	Motor data sheets	:	Sheet 1 to 8
	ii)	Motor & load Torque v/s Speed Curves	:	Sheet 9
	iii)	Performance Curves	:	Sheet 10
	iv)	Current v/s starting time	:	Sheet 11
	v)	Thermal withstand characteristics	:	Sheet 12
	vi)	Name Plate Drawing	:	Sheet 13
	vii)	Power Terminal Box Drawing	:	Sheet 14
	viii)	Space Heater Terminal Box Drawing	:	Sheet 15

	Motor Manufacturer	Driven Equipment Supplier	Package Contractor
Prepared by			
Reviewed by			
Approved by			

Motor manufacturer's name and address	**Date of issue, Rev No**

NUCLEAR POWER CORPORATION OF INDIA LIMITED	
ANNEXURE-B TO PC-E-501 FORMAT FOR SUBMISSION OF TECHNICAL PARTICULARS FOR MEDIUM VOLTAGE INDUCTION MOTORS EQUAL OR LESS THAN 50kW FOR 700MWe (To be filled in by Motor Manufacturer and submitted through driven equipment Manufacturer / Package Contractor)	**Project: 700MWe** **Page : 2 of 8**

Sl.No.	Particulars	
1.0	**Guaranteed operating conditions for the motor**	
1.1	Ambient temperature, ^{0}C	
1.2	Altitude, M	
1.3	Humidity at 40^{0}C, (%)	
1.4	Type of environment (corrosive/non-corrosive)	
1.5	Location (indoors/outdoors)	
1.6	Hazardous condition (Yes/No)	
1.7	Rated voltage & its variations, (V)	
1.8	Rated frequency & its variations, (Hz)	
1.9	Permissible un-balance in supply voltage, (%)	
1.10	Permissible harmonic content in supply voltage, (%)	
1.11	Combined voltage & frequency variations, (%)	
1.12	Number of phases	
1.13	Method of system grounding.	
1.14	Seismic capability: if specified in the annexure-A, whether qualification of motor and the driven equipment assembly along with accessories and auxiliaries included in the scope of the tender? Identify the methodology for seismic qualification.	
1.15	Radiation withstand capability of the motor	
1.16	Auxiliary power supply requirements for space heaters	
1.17	Whether the motors are adequately designed to operate satisfactorily when supplied with power supply from electronic drives intended to be used for the driven equipment?	
2.0	**GENERAL**	
2.1	Application/Driven equipment	
2.2	Method and type of coupling to driven equipment.	
2.3	Type of motor (SCR/SR)	
2.4	Frame size	
2.5	Mounting	
2.6	Single shaft / double shaft extension.	
2.7	Direction of rotation (viewed from drive end)	
2.8	Rotation – uni /bi-directional	
2.9	Reverse rotation stop provided?	
2.10	Applicable standards/codes.	
2.11	Stator winding connection	
2.12	Winding resistance per phase*	

Motor manufacturer's name and address	**Date of issue, Rev No**

NUCLEAR POWER CORPORATION OF INDIA LIMITED	
ANNEXURE-B TO PC-E-501 FORMAT FOR SUBMISSION OF TECHNICAL PARTICULARS FOR MEDIUM VOLTAGE INDUCTION MOTORS EQUAL OR LESS THAN 50kW FOR 700MWe (To be filled in by Motor Manufacturer and submitted through driven equipment Manufacturer / Package Contractor)	**Project: 700MWe** **Page : 3 of 8**

3.0	**RATING**		
3.1	Rated output (KW)		
3.2	Rated speed (RPM)/Synchronous speed (RPM)		
3.3	KW actually required by the drive equipment under specified operating conditions.		
4.0	**DUTY**		
4.1	Type of duty		
5.0	**STARTING**		
5.1	Method of starting		
5.2	Starting current (% of full load current)		
5.2.1	At rated voltage		
	a)	Including I.S. tolerance	
	b)	Excluding I.S. tolerance (Committed value)	
5.2.2	At 80% voltage		
	a)	Including I.S. tolerance*	
	b)	Excluding I.S. tolerance* (Committed value)	
5.3	Minimum voltage required for starting (% of rated voltage)		
5.4	Starting time with DOL starting with driven equipment coupled		
	a)	At rated voltage, (sec)	
	b)	At 80% voltage *, (sec)	
5.5	Max. No. of successive starts on full load		
5.5.1	In cold condition		
5.5.2	In hot condition		
5.6	No. of equally spread starts per hour		
6.0	**INSULATION**		
6.1	Class of insulation for stator		
6.2	Permissible temperature rise (by resistance method)		
	a)	Under normal conditions, (^{0}C)	
	b)	Under extreme voltage conditions (90/110% of rated voltage whichever is severe), (^{0}C)	
6.3	Tropical Treatment of motor		
6.3.1	Material of insulation		
6.3.2	Treatment of insulation, stator and rotor core for anti-fungal growth		
7.0	**COSTRUCTION & MATERIALS**		
7.1	Degree of protection provided by the enclosure		
7.2	Enclosure type (Fabricated type/ casting)		

Motor manufacturer's name and address	**Date of issue, Rev No**

7.3	Enclosure material grade for		
	a)	Frame	
	b)	End shields	
	c)	Power terminal box	
	d)	Bearing housing	
	e)	Gaskets	
7.4	Material for stator conductors		
7.5	Material for rotor bars, (Cu, Al)		
7.6	Heat loss to environment for the purpose of ventilation design *		
7.7	Type of cooling		
7.8	Painting		
7.8.1	Primer (Epoxy system having polyamide cured non-inhibitive epoxy primer?), (Yes/ No)		
7.8.2	Finish Coats (Polyamide cured epoxy?), (Yes/No)		
8.0	**TERMINAL BOXES**		
8.1	Type of main terminal Box		
8.2	Degree of protection for T. Box enclosure		
8.3	No. of cable entries*		
8.4	Max. cable size suitable for the terminal box/Actual cable size, (sqmm)*		
8.5	Direction of cable entry		
8.6	Size of cable gland plate suitable for		
	a)	Motor cable*	
	b)	Space heater cable*	
8.7	Cable type & length for submersible motor pump set		
9	**BEARINGS**		
9.1	Type of bearing		
9.2	D.E bearing number and make.		
9.3	N.D end bearing number and make		
9.4	Standard L10 life of bearing.		
9.5	Type and grade of lubricant*		
9.6	Bearing end play (mm)* Axial Radial		
9.7	Thrust bearing losses*		
9.8	Regressing interval		
9.9	Maximum permissible bearing temperature, (^{0}C)		

	DE NDE		
9.10	Whether bearings are designed considering all loads expected during all operating conditions including seismic conditions (if specified) of the driven equipment?		
9.11	Whether bearings are designed for operation during and after LOCA, (only if the requirement is specified)		
10	**ACCESSORIES**		
10.1	Space – heaters		
	a)	Voltage	
	b)	Wattage/ space heater*	
	c)	Nos. proposed to be used*	
	d)	Location*	
	e)	Expected temperature of in side air above the out side ambient air temperature*	
11	**WEIGHT AND MOMENT OF INERTIA**		
11.1	Weight of stator (Kg.)*		
11.2	Weight of rotor (Kg.)*		
11.3	Total weight of motor (Kg.)*		
11.4	Shipping weight of motor (Kg.)*		
11.5	Shipping dimensions LXBXH*		
11.6	Rotor GD^2 (Kgm^2)*		
11.7	GD^2 of driven equipment referred to motor speed (kgm^2)*		
12	**PERFORMANCE**		
12.1	Full load current (amps)		
12.2	No load current. (amps)		
12.3	Full load speed (rpm)		
12.4	No load speed (rpm)		
12.5	Efficiency At full load (%) At 75% load (%)* At 50% load (%)*		
12.6	Power factor At full load At 75% load* At 50% load* At starting*		
12.7	Noise pressure level of motor at 1.0 m at no load, db (A)		

Motor manufacturer's name and address	**Date of issue, Rev No**

12.8	Velocity of vibration at		
	a)	No load (microns), mm/s	
	b)	With load (microns), mm/s	
12.9	Critical speed (rpm)		
	a)	Lower	
12.10	Safe stall time at 80% & 100% voltages, (sec)		
	i)	When motor is at rated operating temperature	
	ii)	When motor is at ambient temp	
	iii)	Limiting stator and rotor temp. considered to determine stall time, (^{0}C)	
12.11	Maximum number of starts permissible per year		
12.12	a)	Stator thermal time constant*	
	b)	Stator cooling time constant*	
12.13	Overload capacity:		
12.14	Torque		
12.14.1	Torque at full load, (% & time)		
12.14.2	Starting torque (% of full load torque) At rated voltage At 80% voltage*		
12.14.3	Pull-out torque (% of full load torque) at rated voltage		
12.14.4	Pull-up torque (% of full load torque) at rated voltage		
13.0	**CONNECTIONS**		
13.1	Stator		
13.2	Number of connections brought out		
14.0	**INSPECTION**		
14.1	Performance of routine tests in the presence of Purchaser / Package contractor as specified in Annexure-A agreed?, (Yes/No)		
14.2	Performance of all type tests as specified agreed if the Purchaser does not find type test reports acceptable?, (Yes/No)		
14.3	Whether full compliance to PC-E-501 agreed?, (Yes/No)		
15.0	**DRAWINGS, CATALOGUES, DATA SHEETS**		
15.1	Descriptive pamphlets for the offered motor enclosed?, (Yes/No)		
15.2	Torque vs. speed characteristics curve at rated voltage and frequency*		
	a)	For motor	

	b)	For driven equipment	
15.3	Current vs. speed characteristic curve at rated voltage and frequency during acceleration*		
15.4	Thermal withstand characteristic curve and data in digital form for		
	a)	Hot condition*	
	b)	Cold condition*	
15.5	Current vs. time characteristic curve during acceleration*		
15.7	Efficiency, Power factor and current vs. load characteristics*		
15.8	Dimensional drawing showing cross sectional view and identification of components and their material specification, shaft, fan etc*.		
15.9	Dimensional drawing of the terminal boxes showing dimensions, permissible cable size, degree of protection, materials of fabrication, gasket material etc and the method of terminating the purchaser's incoming cables*.		
16.0	**Additional Technical Particulars for Motors in Reactor Building**		
16.1	Applicable standards		
16.2	Is the motor designed to operate under normal and Loss of coolant accident/ Main Steam Line Break conditions, (Normal condition/Normal and Accidental condition.)		
16.3	Capability of the motor to withstand specified radiation levels (Test certificate to be submitted)		
16.4	List of insulating materials used and their radiation withstand capability:		
16.4.1	Stator conductor		
16.4.2	Slot liner		
16.4.3	Slot wedge		
16.4.4	End connections		
16.4.5	Over hang portion		
16.4.6	Varnish for impregnation		
16.4.7	Motor terminal		
16.4.8	Gaskets		
16.4.9	Lubricants		
16.5	Capability of the motor to continuously operate under the specified accident conditions (LOCA/MSLB) viz. temperature, pressure and relative humidity (Test certificate to		

	be submitted or type test shall be performed as per approved procedure).	
16.6	Capability of the motor to withstand specified seismic withstand requirements.	

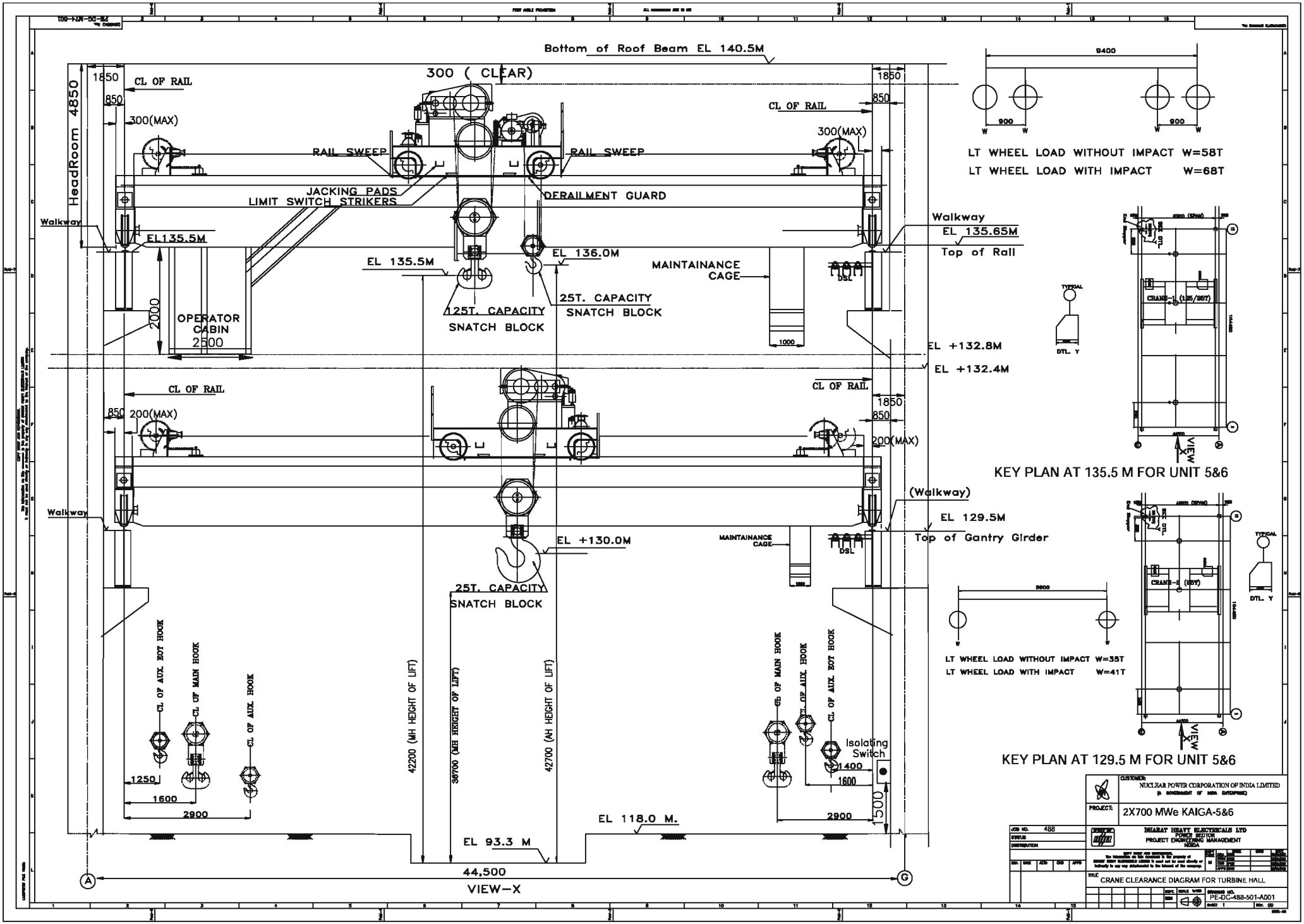
Note: a) All data sheets and characteristic curves should be strictly in the above format in A4 size sheets with continuous page numbers, properly bound and provided with a cover sheet indicating names and signatures of persons responsible for preparation, checking, approving of documents at motor manufacturer, driven equipment vendor, EPC contractor etc before submission to the Purchaser. Document shall have Purchaser's purchase order reference, EPC contractor's purchase order reference and driven equipment vendor's purchase order reference, Purchaser's project identification, Motor tag numbers, revision number, date of revision etc on the cover sheet.

b) All drawings shall be in A3 size sheets and shall indicate Purchaser's project identification, motor tag numbers, purchase order numbers etc.

c) Items marked * can be submitted after placement of order and after completion of detailed engineering.

d) The vendor shall attach Sheet nos 9 to 15 referred in Cl no 10. Alternatively Sheet nos 13 to 15 can be submitted as separate documents.

CRANE CLEARANCE DIAGRAM


Bottom of Roof Beam EL 140.5M
300 (CLEAR)
HeadRoom 4850
1850
850
CL OF RAIL
300(MAX)
RAIL SWEEP
JACKING PADS
LIMIT SWITCH STRIKERS
DERAILMENT GUARD
Walkway
EL135.5M
EL 135.5M
EL 136.0M
MAINTAINANCE CAGE
DSL
125T. CAPACITY SNATCH BLOCK
25T. CAPACITY SNATCH BLOCK
2000
OPERATOR CABIN
2500
1000
Walkway
EL 135.65M
Top of Rail
EL +132.8M
EL +132.4M
200(MAX)
EL +130.0M
(Walkway)
EL 129.5M
Top of Gantry Girder
CL OF AUX. HOT HOOK
CL OF MAIN HOOK
CL OF AUX HOOK
42200 (MH HEIGHT OF LIFT)
36700 (MH HEIGHT OF LIFT)
42700 (AH HEIGHT OF LIFT)
1250
1600
2900
Isolating Switch
1400
1500
EL 118.0 M.
EL 93.3 M
44,500
VIEW–X
9400
900
LT WHEEL LOAD WITHOUT IMPACT W=58T
LT WHEEL LOAD WITH IMPACT W=68T
TYPICAL
DTL. Y
VIEW X
KEY PLAN AT 135.5 M FOR UNIT 5&6
LT WHEEL LOAD WITHOUT IMPACT W=35T
LT WHEEL LOAD WITH IMPACT W=41T
KEY PLAN AT 129.5 M FOR UNIT 5&6
CUSTOMER: NUCLEAR POWER CORPORATION OF INDIA LIMITED
PROJECT: 2X700 MWe KAIGA-5&6
BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA
JOB NO. 488
TITLE: CRANE CLEARANCE DIAGRAM FOR TURBINE HALL
DRG. NO. PE-DC-488-501-A001

PAINTING SPECIFICATION:

Before packing and dispatch, all crane structures/parts/equipment/components of mechanical and electrical parts shall be thoroughly cleaned by sand blasting or shot blasting (except machined surfaces) to remove all dirt, grease, scale and rust and painted with two coats of epoxy finished paint. Total DFT shall not be less than 250 microns. Structural portions of the cranes shall be painted with Light Orange (557). All the machined surfaces shall be coated with anti-rust black compound. Electrical component shall be epoxy based painting of Air Craft Grey shade No. 693. All the interior of panel shall be coated with epoxy based brilliant white shade.
Alternatively, powder coating is acceptable for panel. In such cases, the DFT shall not be less than 50 microns. The following are the details of the same

9.1 Surface Preparation:

a) Remove all the weld spatters &slag from welds and break all edges which are sharp that cannot be coated properly.
b) Prior to painting /Coating check required surfaces are clean, dry and free from dust loose particles.
c) Main structural surface is to be cleaned with Degreasing and blast cleaning to SA 2 ½ requirements.
d) Difficult to blast clean areas may be mechanically cleaned to ST2/ST 3 requirements.

9.2 Protection

Protect or remove the following items and surfaces during the cleaning, painting operations

a) Machined Surface.
b) Galvanized steel, stainless steel &nonferrous metal.
c) Rubber, Glass &Plastic.
d) Name Plates, Match Marking and Instruction plates.
e) Area within 75-100 mm of proposed field wield.

9.3 Painting & Coating

a) Painting shall commence within 4 hours of blast cleaning or before browning occurs.
b) After proper cleaning &surface penetration start the painting work.
c) Detailed Painting procedure should be as per approved procedure prepared by supplier and approved by purchaser. The painting scheme should have coats of Epoxy Zinc rich primer, Intermediate Epoxy High Build MIO based Coat, Final Coat of Polyamide Cured pigmented Epoxy based Paint& Epoxy Acrylic PU based paint.
d) Painting shall not be done when the surface temperature is below 10° C or more than 40 ° C and also RH is more than 80 %.

9.4 Inspection

a) Make, batch no& Shelf life of paints to be verified and recorded prior to application.
b) Adhesion test to be carried out on each coat by supplier.
c) DFT of each coat to be measured at random selected points and the minimum measured thickness shall be recorded.

9.5 Make of Paint
Paint system of only one of vendor namely ASIAN PAINT/BERGER PAINT/SHALIMAR
PAINT shall be used. Primer and paints of different manufacturers shall not be intermixed.

Mandatory Spares:

1 LOT FOR 125/25T MAIN EOT CRANE & 1 LOT FOR 25T AUX EOT CRANE

Sr. No.	Item	Quantity Nos. / Sets
1.0	Linings for Brakes	
	Main Hoist & Auxiliary Hoist	3 Pairs
	Cross travel	3 Pairs
	Long Travel	3 Pairs
2.0	Bearings	
	For each motor for all motions	1 Set
	Main Hoist Gearbox & Auxiliary Hoist	1 Set
	Cross Travel Gearbox	1 Set
	Long Travel Gearbox	1 Set
	Cross Travel Wheels	1 Set
	Long Travel Wheels	1 Set
	Oil Seals	
	Gear Couplings	2 Sets
	Main Hoist gear box & Auxiliary Hoist	2 Sets
	Cross travel gear box	2 Sets
	Long travel gear box	2 Sets
	Brake Spring	
	Main Hoist & Auxiliary Hoist	1 Pair
	Cross travel Unit	1 Pair
	Long Travel Unit	1 Pair
	Brake Disc	
	Main Hoist & Auxiliary Hoist	1 Pair

	Cross travel Unit	1 Pair
	Long Travel Unit	1 Pair
	'O' Ring	
	Main Hoist & Auxiliary Hoist	2 Sets
	Cross travel Unit	2 Sets
	Long Travel Unit	2 Sets
	Bearing Seal	
	Main Hoist & Auxiliary Hoist	2 Sets
	Cross travel Unit	2 Sets
	Long Travel Unit	2 Sets
	ELECTRICAL	
	Power and Control PCB Cards	1 Set for each Drive
	Push Button	10 % of total qty.
	Current collector of DSL	One per each size.

Note:

1) In-case spares indicated in the list are not applicable to the particular design offered by the bidder the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.
2) Any item which is quoted as "not applicable" in the above list and is found to be "applicable" at a later date shall be supplied by the Bidder without any commercial implications. The Bidder shall note that if there in any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.
3) All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares should include all mounted accessories like components, boards, add or items, fitting, connectors etc. and be complete in all respects so that the replacement of the main items by these pares does not require any additional item. The vendors must conform the pair to pair compatibility of each electrical spares modules with the modules should be supplied in the original package. All electronic modules should be pre-set and/or pre-programmed for ready use at site.
4) Set for the particular equipment, would include all components required to replace the item, for example a set of bearing shall include all hardware normally required while replacing the bearings One (1) set means 100% requirement for one crane.

Maintenance Tools and Tackles:

A complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual for the crane shall be supplied for each crane. Each tool and wrench shall be stamped so as to be identified, easy for its use. The tools shall be supplied in steel toolbox and with a copy of instruction manual. The items supplied shall be of the best quality and minimum the following shall be provided for each type/capacity Crane

S-No.	Description	Qty.
1	Complete set of ring spanners (Indicate the sizes offered)	1 Set
2	Complete set of screwdrivers (Min. 6 Nos., Indicate the sizes)	1 Set
3.	Adjustable Spanner	1 No.
4.	Insulated plier	1 No.
5	Wrench spanner	1 No.
6.	Grease Gun	1 No.
7.	Oil Gun.	1 No.
8.	Hand Lamp.	1 No.
9	Line tester	1 No.

APPROVED BRANDS

1. Push Button: GE/ BCH/ L&T/SIEMENS.
2. Emergency Push Buttons: GE / BCH / L&T.
3. Resistors: Electromagnet/SOC/Omega.
4. Limit Switches: GE / BCH/ Speed-O-Control.
5. Sockets/ Switches: Anchor/ Bajaj/Crompton/MDS.
6. Indicating Lamps: GE / L&T/ Siemens.
7. Contactors : GE / Siemens/ L&T
8. Power/ Control Switches: GE / Siemens/ L&T
9. Fuses/ Over Load Relays: GE / Siemens/ L&T
10. MCB: MDS/ Havell/Siemens.
11. VVVF: ABB, TELEMECHANIQUE, SIEMENS, ALENBRADLY.
12. Hooks: Steel Forgings, Smriti Forgings or any other reputed vendor with prior approval from NPCIL.
13. Wire Ropes: Bharat Wire Ropes, Usha Martin.
14. Brakes: Speed-O-Controls, Emco Lenze, Electromag, Pethe.
15. DSL: Safe line, Safe Track, Armatic, Mobilis Elite.
16. Radio remote controls: SNT controls and any other reputed vendor subjected to prior approval from NPCIL.

However for any additional make, the PURCHASER reserves the right to accept or reject any of the brands

DRAWING SUBMISSION SCHEDULE:

DRG. TITLE	NPCIL DOC. NO.	BHEL DOC. NO.	SCHEDULE
QAP for 125/25T Main EOT Crane*	Kaiga5&6/QAP/76121/00021	PE-V0-488-501-A501	3 Week
Structural Design Calculation for 125/25T main Double Girder*	Kaiga-5&6/DC/76121/00022	PE-V0-488-501-A512	6 Week
Cradle Design Calculation for 125/25T Main EOT Crane	Kaiga-5&6/DC/76121/00023	PE-V0-488-501-A552	12 Week
GA Drawing for 125/25T Double Girder Main EOT Crane*	Kaiga-5&6/76121/8002/GA	PE-V0-488-501-A505	3 Week
Mechanism Sizing Calculation for 125/25T Main Double Girder EOT Crane*	Kaiga-5&6/DC/76121/00021	PE-V0-488-501-A504	3 Week
Crab Arrangement Drawing for 125/25T Double Girder main EOT Crane	Kaiga-5&6/76121/8003/GA	PE-V0-488-501-A506	4 Week
DSL Fixing arrangement drawing for 125/25T DG EOT	Kaiga-5&6/76121/8004/GA	PE-V0-488-501-A508	4 Week
PANEL GA DRAWING including DBR FOR 125/25T MAIN EOT CRANE	Kaiga-5&6/76121/8001/GA	PE-V0-488-501-A518	4 Week
Cable selection calculation for 125/25T Main EOT Crane	Kaiga-5&6/76121/8001/DD	PE-V0-488-501-A519	4 Week
Control transformer calc for 125/25T TG EOT	Kaiga-5&6/76121/8004/DD	PE-V0-488-501-A541	4 Week
Data Sheet for 125/25T Main EOT CRANE	Kaiga-5&6/76121/8001/DS	PE-V0-488-501-A527	8 Week
DSL selection calculation 125/25T MAIN EOT Crane	Kaiga-5&6/76121/8002/DD	PE-V0-488-501-A542	4 Week
Electrical control schematic drawing/ wiring diagram including Master controller & RRC drawing for 125/25T EOT Crane*	Kaiga-5&6/76121/8001/ED	PE-V0-488-501-A517	4 Week
ELECTRICAL CONTROL WRITE UP FOR 125/25T MAIN EOT CRANE	Kaiga-5&6/76121/8005/DD	PE-V0-488-501-A520	4 Week
Lighting Sizing Calculation for 125/25T Main EOT Crane	Kaiga-5&6/76121/8003/DD	PE-V0-488-501-A543	4 Week
TERMINAL DIAGRAM FOR 125/25T MAIN EOT CRANE	Kaiga-5&6/76121/8001/TL	PE-V0-488-501-A544	4 Week
BILL OF MATERIAL FOR 125/25T MAIN EOT CRANE	Kaiga-5&6/76121/8001/BM	PE-V0-488-501-A545	4 Week
Motor Data Sheet for Aux Hoist for 125/25T Main EOT Crane	Kaiga-5&6/76121/8003/DS	PE-V0-488-501-A502	8 Week
Motor Data Sheet for Long Travel for 125/25T Main EOT Crane	Kaiga-5&6/76121/8005/DS	PE-V0-488-501-A540	8 Week
Motor Data Sheet for Main Hoist for 125/25T MAIN EOT Crane	Kaiga-5&6/76121/8002/DS	PE-V0-488-501-A503	8 Week

MAIN HOOK DRAWING	Kaiga-5&6/76121/8010/DD	PE-V0-488-501-A509	4 Week
Gantry Rail Installation	Kaiga-5&6/76121/8020/DD	PE-V0-488-501-A532	4 Week
Bill of Material for 25T AUX EOT Crane	Kaiga-5&6/76121/8002/BM	PE-V0-488-501-A435	10 Week
Data Sheet for 25T AUX EOT CRANE	Kaiga-5&6/76121/8006/DS	PE-V0-488-501-A427	10 Week
Motor Data Sheet for Main Hoist for 25T AUX EOT Crane	Kaiga-5&6/76121/8007/DS	PE-V0-488-501-A451	10 Week
Motor Data Sheet for Cross Travel for 25T AUX EOT Crane	Kaiga-5&6/76121/8008/DS	PE-V0-488-501-A452	10 Week
Motor Data Sheet for Long Travel for 25T AUX EOT Crane	Kaiga-5&6/76121/8009/DS	PE-V0-488-501-A453	10 Week
Cable Selection Calculation for 25T AUX EOT CRANE	Kaiga-5&6/76121/8006/DD	PE-V0-488-501-A419	4 Week
DSL Selection Calculation for 25T Aux EOT Crane	Kaiga-5&6/76121/8007/DD	PE-V0-488-501-A420	4 Week
Lighting sizing calculation for 25T Aux EOT Crane	Kaiga-5&6/76121/8008/DD	PE-V0-488-501-A422	4 Week
Control Transformer Calculation for 25T Aux EOT Crane	Kaiga-5&6/76121/8009/DD	PE-V0-488-501-A421	4 Week
Electrical control Write up for 25T AUX EOT	Kaiga-5&6/76121/8010/DD	PE-V0-488-501-A425	4 Week
Electrical control schematic drawing/wiring diagram including RRC & Pendant for 25T AUX EOT*	Kaiga-5&6/76121/8002/ED	PE-V0-488-501-A417	4 Week
Panel GA Drawing including DBR for 25T AUX EOT Crane	Kaiga-5&6/76121/8005/GA	PE-V0-488-501-A418	4 Week
TERMINAL DIAGRAM FOR 25T AUX EOT CRANE	Kaiga-5&6/76121/8002/TL	PE-V0-488-501-A450	4 Week
GA Drawing for 25T D.G. AUX. EOT Crane*	Kaiga-5&6/76121/8006/GA	PE-V0-488-501-A405	3 Week
SIZING CALCULATION for 25T D.G. AUX. EOT Crane *	Kaiga-5&6/76121/00021/DC	PE-V0-488-501-A404	3 Week
DSL Fixing arrangement drawing for 25T AUX DG EOT	Kaiga-5&6/76121/8007/GA	PE-V0-488-501-A408	4 Week

"*" marked drawings are Primary documents.

Schedule in week, is from date of LOI

Bidder to follow the following the drawing submission schedule:

a) 1st submission of drawings from date of LOI as per the submission schedule.
b) Every revised submission incorporating comments – within 7 days.

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate (every sheet) and furnish same with the offer.

a. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions other than those mentioned under "exclusion" and those resolved as per 'Schedule of Deviations', if applicable, with regard to same.

b. There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'.

c. Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This shall be within the contracted price with no extra implications to BHEL after award of the contract.

d. All drawings/ data-sheets/ calculations etc. submitted along with the offer shall be considered for reference only, same shall be subject to BHEL/ CUSTOMER approval in the event of order.

e. The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified/ intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre - bid discussions, otherwise BHEL/ Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

   For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f. The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

g. All sub vendors shall be subject to BHEL/ CUSTOMER approval in the event of order.

h. Guarantee for plant /equipment shall be as per relevant clause of GCC /SCC /Other Commercial Terms & Conditions.

i. In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities. This clause will apply in case during site commissioning additional requirements emerges due to customer and/ or consultant's comments. No extra claims shall be put on this account.

j. Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k. As built drawings shall be submitted as and when required during the project execution.

l. The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

m. Regarding commercial documents / deviations, BHEL clarified that commercial documents /deviations shall not been considered during technical evaluation. However if any issue in the commercial documents / deviation related to technical requirements needs to be highlighted and resolve in technical evaluation only.
No aspect of commercial issues needs to be highlighted / resolved in technical evaluation and their offer is strictly in compliance with technical specification. BHEL also clarified to the bidder any technical deviations (e.g. related to MDL, required documentation etc. for completion of the Project) raised by them in commercial deviation either explicit or implicit shall be considered null and void even if agreed by BHEL during commercial evaluation stage.

Bidder agreed to confirm and compliance with technical specification and subsequent clarification on bids during pre- award discussion.