NUCLEAR POWER CORPORATION OF INDIA LTD
(A GOVT. OF INDIA ENTERPRISE)

SPECIFICATION NO.: PP-E-00548

TECHNICAL SPECIFICATION FOR DESIGN AND DEVELOPMENT OF 2.8 MW, 6.6 KV, 4 POLE INDUCTION MOTOR FOR 220MWe PRIMARY COOLANT PUMP

USI NO. 50100

REVISION NO. :	0			
DATE OF ISSUE (MONTH/YEAR)	JANUARY 2025			
TOTAL NO. OF PAGES:	**54 +3**			

ORIGINAL

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(For Revisions See Revision Control Sheet)

REVISION CONTROL SHEET

DOCUMENT TYPE : TECHNICAL SPECIFICATION
NO. : PP-E-00548
TITLE : TECHNICAL SPECIFICATION FOR DESIGN AND DEVELOPMENT OF 2.8 MW, 6.6 KV, 4 POLE INDUCTION MOTOR FOR 220MWe PRIMARY COOLANT PUMP

Rev. No.	Date	Description of Revision	Revised By	Checked by	Reviewed by	Approved by

NPCIL PROPRIETARY

1.0 SCOPE

This Specification establishes the technical requirements for the design, analysis, and preparation of drawings, manufacture, inspection, testing and documentation of induction motor meant to work as a prime drive of the existing primary coolant pump installed at 220MWe stations.

This Specification is intended to complement and be read in conjunction with existing primary coolant pump details and other interfacing details. All details for primary coolant pump and interfacing details required for the motor design, manufacturing and analysis shall be listed out and submitted to NPCIL.

2.0 CONTENTS

3.0 APPLICABLE CODES AND STANDARDS

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

S. No.	Standard Number	Standard Title
1	IS-4029	Guide for Testing Three Phase Induction Motors
2	IS-12065	Permissible limits of noise level for rotating electrical

		machines
3	IS-12075	Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity
4	IS-13508	Test Procedure for Measurement of Loss Tangent Angle of Coils and Bars for Machine Winding-Guide
5	IS-14578	Three-phase induction motors for use in nuclear power plants - Specification
6	IEC-60034	Rotating Electrical Machines
7	IEC-60529	Degrees of protection provided by enclosures (IP Code)
8	IEEE-43	IEEE Recommended Practice for Testing Insulation Resistance of Electric Machinery
9	IEEE-1043	IEEE Recommended Practice for Voltage-Endurance Testing of Form- Wound Bars and Coils
10	NEMA MG-1	Motors and Generators
11	ASME B&PVC Section II	Material specification
12	ASME B&PVC Section III	Nuclear Power Plant Components.
13	ASME B&PVC Section V	Non-Destructive Examination.
14	ASME B&PVC Section IX	Welding Qualifications.
15	ASME B&PVC Section XI	ISI
16	PP-P-1819	Technical specification on method and procedures for Seismic qualification of valves; panels, devices; rotating and reciprocating equipment; tanks, vessels and supports.
NPCIL Approved NDT Procedures		
17	PP-P-2009	Procedure for Ultrasonic Examination of Pressure Retaining Welds of Piping and Vessel Butt-Weld Joints
18	PP-P-2010	Procedure for Ultrasonic Examination of Butt And Fillet Weld Joints In Structural Steel Fabrication
19	PP-P-2011	Procedure For Ultrasonic Examination of Steel Plates By Manual Contact
20	PP-P-2012	Ultrasonic Examination Procedure for Shaft Material
21	PP-P-2014	Procedure for Ultrasonic Examination of Steel Forgings For General Purpose
22	PC-E-615	Technical Specification for Paints in Nuclear Power Plants
23	QAD-NDT-PROC-MT-01	Procedure for MPT with prod technique
24	QAD-NDT-PROC-MT-02	Procedure for MPT with yoke technique

25	QAD-NDT-PROC-MT-03	Procedure for MPT with wet horizontal / stationary MPT machine for gears, disc and flange
26	QAD-NDT-PROC-MT-04	Procedure for MPT with wet horizontal / stationary MPT machine for hollow (ID & OD) parts.
27	QAD-NDT-PROC-MT-05	Procedure for magnetic particle testing with horizontal/stationery magnetic particle machine
28	QAD-NDT-PROC-PT-01	Procedure for liquid penetrant examination (colour contrast solvent removable type)
29	QAD-NDT-PROC-PT-02	Procedure for liquid penetrant examination (colour contrast water washable type)
30	QAD-NDT-PROC-PT-03	Procedure for liquid penetrant examination (fluorescent)
31	QAD-NDT-PROC-PT-04	Procedure for liquid penetrant examination (general requirement)
32	QAD-NDT-PROC-PT-05	Procedure for approval of family of chemicals used for liquid penetrant examination

If this Specification conflicts in any way with any of the above standards, this Specification shall have precedence and govern.

4.0 GENERAL DESIGN REQUIREMENTS

4.1 General:

4.1.1 Motors shall be designed, manufactured, inspected, tested and equipped with accessories in accordance with this specification, and details furnished in attached QAP 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. List of all special tools and tackles required for assembly, disassembly and maintenance of motor along with their details and required drawings shall be submitted.

4.1.2 Design and manufacture of the motors shall be as per the requirements of the existing driven equipment. Any pump, motor installation, motor accessories interface points etc. details required for design of motor shall be obtained from NPCIL. The motor manufacturer shall co-operate fully with NPCIL by furnishing required information for proper assembly and operation of the motor with existing pump and other accessories units as a whole and to offer a motor suitable for the driven equipment duty and application.

4.1.3 Motors manufacturer shall be responsible for coordinating with NPCIL to obtain all required details and information regarding existing site equipment and location details such that the motor with existing pump is able to meet all specification requirements and for satisfactory operation of complete unit.

4.1.4 All sub-contracting shall be subjected to NPCIL approval. Motor OEM shall be responsible for all the activities of sub-contractors.

4.1.5 The motor shall be designed for a service life of generally 40 years.

4.1.6 Bidder shall carry out the seismic analysis and provide the Seismic analysis report and stick model of motor.

4.2 Rotor:

4.2.1 The rotor design shall provide a rigid cage construction with copper bars firmly wedged in bar slots and solidly bonded to the copper end rings (wherever provided). 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 bars shall be made of either electrolytic tough pitch high conductivity copper bars or copper silicon bars. Final material selection for rotor bar and rotor shaft shall be the responsibility of manufacturer to meet specification, testing and performance requirements.

4.2.3 Rotor shaft shall be of forged material. The shaft shall be ultrasonically tested and after final machining, it shall be dye penetrant tested. Ultrasonic, dye penetrant and radiographic examination shall be as per approved NPCIL procedures which shall be submitted to successful bidder. Acceptance norms for defects in shafts shall be as per the approved NPCIL procedures.

4.2.4 Rotor bars shall be brazed to the end rings by qualified brazers using qualified brazing procedure in accordance with acceptable standards for brazing. Induction brazing is preferred.

4.2.5 Retaining rings, if used, shall be forged material. Forging shall be subjected to ultrasonic and dye penetrant testing as per approved NPCIL procedure.

4.2.6 The complete drive train assembly consisting of motor rotor assembly, coupling, existing driven equipment and all other attachments shall be designed, and demonstrated by documentation regarding adequacy to withstand instantaneous torque resulting due to fast auto bus transfer at the supply system feeding the motors. Refer to clause 5.3 of this specification.

4.3 Stator

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. Manufacturer shall select appropriate insulation material of high quality to make overall insulation system to meet specified class of insulation and expected life. Use of following insulation material or better material for stator conductor is suggested:

(a.) Conductor inter-turn, slot & overhang insulation – Glass/polyester baked mica paper tape bonded with epoxy resin.

(b.) Slot corona protection material – Graphite loaded non woven polyester tape.
(c.) End corona protection material outside stator core – Silicon carbide loaded paint or tape.
(d.) Finishing tape on coil overhang – Glass/polyester high shrink tape with anti-tracking properties.
(e.) Impregnation of stator core pack – Epoxy-polyester resin

4.3.2 The insulation system of the motor shall be vacuum pressure impregnated (VPI). The whole assembly of stator winding and overhang shall be vacuum impregnated in resin, pressurized and heat cured.

4.3.3 Supplier shall describe insulation and insulation treatment and its capacity to meet the operating requirements specified. Details shall be submitted along with datasheet.

4.3.4 Motor core and winding shall be given tropical and fungicidal treatment for 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 measures.

4.3.5 Motor insulation of oil lubricated motors shall be designed to operate satisfactorily when exposed to oil vapour and, or oil leaks on to the stator winding.

4.3.6 Insulation at joints in the motor winding such as at coil connection etc. shall be insulated 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 winding conductors 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.

4.3.7 Overhang portion shall be adequately braced to withstand forces due to repeated re-starts and voltage conditions due to fast bus transfer. Supports for the overhang portion and slot wedges shall be of non-magnetic material.

4.3.8 Insulation system for the motor shall be designed to withstand satisfactorily without any deterioration the voltage surges produced due to chopping of currents by vacuum circuit breakers controlling the motors. Suppliers shall indicate clearly the level of inter-turn insulation provided. Suppliers shall furnish type test report and carry out impulse withstand voltage tests for main and inter-turn insulation as per applicable standards. Further, complete winding of motor shall also be subjected to tan delta and delta tan delta measurements at room and at elevated temperatures.

4.3.9 Motor shall be provided with insulation systems, terminal supports, lead wires, control wiring, connectors, terminal blocks, gaskets, seals, lubricating oil etc. capable of

withstanding specified radiation dose during its service life including accident conditions if any, as specified in this specification.

4.3.10 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 nos. of 4-wire duplex type RTDs per phase and suitably distributed in the winding and terminated in a separate terminal box through an intermediate terminal box if required.

4.4.2 Two numbers of 4-wire duplex RTD shall be embedded in each bearing respectively.

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

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

4.4.5 RTD insulation shall be minimum class-H and tolerance as per class-B. RTDs shall be insulated from HV winding and its lead shall be shielded. The insulation and shield shall prevent high voltage in event of short circuit between HV windings and RTDs.

4.5 Enclosure:

Type of enclosure shall be as specified in this specification. The type of cooling of the motor shall be as specified in this specification.

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's approval against a specific request of vendor for use of such alternate material.

4.6.2 Steel plates used for stator frame, end shield etc having thickness more than 16 mm shall be subjected to Ultrasonic testing.

4.6.3 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.

4.6.4 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 approved NPCIL procedures.

4.7 Terminal Boxes:

4.7.1 Motors shall have separate terminal boxes provided for each of the following:

i) Stator leads
ii) Space heaters
iii) Temperature detectors
iv) Neutral terminal box
v) Instruments

4.7.2 Terminal boxes shall be fabricated from steel plates. The power terminal box shall be of phase segregated construction with metallic barrier between the phases. The stator leads shall be connected to terminal bushings by insulated cable through a suitable insulating barrier and terminated using clamp or compression type terminals. The terminal bushing shall be suitable for 6.6kV resistance earthed system and all technical details of bushings as per applicable standard shall be submitted in technical datasheet.

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 The phase segregated metallic barriers shall be earthed within the power terminal box for all the compartments.

4.7.5 Power terminal box shall be suitable for withstanding the through fault current level of 44 kA fed by the network (to which the motor is connected) for 0.25 seconds (without any back up HV HRC fuses).

4.7.6 Power terminal box complete with cable end box shall be designed and tested at NABL accredited test laboratory to prove compliance with the following requirements of this specification:

4.7.6.1 The following tests shall be made:

(a) A three phase, through fault current test at 44 kA rms and 100 kA peak for 0.25 seconds. The test shall not result in any mechanical or electrical damage to the terminal box and terminals.

(b) A three phase short-circuit test at 500MVA (either at 6.6kV, 44kA, for 0.25 seconds or at 11kV, 40kA, for 0.2 seconds) for air insulated and phase segregated power terminal boxes. The test shall not result in any external damage other than rupturing of pressure relief device. However, parts inside the terminal box may be damaged during the test.

(c) A single phase to earth short circuit test (either at 6.6kV, min. 2000A, for 0.25 seconds or at 11kV, min. 2000A, for 0.2 seconds); the test shall not result in any

damage to power terminal box other than rupturing of pressure relief device. This test shall not result in spread or propagation of the fault to or between the other two phases, which are to be at rated potential for the test.

4.7.7 Terminal boxes shall be suitable for bottom/top entry of cables (as per NPCIL site requirement). Terminal boxes shall be provided with EPDM rubber gaskets (or approved equivalent) on all bolted joints to provide a degree of protection equal to IP 55. The terminal boxes shall be suitable for terminating the incomer cables as specified in this specification. The terminal box for neutral and stator leads shall be of the detachable type.

4.7.8 Minimum distance between power terminals and gland plate for main PSTB shall be kept at 650mm for installation of HV cables termination kit.

4.7.9 Special care shall be taken in designing the terminal box for incomer power cables so as to allow sufficient space for bending of cables and adequate electrical clearances. Phase to earth air clearance inside the terminal box shall be minimum 63mm and minimum creepage distance over the surface of bushings and surfaces resistant to tracking shall be 90mm. Lower clearance/distance is acceptable for impulse tested terminal boxes, subject to review and approval by NPCIL.

4.7.10 All terminals, connectors, cables and conductors whether in a terminal box or otherwise, shall be fully insulated with no bare live parts. The design shall be such as to enable ready disconnection of motor from its supply cable to permit separate testing of the supply cable or motor windings.

4.7.11 The cables from the cable gland to the terminals or connectors and terminal leads from these terminals or connectors to the windings, for a distance of 150 mm beyond their point of entry in to the motor frame, shall be adequately braced to withstand the forces produced by maximum fault current (44 kA) and shall have copper conductor of cross section to give not more than 0.403 kA /mm2 current density, under such condition.

4.7.12 Separate terminal box shall be provided for the neutral leads of the stator. The motor manufacturer shall provide CTs for differential protection of motor in this terminal box. Specifications for CTs will be given by NPCIL to enable the supplier of motor to supply and install CTs. CT secondary leads shall be brought out to separate terminal box provided with short circuiting type terminal blocks.

4.7.13 Terminal box shall be provided with two numbers of M-12 bolts (or of appropriate size concurred by NPCIL) with nuts for grounding.

4.7.14 Terminals for RTDs and BTDs and other instruments and auxiliaries shall be of plug-in type quick disconnecting type of connectors of approved make and type.

4.7.15 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 NPCIL. Adequate size of undrilled gland plates shall be provided to facilitate termination of cables.

4.7.16 Wiring from RTDs, CTs, instruments, space heaters, BTDs etc. including instruments if any free issued for the motor by NPCIL, to their respective terminal boxes shall be routed through metallic flexible conduits adequately supported on removable type of clamps on the motor body.

4.7.17 All instruments shall be provided with identification numbers inscribed on aluminum tags and firmly 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.

4.8.2 Vertical motors shall be provided with single or double (as required) thrust and guide bearings as specified in Technical Datasheet of this specification.

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 NPCIL all necessary details of existing pump and motor set for selection of bearing and in consultation with the bearing vendor, select suitable bearings. Complete details regarding selection and technical particulars of bearings and its cooling arrangement provided shall be submitted to NPCIL.

4.8.4 Operating temperature of bearings under all conditions shall be within the limits prescribed by the bearing manufacturer. Oil vapour 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 be designed to keep bearings temperatures within design limits are necessary. For forced oil lubrication system, the design and operation of the system shall include all instruments (Dial type thermometer with alarm and trip contacts, oil level indicator etc.,) to monitor conditions, provide annunciation and to provide interlocks to prevent inadvertent operation of bearings without adequate lubrication.

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 Bearings shall be provided with suitable insulation at one end (preferably NDE) to avoid circulating shaft currents. Wherever provided all oil and water pipes, direct driven oil pumps etc. shall be insulated where necessary to prevent a return path through the bearings for motor shaft currents.

4.8.8 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. Data regarding suggested re-lubrication intervals shall be furnished. Since, this motor is required to operate following Loss of Coolant Accident (LOCA) and Main

Steam Line Break (MSLB), bearing lubricant and bearing shall be capable of remaining in satisfactory operating condition after withstanding pressure and temperature conditions prevailing at the motor location during and subsequent to LOCA and MSLB.

4.8.9 For pressure lubrication, motor bearings shall be of the sleeve type arranged for pressure lubrication, supplied from lubrication system of the driven machine, with ring oiling for starting and emergency duty. The ring oiling shall be adequate for starting and continuous operation of the motor for at least 5 minutes without the pressure oiling system in operation. Oil sight flow gauges shall be supplied to indicate oil flow from each motor bearing.

4.8.10 In respect of forced lubrication, adequate lubrication shall be ensured during all conditions such as starting, running and coasting down. Motor manufacturer shall design the lubrication system at par with existing motor lubrication system in 220 MWe PHWR units of NPCIL. Existing system has a external oil supply unit (OSU) for forced lubrication. Required details of the OSU shall be provided by NPCIL. Motor manufacturer should provide details regarding the lubrication system.

4.8.11 Following information shall be submitted for bearings:
a) Make, type and life expectancy of bearings
b) Lubricating arrangement and cooling requirements
c) Oil make-up interval (Re-lubricating interval) for bearings
d) Radial and axial loads under operating and stand still conditions
e) Permissible operation and limitations for different operating modes such as loss of cooling water.

4.9 **Heat Exchangers**:

4.9.1 Adequate margin shall be provided in the design of heat exchangers to allow for fouling of cooling tubes or ducts under service conditions. Provision shall be made for easy cleaning of tubes or ducts where possible on load.

4.9.1.1 Water-cooled Heat Exchangers: The heat exchangers and any connecting piping shall be arranged to eliminate any possibility of water entering the motor enclosure and falling on the motor winding, etc. in the event of a leakage of cooling water. Heat exchangers shall be provided with valves for draining from its lowest points. Cooling system shall be complete with heat exchangers, piping, valves, instruments etc. to make the system complete. Details shall be submitted along with the offer. The materials for the cooler shall be such as to avoid any electrolytic action. Water coolers shall be hydro tested with water as a test medium at 1.5 times the maximum working pressure. A dial type thermometer with alarm and trip contacts shall be provided to give warning of excessive motor in-let air temperature. Heat exchangers for Motors provided with air to water heat exchangers shall be designed, manufactured, inspected in accordance with applicable national standards for such heat exchangers. Water leak detection switches along with flow switch with water flow indicators shall be provided. The design of heat exchanger shall take in to account the maxi-

mum water temperature from site sources, allowable pressure drop, maximum temperature of outlet water etc. The permissible temperature rise of motor winding shall be calculated considering the maximum temperature for the winding specified and temperature of cold air leaving the heat exchanger under the worst conditions of ambient air/ water. The design of heat exchanger shall be subject to approval of the NPCIL.

4.10 **Balancing and Vibration**:

4.10.1 Motor OEM shall submit detailed procedure and technical parameters with regard to balancing and vibration.

4.10.2 Vibrations for motor shall not exceed the same limits for lower bearings and 1.5 times these limits for upper bearings. Tests for measuring amplitudes and velocity of vibration on all directions shall be carried out in the presence of NPCIL representatives. Test data with test diagram showing amplitudes and velocity of vibration at various locations shall be submitted along with test reports.

4.10.3 Balancing of rotor with all components mounted shall be carried out at rated RPM or as permitted by the standards. 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. report shall be a part of Routine test reports.

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

4.10.5 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.

4.11 Grounding:

4.11.1 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 (or of appropriate size concurred by NPCIL) shall be provided for the power terminal box.

4.11.2 Gasketted joints shall be provided with metallic bypass connections of adequate size to ensure earth continuity.

4.12 Space Heaters:

4.12.1 Motor 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.

4.13 Couplings:

4.13.1 Motor manufacturer shall obtain from NPCIL necessary details about coupling of existing pump motor set and shall match the coupling arrangement of its motor with existing arrangement.

4.14 Direction of Rotation:

4.14.1 Direction of rotation shall be as given in Technical Datasheet of this specification.

4.15 Mounting and Dowelling:

4.15.1 Mounting arrangement shall be matched with the requirements of the existing system.

4.16 Lifting facility:

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

4.17 Drain Plugs:

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

4.18 Name plate and Diagram of Connections:

4.18.1 Motor shall have a nameplate showing all the particulars specified in relevant clause of IEC-60034. In addition, the nameplate shall also indicate

(a) The type of bearings used for motor, the details of recommended lubricant and re-lubrication interval

(b) Limit and conditions of successive starts. Separate name plate shall be provided for forced lubrication & heat exchanger system.

(c) Frame reference, insulation class, efficiency, winding connection

4.19 Flywheel:

4.19.1 Flywheel will be mounted between the bearings in motor at the non driving end. The unit shall be suitably protected to prevent persons from accidentally contacting rotating parts. The flywheel shall meet the requirements from US NRC Regulatory Guide 1.14 – Rev. 1, Edition August, 1975.

4.19.2 Material and Fabrication

a) The flywheel material should be of closely controlled quality and should be produced by the vacuum-melting and degassing process or the electroslag remelting process.

b) Fracture toughness and tensile properties of flywheel material should be checked by tests that yield results suitable to confirm the applicability to that of flywheel of the properties used in the fracture analysis called for in this specification.

c) All flame cut surfaces (if any) should be removed by machining to a depth at least 12 mm below the flame cut surface.

d) Welding, including tack welding and repair welding shall not be permitted in the finished flywheel unless the welds are inspectable and considered as potential sources of flaws in the fracture analysis.

4.19.3 Design

a) The flywheel assembly, including any speed limiting devices, the shaft, and the bearings, should be designed to withstand normal conditions, transient conditions, pipe break and the Safe Shutdown Earthquake loads without loss of structural integrity.

b) Design speed should be at least 125% of normal speed (defined as the synchronous speed of the A.C. drive motor at 50 Hz).

c) An analysis shall be conducted to predict the critical speed for ductile fracture of the flywheel as per methods and limits of paragraph at Appendix F, F-1320 & F-1330 of ASME code Section III-NB, latest edition. The analysis shall be submitted to NPCIL for evaluation.

d) An analysis should be conducted to predict the critical speed for non-ductile fracture of the flywheel. Justification should be given for the stress analysis method, the estimate of flaw size and location, which should take into account initial size and flaw growth in service and the values of fracture toughness assumed for the material. The analysis shall be submitted to the NPCIL for evaluation.

e) An analysis should be conducted to predict the critical speed for excessive deformation* of the flywheel. This analysis shall also be submitted to NPCIL for evaluation. (*As defined in Section B of Reg. Guide 1.14).

f) The normal speed should be less than one half of the lowest of the critical speeds calculated above.

h) Flywheel TNDT shall be < (-) 65 °C. At (-) 32 °C Charpy 'V' impact energy required is 68J minimum and lateral expansion > 0.89mm.

4.19.4 Testing

a) Each flywheel assembly should be spin tested at 120% of the synchronous Speed.

4.19.5 Inspection and Testing

a) Following the spin testing as given above, each finished flywheel should receive a check of critical dimensions and non-destructive examination as follows:

1) Areas of higher stress concentrations, e.g. bores, key ways, splines, and drilled holes and surfaces adjacent to these areas on the finished flywheel should be examined for surface defects in accordance with paragraph NB-2545 or NB-2546 of ASME Code Section III NB.

2) Each flywheel should be subjected to a 100% volumetric examination by ultrasonic method in accordance with paragraph NB-2540 of ASME Code Section III NB.

b) The flywheel shall be amenable for in-service inspection as specified in Reg. Guide 1.14. The manufacturer shall submit written procedures with sketches for carrying out aforesaid in-service inspections.

c) Flywheel TNDT of < (-) 65 °C and Charpy 'V' impact energy of 68J minimum and lateral expansion > 0.89mm at (-)32 °C shall be established.

5.0 PERFORMANCE REQUIREMENTS

5.1 Starting Duty:

5.1.1 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.

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, bus transfer etc. The total number of starts during the design life of motor shall be commensurate with the requirements of driven equipment.

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.

5.2.1 The locked rotor current shall not exceed the limits as mentioned in technical Datasheet of this specification.

5.3 Fast Bus Transfer:

5.3.1 Motors shall be capable of withstanding the 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 manufacturer shall submit required calculations to prove suitability of stator winding and overhang bracing portion under various operating conditions like start up, fast bus transfer and electrical faults. Motor manufacturer shall also submit torsional analysis report for complete pump motor drive train assembly. All required data and details of existing pump shall be obtained from NPCIL for this torsional analysis.

Motor manufacturer shall carry out torsional analysis after obtaining NPCIL system data and submit analysis report.

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 210% of full load torque.

5.5 Over speed

5.5.1 Unless otherwise indicated in technical datasheet of this specification, 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.

5.6.2 Where safe stall time at 100% rated voltage is less than starting time at 80% of rated voltage, due to high inertia of the motor and driven equipment assembly, suitable speed switch with two potential free contacts and speed sensing and monitoring system for remote speed monitoring shall be provided along with the motor. Details of such speed sensing and monitoring system shall be provided.

5.6.3 Motor manufacturer shall submit calculations indicating the safe stall times and permitted number of cold and hot re-starts considering permissible stator and rotor temperature under stall conditions. The permissible stator and rotor temperatures for the purpose of calculating safe stall times shall be limited to °C and 400°C for stator with class-F insulated copper conductor and rotor copper bars respectively.

5.6.4 As specified in Technical Datasheet of this specification, motor manufacturer by analysis of complete assembly of motor, coupling, existing driven equipment and mounting arrangements shall qualify that motor and the existing driven equipment assembly would continue to perform intended function during and after subjected to specified level of earthquake without any deterioration in the performance. All necessary details for the same shall be taken from NPCIL.

5.6.5 Motors offered shall have efficiency values as given in Technical Datasheet of this specification.

6.0 INSPECTION AND TESTS:

6.1 Motor manufacturer shall submit detailed test plan and procedure as per this Specification and latest applicable IS/IEC or other standards for NPCIL concurrence.

6.2 All routine tests mentioned in Annexure-B shall be conducted on the motor by the manufacturer at his work and test certificates shall be furnished to the NPCIL representative (QA) for approval.

6.3 Type test shall be conducted on the motor. Test reports for all type tests as given in Annexure-B shall be submitted for NPCIL review. In case type test reports are not acceptable to NPCIL, additional type tests shall be performed. Type test certificates shall be submitted for review and approval of NPCIL. Any special test and or qualification test if specified in Technical Datasheet shall be performed in accordance with an approved procedure and test reports shall be submitted after testing / qualification.

6.4 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.

6.5 NPCIL or his authorized 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. NPCILshall also have the right to conduct at his expense any additional tests or inspection he deems necessary.

6.6 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.

6.7 The motor manufacturer shall inform NPCIL inspector well in advance (minimum 14 days advance period), to enable NPCIL inspector to plan visits to the manufacturer's works for inspection during different stages of manufacture, which shall be as per detailed quality control plan attached as Annexure 'B'. The motor manufacturer will be required to develop a quality control plan in line with the requirements indicated in Annexure 'B' and submit the QAP for approval by NPCIL. Motor manufacturer shall prepare and submit motor test procedure, Class-F insulation test procedure, environment qualification procedure of Class F Insulation system etc. for NPCIL approval.

6.8 The motor manufacturer shall supply to NPCIL 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 work.

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

6.10 Ultrasonic, dye penetrant and radiographic examination shall be conducted as per approved NPCIL procedure which shall be submitted to the motor manufacturer.

7.0 PAINTING

7.1 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 epoxy based having Polyamide cured non-inhibitive epoxy paint compatible with inorganic ethyl zinc silicate primer with epoxy topcoats to shade 631 of IS-5.

8.0 DRAWINGS AND DOCUMENTS:

8.1 Motor manufacturer shall furnish following drawings for NPCIL approval:

(a.) Drawings showing overall dimensions and all other essential dimensions along with cross-sectional views and motor data sheets as per Annexure-A.

(b.) Detailed drawing for terminal boxes, clearance, conductor termination, cable gland and degree of protection should also be marked on this drawing. Details of conductor from terminals to the stator winding shall be indicated.

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

(d.) Flow sheets for cooling, lubrication and other auxiliary systems, if provided. Write-up on cooling system. Cooler drawing

(e.) Drawing showing locations of winding RTDs and BTDs. RTDs should be identified with the windings they are associated with.

(f.) Seismic qualification report for motor.

(g.) Welding/Brazing procedures and acceptance norms.

(h.) Ability of the drive train to withstand torsional stresses due to fast transfer.

(i.) Handling, assembly and disassembly details.

(j.) Site preservation instruction details

(k.) Material and dimension details of all types of gaskets and O' rings used in motor.

(l.) Detailed procedure for assembly and disassembly of motor of each type and rating.

(m.) Quality assurance plan inline with the QAP given in this specification.

(n.) Connection diagram for instruments for motor

(o.) Pneumatic brake sizing calculation. dimension drawing, arrangement, assembly

(p.) Stress analysis report, Rotor dynamic analysis

(q.) Environmental qualification procedure for insulation system including accelerated thermal, radiation aging and vibration test.

(r.) Class-F certification procedure for insulation system.

(s.) Motor test procedure

(t.) Mechanical test. Non-destructive examination, welding, heat treatment, repair, dimension check, shop test and other relevant procedures

8.2 Motor manufacturer shall take up manufacturing after NPCIL has approved the drawings.

8.3 one prints of all drawings should be submitted for approval. After completion of motor design and successful testing, one sets of hard copies of all final approved documentation and two sets of Pen Drives with all scanned copies of documents, drawings, data sheets and characteristic curves, all routine, type tests and documents related to stage wise inspection shall be supplied.

8.4 Following characteristic curves/drawings shall be supplied:

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

8.4.2 Starting current Vs time and speed at 100% and 90% and 80% voltages.

8.4.3 Power factor, efficiency, load current Vs Load

8.4.4 Thermal withstand characteristics for motor under cold and Hot conditions

8.4.5 Negative sequence current capability curve

8.4.6 Residual voltage Vs time (Voltage decay curve)

8.4.7 Winding diagram

8.4.8 Motor equivalent circuit diagram showing stator and rotor resistance, leakage reactance and magnetizing reactance

8.4.9 Efficiency and Power factor vs. speed

9.0 INSTRUCTION MANUALS

9.1 Supplier shall furnish 3 copies of instruction manuals and two Pen Drives with completely scanned copies of documents covering storage, installation, detailed assembly, disassembly procedures, operation and maintenance of the motors, site preservation instructions. 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 as per requirement.

ANNEXURE – A

DATA SHEET-A: TECHNICAL DATASHEET FOR PRIMARY COOLANT PUMP MOTOR		
Sl. No.	**PARTICULARS**	**DESCRIPTION**
1.0	**OPERATING CONDITIONS**	
1.1	Ambient temperature at location of motor	50˚C
1.2	Cooling water at inlet to the motor cooling system	35˚C
1.3	Site altitude	Less than 1000M
1.4	Humidity	90% at 40°C (normal operation) & 100% (accident conditions)
1.5	Floor Elevation of motor	112.5M (approx.)
1.6	Type of environment	Tropical with high humidity
1.7	Location (indoors/outdoors)	Indoor
1.8	Hazardous condition	Radioactive environment
1.9	Rated voltage and its variation	6.6kV ± 10%
1.10	Rated frequency and its variation	50Hz ± 5%
1.11	Permissible un-balance in supply voltage	3%
1.12	Permissible harmonic content in supply voltage	5%
1.13	Combined voltage & frequency variation	10% (absolute)
1.14	Number of phases	3
1.15	Method of system grounding	Resistance grounded (ground fault current limited to 400A)
1.16	Power supply voltage for auxiliaries	(a) 240V AC, 50 Hz, 1-Phase for space heater (b) 240V AC, 50 Hz, 1-Phase or 24V DC/ 48V DC for instrumentation and controls
2.0	**GENERAL**	
2.1	Application/Driven equipment	Primary Coolant Pump
2.2	Type of motor (SCR/SR)	SCR
2.3	Nature of application of the motor	Motor is not safety related but critical
2.4	Direction of rotation	Clock wise as seen from bottom side of the motor (DE side)

2.5	Mounting	Vertical (Flange mounted)
2.6	Single shaft/ double shaft extension	Single shaft
2.7	Dimensional limitations if any	Shall in general match with existing 220MWe PCP motor and shall be able to accommodate and shall have sufficient maintenance and erection clearance for existing motor location at station. Inter-facing connections with station existing systems shall match with existing PCP motor. Coupling to existing PCP, bear-ing, mounting arrangement shall be as per the existing pump and PCP motor installed at station. (Exact installed and exterior dimensions shall be provided by NPCIL)
2.8	Rotation – Uni/ Bi-directional	Unidirectional
2.9	Reverse rotation stop provided	Yes
2.10	Speed	1500 RPM, synchronous speed
2.11	Efficiency	Minimum 94% with no negative toler-ance
2.12	Power factor	(a) Full load $\geq$ 0.85 (b) Starting $\geq$ 0.125
2.13	Stator winding connection	Star
3.0	**RATING**	
3.1	Rated output	2.8 MW
4.0	**DUTY**	
4.1	Type of duty	S1, Continuous
4.2	Over speed operation requirements	(a) For Flywheel: Designed for 125% of Synchronous speed and Tested at 120% of Synchronous speed for 2 minutes (b) For Rotor/ Motor: 120% of Syn-chronous speed for 2 minutes Details as per approved QAP
5.0	**STARTING**	
5.1	Method of starting	Direct On Line (DOL)
5.2	Permissible starting current as % of full load current at rated voltage	600% including positive tolerance
5.3	Minimum voltage required for starting & accelerating at full load	80% of rated voltage

5.4	Number of successive starts on full load followed by next start after 20 minutes. (a) In cold condition (b) In hot condition.	 Minimum 3 Minimum 2
5.5	No. of equally spread starts per hour.	Minimum 3
6.0	**INSULATION**	
6.1	Class of insulation for stator winding	Minimum Class-F
6.2	Permissible temperature rise of motor windings, measured by winding resistance (a) Under normal operating conditions of voltage and frequency, ambient temperature and coolant water inlet temperature (b) Under extreme conditions of voltage and frequency	(a) 70°C (ambient temp.-50°C) (b) 80°C (ambient temp.-50°C)
6.3	Main insulation impulse withstand voltage	31.4kVp
6.4	Inter turn impulse withstand voltage	20.4kVp
7.0	**ENCLOSURE**	
7.1	Type of enclosure	Totally enclosed conforming to IS-14578 and IEC-60034-5
7.2	Degree of protection	IP-55
8.0	**COOLING**	
8.1	Type of cooling	CACW, IC 81W, Bidder to indicate cooling as per IS-6362/ IEC 60034-6
8.2	Quality of cooling water (if other than IS-1710)	Potable water
8.3	Cooling water pressure at inlet Cooling water system design pressure Heat load Cooling water flow Cooling water Delta-T	Inlet pressure: ~ 3 kg/cm^2 (g) Inlet temperature: ~ 35°C Design Pressure: ~ 10 kg/cm^2 (g) Delta-T: ~ 5°C (Heat load and cooling water flow to be mentioned by motor OEM)
8.4	Leakage detector required Process water leakage in Air/ water cooler of stator winding cooling system	Yes (Within motor HX bottom) with instrumentation such as float operated level switch
8.5	Maximum temperature rise of cooling water and permissible pressure differen-	5°C, ~ 1 kg/ cm^2

	tial across the heat exchanger	
8.6	Any instrumentation requirements associate with forced water- cooling? Indicate details	Vendor to indicate/ recommend necessary instrumentation required in process water line of the motor cooler/ oil sump coils .
8.7	Air cooler (of stator winding) instrumentation	Each cooler to have inlet & outlet air temperature monitoring sensors PT-100
9.0	**TERMINAL BOXES (TB)**	Power TB shall be phase segregated with metallic barrier between the phases. Neutral formation conductor shall also be rated for normal and starting current. All TB for instrumentation shall have industrial grade quick connect/ disconnect soldered pin connectors – similar to "Harting" or equivalent with 24 pin with 10 pair cable entry
9.1	Neutral T. Box suitable to accommodate differential C.T.	Required to accommodate 3 nos. of single phase CT whose details are given below: PS class CT 350/1A Vk ≥ 100V Rct (75°C) ≤ 2 Ω Ie at Vk/2 ≤ 30mA
9.2	Degree of protection for TB enclosure	IP55
9.3	Number of cable entries for power TB	One run of power cable
9.4	Power cable size and type.	3 Core 240 Sqmm, copper conductor, XLPE insulated (OD ~ 82 mm approx.)
9.5	Separate terminal box required for: Stator phase terminals For forming star connections Space heater terminals Winding RTD's terminals Bearing RTD's terminals Speed Switch TB for instrumentation associated with motor	 Yes Yes Yes Yes Yes Yes Upper & lower bearing oil level switches, water leak switches, bearing vibration monitoring devices, flywheel position indicator, cold/ hot air RTD etc.
9.6	Size of cable for space heater external connection	6 sq.mm Cu. conductor, 2 core PVC insulated, FRLS PVC sheathed.

9.7	Size of cable for RTD and BTD external connection.	1.5 sqmm, Cu conductor, 10 pair, PVC insulated, FRLS PVC sheathed.
9.8	Location of terminal boxes when viewed from non-driving end	Shall match with existing PCP motor for easy connection & termination of existing external cabling.
9.9	Speed measuring system	(i) The speed measuring system with non-contact type sensor shall be provided for measuring & displaying motor speed with ±5% accuracy and with response time of < 0.5 second (ii) The system shall also have two sets of potential free changeover contact outputs which shall change state when motor speed crosses set point adjustable by NPCIL at site. (iii) The system shall be able to give 4-20 mA output corresponding to 0-1500 RPM with load up to 600 ohms.
10.0	**BEARINGS**	
10.1	Type of bearings	Sliding DE bearing – Guide NDE bearing- Tilting Pad type thrust & Guide Speed = 1500 RPM Over speed = 1800 RPM Starting load, continuous operating load etc. shall be taken from existing PCP pump motor set. Vibration measuring sensors (2 nos. 90° apart) for upper (NDE) and lower bearing (DE) housings shall be provided
10.2	Type of lubrication	At par with existing 220 MWe IPHWR OSU type systems. Details shall be provided by NPCIL
10.3	Expected re-lubrication interval	Minimum 2 years (During Biennial shut down – BSD)

10.5	Whether any additional accessories are required for bearing cooling system, if so indicate		Two nos. of RTDs each for NDE and DE bearings. All RTDs shall be placed in thermowells
11.0	**ACCESSORIES**		
11.1	Temperature detector in windings:		PT-100, 3 wire SIMPLEX
11.2	Temperature detector in bearings:		PT-100, 3 wire duplex
11.3	Provision for air gap measurement		Motor OEM to mention
11.4	RTD insulation class		Class H
11.5	Vibration monitoring system required		Yes
12.0	**INSPECTION, TESTING AND QUALIFICATION**		
12.1	Inspection as detailed in the specification and typical QAP attached as Annexure-B required.		Yes. However, the attached QAP is only a sample QAP and elaborate QAP to be prepared and shall be submitted for NPCIL approval. Any deviation to specification QAP shall be clearly brought out in submitted QAP.
12.2	Acceptance criteria for NDT as per applicable standards as follows:		
	i)	Liquid penetrant inspection	As per NPCIL specification/ procedure
	ii)	Ultrasonic inspection	As per NPCIL specification/ procedure
12.3	Whether any special tests other than those indicated in this specifications and Indian Standards/ International Standards are required to be performed? If so, indicate details.		Yes (i) Type testing for radiation qualification for required materials as per 13.4 below. (ii) No load operation for 100 hours (iii) Checking of flywheel coast down time. (iv) Torsion analysis of rotor This analysis shall take into account various operating conditions such as start-up, fast bus transfer (supply change over from one source to another) and electrical fault conditions to access the torsional forces on the rotating train and adequacy of rotating train including stator winding

<table>
<tr><td></td><td></td><td>overhand support bracing)
(v) Voltage decay characteristics during tripping
(vi) Starting, running & block rotor condition current characteristics
(vii) Any test called in as per latest National/International Standard is also applicable</td></tr>
<tr><td>12.4</td><td>Whether seismic qualification of complete motor along with all accessories and auxiliaries are required to be qualified for the specified seismic levels at its location?</td><td>Methodology as per NPCIL spec PP-P-1819
<table><tr><td>Seismic level</td><td>Structural integrity</td><td>Operability</td></tr><tr><td>SSE</td><td>Yes</td><td>Yes</td></tr><tr><td>OBE</td><td>Yes</td><td>Yes</td></tr></table>Seismic spectra will be furnished later</td></tr>
<tr><td>13.0</td><td>Special Requirements for Reactor building motor</td><td></td></tr>
<tr><td>13.1</td><td>Whether the complete motor assembly is required to be qualified for operation during and following LOCA/MSLB</td><td>No</td></tr>
<tr><td>13.2</td><td>If motor is required to be qualified for LOCA/MSLB, enclose applicable temperature and pressure transient details.</td><td>Not applicable</td></tr>
<tr><td>13.3</td><td>Tag number of motor required to be qualified for LOCA/MSLB</td><td>Not applicable</td></tr>
<tr><td>13.4</td><td>Whether motor insulating materials, auxiliaries, wiring, terminal blocks, connectors, gaskets, lubricants etc. are required to withstand radiation and operate satisfactorily</td><td>Yes

For normal and accident conditions.</td></tr>
<tr><td>13.5</td><td>Cumulative radiation dose under normal and accident conditions.</td><td>50 Megarads (gamma)</td></tr>
<tr><td>13.6</td><td>Cumulative radiation dose under normal conditions</td><td>Covered above</td></tr>
<tr><td>13.7</td><td>Tag number of motor for which radiation qualification is required but LOCA/MSLB qualification is not required.</td><td>-----</td></tr>
<tr><td>13.8</td><td>Expected external over pressure likely</td><td>2.0 kg/ cm^2 (g)</td></tr>
</table>

	to be experienced by motors and their accessories during reactor building pressure test.	
14.0	Specific Requirements if any pertaining to shaft, fly wheel, bearing, brake / anti reverse rotation device and analysis etc.	1. For analysis – Refer 12.3 above
		2. Motor overall dimension and maximum weight shall be limited to existing PCP motor (NPCIL will provide the limiting dimensions)
		3. Flywheel – (i) Approx weight of flywheel is 2.5 T. vender to provide exact weight suitable for coasting down time specified. (ii) Flywheel and shaft requirement shall be as per this specification (Motor shaft material will be 17Mn5 or equivalent subject to NPCIL's approval and flywheel SA 508 Gr 4N class 1 (Sa 508 Cl 4 formerly) (iii)Flywheel shall be as per USNRC regulatory guide 1.14 Rev 1 (iv) Flywheel position monitoring - two eddy current probes on the sides of flywheel 180° apart, connected to monitoring system (vertical movement range 0-20 mm), which gives output of 4-20 mA for a load of 600 Ω. (v) Fracture toughness requirements as per ASME Section III Div 1 NB 2300.
		Cooler requirement as per TEMA class C and ASME section III.

ANNEXURE - B

Data Sheet-B: Format for the data be filled by the Bidder

(TECHNICAL PARTICULARS TO BE SUPPLIED WITH TENDER)

(Following information to be submitted)

1.	Name and address of Motor Manufacturer		:	
2.	Document No.		:	
3.	Rev. No. & Date		:	
4.	Quantity		:	
5.	Contents		:	
	i)	Motor data sheets	:	Sheet 1 to 10
	ii)	Motor & load Torque vs Speed Curves	:	Sheet 11
	iii)	Performance Curves	:	Sheet 12
	iv)	Current and speed vs starting time	:	Sheet 13
	v)	Thermal withstand characteristics	:	Sheet 14
	vi)	Negative sequence current withstand capability curve	:	Sheet 15
	vii)	Residual voltage v/s time characteristics	:	Sheet 16
	viii)	Write up on insulation system	:	Sheet 17

	Motor Manufacturer
Prepared by	
Reviewed by	
Approved by	

Sl. No.	Particulars	
1.0	**Guaranteed operating conditions for the motor(s)**	
1.1	Ambient temperature ^{0}C	
1.2	Cooling water temperature at inlet ^{0}C.	
1.3	Altitude	
1.4	Humidity (%)	
1.5	Type of environment (corrosive/non-corrosive)	
1.6	Location (indoors/outdoors)	
1.7	Hazardous condition.	
1.8	Rated voltage & its variations.	
1.9	Rated frequency & its variations.	

Sl. No.	Particulars		
1.10	Permissible un-balance in supply voltage		
1.11	Permissible harmonic content in supply voltage		
1.12	Combined voltage & frequency variations		
1.13	Number of phases		
1.14	Method of system grounding.		
1.15	Seismic capability: if specified in the annexure-A, whether qualification of motor along with accessories and auxiliaries included in the scope of the tender? Indicate the proposed method of qualification.		
1.16	Auxiliary power supply requirements		
	i)	For auxiliaries	
	ii)	For space heaters	
	iii)	For instrumentation & control	
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		
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)	With I.S. tolerance	
	b)	Without I.S. tolerance	

Sl. No.	Particulars		
5.2.2	At 80% voltage		
	a)	With I.S. tolerance	
	b)	Without I.S. tolerance	
5.3	Minimum voltage required for starting		
5.4	Starting time with DOL starting with driven equipment coupled		
	a)	At rated voltage	
	b)	At 80% voltage	
	c)	At 110% voltage	
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		
6.2	Permissible temperature rise (by resistance method)		
	a)	Under normal conditions:	
	b)	Under extreme voltage conditions (90% of rated voltage):	
6.3	Tropical Treatment of motor		
6.3.1	Material of insulation (Please enclose complete write up in a document form showing sectional view of slot, over hang and detailing the insulation system)		
6.3.2	Treatment of insulation, stator and rotor core for anti-fungal growth		
6.4	Main insulation impulse withstand voltage		
6.5	Inter turn impulse with stand voltage		
6.6	Radiation withstand capability of insulation system and other materials used in the motor (If specified, only for motors 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		

Sl. No.	Particulars		
7.6	Material for short circuiting rings		
7.7	Material for retaining rings		
7.8	Material for rotor shaft		
7.9	Material for fly wheel (if provided)		
7.10	Heat loss to environment for the purpose of ventilation design		
7.11	Type of cooling		
7.12	Painting		
7.12.1	Primer: - (Compatible with epoxy paint and based on inorganic ethyl zinc silicate?)		Yes/ No If No, indicate details
7.12.2	Finish Coats:- (Epoxy?)		Yes/ No. If no, indicate details
8.0	**TERMINAL BOXES**		
8.1	Type of main HT stator T. Box		Phase segregated
8.2	Fault withstand capacity at rated voltage and its duration for:		
	a)	Internal faults	
	b)	External faults, kA (rms & peak)	
8.3	Neutral T. Box suitable to accommodate differential C.T.		
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	Max. cable size suitable for the terminal box/Actual size		
8.8	No. of terminals for main winding.		
8.9	Size of connections from windings to terminals.		
8.10	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.		
8.11	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 ETD's terminals (Yes/No)	
	h)	Whether provision of flexible metallic conduits as specified in clause no 5.17.15 included in scope of supply?	
8.12	Direction of cable entry.		
8.13	Size of cable gland plate suitable for		
	a)	Motor cable	
	b)	Space heater cable	

Sl. No.	Particulars		
	c)	RTD cable	
8.15	Whether disconnecting type terminals for CTs provided?		
8.16	Plug-in terminals for RTDs, accessories, BTDs etc provided for motors?		
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	Quantity of lubricant required.		
9.7	Bearing cooling.		
9.8	Bearing insulation for shaft current provided (Yes/No)		
9.9	Bearing end play (mm) Axial Radial		
9.10	Thrust bearing losses		
9.11	Regressing interval.		
9.12	Maximum permissible bearing temperature DE NDE		
9.13	Whether bearings are designed considering all loads expected during all operating conditions including seismic conditions (if specified) of the driven equipment?		
9.14	Whether bearings are designed for operation during and after LOCA/MSLB, (only if the requirement is specified)		
9.15	List of auxiliaries and instruments provided incase of forced cooled bearing		
9.16	Detailed write up on bearing forced cooling enclosed?		
10	**ACCESSORIES**		
10.1	Temperature detectors in windings		
10.2	Temperature detectors in bearings		
10.3	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	

Sl. No.	Particulars	
10.4	Dial type temperature indicator for the following provided	
	a) bearings	
	b) cooling air/water	
10.5	CTs for differential protection provided? if yes; indicate details of CTs.	
10.6	Inspection plugs for air-gap measurement provided?	
10.7	RTDs insulation details	
10.8	Whether RTDs leads are screened	
11	**Heat Exchangers (if provided)**	
11.1	Medium in the shell side	
11.2	Medium in the tube side	
11.3	Heat exchanged	
11.4	Quantity of fluid in the tube side	
11.5	Quantity of fluid in the shell side	
11.6	In let and out let temperatures of fluid in the tube side	
11.7	Inlet and out let temperatures of fluid in the shell side	
11.8	Material of the tubes	
11.9	Material of the shell/enclosure	
11.10	Number and diameter of tubes	
11.11	Design pressure of water system	
11.12	Design pressure of air system	
11.13	Maximum permissible inlet pressure for site water to HX	
11.14	Water leak detector provided?	
11.15	Maximum temperature of cool air entering motor under maximum temperature of inlet water.	
11.16	Maximum differential pressure across the HX for site process water.	
11.17	Design and manufacturing standards	
12	**WEIGHT AND MOMENT OF INERTIA**	
12.1	Weight of stator (Kg.)	
12.2	Weight of rotor (Kg.)	
12.3	Total weight of motor (Kg.)	
12.4	Shipping weight of motor (Kg.)	
12.5	Shipping dimensions LXBXH	
12.6	Rotor GD^2 (kgm^2)	
12.7	GD^2 of driven equipment referred to motor speed (kgm^2)	
13	**PERFORMANCE**	
13.1	Full load current (amps)	
13.2	No load current. (amps)	

Sl. No.	Particulars		
13.3	Full load speed (rpm)		
13.4	No load speed (rpm)		
13.5	Efficiency At full load (%) At 75% load (%) At 50% load (%)		
13.6	Power factor At full load At 75% load At 50% load		
13.7	Noise pressure level of motor at 1.0 m at no load db (A)		
13.8	Velocity of vibration at		
	a)	No load (microns), mm/s	
	b)	With load (microns), mm/s	
13.9	Critical speed (rpm)		
	a)	Upper	
	b)	Lower	
13.10	Safe stall time secs at 80% & 100% voltages		
	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 – Deg.C	
13.11	The minimum number of starts the motor is capable of during its lifetime of 40 years?		
13.12	a)	Stator heating time constant.	
	b)	Stator cooling time constant	
13.13	Overload capacity:		
13.14	Torque		
13.14.1	Torque at full load.		
13.14.2	Starting torque (% if full load torque) At rated voltage At 80% voltage		
13.14.3	Pull-out torque (% of full load torque) at rated voltage		
13.14.4	Pull-up torque (% of full load torque) at rated voltage		
14.0	**CONNECTIONS**		
14.1	Stator		
14.2	Number of connections brought out.		
14.3	Cross section of connections from winding to terminals		
15.0	**INSPECTION**		

Sl. No.	Particulars		
15.1	NPCIL inspection in works as specified detailed in QAP agreed?		Yes/No
15.2	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
15.3	Welding procedure and welder qualification as specified agreed?		Yes/No
15.4	Brazing procedure qualification and brazer qualification agreed for brazing of stator connections and rotor bars with end rings?		Yes/No
15.5	Performance of all routine tests as specified agreed?		Yes/No
15.6	Performance of all type tests as specified agreed?		Yes/No
15.7	Whether full compliance to QAP attached as Annexure-C to PC-E-503 agreed?		Yes/No
15.8	Whether full compliance to PC-E-503 and annexure-A, Annexure-D and Annexure-E to PC-E-503 agreed?		Yes/No. If no, clearly indicate clause wise deviations
16.0	**DRAWINGS, CATALOGUES, DATA SHEETS**		
16.1	Descriptive pamphlets for the offered motor enclosed?		Yes/No
16.2	Details of reverse rotation stop enclosed?		
16.3	Torque vs. speed characteristics curve at rated voltage and frequency		
	a)	For motor	
	b)	For driven equipment	
16.4	Current vs. speed characteristic curve at rated voltage and frequency during acceleration.		
16.5	Thermal withstand characteristic curves and data in digital form for		
	a)	Hot condition	
	b)	Cold condition	
16.6	Current vs. time characteristic curve during acceleration		
16.7	Negative sequence current capability curve		
16.8	Efficiency. Power factor, speed and current vs. load characteristics		
16.9	Efficiency, Power factor vs. speed characteristics		
16.10	Dimensional drawing showing cross sectional view and identification of components and their material specification, typical stator slot and rotor bar, shaft, fan, bearings etc.		

Sl. No.	Particulars	
16.11	Dimensional drawing of the terminal boxes showing dimensions, permissible cable size, degree of protection, materials of fabrication, etc and the method of terminating the incoming cables.	
16.12	Motor winding diagram attached?	
16.13	Motor equivalent circuit diagram showing stator and rotor resistance, leakage reactance and magnetizing reactance attached?	
16.14	Residual voltage at motor terminals versus time characteristics after supply disconnection to motor at full load	
16.15	Measures taken to demonstrate adequacy of design of the drive train to withstand instantaneous torsional torque on account of fast transfer	
16.16	Type test certificates to prove the specified fault withstand capability of power terminal box for both (a) internal faults and (b) external faults.	
16.17	List of dimension and material details of all gaskets and O' rings used in overall motor attached?	
16.18	Detailed procedure for assembly and disassembly of motor of each type and rating attached?	
17.0	**Additional Technical Particulars For High Voltage Induction Motors In Reactor Building**	
17.1	Applicable standards	
17.2	Is the motor designed to operate under normal and Loss of coolant accident/MSLB (accident) conditions?	Normal condition/ Normal and Accidental condition.
17.3	Capability of the motor to withstand specified radiation levels (Test certificate to be submitted for the insulating materials used).	
17.4	List of insulating materials used and their radiation withstand capability:	
17.4.1	Stator conductor	
17.4.2	Slot liner	
17.4.3	Slot wedge	
17.4.4	End connections	
17.4.5	Over hang portion	
17.4.6	Varnish/Resin for impregnation	

Sl. No.	Particulars	
17.4.7	Motor terminals	
17.4.8	Gaskets	
17.4.9	Lubricants	
17.4.10	Control wires and accessories	
17.5	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:

a) 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 before submission to the NPCIL. Alternatively characteristic curves can be submitted as separate documents in A3 size sheets. Document shall have revision number, date of revision etc. on the cover sheet.

b) Document detailing insulation system shall be a part of datasheet.

NUCLEAR POWER CORPORATION OF INDIA LIMITED

INDICATIVE QUALITY ASSURANCE PLAN FOR 2.8MW Motor

Scope and Purpose:

This document indicates the requirements expected from the manufacturer of motors. Motor manufacturer shall submit forNPCIL's approval a quality assurance plan in line with this document incorporating specific document numbers for "format of records", "acceptance norms" and "reference documents" etc. If required by the NPCIL, reference documents indicated shall be shown before approval of QAP.

QAP NO:	R: Review	H: Hold	3: External laboratory
	P: Perform	1: NPCIL	
	W: Witness	2: Motor Manufacturer	

LEGEND	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: Hold Point	
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.

* 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 "Motor manufacturer", NPCIL will witness on sample basis.

		QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR											
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		**Receiving Material Inspection**											
1.1	Stator Frame/Bracket, Terminal Box, Flywheel Housing	a) Chemical composition	Major	Chemical	1 Sample/Lot	NPCIL approved drawing/TS/Standard	NPCIL approved drawing/TS/Stan	TC	1	3	2		NABL Accrediated lab Reports will be furnished for review.
		b) Mechanical properties (tensile, Yield & Elongation)	Major	Mechanical	1 Sample/Lot	NPCIL approved drawing/TS/Standard	NPCIL approved drawing/TS/Standard	TC	1	2			
		c) Visual check	Major	Visual	100%	Drawing	Drawing	Report	1	2			
		d) Dimensional Measurement	Major	Measurement	100%	NPCIL approved drawing/TS	NPCIL approved drawing/TS	Report	1	2			
		e) Ultrasonic Testing of Plates for Stator Frames/Bracket and Flywheel housing with thickness more than 16mm	Major	NDT	100%	NPCIL Procedure/Standard	NPCIL Procedure/Standard	TC		3,2	1	1	20% Random by 1 and 100% plates shall be UT certified by Plate manufacturer
1.2	Fan Assembly (Fan Hub & Blades)	a) Chemical composition	Major	Chemical	1 Sample/Lot	NPCIL approved drawing/TS/Standard	NPCIL approved drawing/TS/Standard	TC	1, 2	3	1, 2		NABL Accrediated lab Reports will be furnished for review.
		b) Mechanical properties for fan hub-Tensile,Yield&Elongation, For blade- Tensile & Elongation	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1, 2	3	1, 2		
		c) Ultrasonic Testing on Fan hub	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1, 2	3	1, 2		
		d) Radiography on Fan Blades	Major	NDT	100%	IS/PS	IS/PS	TC	1, 2	3	1, 2		
		e) DP test on Fan Blades	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1, 2	3	1, 2		
		f)Visual and Dimensional Measurement	Major	Measurement	100%	NPCIL approved drawing/TS	NPCIL approved drawing/TS	Report	1	2			In Visual examination corelation of material with MTC to be checked.
1.3	Rotor Forged Shaft	a) Chemical composition	Major	Chemical	1 Sample/Lot		NPCIL approved drawing/TS/Standard	TC	1	3	2		NABL Accrediated lab Reports will be furnished for review.
		b) Mechanical properties (tensile, Yield & Elongation)	Major	Mechanical	1 Sample/Lot	NPCIL approved drawing/TS/Standard	NPCIL approved drawing/TS/Standard	TC	1	3	2		

QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR													
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	
1.3	Rotor Forged Shaft	c) Ultrasonic Testing of Plates	Major	NDT	100%	NPCIL Procedure/Standard	NPCIL Procedure/Standard	TC		2	1		10% Random by 1
		d) Dimensional Measurement	Major	Dimensional	100%	NPCIL approved drawing	NPCIL approved drawing	TC	1	2			
		e) DP test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			10% Random by 1
1.4	Fly Wheel Blank	a) Chemical composition	Major	Chemical	1 Sample/Lot	NPCIL approved drawing/TS/Standard	NPCIL approved drawing/TS/Standard	TC	1	3	2		NABL Accrediated lab Reports will be furnished for review.
		b) Mechanical properties	Major	Mechanical	1 Sample/Lot	NPCIL approved drawing/TS/Standard	NPCIL approved drawing/TS/Standard	TC	1	3	2		
		c) Ultrasonic Testing of Plates	Major	NDT	100%	NPCIL Procedure/Standard	NPCIL Procedure/Standard	TC		2	1		10% Random by 1
		d) DP test	Major	NDT	100%	NPCIL Procedure/Standard	NPCIL Procedure/Standard	TC		2	1		10% Random by 1
1.5	Bare Stator Copper Conductors	a) Chemical composition	Major	Chemical	1 Sample/Lot	Drawing/Spec	Drawing/Spec	TC	1	3	2		
		b) Mechanical properties	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1	3	2		
		c) Electrical Resistivity	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		d) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		e) Visual Check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
1.6	Insulating Material (Conductor tape, main insulating tape, end sealing tape, semi conducting tape etc.)	a) Dimensional Measurement	Major	Dimensional	1 Sample/Lot	Drawing	Drawing	TC	1	2			
		b) Chemical composition	Major	Chemical	1 Sample/Lot	Drawing/Spec	Drawing/Spec	TC	1	2			
		c) Temperature class	Major	Test Report	100%	Drawing/Spec	Drawing/Spec	TC	1	2			
		d) BDV	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		a) Insulation Coat thickness	Major	Measurement	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		b) Chemical composition	Major	Chemical	1 Sample/Lot	IS/PS	IS/PS	TC	1	3	2		
		c) Mechanical properties	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1	3	2		
		d) Bend test	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1	3	2		

		QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR											
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	
1.7	Stator/Rotor Core Stamping	e) Specific total loss measurement (before & after ageing)	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		f) Unaged specimen magnetization	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		g) Stacking factor	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		h) Anisentropy losses	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		i) Surface IR	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
1.8	Rotor Copper Bar	a) Chemical composition	Major	Chemical	1 Sample/Lot	IS/PS	IS/PS	TC	1	3	2		
		b) Mechanical properties	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1	3	2		
		c) Electrical Resistivity	Major	Electrical	100%	IS/PS	IS/PS	TC	1	2			
		d) Dimensional Measurement	Major	Measurement	100%	Drawing	Drawing	TC	1	2			
		e) DP test	Major	NDT	10%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
1.9	Short Circuiting Ring	a) Chemical composition	Major	Chemical	100%	IS/PS	IS/PS	TC	1	3	2		
		b) Mechanical properties	Major	Mechanical	100%	IS/PS	IS/PS	TC	1	3	2		
		c) Electrical Resistivity	Major	Electrical	100%	IS/PS	IS/PS	TC	1	2			
		d) Dimensional Measurement	Major	Measurement	100%	Drawing	Drawing	TC	1	2			
		e) Visual Check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		f) Heat Treatment	Major	Mechanical	100%	IS/PS	IS/PS	TC	1	2			
		g) Ultrasonic test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		h) DP test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
1.10	Rotor Core	a) Insulation Coat thickness	Major	Measurement	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		b) Chemical composition	Major	Chemical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		c) Mechanical properties	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		d) Bend test	Major	Mechanical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		e) Magnetic loss measurement	Major	Electrical	1 Sample/Lot	IS/PS	IS/PS	TC	1	2			
		f) Surface IR	Major	Electrical	1 Sample/Lot	Drawing	Drawing	TC	1	2			
		a) Chemical composition	Major	Chemical	100%	Drawing	Drawing	TC	1	2			

		QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY R	P	W	H	REMARKS
1.11	Short Circuiting Ring	b) Mechanical properties	Major	Mechanical	100%	Drawing	Drawing	TC	1	2			
		c) Ultrasonic test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		d) DP test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
1.12	Rotor End Plate	a) Dimensional check	Major	Dimensional	100%	IS/PS	IS/PS	TC	1	2			
		b) Visual check	Major	Visual	100%	IS/PS	IS/PS	TC	1	2			
		c) Mechanical properties	Major	Mechanical	100%	IS/PS	IS/PS	TC	1	2			
		d) Chemical composition	Major	Chemical	100%	IS/PS	IS/PS	TC	1	2			
		e) Ultrasonic test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
1.13	RTDs	a) Temperature Calibration	Major	Measurement	100%	IS/PS	IS/PS	TC	1	2			
		b) Dimensional check	Major	Dimensional	100%	IS/PS	IS/PS	TC	1	2			
		c) Accuracy	Critical	Measurement	100%	IS/PS	IS/PS	TC	1	2			
1.14	Current Transformers	a) Verification of ratings	Critical	Visual	100%	IS/PS	IS/PS	TC	1	2			
		b) Review of routine test certificates	Major	Review	100%	IS/PS	IS/PS	TC	1	2			
		c) Review of type test certificates	Major	Review	Sample	IS/PS	IS/PS	TC	1	2			
1.15	Space Heaters	a) HV test	Major	Electrical	100%	IS/PS	IS/PS	TC	1	2			
		b) IR test	Major	Electrical	100%	IS/PS	IS/PS	TC	1	2			
		c) Rating	Major	Measurement	100%	Drawing	Drawing	TC	1	2			
1.16	Bearings & Bearing Housings	a) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		b) Dimensional check	Major	Dimensional	100%	IS/PS	IS/PS	TC	1	2			
		c) DP test on weld surfaces	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		d) RT on Bearing Pad housing (Casting)	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		e) UT on Plates	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
1.17	Coolers	a) Mechanical Properties	Major	Mechanical	100%	IS/PS	IS/PS	TC	1, 2	3			
		b) Chemical composition	Major	Chemical	100%	IS/PS	IS/PS	TC	1, 2	3			
		c) Dimensional check	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		d) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			

QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR														
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	
		e) DP test on welds	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
1.18	Power Terminal Box	a) Visual & dimensional check	Major	Visual & dimensional	100%	Test Report	Test Report	TC	1, 2	3			Review of type test report.
		b) Review of type test reports	Major	Review	Sample	IS/Drawing	IS/Drawing	TC	1, 2	3			
		c) Compliance to type tested terminal boxes	Major	Review	Sample	IS/Drawing	IS/Drawing	TC	1, 2	3			
1.19	Slot Wedge	a) Verification of test certificate for Mechanical & Electrical tests	Major	Review	Sample	IS/Drawing	IS/Drawing	TC	1, 2	3			
2	**In-Process Inspection**												
2.1	Stator Frame/Bracket, Terminal Box, Flywheel Housing Fabrication	a) Use of Qualified Welder	Major	Process	Record verification	PS	PS	TC	1	2			TC to be furnished batchwise
		b) Visual examination of weld seams	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) DP test on Welds	Major	NDT	100% of accessible area	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		d) Heat Treatment	Major	Mechanical	100%	IS/PS	IS/PS	TC	1	2			
	Stator Frame/Bracket, Terminal Box, Flywheel Housing Machining	a) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) MPI on load bearing surfaces of Frame & Flywheel Housing	Major	NDT	100%	IS/PS	IS/PS	TC	1	2			
		d) Run out measurement on stator concentricity and fan	Major	Measurement	100%	IS/PS	IS/PS	TC	1	2			
2.2	Fan Assembly (Fan Hub & Blades) Fabrication	a) Use of Qualified Welder	Major	Process	Record verification	PS	PS	TC	1	2			TC to be furnished batchwise
		b) Visual examination of weld seams	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) DP test on Welds	Major	NDT	100% of accessible area	NPCIL Procedure	NPCIL Procedure	TC	1	2			

		QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR											
SR. NO.	COMPONENT/MFG. STAGE	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY R	P	W	H	REMARKS
		d) Heat Treatment	Major	Mechanical	100%	IS/PS	IS/PS	TC	1	2			
	Fan Assembly (Fan Hub & Blades) Machining	a) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) Concentricity & run out of Fan	Major	Measurement	100%	IS/PS	IS/PS	TC	1	2			
2.3	Rotor Shaft & Ribs Fabrication	a) Use of Qualified Welder	Major	Process	Record verification	PS	PS	TC	1	2			
		b) Visual examination of weld seams	Major	Visual	100%	IS/PS	IS/PS	TC	1	2			
		c) DP test on weld seams	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		d) Stress Relieving	Major	Process	100%	IS/PS	IS/PS	TC	1	2			
		e) Steel melting for Shaft Blank	Major	Spectrometric	1 sample/Lot	IS/PS	IS/PS	TC	1	2			
		f) Ingot & Forging for shaft blank	Major	Dimensional	1 sample/Lot	IS/PS	IS/PS	TC	1	2			
		g) Heat treatment for shaft blank	Major	Process	1 sample/Lot	IS/PS	IS/PS	TC	1	2			
		h) Mechanical properties (tensile/impact on both ends)	Major	Mechanical	1 sample/Lot	IS/PS	IS/PS	TC	1	2			
		i) Ultrasonic test	Major	NDT	1 sample/Lot	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		j) Dimensioanl check	Major	Dimensional	1 sample/Lot	Drawing	Drawing	TC	1	2			
	Rotor Shaft & Ribs Machining	a) DP test on entire machined sutface of shaft & ribs	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		b) Dimensional check including contact area checking by Ring Gauge	Major	Measurement	100%	IS/PS/Drawing	IS/PS/Drawing	TC	1	2			
		c) Surface finish, run out & concentricity	Major	Visual/Measurement	100%	Drawing	Drawing	TC	1	2			
		d) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
2.4	Auxiliary Shaft for Flywheel Balancing	a) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Contact area checking by Ring Gauge	Major	Measurement	100%	IS/PS/Drawing	IS/PS/Drawing	TC	1	2			

		QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR											
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
2.5	Fly Wheel Machining	a) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Run out measurement	Major	Measurement	100%	Drawing	Drawing	TC	1	2			
		c) Examination of Taper Bore contact area with plug guage	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		d) DP test for bore & balancing groove	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		e) Ultrasonic after machining	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2	1		
		f) MPI excluding bore, balancing groove	Major	NDT	100%	IS/PS	IS/PS	TC	1	2	1		
	Fly Wheel Balacing	a) Balancing of Flywheel (On Auxiliary Shaft) at 1200rpm	Major	Testing	100%	IS/PS	IS/PS	TC	1	2	1		
		b) Overspeeding at 1875rpm for 2 minutes and balancing check at 1200rpm	Major	Testing	100%	IS/PS	IS/PS	TC	1	2	1		
		c) Checking of surface roughness	Major	Measurement	100%	Drawing	Drawing	TC	1	2	1		
		d) DP test for bore & balancing groove	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2	1		
		e) Ultrasonic after balancing	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2	1		
		f) MPI excluding bore, balancing groove	Major	NDT	100%	IS/PS	IS/PS	TC	1	2	1		
		g) Visual Inspection	Major	Visual	100%	Drawing	Drawing	TC	1	2			
2.6	Stator Coil Manufacturing	a) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) Inter turn test	Major	Electrical	100%	IS/PS	IS/PS	TC	1	2			
		d) DC HV test including IR measurement	Major	Electrical	100%	IS/PS	IS/PS	TC	1	2			
		e) Power frequency voltage test	Major	Electrical	2 samples/Coil	IS/PS	IS/PS	TC	1	2			
		f) Impulse Voltage withstand test	Major	Electrical	2 samples/Coil	IS/PS	IS/PS	TC	1	2			
		g) Class-F certificaion test	Major	Electrical	5 insuated Coils	IS/PS	IS/PS	TC	1	2	1		

QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR														
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	
2.7	Stator Main Stamping	a) Dimensional Check	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Burr Checking	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) Insulation coat thickness	Major	Measurement	2 Samples/Lot	IS/PS	IS/PS	TC	1	2			
2.8	Stator Vent Stamping	a) Dimensional Measurement	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) Visual Check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		c) Quality of projection welding of spacers	Major	Visual	100%	Drawing	Drawing	TC	1	2			
2.9	Stator/Rotor End Plate	a) Mechanical Properties	Major	Mechanical	100%	IS/PS	IS/PS	TC	1	2			
		b) Chemical composition	Major	Chemical	100%	IS/PS	IS/PS	TC	1	2			
		c) Dimensional check	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		d) Ultrasonic test of rotor end plate	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		e) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
2.10	Stator Core	a) Dimensional check	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		b) DP on load bearing machined surface	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		c) Compactness of core	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		d) Visual check	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		e) Check Slot size by gauge	Major	Measurement	100%	Drawing	Drawing	TC	1	2			
		f) Hot spot measurement at 1 Tesla	Critical	Measurement	1 Sample	IS/PS	IS/PS	TC	1	2			
2.11	Short Circuiting Ring Machining	a) DP test on SC Ring (on joint machined)	Major	NDT	10%	NPCIL Procedure	NPCIL Procedure	TC		2	1		
2.12	Retaining Ring Machining	a) Dimensional check	Major	Dimensional	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		b) Visual check	Major	Visual	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		c) DP test	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		a) Dimensional Check	Major	Dimensional	100%	NPCIL approved drawing/Spec	NPCIL approved	TC	1	2			

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									R	P	W	H	
2.13	Rotor Main Stamping	b) Burr Checking	Major	Visual	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
2.14	Rotor Vent Stamping	a) Dimensional Measurement	Major	Dimensional	100%	NPCIL approved drawing/Spec	NPCIL approved	TC	1	2			
		b) Visual Check	Major	Visual	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		c) Quality of projection welding of spacers	Major	Visual	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1, 2				
2.15	Rotor Core	a) Dimensional check	Major	Dimensional	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		b) Slot size check with gauge	Major	Measurement	100%	IS/PS	IS/PS	TC	1	2			
		c) Compactness of core	Major	Visual	100%	Drawing	Drawing	TC	1	2			
		d) Hot spot measurement	Critical	Measurement	1 Sample	IS/PS	IS/PS	TC	1	2			
		e) Smoothness of internal slots	Major	Visual	100%	Drawing	Drawing	TC	1	2			
2.16	Wound Rotor (SC Ring Brazing)	a) Check record of approved bracing process & qualified bracers	Major	Record verification	100%	PS	PS	TC	1	2			
		b) Preparatory check before bracing	Major	Visual	100%	IS/PS	IS/PS	TC	1	2			
		c) Visual inspection of braced joints & process control during bracing	Major	Visual	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		d) Ultrasonic test of braced joints	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		e) Dimensional check	Major	Dimensional	100%	Drawing	Drawing	TC	1	2			
		f) Run out & concentricity check for journal & coupling diameter	Major	Measurement	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
2.17	Wound Rotor with Fan	a) Balancing at rated speed	Major	Testing	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			

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									R	P	W	H	
2.18	Rotor Assembly	a) Dynamic balancing of rotor complete with fans, flywheel and pole wheel assembly at rated speed and overspeed at 120% of rated speed for 2 minutes	Major	Testing	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC		2	1	1	
2.19	Flywheel Mounting on Shaft	a) Ultrasonic of flywheel for detection of contact area between flywheel & shaft	Major	NDT	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC		2	1	1	
2.20	Wound Stator	a) RTD resistance measurement before laying of coil	Major	Measurement	100%	IS/IEC	IS/IEC	TC	1	2			
		b) Check stator bracing & overhang arrangement	Major	Visual	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
2.21	Stator Winding	a) Interturn testing	Major	Electrical	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		b) DC HV test after bracing	Critical	Electrical	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
2.22	Stator Bracing	a) Phase resistance measurement	Major	Measurement	100%	NPCIL approved drawing/Spec	NPCIL approved	TC	1	2			
		b) Polarity test	Major	Measurement	100%	NPCIL approved drawing/Spec	NPCIL approved	TC	1	2			
2.23	VPI Process	a) Check record of resin/varnish viscosity	Major	Record verification	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
		b) Impregnated resin and hardner as per specification	Major	Record verification	100%	NPCIL approved drawing/Spec	NPCIL approved drawing/Spec	TC	1	2			
2.24	Wound stator after VPI	a) IR & PI of winding after VPI	Major	Electrical	100%	IS/IEC	IEEE std 43/IEC 60034-27	TC	1	2			
		b) Resistance & IR of RTDs after VPI	Major	Electrical	100%	IS/IEC	IS/IEC	TC	1	2			
		c) Winding resistance measurement after VPI	Major	Electrical	100%	IS/IEC	IS/IEC	TC	1	2			

QUALITY ASSURANCE PLAN 2.8MW INDUCTION MOTOR													
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									R	P	W	H	
2.25	Bearing and bearing housing	UT of Bearing Pads after forging and before babbitting	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC		2	1		
		UT & DP test of Bearing Pads after babbitting	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC		2	1		
		DP test of Bearing Pads after machining	Major	NDT	100%	NPCIL Procedure	NPCIL Procedure	TC		2	1		
2.26	Other accessories and auxiliaries	Review of test reports	Major	Review	100%	IS/PS	IS/PS	TC	1	2			
		Review of environmental qualification reports	Major	Review	100%	IS/PS	IS/PS	TC	1	2			
		Functional verification	Major	Testing	100%	IS/PS	IS/PS	TC	1	2			
2.27	Reverse rotation ratchet (if provided)	Verification of mechanical properties of materials used	Major	Mechanical	1sample / lot	IS/PS	IS/PS	TC	1	2			
		Verification of chemical properties of materials used	Major	Chemical	1sample / lot	IS/PS	IS/PS	TC	1	2			
		Examination of welds, welding process, and welders	Critical	NDT	1sample / lot	NPCIL Procedure	NPCIL Procedure	TC	1	2			
		Functional tests	Major	Testing	100%	IS/PS	IS/PS	TC	1	2			
3		**Tests**											
3.1	Motor Assembly	a) Visual check	Major	Visual	100%	Approved Drawing/Spec	Approved Drawing/Spec	Test Report	1	2			
		b) Check for completeness & accessories	Major	Visual	100%	Approved Drawing/Spec	Approved Drawing/Spec	Test Report	1	2			
		c) Mounting & Dimensional check	Major	Dimensional	100%	Approved Drawing/Spec	Approved Drawing/Spec	Test Report	1	2			
		d) Runout of shaft extension, spigot and flange	Major	Mechanical	100%	Approved Drawing/Spec	Approved Drawing/Spec	Test Report	1	2			
		e) Measurement of bearing clearances	Major	Measurement	100%	Approved Drawing/Spec	Approved Drawing/Spec	Test Report	1	2			
		f) Air gap measurement (Stator ID & Rotor OD)	Major	Measurement	100%	Approved Drawing/Spec	Approved Drawing/Spec	Test Report	1	2			
		a) IR of winding before and after HV test	Major	Electrical	100%	IEEE standard 43-2013 clause 5.3	IEEE standard 43-2013 clause 5.3	Test Report		2	1	1	
		b) HV test	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	

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									R	P	W	H	
		c)1. Winding Resistance measurement .2.Continuity and IR of RTDs.BTDs.	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
		d) Resistance measurement,IR & HV on space heater	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
		e)No load curve&no load running and measure voltage,current,power and speed& bearing temperature during steady state condition	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
		f) Phase sequence & direction of rotation	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
3.2	Routine Test	g) Locked rotor test-reading of current,voltage and power input at suitable reduced voltage @50%,75%,100% and greater than 100%(Subjected to plant limitation)of rated current for calculation of starting current,starting torque&pull out torque by graphical extrapolation	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
		k) Reduced voltage running test on no load	Major	Electrical	100%	IS/Corresponding IEC 60034 parts	IS/Corresponding IEC 60034 parts	Test Report		2	1	1	
		l) No load test and bearing temp. rise	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
		m) Shaft voltage	Major	Electrical	100%	IS/Drawing	IS/Drawing	Test Report		2	1	1	
		n) Polarisation index	Major	Electrical	100%	IS	IS	Test Report		2	1	1	
		o) Noise level on No load	Major	Electrical	100%	IS	IS	Test Report		2	1	1	

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									R	P	W	H	
		p) Vibration measurement on No Load	Major	Electrical	100%	IS	IS	Test Report		2	1	1	
		q) Functional checks on all accessories and auxiliaries	Major	Electrical	100%	NPCIL Appr Drawing/Spec	NPCIL Appr Drawing/Spec	Test Report		2	1	1	
		r) Completeness	Major	Visual	100%	NPCIL Appr Drawing/Spec	NPCIL Appr Drawing/Spec	Test Report		2	1	1	
		s) Terminal marking and rating plate details	Major	Visual	100%	NPCIL Appr Drawing/Spec	NPCIL Appr Drawing/Spec	Test Report		2	1	1	
		t) Overspeed test at 120% rated speed for 2 min.	Major	Electrical	100%	Corresponding IEC 60034 parts	Corresponding IEC 60034 parts	Test Report		2	1	1	
		u) Functional check on vibration monitoring system	Major	Electrical	100%	Drawing	Drawing	Test Report		2	1	1	
		v) Verification of type of terminals	Major	Electrical	100%	IS	IS	Test Report		2	1	1	
		w)Operation of control panel	Major	Electrical	100%	IS	IS	Test Report		2	1	1	
3.3	Type Tests (In addition to all tests mentioned in routine test)	a) Temp. rise test by mixed frequency method at 110%FLC corresponding to 90%	Major	Electrical	On one motor	IEC	IEC	Test Report		2	1	1	
		b) Load test and derivation of performance data corresponding to 50%, 75% and 100% load at rated voltage and Calculation of Efficiency	Major	Electrical	On one motor	IEC	IEC	Test Report		2	1	1	
		c) Operation of motor on full load at 70% (60% safety motors) voltage for 1 second & 80% (70% for safety motors) voltage for 10 min.	Major	Electrical	On one motor	IEC	IEC	Test Report		2	1	1	

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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	
		d) Test for degree of protection by enclosures of motor and terminal box.	Major	Test	On one motor	IS/Drawing	IS/Drawing	Test Report		2	1	1	In case of large frame size motors, second numeral test shall be conducted in test lab/motor manufacturer's premises in presence of NPCIL QA, whereas for first numeral test either vendor can submit analysis report indicating dimensional details, material details and design details to meet the first numeral test criteria or can test a similar construction type motor of smaller frame size. The acceptance of first numeral test report on smaller frame size motor or analysis report on same motor shall be subject to NPCIL's review and approval.
		e) Recording of motor terminal voltage decay after switching off of the input supply voltage	Major	Test	On one motor	IS/Drawing	IS/Drawing	Test Report		2	1	1	
		f) Recording of motor speed decay after switching of the input supply voltage	Major	Test	On one motor	IS/Drawing	IS/Drawing	Test Report		2	1	1	
		h) Determination of moment of inertia by retardation test&measurement of coasting down time	Major	Test	On one motor	Approved test procedure	Approved test procedure	Test Report		2		1	
		i) tan delta & delta tan delta on stator winding at room temperature	Major	Test.	On one motor	IS/IEC	IS/IEC	Test Report		2	1	1	Test conducted during stator coil manufacturing stage is acceptable
		j) Momentary overload test at 160% of current for 15 seconds by Mixed Frequency Heat Run method	Major	Test	On one motor	IS/IEC	IS/IEC	Test Report		2	1	1	
		K)Seismic qualification	Major	Testing/Analysis	On one motor	As per approved procedure	As per approved procedure	Test Report		2	1	1	

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									R	P	W	H	
		L)No load -Mechanical Run test for 100hours and measurement of motor parameters	Major	Test	On one motor	IS/IEC	IS/IEC	Test Report		2	1	1	
		M)Qualification of VPI insulation system for HV motors against Radiation,Thermal and vibration ageing											
		N)Strip test-Visual&DP test on Thrust&guide padson NDE side	Major	NDE/Visual	one one motor	Approved procedure	Approved procedure	Test record		2	1	1	
		O) Completeness check and BOM verification	Major	Visual	one one motor	Approved procedure	Approved procedure	Test record		2	1	1	
4.0	Final Inspection	a) Painting finish and Dry Film Thickness	Major	Visual	100%	Approved GA Drg.	Approved GA Drg.			2		1	Radiation resistant paint shall be used
		b) Review of end documents	Major	Review of all documnent for motor	100%	Approved documents	Approved documents	PS		2		1	
5.0	All other qualification and testing shall meet the pump specifications.												

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