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| Assets Planning And Delivery Group  Engineering |

DESIGN STANDARD DS 26-20

Type Specifications - Electrical

Type Specification for L.V. Submersible Bore Hole Cage Induction Motor

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| version 2  revision 1 |
| MAY 2023 |

**FOREWORD**

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning, and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction, and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

[Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)](https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/overview_general_regulations.pdf)

Enquiries relating to the technical content of a Design Standard should be directed to the Principal Engineer, Electrical (Power) Section, Infrastructure Design Branch. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

**Head of Engineering**

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This Standard is intended solely for application to the acquisition of water infrastructure in Operating Areas in Western Australia where the Water Corporation has been licensed to provide water services subject to the terms and conditions of its Operating License.

This Standard is provided for use only by a suitably qualified professional design engineer who shall apply the skill, knowledge and experience necessary to understand the risks involved and undertake all infrastructure design and installation specification preparation work.

Any interpretation of anything in this Standard that deviates from the requirements specified in the project design drawings and construction specifications shall be resolved by reference to and determination by the design engineer.

The Corporation accepts no liability for any loss or damage that arises from anything in the Standard including loss or damage that may arise due to the errors and omissions of any person.

REVISION STATUS

The revision status of this standard is shown section by section below:

| **REVISION STATUS** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **SECT.** | **VER./REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION**  **(Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
| **2** | **2/0** | **12.02.16** | **8** | **Sec 2 revised** | **NHJ** | **MSP** |
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| --- | --- | --- | --- | --- | --- | --- |
| **7** | **2/0** | **12.02.16** | **9** | **Sec 7 revised** | **NHJ** | **MSP** |
| **7** | **2/1** | **11.04.23** | **9** | **Sec 7 revised** | **SWG** | **EDG** |

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| **8** | **2/0** | **12.02.16** | **9** | **Sec 8 revised** | **NHJ** | **MSP** |
| **8** | **2/1** | **11.04.23** | **9** | **Sec 8 revised** | **SWG** | **EDG** |

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| **9** | **2/1** | **11.04.23** | **10** | **Sec 9 revised** | **SWG** | **EDG** |
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| **11** | **2/0** | **12.02.16** | **10** | **Sec 11 revised** | **NHJ** | **MSP** |
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| **12** | **2/0** | **12.02.16** | **10-11** | **Sec 12 new** | **NHJ** | **MSP** |
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| **13** | **2/0** | **12.02.16** | **11** | **Sec 13 revised** | **NHJ** | **MSP** |
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| **14** | **2/0** | **12.02.16** | **11** | **Sec 14 new** | **NHJ** | **MSP** |
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| **15** | **2/0** | **12.02.16** | **11** | **Sec 15 revised** | **NHJ** | **MSP** |
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| **16** | **2/0** | **12.02.16** | **11** | **Sec 16 revised** | **NHJ** | **MSP** |
| **16** | **2/1** | **11.04.23** | **11** | **Sec 16 revised** | **SWG** | **EDG** |

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| **18** | **2/0** | **12.02.16** | **12-13** | **Sec 18.3 and Sec 18.4 revised** | **NHJ** | **MSP** |
| **18** | **2/1** | **11.04.23** | **12** | **Sec 18 revised** | **SWG** | **EDG** |

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| **19** | **2/0** | **12.02.16** | **13** | **Sec 19 revised** | **NHJ** | **MSP** |
| **19** | **2/1** | **11.04.23** | **13** | **Sec 19 revised** | **SWG** | **EDG** |

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| **20** | **1/4** | **30.08.11** | **27l** | **20 revised** | **NHJ** | **AAK** |
| **20** | **2/0** | **12.02.16** | **13** | **Sec 20 revised** | **NHJ** | **MSP** |
| **20** | **2/1** | **11.04.23** | **13** | **Sec 20 revised** | **SWG** | **EDG** |

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| **21** | **2/0** | **12.02.16** | **14** | **Sec 21 revised – Sand Slinger and Shaft Seals removed** | **NHJ** | **MSP** |
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| **22** | **2/0** | **12.02.16** | **14-15** | **Sec 22 renamed and revised** | **NHJ** | **MSP** |
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| **23** | **2/0** | **12.02.16** | **15** | **Sec 23 new** | **NHJ** | **MSP** |
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| **25** | **2/0** | **12.02.16** | **16** | **Sec 25 revised** | **NHJ** | **MSP** |
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| **27** | **2/1** | **11.04.23** | **16** | **Sec 27 revised** | **SWG** | **EDG** |
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| **PREVIOUS REVISION STATUS HISTORY** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **VER./**  **REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION**  **(Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
| **0/3** | **30.10.02** | **All** | **New section** | **NHJ** | **AAK** |
| **0/4** | **01.09.03** | **3** | **20.14 general revision** | **NHJ** | **AAK** |
| **0/4** | **01.09.03** | **9** | **Annexure** | **NHJ** | **AAK** |
| **0/4** | **01.09.03** | **10** | **Tender Technical Response** | **NHJ** | **AAK** |
| **0/4** | **01.09.03** | **All** | **Reformatted** | **NHJ** | **AAK** |
| **1/0** | **27.02.04** | **All** | **Sections split** | **NHJ** | **AAK** |
| **1/1** | **23.05.05** | **All** | **Paragraphs renumbered** | **NHJ** | **AAK** |
| **1/2** | **30.04.07** | **10** | **20, 21.4 revised** | **NHJ** | **AAK** |
| **1/3** | **02.06.09** | **6** | **6 revised** | **NHJ** | **AAK** |
| **1/3** | **02.06.09** | **7** | **8 revised** | **NHJ** | **AAK** |
| **1/3** | **02.06.09** | **8** | **16 revised** | **NHJ** | **AAK** |
| **1/3** | **02.06.09** | **11** | **26 revised** | **NHJ** | **AAK** |

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# General

1. This Specification covers the requirements for the design, manufacture, assembly, inspection, factory testing, packaging, transport to site, on site assembly, on site testing, and commissioning of a Low Voltage submersible cage induction motor
2. The motor shall be supplied to site complete with all necessary accessories and miscellaneous material, minor parts and other such items necessary to complete assembly, testing, and commissioning of the motor
3. The installation and connection of the motor will be carried out by others in accordance with the Contractor’s instructions
4. If so specified in the Annexure, the Contractor shall supervise the installation and commissioning of the motor

# Site

1. The motor will be installed in a bore hole on a site, the location of which shall be as detailed in the Annexure
2. Access to the site shall be as detailed in the Annexure

# Operating Environment

The motor shall be suitable for continuous operation fully submerged in water under the environmental conditions detailed in the Annexure.

# Operating Mode

The motor shall be used to drive a centrifugal bore hole pump and the mode of operation for the motor shall be as detailed in the Annexure.

# Work by the Principal

1. If so specified in the Annexure, the motor shall be supplied to the Principal as part of a bore hole motor pump set
2. The Principal will install the motor pump set in the bore hole and will connect the unit both hydraulically and electrically
3. Other work to be performed by the Principal shall be as detailed in the Annexure

# Information to be Provided by the Contractor

The Contractor shall provide the following documentation in respect to the motor and shaft seal unit at the times shown hereunder:

1. General Arrangement Drawings including

certified mounting dimensions - 28 days after date of order

1. Final Design Equivalent Circuit Values

(confirming values in the Contractor’s offer) - 28 days prior to factory tests

1. Inspection and Test Plan - 28 days prior to factory test
2. Factory Test Certificates - within 7 days of the tests

and at least 7 days prior to dispatch to site

1. Operating and Maintenance Manual - On delivery

# Contractor’s Drawings

1. All drawings provided by the Contractor shall be in accordance with the latest issue of the Water Corporation Design Standard DS24 – Electrical Drafting
2. All drawings shall be prepared in AutoCAD format, Release 2018 or later software
3. Drawings shall be prepared on the “Electrical” A1 metric drawing sheet and title block provided in the Water Corporation eXternal (WCX) package (available for download) in accordance with the Water Corporations Design Standard DS80
4. The drawings shall provide within the title block, the details to identify the drawing, including but not limited to its title, plan number, revision status, date of issue, Corporate project number, contractor’s name and reference number (if applicable)
5. Drawings detail shall include, but not limited to, the general arrangement, panel layout, power and control circuit diagrams and equipment specifications, as required
6. The contractor shall submit drawings in both AutoCAD and PDF formats in accordance with the Drawing Submission Process. Adequate contrast within the PDF image shall be maintained between drawing content and background to ensure the clarity and quality of the drawings

# Standards

The workmanship, equipment and materials provided in accordance with this motor Specification shall comply in design, construction, rating and performance with the current relevant Australian Standards and Codes. In their absence, the equipment shall comply with relevant International Standards together with the requirements of competent Authorities having jurisdiction over all or any part of the manufacture, installation and operation of the equipment.

Specific reference is made in this motor specification to the following Australian and International standards:

AS 1359.102.1 Rotating Electrical Machines – methods of determining losses and efficiency – General

AS 1359.114 Rotating electrical machines – Vibration measurement and limits

AS 60034.1 Rotating electrical machines – Rating and Performance

AS 60034.5 Rotating electrical machines – Degrees of protection provided by the integral design of rotating electrical machines (IP Code)

AS 60034.12 Rotating electrical machines - Starting performance of single-speed three-phase cage induction motors

AS/NZS ISO 9001 Quality management systems – Requirements

IEC 60034-6 Rotating electrical machines – Methods of cooling (IC Code)

IEC 60085 Electrical insulation – Thermal evaluation and designation

IEC 60751 Industrial platinum resistance thermometers and platinum temperature sensors

NEMA MG-1 Motors and Generators

# Quality Assurance

The motor shall be manufactured under a Quality System certified by an Accredited Authority to be in accordance with AS/NZS ISO 9001 or an approved equivalent.

# Power Supply to Motor

The motor shall be rated for operation from a 3 phase power supply with a phase sequence of RWB and other characteristics as specified in the Annexure.

# Motor Type

The motor shall be a cage induction motor type generally in accordance with AS 60034.12 and shall be suitable for operation in the mode detailed in the Annexure. The motor shall be a 2 pole or 4 pole as specified in the Annexure.

# Performance Characteristics

## General

Performance characteristics specified hereunder shall be at rated voltage and rated frequency.

## Duty

1. The motor shall be rated for duty S1 in accordance with AS 60034.1
2. The motor’s nominal maximum duty load shall be as specified in the Annexure

## Rated Output Power

1. The motor’s nameplate maximum output power rating shall be as specified in the Annexure. This rating will be higher than the nominal maximum duty load in order to allow for pump load tolerance or voltage unbalance derating
2. The motor’s nameplate maximum output power rating shall be at the motor’s rated frequency and under the specified operating conditions
3. Motor derating for ambient conditions shall not be permitted

## Minimum Efficiencies

The motor shall have efficiencies at 50% load, 75% load and 100% load not less than the values quoted in the Contractor’s Tender Response Schedule.

## Minimum Power Factors

The motor shall have power factors at 50% load, 75% load and 100% load not less than the values quoted in the Contractor’s Tender Response Schedule.

## Starting Characteristics

The motor shall have torque versus speed and current versus speed characteristics in accordance with the values and curves submitted with the Contractor’s Tender Response Schedule.

# Direction of Rotation

The motor’s direction of rotation shall be clockwise facing the non-drive end.

# General Mechanical Features

1. The nominal overall diameter of the motor shall be as shown in the Annexure
2. The motors shall be provided with 316 stainless steel shaft, stator frame and associated fasteners. Unless stainless steel stator ends are specified in the Annexure, stator ends shall be of epoxy coated cast iron
3. The precise overall diameter, mounting dimensions and arrangements together with other general mechanical features for motors having nominal overall diameters of 4 inch, 6 inch and 8 inch shall be as specified in NEMA Std. MG1 Section 18 Figures 18-18, 18.19 and 18-20 respectively
4. For larger diameter motors general mechanical features of the type indicated on NEMA Std. MG1 Section 18 Figure 18-20 shall be as indicated on the external dimensions drawing submitted with the Contractor’s Tender Response

**Such drawings shall include dimensions and tolerances of the motor shaft diameter, shaft extension, shaft key mounting flange and mounting holes**.

# Cooling

1. The type of motor cooling used by the motor shall be IEC 60034-6 designation IC4W1W1
2. The primary coolant shall be not less than 90% water. Any additives in the primary coolant shall be of a type certified by an independent authority to be suitable for use in potable water
3. The primary coolant shall be circulated within the motor so as to facilitate internal heat transfer and to provide adequate lubrication to the motor bearings

# Enclosure

1. The motor enclosure including cable terminations shall be designed to exclude completely water from the bore when the motor is installed and operating under the conditions specified in the Annexure
2. The motor shall be of submersible construction, protected in accordance with AS 60034.5 Classification IP68 to a depth of submersion of 200 metres
3. The motor shall be fitted with a mechanical drive end seal and stainless steel slinger to prevent external water and foreign material from entering the motor
4. Seal faces shall be silicon carbide on silicon carbide
5. The motor enclosure shall incorporate a suitably sized diaphragm bellows to provided adequate pressure compensation for primary coolant heating and increased pressure due to submergence

# Vibration

The motor shall be designed and constructed so that the vibration severity level under free suspension mounting conditions shall not exceed 1.8 mm/s r.m.s. over the frequency range 10 Hz to 1 kHz in accordance with AS 1359 Part 114.

# Windings

## General

The motor windings shall be:

1. Of the wet winding type
2. Designed so as to have an even temperature distribution free from hot spots
3. Suitably braced to give adequate rigidity under starting and locked rotor fault conditions

## Insulation

1. The motor winding conductors shall be water-tight wire which is double insulated and sheathed and which is completely unaffected by the motor’s primary coolant
2. All motor insulation shall have a maximum temperature rating of not less than 90°C

## Winding Temperature Rise

1. The motor average winding temperature as measured by change in resistance shall not exceed a value 20°C below the maximum allowable winding temperature for the class of insulation installed, under all of the following conditions concurrently:
2. The motor is running at nameplate rated full load current
3. The water temperature is at the maximum temperature specified in the Annexure
4. The motor is installed in a bore hole casing of the diameter specified in the Annexure
5. The pumped water flow rate is at 80% of the maximum pumped flow rate specified in the Annexure
6. Similarly, the motor maximum winding temperature as measured by a resistance temperature detector embedded in the upper crown of the winding shall not exceed a value 15°C below the maximum allowable winding temperature for the class of insulation installed, under all of the above conditions concurrently
7. For example, under the above concurrent conditions, the average winding temperature of a motor with IEC 60085 Class 90 (Y) insulation shall not exceed 70°C and the temperature in the upper crown of the winding shall not exceed 75°C

## Winding dV/dt Rating

The winding wire shall have an insulation voltage rating of 1000 Volts i.e. the winding turn to turn insulation voltage rating shall be not less 2000 Volts.

# Connections

1. All required electrical connections to the motor shall be brought out through water-proof glands as cable tails not less than 4 metres long
2. Three power connection cable tails shall be brought out and these shall be single core Siemens Hydrofirm or equivalent cable
3. All temperature sensor connections shall be brought out in a single multicore screened cable having PVC insulated 0.5 mm2 copper conductors, an overall braided screen, a polyether polyurethane RoHS compliant outer sheath and a temperature rating of not less than 75°C

# Temperature Sensors

1. If the motor has a power rating ≥ 11kW, it shall be provided with winding over temperature protection by way of at least one temperature detector installed within the motor. Such temperature detectors shall be resistance temperature detectors (RTD’s) or thermistors
2. Where over temperature protection of motor windings is to be provided by thermistor protection, the thermistors shall be embedded in the windings during the manufacturing process. Fitting of thermistors to motor windings after motor manufacture is not permitted
3. Where over temperature protection of motor windings is to be provided by RTD’s and the RTD’s are to be installed in the motor windings, the RTD’s shall be embedded in the motor windings during the manufacturing process. Fitting of RTD’s to motor windings after motor manufacture is not permitted
4. All RTD’s shall be 3 wire industrial platinum resistance sensors in accordance with IEC 60751 class A
5. If the motor over temperature detectors are in the form of RTD’s, they are preferred to be installed in one or more of the following locations specified in the Annexure:
   1. In the upper crown of the winding
   2. In the lower crown of the winding
   3. In the winding within the motor frame
   4. Adjacent to the thrust bearing
6. If specified in the Annexure as being required, the motor shall be supplied with temperature monitors which shall:
7. Include lead resistance compensation function
8. Be suitable for connection to 3 wire RTD’s
9. Provide a read out of measured temperature
10. Provide a set of change over alarm or trip contacts

# Bearings

## Radial Bearings

The motor stainless steel shaft shall run in with carbon sleeve bearings lubricated by the primary coolant.

## Thrust Bearing

The motor shall be fitted with the thin film self-aligning thrust bearings lubricated by the primary coolant.

The up thrust bearing shall be capable of carrying an axial thrust load of not less than twice the weight of the rotor or the maximum up thrust load specified in the Annexure, whichever is the greater.

The down thrust bearing shall be capable of carrying an axial down thrust of not less than twice the weight of the rotor plus the maximum pump down thrust load specified in the Annexure

The down thrust bearing shall be of the carbon rotating disc and stainless steel segments type.

## Bearing Life

Motor radial and thrust bearings shall have a rated life of not less than 60,000 hours.

# Type Tests

## General

Type tests shall be defined as performance tests taken on the first machine of a particular type of design to determine the characteristics of the machine and to verify conformance with its specifications.

## Thermal Performance

The design of each type of motor shall have been subjected to thermal performance type tests in accordance with the requirements of AS 60034.1. Such tests shall include:

* + 1. Winding resistance measurement
    2. Winding temperature rise

## Efficiency

Each type of motor shall have been subjected to efficiency type test by the summation of losses method in accordance with AS 1359.102.1.

Such efficiency type tests shall have been carried out at 50% rated load, 75% rated load and 100 % rated load.

## Vibration

The design of each type motor shall have been subjected to vibration performance type tests in accordance with the requirements of As 1359.114.

## Other Type Tests

The design of each type of motor shall have been subjected to type tests to verify conformance with its specifications in respect to:

* + 1. Locked rotor current
    2. Locked rotor torque
    3. Pull up torque
    4. Breakdown torque
    5. Full load torque
    6. Full load speed
    7. Full load power factor
    8. Full load current

## Type Test Certificates

The motor shall be provided with a type test certificate certifying that the particular motor had been successfully type tested in accordance with AS 60034.1.

# Routine Tests

## General

Routine tests shall be defined as factory tests to which each individual motor is subjected during or after manufacture to ascertain whether it complies with certain criteria.

## Criteria to be Routine Tested

The motor shall be subjected to routine tests in accordance with AS 60034.1 to verify conformance with its specifications in respect to:

* + 1. Winding resistance
    2. No load current
    3. No load losses
    4. Direction of rotation
    5. Voltage withstand test

## Routine Test Certificates

Each motor shall be provided with a routine test certificate certifying that the particular motor had been successfully routine tested in accordance with AS 60034.1.

# Delivery and Installation

1. The Contractor shall deliver, unload, unpack and assemble as necessary the complete motor at the site
2. The Contractor shall inspect the unpacked motor and shall ensure that it is undamaged
3. The Contractor shall give the Principal seven days’ notice when the motor will be ready for installation
4. The installation of the motor shall be completed by the Principal in the presence of the Contractor and to the Contractor’s satisfaction if supervision by the Contractor is specified in the Annexure

# On site Testing

1. Before the Contractor makes the motor available to the Principal for installation and connection to the electrical system, the contractor shall carry out a 1000 Volt insulation test
2. The Contractor shall supply all equipment, materials and labour for such testing and shall make the test results available to the Principal at the time that the motor is made available for connection to the electricity supply

# As-Constructed Information

The Contractor shall provide as-constructed information on all drawings detailing all changes and modifications made during the construction and installation phases of the project.

The contractor shall submit drawings in both AutoCAD and PDF formats in accordance with the Drawing Submission Process. Adequate contrast within the PDF image shall be maintained between drawing content and background to ensure the clarity and quality of the drawings.

# Manuals

1. The Contractor shall supply 1 hard copy and 1 soft copy of comprehensive instruction manuals for the motor, written in English and covering the complete operation and maintenance requirements of all equipment supplied under the Contract
2. The manuals shall be printed on high grade A4 size paper and shall be bound in a high grade A4 size loose leaf binder
3. Information included in the manuals shall include:
   * 1. Operating instructions
     2. Safety instructions and warnings
     3. Maintenance instructions and schedules
     4. Recommended spare parts and special tool list
     5. As constructed drawings
     6. Test reports and test certificates

**Annexure to Specification**

**for**

**Low Voltage Submersible Bore Hole Cage Induction Motor**

**Project:**

Site Location:

Type of Access to Site:

Bore Hole Internal Diameter: metres

Depth of Installation below ground level: metres to motor DE

**Operating Environment:-**

Maximum pumped flow rate: litres/sec

Minimum pumped flow rate: litres/sec

Maximum head of water above the motor: metres

Maximum water temperature:  oC

Sediment concentration: mg/l

**Water chemical composition:**

Predicted or test values:

Total soluble salts: mg/l pH:

Sodium: mg/l Potassium mg/l

Magnesium: mg/l Calcium mg/l

Bicarbonate: mg/l Sulphate mg/l

Chloride: mg/l Nitrogen mg/l

Carbonate: mg/l Silica: mg/l

Iron mg/l Alkalinity (as CaCO3) mg/l

One way primary coolant check valve

(permitted or not permitted) .

Stainless steel stator ends (required or not required)

Motor temperature(s) monitor (required or not required)

To be supplied as part of a combined pump set, (yes or no):

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**for**

**Low Voltage Submersible Bore Hole Cage Induction Motor**

**Operating Mode -**

Fixed or variable speed:

Maximum Operating Load: kW at …Hz

Type of Starter:

Estimated starting time: secs

Estimated Annual Running Time: hours

Capitalised Cost of Losses: $/kW

Power supply to fixed speed motor:

Frequency: Hz

Frequency tolerance: +/1

Phase to phase voltage: Volts, with neutral grounded solidly

Voltage tolerance (long term) %

Impedance of electrical supply system to motor: ………………….. +/-……………………. Ohm

Power supply to motor from variable speed controller:

Phase to phase voltage at 50 Hz: Volts

Motor operating frequency range: Hz to ………………………….

Total Harmonic Distortion in controller output voltage: %

Voltage waveform, (raw PWM or filtered sine wave):

Neutral grounded or floating:

Motor rated frequency (60 Hz or 50 Hz): Hz

Number of poles (2 pole or 4 pole) kW

Motor power output S1 duty rating at above frequency: kW

Motor nominal overall diameter inches

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**for**

**Low Voltage Submersible Bore Hole Cage Induction Motor**

If fixed speed operation:

Maximum locked rotor current: Amps

Minimum locked rotor torque: newton metres

Minimum pull up torque: newton metres

Minimum break down torque: newton metres

Pump maximum up thrust: newtons

Pump maximum down thrust: newtons

Additional work to be done by the Principal:

Contractor Supervision of Installation (required or not required):

Witnessed Tests (required or not required):

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| **Type Specification for LV Submersible Bore Hole Cage Induction Motor**  **Tender Technical Response Schedule** | | | | | |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **1** | **General** |  |  |  |  |
| **2** | **Site** |  |  |  |  |
| **3** | **Operating Environment** |  |  |  |  |
| **4** | **Operating Mode** |  |  |  |  |
| **5** | **Work by Principal** |  |  |  |  |
| **6** | **Information from Contractor** |  |  |  |  |
|  | Equivalent Circuit Values |  |  |  | Stator resistance Ohms = |
|  |  |  |  |  | Stator reactance Ohms = |
|  |  |  |  |  | Rotor resistance Ohms = |
|  |  |  |  |  | Rotor reactance Ohms = |
|  |  |  |  |  | Magnetising conductance Mhos = |
|  |  |  |  |  | Magnetising susceptance Mhos = |
|  |  |  |  |  | Turns ratio = |
|  |  |  |  |  | Friction/windage loss kW = |
| **7** | **Contractor’s Drawings** |  |  |  |  |
| **8** | **Standards** |  |  |  |  |
| **9** | **Quality Assurance** |  |  |  |  |
| **10** | **Power Supply to Motor** |  |  |  | Rated Hz |
|  |  |  |  |  | At rated Hz, rated Volts = |
|  |  |  |  |  | Frequency range = …….Hz to ……..Hz |
| **11** | **Motor Type** |  |  |  |  |
|  |  |  |  |  | Stator star or delta connected? |
|  |  |  |  |  | Rated Hz synchronous r.p.m. = |
| **12** | **Performance Characteristics** |  |  |  |  |
| 12.1 | General |  |  |  | Values hereunder at rated Volts & Hz |
| 12.2 | Duty |  |  |  | Duty type = |
| 12.3 | Rated Output Power |  |  |  | Rated kW = |
| 12.4 | Minimum Efficiencies |  |  |  | Efficiency at 50% load % = |
|  |  |  |  |  | Efficiency at 75% load % = |

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| **Type Specification for LV Submersible Bore Hole Cage Induction Motor**  **Tender Technical Response Schedule** | | | | | |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | | **Comments** |
|  |  |  | **Yes** | **No** |  |
|  |  |  |  |  | Efficiency at 100% load % = |
| 12.5 | Minimum Power Factors |  |  |  | Power Factor at 50% load % = |
|  |  |  |  |  | Power Factor at 75% load % = |
|  |  |  |  |  | Power Factor at 100% load % = |
| 12.6 | Starting Characteristics |  |  |  | Stator full load Amps = |
|  |  |  |  |  | Full load rpm = |
|  |  |  |  |  | Full load torque Nm = |
|  |  |  |  |  | Breakdown torque Nm = |
|  |  |  |  |  | Breakdown torque rpm = |
|  |  |  |  |  | Breakdown torque speed Amps = |
|  |  |  |  |  | Stator locked rotor Amps = |
|  |  |  |  |  | Locked rotor torque Nm = |
|  |  |  |  |  | *Current versus rpm curve to be attached* |
|  |  |  |  |  | *Torque versus rpm curve to be attached* |
| **13** | **Direction of Rotation** |  |  |  |  |
| **14** | **General Mechanical Features** |  |  |  |  |
|  | Stator and material |  |  |  | Stainless steel or not? motor diam inches = *Note: if diam > 8 inches attach mounting detail drawing* |
| **15** | **Type of Cooling** |  |  |  |  |
|  |  |  |  |  | IC rating = |
|  | Cooling additive |  |  |  | Type = |
|  |  |  |  |  | Concentration % = |
|  | Minimum Cooling Water Velocity |  |  |  | At full load current minimum allowable |
|  |  |  |  |  | Cooling water velocity m/s = |
|  |  |  |  |  | *Minimum load m/s =* |
|  |  |  |  |  | *Maximum load m/s =* |
| **16** | **Enclosure** |  |  |  | IP rating = |
|  |  |  |  |  | Overall weight kg = |
|  |  |  |  |  | Rotor weight kg = |
|  |  |  |  |  | Overall length metres = |

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| **Type Specification for LV Submersible Bore Hole Cage Induction Motor**  **Tender Technical Response Schedule** | | | | | |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **17** | **Vibration Level** |  |  |  | *Vibration mm/s rms* |
| **18** | **Windings** |  |  |  |  |
| 18.1 | General |  |  |  |  |
| 18.2 | Insulation |  |  |  | AS 2768 insulation class = |
| 18.3 | Winding Temperature |  |  |  |  |
|  | At nameplate rated current and specified site conditions |  |  |  | Winding average deg. C = Winding upper crown deg. C = |
|  | At nameplate rated current AND 20oC bore water temperature |  |  |  | Winding average rise deg. C = Winding upper crown rise deg C= |
| 18.4 | Winding Voltage Rating |  |  |  | Turn to turn kV = |
| **19** | **Connections** |  |  |  | Tail length m = |
| **20** | **Temperature Sensors** |  |  |  | Total No. = |
|  |  |  |  |  | No. in windings = |
|  |  |  |  |  | Type = |
|  |  |  |  |  | RTD class = |
| **21** | **Bearings** |  |  |  |  |
| 21.1 | Radial Bearings |  |  |  |  |
| 21.2 | Thrust Bearings |  |  |  |  |
| 21.3 | Bearing Life |  |  |  |  |
| **22** | **Type Tests** |  |  |  |  |
| 22.1 | General |  |  |  |  |
| 22.2 | Thermal Performance |  |  |  |  |
| 22.3 | Efficiency |  |  |  | *Note: Tenders will be analysed on the basis of capital cost plus the capitalised cost of losses* |
| 22.4 | Vibration |  |  |  |  |
| 22.5 | Other Type Tests |  |  |  | *(Details of proposal to be attached)* |
| 22.6 | Type Test Certificates |  |  |  | *Currently available, yes or no* |
| **23** | **Routine Tests** |  |  |  |  |
| 23.1 | General |  |  |  |  |
| 23.2 | Criteria to be Routine Tested |  |  |  |  |
| 23.3 | Routine Test Certificates |  |  |  |  |

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| **Type Specification for LV Submersible Bore Hole Cage Induction Motor**  **Tender Technical Response Schedule** | | | | | |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **24** | **Delivery and Installation** |  |  |  |  |
| **25** | **On Site Testing** |  |  |  |  |
| **26** | **As Constructed Information** |  |  |  |  |
| **27** | **Manuals** |  |  |  |  |
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