

|  |
| --- |
| Assets Planning and Delivery GroupEngineering  |

DESIGN STANDARD DS 26-23

Type Specifications – Electrical

Type Specification for Low Voltage Slip Ring Induction Motor

|  |
| --- |
|  |
|  |
| version 2revision 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 Senior Principal Engineer – Electrical, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

**Head of Engineering**

*This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.*

*Users should use and reference the current version of this document.*

© Copyright – Water Corporation: This standard and software is copyright. With the exception of use permitted by the Copyright Act 1968, no part may be reproduced without the written permission of the Water Corporation.

the Copyright Act 1968, no part may be reproduced without the written permission of the Water Corporation.

DISCLAIMER

Water Corporation accepts no liability for any loss or damage that arises from anything in the Standards/Specifications including any loss or damage that may arise due to the errors and omissions of any person. Any person or entity which relies upon the Standards/Specifications from the Water Corporation website does so that their own risk and without any right of recourse to the Water Corporation, including, but not limited to, using the Standards/Specification for works other than for or on behalf of the Water Corporation.

The Water Corporation shall not be responsible, nor liable, to any person or entity for any loss or damage suffered as a consequence of the unlawful use of, or reference to, the Standards/Specifications, including but not limited to the use of any part of the Standards/Specification without first obtaining prior express written permission from the CEO of the Water Corporation.

Any interpretation of anything in the Standards/Specifications that deviates from specific Water Corporation Project requirements must be referred to, and resolved by, reference to and for determination by the Water Corporation’s project manager and/or designer for that particular Project.

REVISION STATUS

The revision status of this standard is shown section by section below. Latest changes highlighted in black text.

| **REVISION STATUS** |
| --- |
| **SECT.** | **VER./REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION****(Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
| **1** | **2/0** | **20.01.16** | **8** | **Section 1 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **3** | **2/0** | **20.01.16** | **8** | **Section 3 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **4** | **2/0** | **30.08.11** | **8** | **Section 4 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **7** | **2/0** | **30.08.11** | **9-10** | **Section 7 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **8** | **2/0** | **20.01.16** | **10** | **Section 8 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **10** | **2/0** | **20.01.16** | **10** | **Section 10 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **11** | **2/0** | **20.01.16** | **10** | **Section 11 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **12** | **2/0** | **20.01.16** | **10** | **Section 12 new** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **15** | **2/0** | **20.01.16** | **11** | **Section 15 new** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **16** | **2/0** | **20.01.16** | **11-12** | **Section 16 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **17** | **2/0** | **20.01.16** | **12** | **Section 17 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **18** | **2/0** | **20.01.16** | **12** | **Section 18 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **19** | **2/0** | **20.01.16** | **12** | **Section 19 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **21** | **2/0** | **20.01.16** | **13** | **Section 21 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **25** | **2/0** | **20.01.16** | **14** | **Section 25 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **29** | **2/0** | **20.01.16** | **16** | **Section 29 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **31** | **2/0** | **20.01.16** | **17** | **Section 31 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **32** | **2/0** | **20.01.16** | **17** | **Section 32 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **34** | **2/0** | **20.01.16** | **18** | **Section 34 revised** | **NHJ** | **MSP** |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Various** | **2/1** | **20.04.23** |  | **Scheduled review, multiple sections updated** | **TL** | **EDG** |
|  |  |  |  |  |  |  |

| **PREVIOUS REVISION STATUS** |
| --- |
| **VER./****REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION****(Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
| **0/4** | **01.09.03** | **All** | **New section** | **NHJ** | **AAK** |
| **1/0** | **27.02.04** | **All** | **Sections split** | **NHJ** | **AAK** |
| **1/1** | **23.05.05** | **All** | **Paragraphs renumbered** | **NHJ** | **AAK** |
| **1/2** | **02.06.09** | **6** | **1 revised** | **NHJ** | **AAK** |
| **1/2** | **02.06.09** | **7** | **7 revised** | **NHJ** | **AAK** |
| **1/2** | **02.06.09** | **8** | **14 revised** | **NHJ** | **AAK** |
| **1/2** | **02.06.09** | **10** | **20.2, 203 revised** | **NHJ** | **AAK** |
| **1/2** | **02.06.09** | **11** | **25.1, 25.2 revised** | **NHJ** | **AAK** |
| **1/2** | **02.06.09** | **13** | **31 revised** | **NHJ** | **AAK** |

DESIGN STANDARD DS 26-23

Type Specifications – Electrical

Type Specification for Low Voltage Slip Ring Induction Motor

**CONTENTS**

*Section Page*

[1 GENERAL 9](#_Toc133839435)

[2 SITE 9](#_Toc133839436)

[3 OPERATING MODE 9](#_Toc133839437)

[4 WORK BY THE PRINCIPAL 9](#_Toc133839438)

[5 INFORMATION FROM THE CONTRACTOR 9](#_Toc133839439)

[6 CONTRACTOR’S DRAWINGS 10](#_Toc133839440)

[7 STANDARDS 10](#_Toc133839441)

[8 QUALITY ASSURANCE 11](#_Toc133839442)

[9 POWER SUPPLY TO MOTOR 11](#_Toc133839443)

[10 MOTOR TYPE 11](#_Toc133839444)

[11 MOTOR DUTY AND RATING 11](#_Toc133839445)

[12 TYPE OF LOAD 12](#_Toc133839446)

[13 SYNCHRONOUS SPEED 12](#_Toc133839447)

[14 DIRECTION OF ROTATION 12](#_Toc133839448)

[15 COOLING 12](#_Toc133839449)

[15.1 Type of Cooling (IC Code) 12](#_Toc133839450)

[15.2 Air Ducts 12](#_Toc133839451)

[15.3 Heat Exchanger 12](#_Toc133839452)

[16 ENCLOSURE (IP CODE) 13](#_Toc133839453)

[17 TYPE OF CONSTRUCTION (IM CODE) 13](#_Toc133839454)

[18 NOISE LEVEL 13](#_Toc133839455)

[19 VIBRATION LEVEL 13](#_Toc133839456)

[20 TERMINATIONS 13](#_Toc133839457)

[20.1 Separation 13](#_Toc133839458)

[20.2 Terminal Boxes 14](#_Toc133839459)

[20.3 Location of Cable Terminations 14](#_Toc133839460)

[21 WINDINGS 14](#_Toc133839461)

[21.1 General 14](#_Toc133839462)

[21.2 Insulation 14](#_Toc133839463)

[21.3 Winding Temperature Rise 14](#_Toc133839464)

[21.4 Stator Lightning Impulse Withstand Voltage 14](#_Toc133839465)

[21.5 Rotor Windings Star Point 14](#_Toc133839466)

[22 SLIP RINGS AND BRUSH GEAR 14](#_Toc133839467)

[22.1 Ratings 15](#_Toc133839468)

[22.2 Slip Ring Material 15](#_Toc133839469)

[23 BEARINGS 15](#_Toc133839470)

[24 COUPLING 15](#_Toc133839471)

[25 ANTI-CONDENSATION HEATING 15](#_Toc133839472)

[26 PROTECTION 16](#_Toc133839473)

[26.1 Winding Over Temperature Protection 16](#_Toc133839474)

[26.2 Bearing Over Temperature Protection 16](#_Toc133839475)

[27 PAINTING 16](#_Toc133839476)

[28 MISCELLANEOUS REQUIREMENTS 16](#_Toc133839477)

[28.1 Holding Down Bolts 16](#_Toc133839478)

[28.2 Jacking Screws 16](#_Toc133839479)

[28.3 Earthing Terminal 17](#_Toc133839480)

[28.4 Lifting Eyes 17](#_Toc133839481)

[29 WORK TESTS 18](#_Toc133839482)

[29.1 General 18](#_Toc133839483)

[29.2 Efficiency Tests 18](#_Toc133839484)

[29.3 Withstand Voltage Tests 18](#_Toc133839485)

[29.4 Other Performance Tests 18](#_Toc133839486)

[29.5 Routine Check Tests 18](#_Toc133839487)

[30 DELIVERY AND INSTALLATION 19](#_Toc133839488)

[31 ON SITE TESTING 19](#_Toc133839489)

[32 AS CONSTRUCTED INFORMATION 19](#_Toc133839490)

[33 MANUALS 19](#_Toc133839491)

[34 LIQUIDATED DAMAGES FOR LOW EFFICIENCY 20](#_Toc133839492)

# GENERAL

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 slip ring induction motor rated not greater than 500 kW.

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.

The installation and connection of the motor will be carried out by others in accordance with the Contractor’s instructions.

The Contractor shall return to site to commission the motor once the electrical and mechanical installation at the site has been completed.

# SITE

The motor will be housed in a weatherproof, well ventilated building on the site, the location of which shall be detailed in the Annexure. Access to the site shall be as detailed in the Annexure.

# OPERATING MODE

The mode of operation for the motor shall be as detailed in the Annexure. The operating environment shall be as detailed in the Annexure

# WORK BY THE PRINCIPAL

* + - * 1. The Principal will supply and install the driven load machine including the bed plate for the motor.
				2. The Principal will install the motor on its bed plate, couple it to its load and connect it electrically.
				3. If air ducts are required as per clause 15.2 the Principal will supply air ducts and couplings of the size and type specified by the Contractor in his/her Tender Technical Response and will install such ducts.

(d) If a cooling water supply is required as per clause 15.3, the Principal will provide and connect a water supply to the motor at the pressure and flow rate specified by the Contractor in his/her Tender Technical Response.

(e) Other work to be performed by the Principal shall be as detailed in the Annexure.

# INFORMATION FROM THE CONTRACTOR

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

* + - * 1. General Arrangement Drawings including

 certified mounted dimensions, and

 foundation loading diagram 28 days after date of order

* + - * 1. Electrical Wiring and Schematic Drawings 14 days prior to factory tests
				2. Final Design Equivalent Circuit Values

 confirming Contractor’s offer) 28 days prior to factory tests

* + - * 1. 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 Specification shall comply in design, construction, rating and performance with the current relevant Australian Standards and Codes.

In their absence compliance shall be with the relevant International Standards together with the requirements of competent Authorities having jurisdiction over all or any part of the design, manufacture, installation and operation of the equipment.

Specific reference is made within this 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 2312 Guide to the Protection of Iron and Steel Against Exterior Atmospheric Corrosion

AS 60034.1 Rotating electrical machines - Rating and performance (IEC 60034-1 modified)

AS 60034.5 Rotating electrical machines - Degrees of protection provided by the integral design of rotating electrical machines (IP Code) (identical to IEC 60034-5)

AS 60034.7 Rotating electrical machines - Classification of types of construction, mounting, arrangements and terminal position (IM Code) (identical to IEC 60034-7)

AS 60034.8 Rotating electrical machines - Terminal markings and direction of rotation (IEC 60034-8 modified)

AS 60034.9 Rotating electrical machines - Noise limits (identical to IEC 60034-9)

AS/NZS ISO 9001 Quality Management Systems – Requirements

IEC 60034-1 Rotating electrical machines - Rating and performance

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

IEC 60034-14 Rotating electrical machines - Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of severity

IEC 60034-15 Rotating Electrical Machines – impulse voltage rating withstand levels for rotating A.C. machines with form wound stator coils

IEC 60034-18 Rotating electrical machines - Functional evaluation of insulating systems

IEC 60085 Electrical Insulation Materials – Evaluation and Classification based on Thermal Endurance

IEC 60751 Specifications for Industrial Platinum Resistance Thermometer Elements

ISO 281 Rolling bearings Dynamic load ratings and rating life

ISO 9223 Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation.

# 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 50 Hz power supply having a solidly grounded neutral, a phase sequence of RWB and other characteristics as specified in the Annexure.

Power supplies to auxiliary equipment will be provided by the Principal to match the requirements specified in the Contractor’s tender submission.

# MOTOR TYPE

The motor shall be of the wound rotor and slip rings induction motor type in accordance with AS 60034.1.

The motor shall be suitable for starting with a multi-step secondary resistance starter limiting the stator starting current to a value not greater than 2 times full load current and not less than 1.25 times full load current. The values of starting resistances shall be calculated by the Principal based on the confirmed per phase star motor equivalent circuit parameters provided by the Contractor. The motor shall have a rated rotor open circuit voltage of not greater than 1500 volts. If so specified in the Annexure, the motor shall be supplied with automatic ring shorting and brush lifting gear.

# MOTOR DUTY AND RATING

The motor duty shall be duty type S1 in accordance with AS 60034.1. The motor maximum power output rating shall be as specified in the Annexure, shall be at the above duty rating and shall be under the specified operating conditions.

# TYPE OF LOAD

The motor shall be suitable for driving the type of load specified in the Annexure.

# SYNCHRONOUS SPEED

The motor’s synchronous speed shall be as specified in the Annexure.

# DIRECTION OF ROTATION

The motor’s direction of rotation as defined in AS 60034.8 shall be as specified in the Annexure.

# COOLING

## Type of Cooling (IC Code)

The type of cooling used shall be one of the following IEC 60034-6 classifications as specified in the Annexure:

1. IC0A1, i.e. air as primary coolant circulated with a motor shaft driven fan from, and back to, the surrounding air,
2. IC2A1, i.e. air as primary coolant with a motor shaft driven fan drawing air directly from surrounding air and discharging outside the pump station via an outlet duct
3. IC3A1, i.e. air as primary coolant with a motor shaft driven fan drawing air from outside the pump station and delivering air to a different location outside the pump station via inlet and outlet ducts.
4. IC8A1W7, i.e. air as primary coolant and water as secondary coolant with a motor mounted heat exchanger, the air being circulated by a motor shaft driven fan and the water being moved by means separate from the motor

## Air Ducts

(a) If the type of cooling is specified in the Annexure as IC2A1, the required length of the above outlet duct as per clause 15.1 (b) shall be as shown in the Annexure.

(b) If the type of cooling is specified in the Annexure as IC3A1, the required length of the above inlet and outlet ducts as per clause 15.1(c) shall be as shown in the Annexure.

## Heat Exchanger

If the type of cooling is specified in the Annexure as IC8A1W7:

1. The hydraulic resistance of the water circuit within the air/water heat exchanger shall be such that at the required maximum flow rate specified by the Contractor in his/her Tender Technical Response, the pressure drop across the heat exchanger shall be not more than the value specified by the Contractor in his/her Tender Technical Response,
2. The heat exchanger shall be provided with detection equipment to trip the motor out on fault should a water leak occur, and
3. The water circuit within the heat exchanger shall be constructed of materials which will not suffer corrosion if used with water having the chemical composition specified in the Annexure.

# ENCLOSURE (IP CODE)

1. If the type of cooling is specified as IC0A1 or IC2A1:

 (i) the motor shall be of drip proof construction and shall be protected to
AS 60034.5 classification IP22, and

 (ii) the motor shall have no ventilation openings in the drive end face of the enclosure, so that spray from a leaking pump seal cannot enter the motor directly.

1. If the type of motor cooling is specified as IC3A1 or IC8A1W7 the motor shall be of totally closed construction and shall be protected to AS 60034.5 classification IP56.
2. Unless the motor is to be provided with automatic ring shorting and brush lifting gear the slip rings shall be located in a separate compartment rom the stator windings, so that carbon dust from brush wear cannot be blown onto the surface of the stator windings.

# TYPE OF CONSTRUCTION (IM CODE)

The motor type of construction and mounting arrangement shall be of the AS 60034.7 classification specified in the Annexure.

#  NOISE LEVEL

The motor shall be fitted with a low noise unidirectional cooling fan and other noise limiting devices. Unless a lower noise level is specified in the Annexure, the emitted noise level shall be at least 12 dB below the relevant value quoted in Table 1 of AS 60034.9.

# VIBRATION LEVEL

The motor shall be designed and constructed so that the vibration severity level under rigid mounting conditions shall not exceed vibration grade R over the frequency range 10 Hz to 1 kHz in accordance with AS 1359.114.

The works test shall be conducted with the half key fitted.

# TERMINATIONS

## Separation

Separate terminal boxes shall be provided for:

1. stator circuit cable connections,
2. rotor circuit cable connections,
3. winding temperature sensor circuit cable connections,
4. anti-condensation heater circuit cable connections, and
5. slip ring shorting and brush lifting control circuits cable connections (if such equipment is fitted).

## Terminal Boxes

Terminal boxed shall be metal construction and shall be sized to provide adequate space for termination of the associated cables as specified in the Annexure.

Stator and rotor terminal boxes shall be rated to withstand an internal arcing fault without danger to nearby personnel and without damage to adjacent plant.

## Location of Cable Terminations

The location of cable terminations shall be as specified in the Annexure.

# WINDINGS

## General

The motor windings shall:

1. form wound;
2. be designed to have an even temperature distribution free from hot spots;
3. be suitably braced to give adequate rigidity under short circuit and starting conditions;
4. be vacuum impregnated with suitable insulating varnish to render them damp proof and oil resistant.

## Insulation

The winding system shall have been developed on the basis of functional evaluation in accordance with IEC 60034.18. Winding insulation shall not be less than IEC 60085 class F.

## Winding Temperature Rise

The winding temperature rise at maximum power output rating shall not exceed the temperature rise limits specified in AS 60034.1 for IEC 60085 Class B insulation.

## Stator Lightning Impulse Withstand Voltage

The Stator Lighting Impulse Withstand Voltage shall be not less than 4 kV.

## Rotor Windings Star Point

The rotor winding star point connection ring shall be located at least 10mm clear of the rotor iron laminations.

# SLIP RINGS AND BRUSH GEAR

##  Ratings

Rotor slip rings and brush gear shall be continuously rated.

Brushes shall be rated for the expected operating load specified in the Annexure. Brush wear shall not be more than 2mm per 1000 operating hours at the normal operation load specified in the Annexure.

Brush lifting and ring shorting gear shall operate from a 50 Hz power supply rated not greater than 240 volts single phase or 415 volts three phase.

## Slip Ring Material

Slip rings shall be made of non-ferrous material suitable for operation in the environment specified in the Annexure.

# BEARINGS

Bearings shall be of the rolling element construction and shall be grease lubricated. The grease used shall be lithium based mineral oil grease, Shell Alvania EPLF2 or equivalent.

The bearing system shall be capable of carrying enough axial load to allow the motor to be run disconnected from the load.

The bearing housings shall be fitted with grease nipples and automatic grease pressure relief and venting systems.

The motor shall be fitted with bearings having a rated operating life in accordance with ISO 281 of 100,000 hours under the specified operating conditions.

# COUPLING

The coupling will be supplied by the Principal. The Principal will provide the Contractor with the drive side half coupling bored to suit the shaft diameter advised by the Contractor and balanced with a half key fitted. The Contractor shall fit the half coupling to the motor shaft and ensure that the balance of the whole rotating element is correct.

# ANTI-CONDENSATION HEATING

The motor shall be fitted with inbuilt anti-condensation heaters rated to raise the temperature of the motor 4oC above ambient with the motor de-energised and the heaters on.

Anti-condensation heaters shall be suitable for operation from a single phase 50 Hz power supply with an operating voltage of 240 volts.

Anti-condensation heaters shall be suitable for supply via a 30 mA Residual Current Device.

A label carrying the following warning, shall be fitted in the vicinity of the anti-condensation heater terminal box.

**CAUTION**

**MOTOR ANTI-CONDENSATION HEATER IS “ON”**

**WHEN THE MOTOR IS “OFF**”

# PROTECTION

## Winding Over Temperature Protection

1. The motor stator windings shall be fitted with over temperature protection either in the form of Resistance Temperature Detectors (RTD’s) embedded in the windings or thermistors embedded in the windings.
2. If RTD’s are supplied these shall be three wire platinum element type having Grade B accuracy in accordance with IEC 60751 and shall have a resistance of 100 ohms at 0oC with a fundamental interval of 38.50 ohms.

Two RTD’s shall be embedded within each phase winding and all RTD’s shall be brought out separately via suitably protected leads so that one set of RTD’s can be used for winding temperature indication and protection and the other set retained as spare.

1. If thermistor protection is supplied, a single P.T.C. thermistor shall be supplied embedded in the end turns of each phase winding. The trip temperature shall be in accordance with the manufacturer’s recommended practice and the temperature – resistance characteristic shall be such that the resistance of each thermistor at trip temperature is 1000 ohms. The connections to each thermistor shall be brought out separately via suitably protected leads.

## Bearing Over Temperature Protection

The motor shall have a thermometer pocket complete with a Resistance Temperature Detector (RTD) in each bearing house. RTD’s shall be three wire platinum element type having Grade B accuracy in accordance with IEC 60751 and shall have a resistance of 100 ohms at 0oC with a fundamental interval at 38.50 ohms.

The RTD’s shall be brought out separately via suitably protected leads. Bearing RTD leads may be terminated in the same terminal box as winding RTD’s if these are fitted, but shall be kept separate from other circuits.

# PAINTING

A paint coating which is rated in accordance with AS 2312 (and ISO 9223) to provide Long Term Protection to steel in industrial environments shall be applied to the motor.

# MISCELLANEOUS REQUIREMENTS

## Holding Down Bolts

If the motor is to be one of a group of similar motors, holes for holding down bolts or set screws and cable terminations shall be drilled to a common template to facilitate interchangeability of motors. The drilling templates shall be such that the location of holes relative to motor centre line remains constant from motor to motor.

## Jacking Screws

If the motor has been specified in the Annexure as floor mounted, jacking screws shall be provided at each motor foot in order to facilitate leveling of the machine prior to installation of necessary shims and final bolting down.

The combined motor/load machine base plate will be supplied and installed by the Principal in accordance with the certified mounting dimensions provided by the Contractor.

## Earthing Terminal

An external motor earthing terminal shall be provided in an accessible position close to the stator termination.

## Lifting Eyes

A minimum of two lifting eyes rated for the weight of the fully assembled motor shall be provided.

# WORK TESTS

## General

The Contractor shall submit the motor to work tests as detailed hereunder and shall provide the Principal with certified test certificates including the actual test results recorded.

The Contractor shall make provision for such tests to be witnessed, if witnessed testing is specified in the Annexure.

## Efficiency Tests

The motor shall undergo testing of motor efficiency by the summation of losses in accordance with AS 1359.102.1 at 50% load, at 75% load and at 100% load.

## Withstand Voltage Tests

The motor shall be submitted to voltage withstand tests in accordance with AS 60034.1.

## Other Performance Tests

The motor shall be submitted to testing in accordance with a recognized National standard to substantiate all of the performance values included in the Contractor’s tender.

## Routine Check Tests

Routine Check Tests shall be defined are those tests applied to the machine necessary to show that it is able to withstand the appropriate dielectric tests, and is in correct working order both electrically and mechanically.

All motors shall be subjected to Routine Check Tests at the manufacturer’s works.

Routine Check Tests shall include the following:

1. winding resistance measurement,
2. winding insulation resistance measurement at not less than 1000 volts,
3. air gaps measurement,
4. dielectric tests in accordance with AS 60034.1
5. confirmation of terminal markings and direction of rotation,
6. open circuit induced secondary voltage,
7. no load tests at rated voltage recording volts, amps and kilowatts, and
8. no load vibration test.

# DELIVERY AND INSTALLATION

The Contractor shall deliver, unload, unpack and assemble as necessary the complete motor at the site.

The Contractor shall inspect the unpacked motor and shall ensure that the motor is undamaged.

The Contractor shall give the Principal seven days notice of when the motor will be ready for installation onto the bed plate and coupling to the driven load. The installation, alignment and coupling shall be completed by the Principal in the presence of the Contractor and to the Contractor’s satisfaction.

# ON SITE TESTING

Before the Contractor makes the motor available to the Principal for connection to the electrical system, the Contractor shall carry out the following tests:

1. insulation resistance test;
2. reduced voltage withstand test.

The Contractor shall supply all equipment, materials and labour for such testing and shall make the results of such tests 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

The Contractor shall supply 3 copies of comprehensive instruction manuals, written in English and covering the complete operation and maintenance requirements of all equipment supplied under the Contract.

The manuals shall be printed on high grade A4 size paper and shall be bound in a high grade A4 Size loose leaf binder.

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. detailed equipment performance specification, and
7. test reports and test certificates.

# LIQUIDATED DAMAGES FOR LOW EFFICIENCY

In addition to any liquidated damages specified in the general conditions of contract, the Contractor shall be liable to the Principal for liquidated damages in respect of failure of the motor to achieve the level of full load efficiency quoted previously in the Tender Technical Response Schedule.

Such liquidated damages shall be calculated on the basis of capitalised cost of losses as specified in the Annexure and on the basis of the losses in excess of the quoted value plus the tolerance allowed in AS 1359.102.1.

**Annexure to Specification**

**For Low Voltage Slip Ring Induction Motor**

**Project:** ……………………………………………………………………..

…………………………………………………………………….

 Site Location: ……………...……………………………………………………..

 ……………………………………………………………………

 ……………………………………………………………………

Type of Access to Site: ……………………………………………………….

Work to be done by the Principal: …………………………………………..

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………….

Operating Mode

 Type of Load (i.e. pump, fan etc):

 Normal Operating Load: …………………………………………….kW

 Overall Starting Time: ………………………………………….seconds

 Estimated Running Annual Time: …………………………………………… hours

 Capitalised Cost of Losses: …………………………………………..$ / kW

Operating Environment

 Maximum Ambient Air Temperature: …………………………………………… oC

 Minimum Ambient Air Temperature: …………………………………………….oC

 Maximum Ambient Air Relative Humidity: ……………………………………... %

 Ambient Air Borne Contaminants: ………………………………………………

 ………………………………………………

**Annexure to Specification**

**for Low Voltage Slip Ring Induction Motor**

Power supply to motor:

 Frequency tolerance: +/- …………………………… %

 Supply to slip ring motor, phase to phase Voltage ……………………… volts

 Voltage tolerance (long term): ………………………………….%

 Impedance of electrical supply system to motor: ……….. + j …………. ohm

Brush lifting and ring shorting gear, required/not required: ………………………………

Motor power output rating at the specified Duty ………………………….. kW

Direction of rotation as per AS 60034.8 ………………………………..

Synchronous Speed: ……………………………….r.p.m.

Type of Construction and Mounting as per AS 60034.7 IM Code: ……………………………..

 Holes drilled to a common template required/not required: ……………………………

Type of Cooling Classification as per IEC 60034-6 IC Code: ……………………………..

 Range of coolant temperature at motor inlet ………….oC to ………………..oC

 If water cooled, cooling water composition:

 If IC2A1 or IC3A1, length of outlet duct …………………………………... m

 If IC3A1, length of inlet ………………………………..… m

 If IC8A1W7, cooling water composition: …………………………………….

 Sodium: ….……………mg/l Potassium: …………………. mg/l

 Magnesium: ……………….mg/l Calcium: …………………. mg/l

 Bicarbonate: ……………….mg/l Sulphate: …………….….. mg/l

 Chloride: ……………….mg/l Nitrate: ………………… mg/l

 Carbonate: ……………… .mg/l Silica: …………… ……. mg/l

 Total Soluble Salts: ………………..mg/l Iron: ……………………mg/l

 Total Hardness: ………………..mg/l

 Alkalinity (as CaCO3) ………………..mg/l pH: …………………………

Winding Over-temperature Protection, RTD’s or Thermistors ………………………………..

**Annexure to Specification**

**For Low Voltage Slip Ring Induction Motor**

Special Low Noise Level design required/not required: ……………………………………

 If required, maximum No Load Sound Power Level: ………………………… dBA

Stator Cable

 Insulation Type: ……………………………………

 Number of Cores: ……………………………………

 Conductor Material: ……………………………………

 Conductor Size: ………………………………..mm2

Rotor Cable

 Insulation Type: ……………………………………..

 Number of Cores: ……………………………………..

 Conductor Material: ……………………………………...

 Conductor Size: …………………………………mm2

 Stator Control Switching Device

 Type: ………………………………………………………………………………..……

 Make and Model: ………………………………………………………………………….

Location of Terminations: ……………………………………………………………

 ……………………………………………………………

 ……………………………………………………………

Test:

Witnessed Tests (required/not required): ……………………………………………………..

|  |
| --- |
| **Type Specification for Low Voltage Slip Ring Induction Motor****Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **1** | **General** |  |  |  |  |
| **2** | **Site** |  |  |  |  |
| **3** | **Operating Mode** |  |  |  |  |
|  | Type of Duty |  |  |  | Offer Duty Type = |
|  |  |  |  |  | Offer motor efficiency % at 0.5 load = |
|  |  |  |  |  | Offer motor efficiency % at 0.75 load = |
|  |  |  |  |  | Offer motor efficiency % at full load = |
|  |  |  |  |  | Offer motor power factor at 0.5 load = |
|  |  |  |  |  | Offer motor power factor at 0.75 load = |
|  |  |  |  |  | Offer motor power factor at full load = |
|  | Operating Equipment |  |  |  |  |
| **4** | **Work by Principal** |  |  |  |  |
| **5** | **Information from Contractor** |  |  |  |  |
|   | Equivalent Circuit Values |  |  |  | Offer stator resistance ohms = |
|   | (Referred to stator) |  |  |  | Offer stator reactance ohms = |
|   |   |  |  |  | Offer motor resistance ohms = |
|   |   |  |  |  | Offer rotor reactance ohms = |
|   |   |  |  |  | Offer magnetising conductance mhos = |
|   |   |   |  |  | Offer magnetising susceptance mhos = |
|   |   |  |  |  | Offer turns ratio = |
| **6** | **Contractor’s Drawings** |  |  |  |  |
| **7** | **Standards** |  |  |  |  |
| **8** | **Quality Assurance** |  |  |  |  |
| **9** | **Power Supply to Motor** |  |  |  |  |
|  |  |  |  |  | Offer motor max. operating kV = |
|   | Power Supply to Auxiliaries |  |  |  |   |
| **10** | **Motor Type** |  |  |  |   |
| **11** | **Motor Duty and Ratings** |  |  |  | Offer rated kW = |
|   |   |  |  |  | Offer stator rated kW = |
|   |   |  |  |  | Offer stator rated volts = |
|   |   |  |  |  | Offer stator rated FLC amps = |
|   |   |  |  |  | Offer rotor rated volts = |
|   |   |  |  |  | Offer rotor rated FLC amps = |
|   |   |  |  |  | Offer stator star or delta connected? |
| **12** | **Type of Load** |  |  |  |  |
| **Type Specification for Low Voltage Slip Ring Induction Motor****Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **13** | **Synchronous Speed** |  |  |  | Offer synchronous r.p.m. = |
| **14** | **Direction of Rotation** |  |  |  |  |
| **15.** | **Cooling** |  |  |  |  |
| 15.1 | Type of Cooling |  |  |  | Offer IC Code = |
| 15.2 | Air Ducts |  |  |  | Offer outlet duct m = |
|  |  |  |  |  | Offer inlet duct m = |
| 15.3 | Heat Exchanger |  |  |  | Offer requirements: |
|  |  |  |  |  | Inlet pressure m H20 = |
|  |  |  |  |  | Flow rate l/s = |
|  |  |  |  |  | Offer material used in water circuit – attach details |
| **16** | **Enclosure** |  |  |  |  |
|  |  |  |  |  | Offer IP rating = |
| **17** | **Type of Construction (IM Code)** |  |  |  | Offer IM rating = |
|  |   |  |  |  | Offer overall weight kg = |
|  |   |  |  |  | Offer rotor weight kg = |
|  |   |  |  |  | Offer shaft diam. Mm = |
|   |   |  |  |  | Offer height to shaft centerline metres = |
|  |  |  |  |  | Offer overall height metres = |
|  |   |  |  |  | Offer overall length metres = |
|  |   |  |  |  | Offer overall width metres = |
| **18** | **Noise Level** |  |  |  | Offer noise power dBA = |
| **19** | **Vibration Level** |  |  |  | Offer vibration mm/s rms = |
| **20** | **Terminations** |  |  |  |  |
| 20.1 | Separation |  |  |  |  |
| 20.2 | Terminal Boxes |  |  |  |  |
| 20.3 | Location of Terminations |  |  |  |  |
| **21** | **Windings** |  |  |  |   |
| 21.1 | General |  |  |  |  |
| 21.2 | Insulation Class |  |  |  | Offer AS 2768 insulation class = |
| 21.3 | Insulation Temperature Rise |  |  |  | Offer Temp Rise deg. C = |
| 21.4 | Stator L.I.W.V. |  |  |  | Offer stator L.I.W.V kV = |
| 21.5 | Rotor star point connection |  |  |  |  |
| **22** | **Slip Rings and Brush Gear** |  |  |  |  |
| 22.1 | Ratings |  |  |  | Offer brush wear rate mm/1000 hrs. = |
|  |   |  |  |  | At operating load kW = |
|   | Brush lifting/ring shorting gear |  |  |  | Offer BL/RS gear rated Volts = |
|   |  (if fitted) |  |  |  | Offer BL/RS number of phases = |
| **Type Specification for Low Voltage Slip Ring Induction Motor****Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
|   |   |  |  |  | Offer BL/RS rated amps = |
|   |   |  |  |  | Offer BL/RS sequence seconds = |
| 22.2 | Slip Ring Material |  |  |  | Offer slip ring material = |
| **23** | **Bearings** |  |  |  |   |
|  |   |  |  |  | Offer roller bearing nominal life hrs. = |
|   |   |  |  |  | Offer ball bearing nominal life hrs. = |
|   |   |  |  |  | Offer roller bearing design load factor =1 |
|  |   |  |  |  | Offer ball bearing design load factor = |
|   | Type and grade of bearing lubricant |  |  |  |   |
|   |   |  |  |  | Regreasing interval running hours = |
| **24** | **Coupling** |  |  |  |   |
| **25** | **Anti-Condensation Heating** |  |  |  | Offer motor temp. rise by heaters deg. C = |
|  | Anti-condensation heaters |  |  |  | Offer heaters rated Volts = |
|   |   |  |  |  | Offer heaters rated Amps = |
| **26** | **Protection** |  |  |  |  |
| 26.1 | Winding O/Temp. Protection |  |  |  | Type O/T protection offered = |
| 26.2 | Bearings O/Temp. Protection |  |  |  |  |
| **27** | **Painting** |  |  |  | Offer paint DFT microns = |
| **28** | **Miscellaneous Requirements** |  |  |  |  |
| 28.1 | Holding Down Bolts |  |  |  |  |
| 28.2 | Jacking Screws |  |  |  |   |
| 28.3 | Earthing Terminal |  |  |  |  |
| 28.4 | Lifting Eyes |  |  |  |  |
| **29** | **Works Tests** |  |  |  |  |
| 29.1 | General |  |  |  |  |
| 29.2 | Efficiency Tests |  |  |  |  |
| 29.3 | Voltage Withstand Test |  |  |  |  |
| 29.4 | Other Performance Tests |  |  |  | *(Details of proposal to be attached)* |
| 29.5 | Routine Check Tests |  |  |  | *(Details of proposal to be attached)* |
|   | Type Tests |  |  |  | Available for motor offered, yes or no? |
| **30** | **Delivery and Installation** |  |  |  |   |
| **31** | **On Site Testing** |  |  |  |   |
| **32** | **As Constructed Information** |  |  |  |   |
| **33** | **Manuals** |  |  |  |  |
| **34** | **Liquidated Damages for Low Efficiency** |  |  |  |  |

END OF DOCUMENT