Technical Specification - High Voltage Motors

Table of Contents

Revision details

Version No.	Clause	Description of revision
1.0	All	General revision
2.0	All	Format update, changing ‘shall’, ‘should’ and ‘may’ to must where relevant to Sydney Water, ‘approved’ replaced with ‘accepted’, minor editorial changes elsewhere.

Introduction

This Specification is for the design, supply and installation of High Voltage Motors for Sydney Water assets.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification must be sufficient to ensure safe systems or work or operation.

It is the user’s sole responsibility to ensure that the copy of the Specification is the current version as in use by Sydney Water.

Sydney Water accepts no liability whatsoever in relation to the use of this Specification by any party, and Sydney Water excludes any liability which arises in any manner by the use of this Specification.

For the purpose of this Specification “Sydney Water” is the nominated person or organisation that has written authority to act on Sydney Water’s behalf.

This document is uncontrolled once printed or downloaded.

Copyright

Acronyms

Term	Definition
AC (ac)	Alternating current
AI	Analogue input
ANSI	American National Standards Institute
AO	Analogue output
AS	Australian Standard
AUD	Australian Dollars
CB	Circuit breaker
CT	Current transformer
c/w	Complete with
DC (dc)	Direct current
DI	Digital input
DO	Digital output
ELV	Extra Low Voltage (i.e. ≤ 50 V AC or ≤ 120 V DC)
EN	European normalised standard
GA	General Arrangement (drawing)
HV	High Voltage (i.e. > 1000 V AC or > 1500 V DC)
IEC	International electrotechnical commission
IEEE	Institute of Electrical & Electronic Engineers
I/O	Inputs/outputs
ISO	International standards organisation
ITP	Inspection and Test Plan
LV	Low Voltage (i.e. Greater than ELV but ≤ 1000 V AC or ≤ 1500 V DC)
MSDS	Material safety data sheet
MV	Medium Voltage (note this term is not used in this specification)
PF	Power factor
PTFE	Polytetrafluoroethylene
pu	Per unit
RTD	Resistive Temperature Device
SAA	Standards Association of Australia
Sec.	Second
SLD	Single line diagram
TBA	To be advised
TBC	To be confirmed
TEFC	Totally enclosed fan cooled

Term	Definition
TEWC	Totally enclosed water cooled
VSD	Variable speed drive

1. General

1.1 Introduction

This specification defines the minimum technical requirements for the design, manufacture, supply and delivery of High Voltage (HV) Motors.

1.2 Scope

This specification does not apply to the installation, commissioning or performance testing of the equipment.

1.3 Proprietary items

Nomination of a proprietary item by Sydney Water does not imply preference or exclusivity for the item identified.

Alternatives that are equivalent to the nominated items can be submitted to Sydney Water for acceptance. The submission must include appropriate technical information, samples, calculations and the reasons for the proposed substitution, as appropriate.

2. Technical requirements

2.1 Environmental requirements

The HV Motor must be designed to suit the following environmental conditions

Environmental conditions		
Maximum ambient temperature		+45 ºC
Maximum 24h average temperature		+35 ºC
Minimum ambient temperature (corresponds to “minus 5ºC indoor class”)		-5 ºC
Maximum relative humidity	For one month	90%
	For 24 hours	95%

2.2 Key ratings and features

The key ratings and features of the HV motor must be as follows:

Ref	Rating or feature	Requirement
1	Motor Type	TEFC / TEWC Squirrel Cage Induction motor
2	Insulation Class, Temperature Rise Class	F, B
3	AC Frequency	50Hz
4	Class	IP55
5	Speed	1500rpm maximum (4 Poles minimum)
6	Efficiency	Above 95% (IE2, IE3)
7	Mounting arrangement	Flange mount (unless specified otherwise)
8	HV Terminal Box Location	Side mount (preferred)
9	HV Cable entry	Main Terminal Box (IP66)
10	LV and ELV cable entry	Separate Terminal Box (IP66)
11	Gland Plate	6mm aluminium (undrilled)
12	Resistive Temperature Devices (RTD)	2 embedded in each winding, 1 on each bearing.
13	Anti-condensation heaters	Required 240 V AC
14	Real time Vibration Monitoring	Required in motors above 600 kW

2.3 Standardisation

Equipment must be designed with standard parts and components readily available within Australia. Parts and components must be standardised as much as possible. All replaceable and consumable equipment must be standard supply equipment. The use of “one off” special designs is not permitted.

3. Technical requirements - construction

3.1 Surface preparation and painting

Surface preparation and paint systems must be selected to give a life of not less than 15 years to first maintenance.

All Metal finishing, the preparation, pre-treatment of surfaces and painting must be carried out strictly in accordance with Sydney Water Standard specification WSA201 - Manual for selection and Application of Protective Coatings and WSA201 - Sydney Water Supplement and PCS100 - Protective coating standard to provide adequate protection against the adverse effects of the site conditions specified in the design specifications.

Preferred paint colours	
Motors - non immersed	T45 (Cootamundra)

3.2 High voltage cable termination

The motor terminals must be designed for HV cable termination using either bolted air insulated connections or plug and socket connection.

The high voltage cable terminations, including all necessary accessories, must withstand the voltage impulse test applied to the motor.

The high voltage cable terminations must be designed to ensure thermal, mechanical, electrical and dielectric compatibility with the motor.

Cable termination facilities must be suitable for use with termination kits readily available within Australia.

Cable entries for single core cables must be designed to minimise the possibility of eddy current heating.

Motor terminal boxes must have the capability of rotating to suit installation requirements.

3.3 Earthing & earth connections

The frame of the motor must be provided with reliable earth connections to a common connection point. An earthing stud must be fitted to the frame of each motor additional to a stud in the motor control box.

3.4 Lifting lugs

Lifting lugs capable of supporting the motor weight must be provided on all motors.

4. Technical requirements - HV motors

4.1 General

a) The power factor of the motor at full load must be not less than 0.85

b) Motor Efficiency at full load must be no less than 0.95

c) The continuous rated output of each motor must be at least 15% in excess of the maximum power required by the driven unit under all specified operating conditions.

d) The maximum speed of any motor and pump combination must be 1500 rpm

e) Motors connected to a variable speed drive (VSD) must be manufactured for frequency converter use.

4.2 Bearings and Lubrication

The bearings must be of modern design, of rolling or plain (anti-friction) type and ample capacity for carrying all thrust and radial loads. All bearings must be readily available metric sizes, lubricated efficiently and capable of long service without maintenance.

All bearings must be temperature monitored.

All rolling bearings must be of ball or roller type, rated in accordance with AS 2729 for a minimum basic rating life (L_{10}) of 10,000 million revolutions. Bearings with non-metallic cages must not be used.

Plain bearings must have steel shafts running in bronze or self-lubricating graphite impregnated bushes and must have a loading, based on projected area, of not more than 300 kPa. Materials other than steel and bronze are subject to Sydney Water acceptance.

All bearings must be to ISO standard design dimensions and must be readily available ex-stock from commercial bearing suppliers.

Sealed Bearings (Self Lubricating)

Bearings must be fully sealed and must be polytetrafluoroethylene (PTFE) lined composite dry bearing material.

Lubricated Bearings

All bearing housings must be fitted with seals and must be grease or oil lubricated. Grease nipples with captive screw caps must be provided for all grease lubricated bearings and where practicable, capillary tubing must be run from the bearings and grouped at a convenient accessible location. Where grease lines are fitted they must not be attached to removable parts. It must be possible to grease the bearings with the machine running without danger to the operator or damage to the seals. Bearing housings must be fitted with pressure relief devices to prevent over pressure.

Oil lubricated bearings must incorporate the following:

An integral oil circulation system. The design of the circulation system and venting arrangement must not allow escape of oil from the bearing.

a) A large capacity adjustable constant level oil make up system

b) An oil level indicator

c) A permanent marking of normal oil level on the bearing housing adjacent to the oil level indicator

d) They should, preferably, be suitable for both mineral and synthetic lubricants.

Bearings must be adequately cooled to accommodate operation of the equipment in an ambient temperature situation of up to 45 ºC under most extreme loading conditions without reduction in calculated load rating or rating life. This must be achieved without special or additional cooling arrangements, such as water cooled heat exchangers or similar.

The Contractor must furnish all bearings with the correct lubricants for at least one year's operation. The bearings must also be adequately lubricated to prevent corrosion during storage and installation and for starting and commissioning the plant. Lubricants must be as recommended by the relevant equipment manufacturer.

Plates indicating the type of oil or grease, quantity and change period must be fixed to the equipment items adjacent to the oil or grease lubrication points. Plates must be engraved stainless steel grade 316, fastened with stainless steel fixings.

All bearings must be capable of maintaining their seal without degradation or decrease of seal capability, e.g. loss of seal element effectiveness due to higher than rated peripheral speed or due to axial shaft float. Neoprene “V” type grease and dirt seals must be provided. Seals must protect against ingress of water and foreign matter and from egress of lubricant. Where locking collars are required to maintain seal element tension these must be of grade 431 stainless steel. Locking screws must be 'Loctited' at final adjustment.

To avoid damage to bearings (work hardening or 'brinelling') due to vibration during transportation, bearings must be packed separately or other suitable precautions taken to protect them.

All electric motor bearings must be self-lubricating ball or roller types of standard design. Grease lubrication is preferred. A roller bearing must be fitted at the driving end. A self-aligning thrust race must be fitted, or alternatively a dual purpose race may be used. This bearing assembly must be retained on the motor shaft by a suitable locking device. The bearing must be so constructed as to prevent a longitudinal displacement of the rotor in either direction due to external forces.

Motor bearings must be insulated in a manner to prevent circulating currents from passing through the bearing surfaces. At locations where the bearings are insulated from the frame precautions must be taken to ensure that any insulation is not short-circuited during motor assembly. The driving end bearing must be earthed via a removable copper shunt.

All bearings of machines larger than 600 kW must be fitted with accelerometers. Thrust and locating bearings require monitoring in all three planes, while for other bearings the accelerometers must cover the two radial planes. The accelerometers must be used for continuous on-line vibration monitoring, warning and shut down when vibrations exceeds pre-set maximum levels. The collected data must be sent to the Sydney Water Corporate Condition Monitoring Database for monthly analysis and reporting.

Furthermore, all bearings of machines larger than 600 kW must be fitted with RTD temperature sensors wired to monitoring, warning and shut down protection system. Temperature detectors must be 3-wire, 100-ohm resistance type PT100. All three wires from each temperature sensor must be wired back to the associated auxiliary terminal box.

Motors intended for VSD use must have an insulated bearing on the non-drive end and a shaft brush on the drive end to reduce bearing damage due to shaft currents.

4.3 Vibration

General

Sydney Water employs a mixture of portable hand-held and on-line permanently mounted condition monitoring equipment. Data collected from these tests is loaded into the Sydney Water Corporate Condition Monitoring Database (Rockwell-Entek Odyssey Software). Generally, hand-held condition monitoring is only carried out on equipment above 25 kW unless an asset is of critical importance to the production process. Equipment over 600 kW requires on-line permanently mounted condition monitoring equipment, such as the Rockwell-Entek Enwatch or XM products, which is able to download readings directly to the Sydney Water database.

For accurate readings to be taken by a hand held probe a direct metal path between the bearings and the outside surfaces of the machine is required. This monitoring point must be accessible for a variety of hand held accelerometer types to be attached while the machine is operating under normal operating conditions. Examples of accelerometer types used within Sydney Water include Magnetic, Probes and Quick Connect.

Where a direct metal path accessible to the probe does not exist, a solid metal stud must be securely fitted to the metal in contact with the bearing. This pick-up mounting must be min. 8 mm diameter and be long enough to allow measurements to be taken by the conditioning equipment. Where clearance holes are required they must be at least 2 mm greater than the stud diameter. If sealing of the hole is necessary, an elastic damping material such as soft rubber must be used. Where it is not feasible to use this method the Contractor must propose an alternative method for Sydney Water acceptance.

Where equipment is to be inaccessible, caged/guarded or enclosed within an acoustic cover, hardwired accelerometers must be mounted on the equipment (in a suitable position as described above) with cabling run to a termination panel mounted on the cover or in safely accessible position. A label must be fitted to motor indicating where the measurements must be taken.

Vibration Severity

Vibration levels of industrial machines must be evaluated in accordance with AS 2625.4. As a minimum, under steady state operating condition at any speed within the machine operating range the vibration level must not exceed the zone boundary A/B vibration rms velocity.

If peak rather than rms value of vibrations is measured, equivalent max. Vibration levels must be determined by the Contractor in accordance with Annex A of AS 2625.4.

All rotating equipment including fans and motors, must be statically and dynamically balanced and installed on bases designed to accommodate vibration isolators.

Wherever possible the Contractor must choose larger, lower-speed pumps. The maximum pump and motor speed must not exceed 1500 rpm.

4.4 Anti-condensation heaters

Anti-condensation heaters must be included in all HV motors.

The auxiliary supply voltage for anti-condensation heaters must be 240 V AC ± 10%.

4.5 Thermal protection

All HV motors will incorporate thermal protection. Two RTDs must be embedded into each winding. Two additional RTDs must monitor the drive end (DE) and the Non Drive End (NDE) bearing. RTDs must be wired to individual DIN rail-mounted protection relays with a digital display showing the instantaneous temperature. These relays must be wired to provide a common alarm output for motor over temperature.

4.6 Motor cooling

All motors must be totally enclosed fan cooled (TEFC) or totally enclosed water cooled (TEWC) unless otherwise stated.

4.7 Hazardous areas

All motors located in a hazardous area must be certified equipment and comply with the installation requirements of AS 60079 and AS 61241.

5. Identification and labelling

All electrical equipment forming part of the HV Motor must be readily identified in the English language by a label in accordance with the relevant standard and this Specification.

All labelling and nameplates must be in accordance with nomenclature used on the relevant electrical Drawings and Schedules provided by Sydney Water.

All labels must be permanent, free from fading, engraved/etched stainless steel secured with stainless steel screws into tapped holes. Departures from these requirements must require the written pre-approval of Sydney Water.

All external and internal labels must be attached to the mounting surface with a minimum of two screws with holes drilled and tapped. Double sided adhesive tape is not acceptable.

All equipment labels must be mounted on a fixed portion of the enclosure directly adjacent to the device.

Terminal block group labels must be manufactured of the material and mounted in accordance with the standard procedures adopted by the terminal strip manufacturer. Terminals must not be made of brittle material.

Generally, labels must be manufactured to the following specification:

Label function and location	Typical label size (mm)	Text colour / Background colour	Label description	Text height (mm)
Motor Rating Plate - Mounted on bracket attached to motor		Black / Stainless Steel		
Motor Main Label - Mounted so visible from front of motor	400L x 250H	Black / Stainless Steel	Motor Number Voltage rating Motor kW Rating	80 50 50
Vibration test point label - Mounted adjacent to vibration test point	80L x 50H	Black / Stainless Steel	Vibration test point	15
Grease point label - Mounted adjacent to grease point	80L x 50H	Black / Stainless Steel	Grease point	15
Terminal box voltage Label - Mounted on front of Terminal box cover	200L x 50H	Black / Stainless Steel	Voltage rating	40
Marshalling box label - Mounted on front door/cover of marshalling box	100L x 50H	Black / Stainless Steel	Marshalling Box	20
All removable cover labels that provide access to high voltage equipment - Mounted on all covers that provide access to HV		White / Red / Black	DANGER HIGH VOLTAGE (to AS 1319)	

6. Spare parts

6.1 Routine maintenance spare parts and/or tools (for defects liability period)

Provide replacement spare parts and/or tools for the commissioning period and up to end of the defects liability period.

All routine maintenance spares must be provided in advance and held in storage at site.

6.2 Long-term maintenance / strategic spare parts and special tools

Provide a priced list of optional recommended spare parts for long-term maintenance activities and strategic planning, as well as any special tools required to perform long-term maintenance activities.

Sydney Water will confirm if it wishes to purchase some (or all) of these recommended spare parts and tools.

7. Manuals and drawings

Two paper copies of erection, maintenance and operating manuals must be supplied.

One electronic copy of all manuals, drawings and test results must be provided on suitable electronic media in PDF file format as a minimum.

Equipment manuals provided must contain details of all aspects of the operation and maintenance of the supplied equipment, a detailed parts list of all major components and copies of all factory test results.

Electrical circuit diagrams must be supplied either with the manuals or as separate A3 size drawings. All drawings must be supplied electronically in an AUTOCAD compatible format.

Equipment manuals and drawings must not contain descriptions or details of alternative equipment not specifically used in the supplied equipment.

Maintenance manuals and regimes must be specific for each site installation, in particular with respect to the maintenance timeframes required for the environmental conditions of the specific site.

8. Reference documents

The HV Motors and all associated equipment and materials must be designed, manufactured and tested in accordance with the latest revisions of the Federal and State statutory requirements, applicable Australian and IEC Standards, as well as the Sydney Water standard specifications.

Document type	Title
Legislation	Work Health and Safety Act 2011 Service and Installation Rules of New South Wales 2006
Policies and procedures	WSA201 - Manual for Selection and application of protective coatings Supplement to WSA201 - Manual for Selection and application of protective coatings. PCS100 - Protective Coatings Sydney Water Corporation Emergency Stop Policy
Other documents	Click to add details of HIDRA and other relevant documents
Standards	AS ISO 1000: The International System of Units (SI) and its application (ISO 1000) AS 1033 (IEC 60282.2): High voltage fuses (for rated voltages exceeding 1000V) (Parts 1 and 2) AS 1170: Minimum design loads on structures (known as the SAA Loading Code). (Parts 2 and 4) AS 1307 (IEC 60099): Surge arresters (diverters) AS 1627: Metal finishing - Preparation and pre-treatment of surfaces AS 1824 (IEC 60071): Insulation coordination (phase-to-earth and phase-to-phase, above 1 kV) (Parts 1 and 2) AS 1931 (IEC 60060): High voltage testing techniques (Parts 1 and 2) AS 2067: Switchgear assemblies and ancillary equipment for alternating voltages above 1 kV AS 2700: Colour standards for general purposes AS/NZS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules) AS/NZS 3008.1.1: Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical Australian installation conditions AS 60038: Standard voltages AS 60044.1 (IEC 60044-1): Instrument transformer – Current transformers AS 60044.2: Instrument transformers – Inductive voltage transformers AS 60079 (IEC 60079): Electrical Apparatus for Explosive Gas Atmospheres ÁS 60137 (IEC 60137): Bushings for alternating voltages above 1000 V AS 60470 (IEC 60470): High-voltage alternating current contactors and contactor-based motor-starters AS 60529 (IEC 60529): Degrees of protection provided by enclosures (IP Code) AS 61241 (IEC 61241): Electrical Apparatus for Explosive Dust Atmospheres AS 62271.1 (IEC 62271-1): High-voltage switchgear and controlgear - Common specifications

Document type	Title
	AS 60470: High-voltage alternating current contactors and contactor-based motor-starters IEC 60034 series: Rotating electrical machines IEC 60072-1: Dimensions and output series for rotating electrical machines IEC 60073: Basic and Safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators.

8.1 Conflicts between Specification, Standards and/or Codes

Review the above standards and make use of them where they are applicable. Identify any conflicts between the above standards and recommend which criteria to use. The Contractor must refer and conflicts in the information to Sydney Water for clarification.

Ownership

Ownership

Role	Title
Group	Integrated Systems Planning - Liveable City Solutions
Owner	Manager of Urban Design and Engineering
Author	Lead Engineer Electrical

Change history

Version No.	Prepared by	Date	Approved by	Issue date
1	Robert Lau / Andrew Manganas / Paul Zhou	5/12/2014	Norbert Schaeper	05/12/2014
2	Paul Zhou	20/02/2020	Steve-Keevil Jones	20/02/2020