Technical Specification - HV Motor Starters

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Revision details

Version No.	Clause	Description of revision
1.0	All	General revision
1.1	Various	Document reformatted. Title changed. Foreword and Copyright added. A general update on the following areas across the entire document including: Changing ‘shall’, ‘should’ and ‘may’ to ‘must’ where relevant to Sydney Water. “Approved’ replaced with ‘accepted’. Updating document to reflect Sydney Water style guide Minor editorial changes elsewhere.

Introduction

This Specification is for the design, supply and installation of HV Motor Starters for Sydney Water assets.

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Acronyms

Term	Definition
AC (ac)	Alternating Current
AI	Analogue Input
AIS	Air Insulated Switchgear
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

Term	Definition
DI	Digital Input
DO	Digital Output
ELV	Extra Low Voltage (i.e. ≤50 V AC or ≤120 V DC)
EN	European Normalised Standard
ESW	Earth Switch
FVC	Fused Vacuum Contactor
GA	General Arrangement (drawing)
GIS	Gas Insulated Switchgear
HMI	Human Machine Interface
HRC	High Rupture Capacity
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
LED	Light Emitting Diode
LV	Low Voltage (i.e. greater than ELV but ≤1000 V AC or ≤1500 V DC)
MCB	Miniature Circuit Breaker
MSDS	Material Safety Data Sheet
MV	Medium Voltage (note this term is not used in this specification)
PF	Power Factor
PIV	Peak inverse voltage
PCC	Point of common coupling
pu	per unit
RFI	Radio Frequency Interference
RMU	Ring Main Unit
SAA	Standards Association of Australia
SCR	Silicon Controlled Rectifiers
SF_6	Sulphur Hexafluoride
Sec.	second
SLD	Single Line Diagram
TBA	To Be Advised
TBC	To Be Confirmed
TCS	Trip Circuit Supervision
THD	Total harmonic distortion

Term	Definition
VC	Vacuum Contactor
VCB	Vacuum Circuit Breaker

1. General

1.1 Introduction

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

1.2 Scope

This specification does not apply to the installation / erection, 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 - general

2.1 Environmental requirements

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

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

The HV Motor Starter Panels must be suitable for installation and service up to an elevation of 1000 m above sea level.

2.2 VSD Key ratings and features

The variable speed drive units must incorporate the following features and design functions:

a) Matched to suit the three phase ac squirrel cage induction motor and load torque requirement of the driven unit in the whole speed operating range

b) Capable of operating continuously as their nominated full rating with expected variations of ±10% in supply voltage and ±2% in supply frequency

c) Capable of withstanding 110% of full current for 60 seconds

d) Capable of allowing 110% of starting torque for quadratic torque drives. Where required constant torque drives (mono pumps, etc) the starting must be capable of supplying up to 160% starting torque.

e) Required to operate at speeds as low as 20% of full speed whilst providing the necessary load torque at these speeds without cogging, overheating or otherwise damaging the motor

f) Capable of setting up three different ramp rates for acceleration and deceleration. Ramp rate selection must be programmable within the VSD and speed dependent. The use of an external tachometer is not acceptable.

g) Manufactured in accordance with ISO 9001 standards and C tick approved

h) Have a fundamental power factor of at least 0.95 and a total power factor of at least 0.9 at full load

i) Have an efficiency of 0.96 at rated power

j) Have output filters that limit the peak voltage and rate of voltage rise to comply with AS 60034-17

k) Output current waveforms must be sinusoidal and as such no motor de-rating must be applied when operated at rated speed and load

l) Acceleration and deceleration time must be fully adjustable

m) Automatic slip adjustment of output frequency and voltage speed for regulation from 0 to 100%

n) Digital and relay outputs for alarm and status signals

o) Protection for current and voltage faults and motor thermal overload

- Failure to connect a motor to the VSD output

- VSD output open circuit that may occur during operation
- Single phase fault or three-phase short circuit on VSD output terminals
- Failure to commutate inverter thyristor due to severe overload or other conditions
- Loss of input power due to opening of VSD input disconnect device or mains power failure during VSD operation
- Loss of one phase of input power during operation
- Motor regeneration due to “turbining” or loss of VSD input power
- Motor overload protected by modelling the operating characteristics of the motor
- Motor overload protection by accepting inputs from thermistors embedded in the motor windings
- With electronic shear pin capability for process drive that requires shear pin protection.

a) Digital inputs to select two programmable pre-selected speeds

b) Alarm, trip signals and display signals for:

- Under voltage
- Over voltage
- Over current
- Under current
- VSD over temperature
- Motor over temperature
- Motor fault - short circuit and earth.

The communication protocol capabilities must be according to Treatment Plant SCADA standards and associated standard templates, drawings and schematic diagrams.

2.3 Soft starters key ratings and features

Soft Starters must be used for acceleration and deceleration of motors. Soft starter must incorporate a bypass operation after start-up. The bypass operation must be achieved without affecting the monitoring and protection functions of the soft starter.

The starters must comprise of:

a) A three phase switch disconnector to provide the isolation

b) A three phase vacuum contactor Category AC-4 to provide for switching/bypass

c) Enclosed fuses to protect the semi-conductor module - one per phase

d) A semiconductor module to accelerate and decelerate the motor. The module must include internal control and self-protection.

e) Electronic relays of thermal overload relay to protect the motor

f) The semiconductor module must be of closed loop type and must have six silicon controlled rectifiers (SCR) in a full wave bridge power circuit

g) The SCRs must have a minimum peak inverse voltage (PIV) of 1200 V. The SCRs must have a rated starting duty of six times full load current starts for 30 seconds.

h) The starter must have an adjustable start up torque setting and adjustable voltage ramps for acceleration and deceleration. The acceleration and deceleration voltage ramps must be adjustable independent of each other.

i) The initial start-up torque setting must have an adjustable minimum range of 20-100%

j) The acceleration voltage ramp must have a minimum range of 5-30 seconds and the deceleration voltage ramp must have a minimum range of 5-60 seconds

k) During a controlled run down deceleration, the motor current must be limited to a value below that of the starting current

l) The starter must be suitable for three phase induction motors

m) The starter must withstand external electrical influences both current and voltage transients

n) The starter must be rated for minimum six starts per hour.

2.4 Other requirements

EMC

The contractor must ensure that the VSDs do not interfere with the communications and instrumentation signals. Electromagnetic interference emitted by the equipment must be within the limits stipulated by the Australian standards or relevant electricity distributor. Full installation instructions for the equipment, referring in particular to electromagnetic interference reducing practices must be provided in clear English text. Noise suppression filters if required to meet EMC standards, must be supplied. Screened power cables must be used for VSDs.

EMC filters must be provided on each VSD to meet the Australian Standards / Electricity distributor and conform to the limits specified in the first environment restricted distribution tested to minimum 100 metres screened motor cable.

HARMONICS

Where VSDs are used on site, the Contractor must perform a harmonics distortion measurement up to the 50^{th} harmonic on the site power supply at the point of common coupling (PCC) within six weeks of the commencement of the concept design. The result of the measurement must be included in the concept design report. On completion of the works the contractor should perform the same tests with the maximum number of VSD's running. These results should be submitted to Sydney Water two weeks after completion. The report must contain all measurements, supporting calculations, diagrams and information. The contractor must obtain prior agreement with Sydney Water on the conditions for determining the total harmonic distortion (THD) prior to undertaking the measurements including:

a) Duration of the measurement period (minimum of seven days)

b) Time of day of the measurement period

c) Measurement of baseline harmonic levels (without VSDs in operation)

d) Measurement of harmonic levels must be taken with the maximum number of VSDs in operation

e) Positioning of measuring equipment

f) Type of measurement equipment

g) Format of the report of the results.

The Contractor must be responsible for the design, supply and installation of harmonic filter(s) required to bring the level of harmonic distortions to within levels as required by Australian standards and to meet the electricity distributor's requirements.

The contractor must design the new VSDs to comply with the limitations on harmonic contribution as required by Australian standards and to meet the electricity distributor's requirements.

In selecting the drive technology and harmonic mitigation options, the contractor must ensure that the total harmonic distortion in voltage contributed by the VSDs at the point of reference for the plant is limited to an acceptable maximum value of the fundamental. The contractor must liaise with the electricity distributor to determine the acceptable maximum value.

In addition, the Contractor must also provide a VSD solution that will have a 5th Harmonic current component which will allow Sydney Water to meet the 5th harmonic current allocation of an acceptable maximum value (amps) for the whole site as specified by the electricity distributor.

Unless otherwise specified, the point of reference for all harmonics calculations and field measurements for both voltage and current distortion must be taken to be the busbars of the main HV switchboard.

The contractor must be responsible for providing all harmonic mitigation measures including any additional harmonic filtering equipment to meet the specified harmonic distortion and allocation limits specified herein.

Radio Frequency Interference (RFI)

It must be ensured that operation of the starter must not produce the following.

a) RFI back to the main supply network

b) RFI which is radiated into the atmosphere

c) RFI which may affect any of the devices in the starter.

Semiconductor Module Protection

The following minimum protection features are to be built into the electronic circuitry of the semiconductor module:

a) Phase loss

b) Incorrect phase sequence

c) Phase imbalance

d) Thermal protection on SCR heat sink

e) SCR protection against short circuits using fast acting HRC fuse protection for SCR

f) A metal oxide varistor and capacitor protective unit must be provided to absorb voltage surges from the supply network

g) Overload

h) Under voltage.

When any of the above protection items operate, a common fault light must be maintained, the motor must be disconnected from the supply voltage and remain locked out of service until manually reset.

However, should the thermal protection on the SCR heat sink operate, a separate fault light must be activated and the motor must then be allowed to automatically restart providing the external control circuit requires that to occur. This fault must bring up a general fault light on the starter panel.

Appropriate wording of fault indication lights and reset labels must be provided.

Starter Control Cubicle

The control cubicle must be suitable for use on a 48 V DC control system, unless otherwise specified.

The cubicle must be constructed to comply with AS 3439.1 and must be of the indoor, free standing enclosed metal clad type, suitable for housing of control and communication equipment.

The degree of protection must be IP 52 to AS 1939. All cubicles must be dust and vermin proof, including the bottom and cable entries.

The segregation for the control cubicle must be form 1. Control and communications equipment and cabling within the control panel must be segregated from the power equipment.

An LED light automatically operated by a door switch must be provided in each panel.

All panels must be constructed from 2 mm (minimum) CRCQ mild steel with adequate supports to withstand mechanical stresses during transport and installation and at times of electrical faults. If there are any welds they must be continuous. Tacks welds will not be accepted.

NB: Indoors refers to inside a pressurised switchroom. All other environments are to be treated as outdoors.

2.5 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 General

The motor starter enclosures must comply with IEC 62271.106 and AS 60470.

The motor starter panels must have front access and be of the same height to provide a uniform profile along the switchboard.

Separate compartments must be provided within each panel of the switchboard for:

a) LV Control section

b) HV Cable termination zone.

The floor of the Switchroom is not considered to be part of the enclosure. The bottom of the panel must be closed off, sealed, dust and vermin proof.

A separate LV compartment for LV/ELV control, monitoring, protection and indication is to form part of each panel located above the relevant HV panel with access for ELV/LV wiring.

Each HV functional unit must be installed in a separate panel. All equipment associated with an individual functional unit must be accommodated in the respective panel.

Only cables associated with a functional unit may enter the cable termination chamber of that functional unit. Under no circumstances must cables from other functional units pass through the cable termination chamber of another functional unit.

3.2 Sheet metal work

The motor starter must be fabricated such that the framework is sufficiently rigid and stable to withstand all normal operating, handling and shipping forces without deformation, misalignment or damage. Removable sections of the enclosure must not be used to obtain such rigidity. Rivets must not be used in the assembly of steel sections.

Where applicable equipment rolling or wheel mechanisms must be such that the withdrawable part can be re-inserted smoothly and gently.

All steel panelling must be of folded construction, utilising 2 mm (minimum) zinc annealed sheet steel.

Adequate lifting facilities must be provided on each major shipping section.

The enclosure design must incorporate the following features.

3.3 Compartment doors

All compartment doors must be suitably designed and braced to prevent sagging or drumming taking into account the weight all the instruments and equipment mounted on them. All panel seams and joins must be continuously welded.

All compartment doors must be fitted with hinges that swing through 120 degrees and be fitted with a latching mechanism to prevent the door from self-closing.

All compartment doors must have earth studs welded on the back of the doors and be equipotentially bonded to the switchboard frame with minimum 4 mm^2 earth conductors.

All compartment doors must have a continuous neoprene seal around the perimeter in order to achieve the required IP classification (the seal must be glued or fixed to the door). Instruments and electrical equipment mounted through panels must be sealed to conform to the specified IP classification.

All full height cubicle doors must be provided with a three point latching system.

All compartment doors must be accessible via the front of the panel and must be fitted with door handles that have padlocking facilities.

3.4 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 Section **Error! Reference source not found.**.

Preferred paint colours	
Electrical Cabinets (Indoor)	RAL7035 (Light Grey) for external surfaces N14 (White) for internal surfaces

3.5 Fixings

All metal handles, hinges, screws and nuts must be of manufacturer's standard finish and suitably protected against corrosion.

Externally fitted fixings must be hot dipped galvanised.

Cadmium plated fixings must not be used.

All current carrying connections must be with conical washers. Bolt length is to be selected so that approximately two threads protrude on final installation.

All equipment located on equipment mounting plates must be fixed via drilled and tapped holes in the mounting plates.

3.6 High voltage cable termination

The enclosure must be designed for high voltage 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 switchboard.

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

The enclosure design must make provision for the installation of fire stopping material to provide a two hour fire rating between the switchboard and the cable basement or subfloor of the switchroom.

Adequate space must be provided within each cable termination compartment for entry, dressing and termination of cables, including sufficient space for safe access by technicians for initial cable termination and subsequent testing and inspection.

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

Cable connection points must be located directly above the corresponding cable entries.

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

All HV cables must be bottom entry through earthed, removable gland plates. Adequate support must be provided for cables, terminals must not be used to support cables.

3.7 Low voltage cable termination

All LV cables must be bottom entry through earthed, removable gland plates. The LV gland plates must be suitable for the fitting of cable glands for the nominated cable types.

Where LV cables do not enter directly into the bottom of the LV equipment compartment, a separate LV cable box must be provided with terminals for termination of the cables or they must be easily routed through full length metal ducting from the cable entry point to LV compartment to ensure complete separation from other compartments.

3.8 Busbars

Busbars must be housed in a separate compartment, and must be sized in accordance with the relevant type test certificate.

Busbars and busbar connections must be capable of carrying rated normal current, rated short-time withstand current and rated peak withstand current compatible with the highest rating of the circuit breaker which form an integral part of the switchboard without:

a) Causing mechanical damage to any part

b) Causing flashover between phases or phase to earth

c) Exceeding a temperature rise which when added to the maximum temperature obtained when carrying the rated normal current continuously is likely to damage the insulation.

All busbars must be rectangular (with radius edges) or circular sections of hard drawn high conductivity electrolytic copper. Single bolt busbar connections will not be acceptable.

All air insulated busbar must be electro-tinned plated.

Busbar connection colour coding		
Supply	L1 L2 L3	Red White Blue
Apparatus	Phase 1 Phase 2 Phase 3	Red White Blue
Neutral	N	Black
Earth	E	Green / Yellow

Busbar layout must not impede the removal and replacement of other equipment in the cubicle.

3.9 Earthing & earth bars

The frame of the enclosure must be provided with reliable earth connections to a common connection point permanently and indelibly marked in accordance with AS 62271.1.

The earth connections must have a rating suitable for the maximum earth fault current and earth fault duration, with minimum physical dimension of 30 mm x 10 mm.

The earth bar must consist of one tinned copper bar extending the full length of the enclosure. Pre-drilled holes and fasteners for terminating screens must be provided for all incoming power cables.

Earthing switches must be provided as detailed in Section 4.4 - Earthing Switches.

3.10 Interlocking

Mechanical key interlocking must be provided between the upstream supply switch and motor stater panel so that only when the upstream supply switch is opened can the motor stater enclosure be earthed and access to the enclosure cabinet be allowed.

4. Technical requirements - motor starters

4.1 General

Fused vacuum contactors must be used for:

a) Direct on-line motor starting circuits

b) Soft starter circuits

The switching device must open simultaneously 3-poles of a 3-phase, 50 Hz circuit with rated voltage between phases equal to the nominated system voltage. The temperature rise of switching devices of any voltage must be subject to the limitation of Table 3 of AS/NZS 2650. Temperature rises must be maintained within the specified limits with the switching device mounted within the switchboard enclosure.

The breaking current rating must be as specified in AS/NSZ 60265.1 and AS 2024 as appropriate. The prospective symmetrical fault levels applicable must be calculated by the Contractor. The switching device must withstand the forces due to maximum fault.

4.2 Fused vacuum contactors (FVCs)

High Voltage Fused Vacuum Contactors must be designed in accordance with AS60470-2001.

Vacuum contactors must have minimum utilization category AC4 and duty of 12 operating cycles per hour, Class12.

Control supply for Fused Vacuum contactor units must be a single mounted VT supply of adequate rating for unit.

The rating selected for a contactor must be on the basis of uninterrupted duty. Rating selection on the basis of intermittent or 8-hour duty is not acceptable. Contactors must be capable of making and carrying for a specified time at least 10 times rated current and must be capable of breaking at least eight times rated current.

All FVC’s must be of withdrawable construction.

It must be possible for the withdrawable FVC to be racked into and out of the service, disconnect and test position both remotely by electrically operation locally by mechanical and electrical operation. All racking operations of the withdrawable FVC must be possible with the compartment door securely closed and mechanical interlocked to prevent inadvertent operation. Electrical and mechanical position indication of the withdrawable CB must be provided.

All withdrawable FVC trucks must be earthed via spring-loaded sliding connection or a plug and socket connection such that the earth connection makes before and breaks after the main circuit connections.

All FVC trucks must be earthed via spring-loaded sliding connection or a plug and socket connection such that the earth connection makes before and breaks after the main circuit connections.

Closing

Vacuum contactors must be electromagnetic operation and must be electrically held unless otherwise specified in site specific specification.

Tripping

Tripping must open the contactor when supply to the holding coil is interrupted.

Striker Pin Operation

Where HV fuses are used in conjunction with vacuum contactors, the fuses must incorporate striker pins. When activated, the striker pin must operate a latching switch with minimum 2 N/C and 2 N/O contacts. The N/O contact will trip the contactor if direct mechanical operation is not possible. The other N/O contact and one N/C contact will be used for remote indication purposes.

4.3 Disconnector switches

Disconnectors must be designed in accordance with AS62271.102.

Disconnector switch mechanisms must be stable and not operate due to vibrations or impact.

Disconnector switch mechanisms must be designed to prevent "slow open" or "slow close" while in normal service due to failure to latch correctly or for any other reason.

The switches must be of the “increased operating frequency” in accordance with the standards. They must have 3 positions as follows and be constructed in such a way that natural interlocks prevent incorrect operation. Padlocking facilities must be provided for each position.

CLOSED Connected

OPENED Disconnected

Earthed

Closing and Opening

Closing and opening must be possible by both:

a) Local mechanical opening and close method (for maintenance purposes)

b) Local and remote electric opening and closing methods

Local and remote indication must be provided to confirm such an event.

Operating voltages

All switching devices must be able to meet their rated making duty for closing circuit voltages from eighty (80%) to one hundred and twenty percent (120%) of nominal and their rated breaking capacity for the open circuit voltages from fifty (50%) to one hundred and twenty percent (120%) of nominal.

4.4 Earthing switches

The outgoing connection to the motor must be provided with a suitable method of earthing the HV cables for maintenance purposes. Actual earthing must be carried out by a fault-make load-break switch or by the connection of portable earths to suitable earthing points in the enclosure.

All earth switches must be provided with mechanical interlocks to ensure that the earth switch cannot be closed onto a ‘Live’ circuit.

Manually operable earth switches must be from outside the equipment enclosure. The speed of operation of the earth switch contacts must be independent of the rate of movement of the operating handle.

Electrical (via auxiliary contacts) and mechanical position indication of the earth switch must be provided. The mechanical position indicators must be visible at the point of operation.

All earth switches must have provision for padlocking the switch in the open and closed position.

Earthing switches must comply with AS 1306-1985, AS/NZS 60265.1-2001 and IEC 62271-102.

4.5 Voltage transformers (VTs)

Voltage transformers must be designed in accordance with AS60044.2-2003 and must have phase-to-phase secondary terminals of 110V.

VT's must have HV fuses and LV miniature circuit breakers. Auxiliary contacts from the LV MCB must be wired to the LV compartment.

VT secondary wiring must be same colour as the respective primary phase conductors.

VT isolating test links must be provided for all metering VTs.

Partial discharge tests must be performed on every VT. Acceptable values for partial discharge must be in accordance with AS 60044.2. NATA test certificates must be supplied.

4.6 Current transformers (CTs)

CTs must comply with AS 600044.1-2003 and be designed with insulation and fault level ratings compatible with the switchgear.

CTs must be mounted within the confines of the enclosure, i.e. it must not be necessary to mount CTs in the cable basement below the enclosure.

CTs must preferably not be mounted in spaces containing the insulating gas (other than air).

CT secondary wiring must be the same colour as the respective primary phase conductors.

CT rating plate details must be duplicated on the outside of the circuit chamber housing the CT.

All CT tappings must be wired to slide test link terminals in the LV compartment of the enclosure.

A magnetisation curve must be obtained from the manufacturer for each CT in order to:

a) Detect damage in transit or installation

b) Prove that the correct cores have been wired out to the relevant terminals.

The DC resistance of each CT secondary winding must be measured and also (where possible) the DC resistance of the transformers and connecting leads, each item being recorded separately.

The insulation resistance of all secondary circuits must be measured at 1000 V DC and recorded.

Primary current injection tests must be conducted on all CTs using adequate primary current to prove correct ratio, polarity and for differential protection schemes, to prove the correct relative polarities of all CTs of each scheme.

Partial discharge tests must be performed on every CT. Acceptable values for partial discharge must be in accordance with AS 60044.1.

Records of all such tests by the CT manufacturer(s) must be collated by the Contractor for review during the auxiliary transformer factory tests (refer Section 7.1 - Routine (Factory) Testing).

4.7 Live line indication

Live line capacitive voltage divider neon indicators must be fitted:

a) On the cable-side of all CBs and FVCs

b) On the busbar-side of the busbar earth switch

c) Testing points (100V)

5. Technical requirements - LV and ELV control and protection equipment

5.1 General

All control equipment must be equipment with IP2X terminals. If this cannot be achieved the Contractor must manufacture removable shrouds.

Where applicable, miscellaneous control equipment such as non-protection type control relays and signal transducers must be selected for mounting on TS35 rail.

Non-protection type control relays must include an onboard mechanism indicating when the relay coil is energised (e.g. mechanical flag or LED).

Equipment mounted directly onto the back pane of the low voltage compartment must be done so using tapped machine screws. Self-tapping screws will be rejected.

5.2 Equipment layout

Within the limitations of the standard size low voltage control compartment, observe the following:

a) All controls, indications or devices with a test or numerical display must be installed preferably no higher than 1800 mm from the floor level, with a maximum of 2000 mm.

c) Duct work must be at least 50 mm from any terminal insertion point

d) Duct work must be at least 50 mm from any rail mounted device

e) Duct work must be at least 50 mm from any other component not mentioned in 2) or 3) above.

5.3 Control and protection equipment on LV compartment door

As a minimum, the LV compartment door of motor stater panels must be fitted with the following control and protection equipment:

DOL staters

Digital protection relay(s) incorporating HMIs.

a) Test block for secondary injection testing of digital protection relay(s)

b) Pilot lights indicating status (RUNNING and STOPPED)

c) Pilot lights indicating Protection trip

d) LOCAL-REMOTE control selector switch

e) START and STOP pushbuttons.

Soft Starters

Digital protection relay(s) incorporating HMIs.

a) Test block for secondary injection testing of digital protection relay(s)

b) Pilot lights indicating status (RUNNING and STOPPED)

c) Pilot light indicating status (BYPASS CLOSED)

d) Pilot lights indicating Protection trip

e) LOCAL-REMOTE control selector switch

f) START and STOP pushbuttons.

VSDs

Digital protection relay(s) incorporating HMIs.

a) Test block for secondary injection testing of digital protection relay(s)

b) Pilot lights indicating status (RUNNING and STOPPED)

c) Pilot light indicating status (BYPASS CLOSED)

d) Pilot lights indicating Protection trip

e) LOCAL-REMOTE control selector switch

f) START and STOP pushbuttons.

Trip and Close / Start and Stop functions must be able to be performed remotely using two different methods. Separate terminals are to be provided for each method. These are:

a) Hard wired from a remote control panel external to the building housing the switchgear

b) Via an external PLC.

The maximum height above floor level for all door-mounted control and protection equipment (measured to the centreline of the equipment) must preferably be not more than 1800 mm, and must not exceed 2000 mm.

5.4 Control switches and control selector switches

Each switchgear low voltage control compartment must be provided with:

a) One (1) two position (REMOTE, LOCAL) selector switch, providing selection of remote or local operation of the switchgear. When the switch is selected in remote, only remote open and close operation must be possible with local functions locked out. When the switch is selected in the local, only local open and close operation must be possible with remote operational functions locked out. Protection tripping must not be affected by which position the selector switch is in.

b) One (1) three position (TRIP, NEUTRAL, CLOSE) control switch with spring return to neutral action, for local trip/close operation of the switchgear.

The mechanical endurance of all control switches must be at least 100,000 operations.

Each control selector switch must be provided with a teardrop style operating handle and an escutcheon or label plate of engraved plastic laminate material having white letters on a black background.

Selector switches and pushbuttons must comply with the following minimum requirements:

a) Oil tight design

b) IP54

c) Engraved escutcheon plate mounted above the switch

d) Contacts rated 240 V AC, 5 A AC, utilisation category AC14, silver plated.

5.5 Pushbuttons

Pushbuttons must be dust-proof and arranged to prevent the ingress of dust into the motor starter. The colours of pushbuttons must comply with IEC60073.

Pushbuttons must not have exposed live terminals.

Emergency stop pushbuttons must be shrouded to avoid accidental trip and must comply with “Sydney Water Corporation Emergency Stops Policy”.

Pushbuttons must comply with the following minimum requirements:

a) Oil tight design

b) IP54

c) 22 mm diameter body

d) Engraved escutcheon plate mounted above the pushbutton

e) Contacts rated 240 V AC, 5 A AC, utilisation category AC14, silver plated.

5.6 Indicating lights

Indication lights must operate on the switchboard at the auxiliary supply as specified in section 2.2 of this specification. The colours of indication lights must typically comply with IEC60073.

Indication lights must comply with the following minimum requirements:

a) Oil tight design.

b) IP54.

c) 22 mm diameter body

d) LED cluster type

e) Lamp replacement from the front only

f) Press-to-test mechanism

g) RED lens for CLOSED/RUNNING

h) GREEN lens for OPENED/STOPPED

i) AMBER lens for ABNORMAL CONDITIONS

j) WHITE lens for NORMAL CONDITIONS

k) Engraved escutcheon plate mounted above the lens

Indicating lamps must be suitable for lamp replacement from the front of the panel without the use of tools.

Indication lights must not have exposed live terminals.

Push to test indicating lights must be used throughout.

5.7 Fuses and links

Fuses and links must be of the cartridge, high rupturing capacity type generally complying with the requirements of AS60269.

All LV fuses and links must be installed with appropriate facilities for isolation lockout with a standard isolation padlock.

5.8 Miniature CB’s

MCB’s must be provided for isolating all auxiliary power supplies in the LV compartment of each tier of all HV Switchboards.

MCB’s must comply with the following requirements:

a) Compliant with AS/NZS 60898.1:2004 and AS 3111-1994

c) DIN-style

d) Fault breaking and fault making capacity of not less than 10 kA

e) Appropriate facilities for isolation lockout with a standard isolation padlock.

5.9 Miniature relays

Miniature relays must comply with the following requirements:

a) Compliant with AS 3947.5:2000

b) Plug-in flat-pin style.

c) DIN rail mounted base

d) 48 V DC coil voltage complete with in-built suppression and diode protection

e) Integral LED indication

f) Contacts rated 240 V AC 5A.

5.10 Digital energy metering

Each motor starter must be provided with a digital power and energy metering unit. The unit must have a digital display where the following power parameters can be displayed. The unit must also have compatible communication capabilities so parameters can be monitored from a PLC/SCADA system using Ethernet TCP/IP and MODBUS.

a) Voltage L-N (average, per phase)

b) Voltage L-L (average, per phase)

c) Frequency

d) Current (average, per phase)

e) kW/MW (total, per phase)

f) kVAr/MVAr (total, per phase)

g) kVA/MVA (total, per phase)

h) kWh/MWh(total, per phase)

i) kVArh/MVArh (total, per phase)

j) kW/MW (demand, peak)

k) kVA/MVA (demand, peak)

l) Current demand (average, per phase)

m) Current peak demand (average, per phase)

n) Power Factor (total, per phase)

o) Voltage THD (per phase)

p) Current THD (per phase).

5.11 Protection relays

All Protection Relays must be in accordance with Sydney Water Standard specification DOC0014 - Protection Relays.

Each motor stater must be provided with a protection relay appropriate to the nature of the protected circuit.

5.12 Anti-condensation heaters

Separate anti-condensation heaters must be provided within each HV cable compartment and each LV compartment of the motor stater panel.

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

Anti-condensation heaters must be controlled by means of individual adjustable thermostats within each compartment.

Isolating circuit breakers within each LV compartment are to be provided for the anti-condensation heaters within that panel.

The anti-condensation heaters, thermostats, and wiring terminations must be guarded and/or shrouded to prevent inadvertent personnel contact with hot surfaces or live terminals during testing, commissioning or routine service and maintenance activities.

5.13 LV and ELV wiring

All LV and ELV wiring is to be installed in a neat and logical manner following standard industry practices.

All LV and ELV wiring must fully comply with the requirements of AS 3000:2007 Wiring Rules.

All conductors must be FLEXIBLE stranded tinned copper wire.

Minimum conductor sizes must be:

Item	Wire type	Wiring and/or Conductors	Colours
Extra Low Voltage (AC or DC)	1.5mm^2 Cu, 0.6/1kV PVC insulated type V75 to AS3147	Active/Positive Neutral/Negative	Light Grey (LtG)
240 V AC control when supplied from same compartment or SCA	2.5mm^2 Cu, 0.6 / 1 kV PVC insulated type V75 to AS 3147	Active Neutral	Brown (BN) Black (BK)
In all other cases		Active Neutral	Orange (O) Black (BK)
CT and VT secondaries	4 mm^2 Cu, 0.6 / 1 kV PVC insulated type V105 to AS 3147	Red Phase White Phase Blue Phase Neutral	Red (R) White (W) Blue (B) Black (BK)
Core Balance toroids	4 mm^2 Cu, 0.6 / 1 kV PVC insulated type V105 to AS 3147	S1 S2	Black (BK) Black (BK)
Earth conductors	Minimum 4 mm^2 Cu, 0.6 / 1 kV PVC insulated type V75 to AS 3147		Green-Yellow (G-Y)
Instrumentation twisted pair conductors		Positive Negative	White (w) Black (BK)
Ethernet	CAT 6		Blue

Item	Wire type	Wiring and/or Conductors	Colours
Conductors connecting voltage free relay contacts where the voltage is undefined	1.5mm^2 Cu, 0.6 / 1 kV PVC insulated type V75 to AS 3147	Active/Positive Neutral/Negative	Violet (V)

All LV and ELV wiring is to be installed in plastic cable duct with clip-on covers, strapped looms or flexible conduit is to be provided from panel to door. Cable ducts are to have 30% spare capacity. Panel to door wiring must include a loop to relieve stress and must be anchored at the panel and the door.

No joints in runs of wiring (i.e. at locations other than at terminals) must be permitted.

All LV and ELV wiring is to be arranged so that the line side is connected to the top of the respective device.

Adhesive wiring supports are unacceptable.

Where wiring is to pass through cut-outs in panelling, the hole must be bushed.

All terminal strips and individual terminal blocks must be labelled using proprietary labelling/numbering systems.

All conductors must be terminated at both ends with pre-insulated crimp terminations. They must be of the correct size for the conductor and must be applied with the terminations manufacturer's tool.

- Ring type termination lugs must be used for terminating to stud-type terminals
- Lip blade termination lugs must be used for terminating to rail-type terminals
- U shaped termination lugs must be used on selector switches and similar small equipment.

Solder connections are not acceptable.

All conductors must be uniquely numbered at both ends in accordance with the respective schematic diagrams.

All field wiring must be marshalled at terminal strips.

Terminals must comply with the following requirements:

a) Tunnel type connectors

b) Disconnect terminals must be provided for all CT and VT secondary wiring in addition to the protection relay test blocks

c) Only one conductor must be terminated on each side of each terminal

d) All terminal strips must maintain a degree of protection of IP2X

e) All field cabling must be terminated on one side of each terminal strip and all panel wiring must be terminated on the other side of the terminal strip

f) For clarity, provide barriers between groups of terminals having different functions (e.g. between terminals for protection and terminals for CT secondaries)

g) Provide a separate earth terminal for each field cable

h) All terminal blocks must be uniquely numbered in accordance with the respective schematic diagrams

i) All terminals must be uniquely numbered in accordance with the respective schematic diagrams.

MCBs must be provided for isolating all auxiliary power supplies in the LV compartment of each tier of all HV switchboards.

5.14 Interfaces with external systems and equipment

Interfaces between the Switchboard and external systems and equipment must be provided in accordance with Sydney Water IICATS requirements.

Such interfaces must include:

a) DIs, AIs and DOs to/from the plant PLC via the comms interfaces

b) All hardwired digital outputs must be volt-free contacts

c) All hardwired digital inputs must be from volt-free contacts

d) Provision for CTs and VTs for future condition monitoring by Anomalert / Artesis or equivalent.

All hardwired CT and VT secondary signals to external systems must be provided with disconnect/test terminals.

6. Identification and labelling

All electrical equipment forming part of the switchboard 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 engraved multi-layered thermosetting plastic secured with cadmium plated machine screws into tapped holes. Departures from these requirements must require the written pre-approval of Sydney Water.

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 Starter rating plate - Mounted on LV compartment door of the centre panel of the fully assembled enclosure	120L x 100H	Black / White	Sellers/manufactures name Purchase order number Year of Manufacture Type and serial number Starter voltage, current, and fault rating	10 10 10 10 10
Circuit number (Sydney Water Number plate style) - mounted on front panel of isolation switch.	100L x 100H	Black/Yellow	Switch Number	80
Circuit name - mounted on HV compartment door of panel, and, rear cover of panel.	100L x 60H	Black / White	Circuit Name	40
FVC MV fuse rating label - Mounted on HV compartment door and the front of FVC	50L x 30H	Black / White	Fuse Fuse rating / Holder rating	10 10
High Voltage compartment label - Mounted on all DANGER HIGH VOLTAGE compartment doors		White / Red / Black	DANGER HIGH VOLTAGE (to AS 1319)	

Label function and location	Typical label size (mm)	Text colour / Background colour	Label description	Text height (mm)
that provide access to HV				
All other 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)	
Current transformer - Mounted on side wall in the LV compartment of specific circuit	50L x 30H	Black / White	Circuit Number Function e.g. metering Cores ratio Class	5 5 5 5
Voltage transformer and reactor labels - Mounted on side wall in the LV compartment of specific circuit	50L x 30H	Black / White	Circuit Number Function e.g. metering winding ratio Class / VA	5 5 5 5
All compartment door mounted equipment labels (e.g. Controllers, indication lights, selector switches, pushbuttons etc) - Mounted on front and rear of LV compartment door below equipment		Black / White		3
All compartment internally mounted equipment labels (e.g. control relays, control MCBs, Terminals etc) - Mounted below equipment		Black / White		3

6.1 Label schedule

A label schedule showing details of each label must be submitted for approval prior to manufacture of the relevant labels.

7. Testing requirements

7.1 Routine (factory) testing

Perform routine (factory) tests on each motor starter prior to shipment to site. Such tests must include all routine tests listed within:

AS 62271.100-2005	HV switchgear and control gear - HV AC circuit-breakers.
AS 62271.102-2005	HV switchgear and control gear - AC disconnectors and earthing switches.
AS 62271.200-2005	HV switchgear and control gear - AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.

Routine (factory) tests must include:

a) Detailed mechanical inspection
b) Detailed electrical inspection
c) Verification of correct labelling
d) Mechanical tests on all mechanical interlocking, key interlocking and padlocking systems
e) Mechanical tests on all CB's earth switches
f) Mechanical tests on all FVC's earth switches
g) Electrical tests on all electrical interlocking and synch-check systems
h) Review of setup parameters for all digital protection relays
i) Functional tests on all operations counters, position indicators, capacitive voltage indicators, etc
j) Functional testing of all control and indication circuits. Functional testing of all protection circuits via secondary injection.
k) Note = secondary injection testing must be carried out at a minimum of three current settings to verify correct operation of protection relays
l) Functional testing of all metering circuits
m) Insulation resistance tests (before dielectric withstand tests)
n) Dielectric withstand tests (power frequency tests)
o) Insulation resistance tests (repeated after dielectric withstand tests)
p) LV wiring flash tests (insulation resistance/dielectric withstand/insulation resistance)
q) HV circuit resistance ("Ductor") test between main busbar tags and outgoing cable tags
r) Inspection of all loose-supplied equipment
s) Verification of all CT ratios and polarity of all CT connections
t) Partial discharge tests on all CTs and VTs (if not already performed at the place of manufacture)
u) Magnetisation tests on all CTs (if not already performed at the place of manufacture)
v) Review of routine test certificates for CBs, FVCs, CTs and VTs (from place of manufacture)
w) Review of routine test certificates (to IEC 60255) for digital protection relays (from place of manufacture)
x) Review of manufacturing inspection and test documentation and records
y) Review of manufacturing defect lists / punchlists.

Representatives from Sydney Water must be given the opportunity to witness the factory tests. 14 calendar days' notice must be given for tests in Australia and 21 calendar days' notice must be given for tests outside Australia.

The results of all factory tests must be available for review during the tests.

A comprehensive Factory Test Report must be submitted to Sydney Water for approval within five working days of completion of the tests for that switchboard or prior to shipment (whichever is the earlier). The Factory Test Report must include:

a) Results of all tests
b) Copies of any test oscillograms, graphs, printouts, etc

c) Copies of all routine test certificates (from place of manufacture) for CBs, FVCs, CTs and VTs

d) Copies of all routine test certificates (from place of manufacture) for digital protection relays

e) Copies of manufacturing inspection and test documentation and records, follower cards, etc

f) Copies of factory defect lists / punchlists

g) Copy of the completed Factory ITP

h) Statement confirming compliance with the specified requirements.

Unless agreed otherwise by Sydney Water, all defects arising prior to or during the factory tests must be rectified to the satisfaction of Sydney Water prior to the respective equipment being shipped to site.

7.2 Site testing

After assembly at site, the Contractor must perform detailed site tests to verify that each HV motor stater is fully complete and ready for energising. The Contractor must complete a copy of -their Pre Commissioning Checks, for each motor stater panel.

Such site tests must comply with the applicable requirements of:

AS 62271.100-2005	HV switchgear and control gear - HV AC circuit-breakers.
AS 62271.102-2005	HV switchgear and control gear - AC disconnectors and earthing switches.
AS 62271.200-2005	HV switchgear and control gear - AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.
AS 60470-2001	HV AC contactors and contactor-based motor-starters.

As a minimum, the following tests must be performed:

a) Detailed mechanical inspection

b) Detailed electrical inspection (including termination of inter-tier wiring)

c) Mechanical tests on all mechanical interlocking, key interlocking and padlocking systems

d) Mechanical tests on all CBs, earth switches

e) Mechanical tests on all FVCs, earth switches

f) Electrical tests on all electrical interlocking and synch-check systems

g) Check of setup parameters for all digital protection relays

h) Functional tests on all operations counters, position indicators, capacitive voltage indicators, etc

i) Functional testing of all control and indication circuits

j) Functional testing of all protection circuits via secondary injection

k) Note - secondary injection testing must be carried out at a minimum of three current settings to verify correct operation of protection relays

l) Functional testing of all metering circuits

m) Insulation resistance tests (before dielectric withstand tests)

n) Dielectric withstand tests (power frequency tests)

o) Insulation resistance tests (repeated after dielectric withstand tests)

p) LV wiring flash tests (insulation resistance/dielectric withstand/insulation resistance)

q) HV circuit resistance (“Ductor") test between main busbar and outgoing cable tags

r) HV circuit resistance (“Ductor") along main busbars

s) Inspection of all loose-supplied equipment

t) Review of assembly inspection and test documentation and records

u) Review of assembly defect lists / punchlists.

Representatives from Sydney Water must be given the opportunity to witness the site tests.

The results of all site tests must be available for review during the tests.

A comprehensive Site Test report must be submitted to Sydney Water for approval within five working days of completion of the tests (or on handover, whichever is the earlier). The Site Test Report must include:

a) Results of all tests

b) Copies of any test oscillograms, graphs, printouts, etc

c) Copies of site defect lists / punchlists

d) Copy of the completed Site ITP

e) Statement confirming compliance with all specified and legislated requirements.

8. Quality assurance and inspection and test plans

The Contractor must implement a quality system that complies with the requirements of ISO 9001 for all work on the HV motor stater panel.

The Contractor must submit for approval two project-specific Inspection and Test Plans (ITPs) for the HV Motor stater panel:

a) **Factory ITP** covering all off-site activities i.e. engineering, design, supply, testing, resolution of factory defects/punchlists, release for delivery, preparation for transport, etc.

b) **Site ITP** covering all on-site activities i.e. delivery to site, unloading, installation, assembly, site testing, resolution of site defects/punchlists, handover, etc.

The ITPs must identify the standards and/or procedures as well as the acceptance criteria that must apply for each stage in the ITPs.

Unless approved otherwise, all standards, procedures and acceptance criteria included in the ITPs must comply with the requirements defined in this Specification.

Perform all work on the HV motor stater panel in accordance with the approved ITPs.

Sydney Water may apply witness points and/or hold points on various stages of the ITPs.

Sydney Water must be given the option of witnessing all inspections and tests including type tests, (routine) factory tests and site tests. Sufficient notice (7 calendar days for tests on site, 14 calendar days for test elsewhere in Australia, 21 calendar days for tests outside Australia) must be given to enable the necessary travel arrangements to be made.

Sydney Water may elect to appoint third party inspector(s) to witness inspections and tests.

All costs associated with attendance by representatives of Sydney Water at inspections and tests must be borne by Sydney Water.

9. Spare parts

9.1 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.

9.2 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.

10. 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.

Where programmable microprocessor-based equipment is used in the motor stater panel, the Contractor must provide an electronic copy of any settings files, any proprietary software required to program the equipment and interface cable.

Where a password is required to access the settings, this password must be provided in the manual.

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.

11. Reference documents

The HV motor starters 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	- DOC0012: Specification HV Switchgear - DOC0014: Specification Protection Relays - CPDMS0022 Technical Specification Electrical - DOC0010 – High Voltage Motor
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 1kV) (Parts 1 and 2) - AS 1852.441: International electrotechnical vocabulary - Switchgear, controlgear and fuses - AS 1931 (IEC 60060): High voltage testing techniques (Parts 1 and 2) - AS 2024 (IEC 62271-105): High voltage AC switchgear and control gear - Switch-fuse combinations - AS 2067: Switchgear assemblies and ancillary equipment for alternating voltages above 1 kV - AS 2467: Maintenance of electrical switchgear - AS 2700: Colour standards for general purposes - AS/NZS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules)

Document type	Title
	- 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 3111: Approval and test specification - Miniature overcurrent circuit-breakers - AS 3947 series: LV switchgear and control gear - AS 4243: Additional requirements for enclosed switchgear and control gear from 1 kV to 72.5 kV to be used in severe climatic conditions - AS 60038: Standard voltages. - AS 60044.1 (IEC 60044-1): Instrument transformer - Current transformers - AS 60044.2: Instrument transformers - Inductive voltage transformers - AS 60137 (IEC 60137): Bushings for alternating voltages above 1000 V - AS/NZS 60265.1:2001 (IEC 60265-1): High-voltage switches - Switches for rated voltages above 1 kV and less than 52 kV - AS 60269 (IEC 60269): Low-voltage fuses - 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/NZS 60898.1 (IEC 60898): Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Circuit-breakers for AC operation - AS 60947 (IEC 60947): Low-voltage switchgear and controlgear. Please note: Some parts still exist as AS/NZS 3947 - AS 62053.21 (IEC 61036): Electricity metering equipment (AC) - Particular requirements - Static meters for active energy (classes 1 and 2) (IEC 62053-21 Ed.1.0 (2003) MOD) - AS 62053.22 (IEC 62053-22): Electricity metering equipment (AC) - Particular requirements - static meters for active energy (classes 0.2 S and 0.5 S) - AS 62054.11 (IEC 62054-11): Electricity metering (ac) - Tariff and load control – Particular requirements for electronic ripple control receivers - AS 62271.1 (IEC 62271-1): High-voltage switchgear and controlgear - Common specifications - AS 62271.100 (IEC 62271-100): High-voltage switchgear and controlgear – High-voltage alternating-current circuit-breakers - AS 62271.102 (IEC 62271-102): High voltage switchgear and controlgear – Alternating current disconnectors and earthing switches - AS 62271.103 (IEC 62271-103): High-voltage switchgear and controlgear – Switches for rated voltages above 1 kV and less than 52 kV

Document type	Title
	- AS 62271.200 (IEC 62271-200): High-voltage switchgear and controlgear – A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV - AS 62271-201 (IEC 62271-201): High-voltage switchgear and controlgear - AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV. - AS 62271-303 (IEC 62271-303): High-voltage switchgear and controlgear - Use and handling of sulphur hexafluoride (SF_6) in high-voltage switchgear and controlgear - IEC 376: Sulfur Hexafluoride - IEC 60073: Basic and Safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators - IEC 60255 series: Measuring relays and protective equipment.

11.1 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 any 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	05/12/2014	Norbert Schaeper	02/12/2014
2	Paul Zhou	20/02/2020	Steve-Keevil Jones	20/02/2020