

E-SPE-STD-010 Low Voltage Variable Speed Drives and Soft Starters

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This document is the property of Seqwater. It must not be copied or reproduced in any way whatsoever without the authority of Seqwater. This document is uncontrolled when printed. An electronic database manages and stores the controlled version.

1. Purpose

This document is part of a suite of Seqwater Engineering Standards which are in alignment with the Seqwater Quality Management System. Their purpose is to provide a consistent approach to the development, modification, and management of Seqwater infrastructure that is fit for purpose, economic over the life of the asset, and meets Seqwater's risk appetite and compliance requirements including Work Health and Safety obligations. This Standard Specification provides the minimum requirements and recommendations for Low Voltage Variable Speed Drives and Soft Starters.

This document must be used in conjunction with the documents it references to assist in ensuring fit for purpose infrastructure. This Standard Specification is not intended to be relied on solely for design, supply, and installation works; advice from specialist engineers and/or manufacturers may be required on a case-by-case basis.

2. Scope

This Standard Specification applies to all Seqwater employees, contractors, suppliers and consultants working for or on behalf of Seqwater unless otherwise stated. It applies to all new assets and to all existing assets undergoing refurbishment or modification. It must be used in conjunction with other relevant Seqwater Engineering Standards and project specific documents to define the technical requirements for infrastructure design and construction.

Where single or discrete components of an existing non-compliant system are to be replaced, refurbished or modified, this standard should not automatically be applied to the entire system retrospectively, however consideration should be given, in consultation with relevant stakeholders, to the extent of the application of the standard outside of the components requiring replacement, refurbishment or modification, to ensure safe, economic, and fit for purpose infrastructure.

Seqwater Engineering Standards include Standard Specifications, Drawings, Procedures, Templates, Forms and Preferred Equipment Lists. Together they detail Seqwater's minimum requirements and recommendations to provide infrastructure that will be fit for purpose, safe, and cost effective to operate and maintain. However, compliance with these requirements and recommendations does not remove, and cannot be relied on as meeting, the designer's overarching responsibility for ensuring infrastructure designed is fit for purpose and safe to construct, operate, maintain, and demolish. The designer must exercise appropriate due diligence to identify and manage hazards so far as is reasonably practicable.

Designers must also ensure compliance with relevant Australian Legislation, Standards, Codes and Guidelines (including those produced by Water Services Association of Australia). Where no Australian Standard exists for a particular application, work must conform to the most current version of an industry accepted international standard. Seqwater Engineering Standards use the International System of Units (SI), unless noted otherwise.

Deviation from meeting the minimum requirements in this Standard Specification requires written agreement from Seqwater as per the deviation process detailed in Procedure X-PRO-STD-008 Asset Standards Management and Application. That process includes completion of an X-TMP-STD-022 Asset Standards Deviation Request Form together with relevant supporting documentation, and submission by the Seqwater Project Representative to the Seqwater Engineering Mailbox. Where noted in this Standard Specification that Seqwater approval, agreement, or

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acceptance shall/must be sought, such approval, agreement or acceptance must be gained through the Seqwater Asset Standard Deviation process, as outlined above.

Responsibility for ensuring compliance with Seqwater Engineering Standards lies with those engaged in the management and execution of design, construction, and modification of Seqwater infrastructure. This includes modifications to the functional design of the infrastructure including technical changes made which would extend an asset outside of its design operating envelope and/or approved operation and maintenance practices.

Any ambiguities or conflicts identified between specific requirements within this Standard and project documents, another Seqwater Engineering Standard or Australian Legislation, Standards, Codes or Guidelines, must be brought to the attention of the Seqwater Document Owner as listed in the document footer, via the Engineering Mailbox, for clarification. Where it is proposed to proceed without meeting the requirements of this standard, agreement must be obtained via the Deviation Process, as outlined above.

Seqwater undertakes regular updates of its Engineering Standards. Before utilising this Engineering Standard, the complete list of Seqwater Engineering Standards should be reviewed to ensure currency and applicability of standards to be applied to the works. These can be accessed on the Waternet Seqwater Engineering Standards & Framework page or from your Seqwater project manager, design manager, or engaging officer.

3. Design Requirements

3.1. Operating Conditions

Unless otherwise specified, all electrical equipment and instrumentation will be required to operate continuously at full load for 24 hours per day, 365 days per year under the climatic conditions detailed in E-SPE-STD-001 Electrical Design and Construction.

All Low Voltage (LV) Variable Speed Drives (VSDs), Soft Starters and associated components shall be selected and installed so that all circuits can operate simultaneously at the full load rating.

LV VSDs and Soft Starters may be installed in both indoor and outdoor locations depending on the application. Indoor installation is preferred where feasible.

3.2. Design Life

All LV VSDs shall have a design life of at least 20 years in the environment and for the duty specified herein and on the Project Documentation. The equipment shall also be suitable for a minimum of 5 years normal continuous operation without maintenance at the duty specified herein and on the Project Data Sheets.

3.3. Design Reliability Target

The target reliability figure for all electrical designs shall be 99% as a minimum for the entire system. Particular care should be taken to avoid single points of failure for the system and there should be no hidden failures, especially for redundant elements in the design.

3.4. Voltage Levels

All LV VSDs and Soft Starters shall be designed for the input voltage levels noted in Table 1.

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Table 1 - Voltage Levels

Condition	Detail
Low Voltage Supplies	3 phase, 4 Wire, 400 Volt +10% -6%, 50 Hz $\pm$ 2%, MEN System Voltage Unbalance <5%
Single Phase Power Supplies	230 V AC, +10,-6%, 2 wire, 50Hz $\pm$ 2%

3.5. Ingress Protection

The minimum IP rating of enclosures shall be in accordance with design criteria provided in Standard Specification E-SPE-STD-001 for Electrical Design and Construction.

4. Performance and Ratings

4.1. General

VSDs and Soft Starters shall be carefully and specifically matched to the associated motor to provide a fully engineered and integrated system.

VSDs and Soft Starters may be supplied as the following types:

- Integral to Motor Control Centre (MCC).
- Wall Mount.
- Free Standing.

The decision on which type to supply will vary from project to project and as such, will be dictated by project requirements. The selected type shall match the IP rating for the installation location.

4.2. Variable Speed Drives

VSDs shall be sized and designed to meet the following:

- VSD starter circuits shall include:
 - Protective device – typically a moulded case circuit breaker; fuses may be used where appropriate. The device shall be selected to suit the design requirements.
 - VSD.
 - Externally provided 24 VDC control supply.
 - Communication interface to the plant PLC/SCADA system for monitoring of all alarms and operating parameters.
 - Minimum Thermal Protection:
 - Motors $\leq$ 50 kW.
Motor thermal protection shall be provided as a minimum by the VSD. Separate embedded temperature sensors are not mandatory unless otherwise specified.
 - Motors $>$ 50 kW and $\leq$ 150 kW.

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Motors shall, as a minimum, be fitted with embedded thermistors connected to the Drive or external protection relay. The protection system shall be configured to initiate a trip in the event of an over-temperature condition to prevent motor damage.

- Motors >150 kW.

Motors shall, as a minimum, be fitted with RTDs (minimum one per phase winding) connected to the Drive or external protection relay to provide continuous temperature monitoring, alarm and protective trip.

- Enhanced Thermal Protection (Where Required)

- Additional or higher-grade thermal protection beyond the minimum requirements specified above shall be provided where warranted, including for motors installed in harsh environmental conditions (such as high ambient temperatures, dust, vibration, humidity, or corrosive atmospheres), in critical or continuous-duty applications, where cooling is impaired due to restricted airflow or enclosed installations, where equipment availability is essential to process continuity, or under other conditions identified by the project risk assessment or operating philosophy.

- The output inverter shall be of the Pulse Width Modulated (PWM) type.
- VSDs shall be sized correctly for the connected load with a target power factor of 0.95 lagging or better.
- The harmonics generated by VSDs shall not exceed the limits as set by the Supply Authority and in any case to be no greater than 5% total harmonic voltage distortion (THDv) on any 400 VAC switchboard bus.
- If required, line side reactors shall be installed in each phase of each drive unit to prevent damage to other line side connected equipment from harmonics emitted by the VSD.
- Radio Frequency Interference (RFI) shall not exceed the limits as specified in AS 61800.3 category C2. The controllers are to include integral RFI filters to meet these requirements.
- The VSD internal switching frequency shall not generate additional audible noise beyond that which is expected in a 50 Hz fixed speed application.
- If required, output common-mode filtering on motor circuits shall be implemented in accordance with the Supplier's recommendations.
- All protection equipment for the controller components and the associated motor shall be provided and arranged to trip the controller when operated and to prevent restarting of the controller until manually reset. Reset push-buttons shall be mounted on the front of the enclosure.
- Each type of fault shall be individually indicated on the front of the enclosure or switchboard cell containing the VSD. Fault indications shall remain active after trip until manually reset.
- All large VSD applications, the Designer shall assess the risk of motor bearing damage due to VSD-induced bearing currents (electrical discharge machining, EDM) and shall specify appropriate mitigation measures, including output filters and/or insulated bearing arrangements, suitable for the motor and installation conditions.

4.2.1. Hardware Requirements

VSDs supplied must meet the following construction requirements:

- VSDs shall be of the variable voltage/frequency converter fed type suitable for standard squirrel-cage induction motors directly coupled to the driven equipment.

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- If the results of a risk assessment conducted in accordance with AS 4024 indicate that an emergency stop is required, the VSD shall incorporate integrated SIL certified safe stop modules to be used for the emergency stop.
- The controller shall be fully microprocessor based solid state electronic type units with all set-up and operating parameters entered/displayed via an integral keypad and digital display console.
- The VSD should uniformly ramp the motor speed to the speed control setpoint device/signal. The acceleration rate shall be an adjustable parameter.
- The controller shall be ready for operation automatically following a power failure.
- The PWM carrier frequency shall be adjustable in order to minimise motor noise.
- The Variable Speed Drive shall be provided with the following minimum onboard I/O:
 - A minimum of four (4) configurable and freely assignable digital inputs.
 - A minimum of two (2) programmable dry contact relay outputs
 - A minimum of one (1) programmable analogue 4–20 mA input.
 - A minimum of one (1) programmable analogue 4–20 mA output.
- All cabling between VSDs and motors shall be installed in suitable screened VSD type power cables. The screening shall be continuous from the controller to the motor and installed as per the manufacturer's recommendations.
- For installations with long motor cable lengths, the Designer shall assess the need for a motor output choke and shall specify such devices in accordance with the VSD manufacturer's recommendations.
- Cable glands for VSD screened power cables shall be from the type recommended by the VSD manufacturer.
- The following controls and indications shall be provided on the MCC starter cubicle door or on the outside of an externally mounted VSD enclosure as a minimum:
 - Digital speed indicator to show motor speed from 0-100% (part of the VSD operator interface).
 - "Available", "Running" and "Fault" indication. Some or all of this indication may be provided as part of the VSD proprietary operator interface provided that the display is available in an "operator friendly" mode (e.g. indication lights) and does not require the operator to scroll through the interface screen display.

4.2.2. Control & Monitoring Requirements

VSDs shall meet the following control and monitoring requirements:

- Local/Off/Remote control selection
 - When the drive is in "Local" mode, it shall be started and stopped directly by start and stop buttons on the MCC cell or keypad, with no sequence interlocking. Speed shall be adjusted manually by up/down buttons or rotary dial on the VSD interface.
 - In "Remote" mode, the drive shall be started and stopped by the plant PLC/SCADA system via an interposing relay. Speed shall be controlled via a 4-20mA analogue signal from the PLC/SCADA system.
- The PLC/SCADA shall monitor all drive operating parameters and alarm types via dedicated Ethernet protocol and shall meet the communication protocols stated in I-SPE-STD-013 Control Systems Design and Construction.
- All VSD motor starter control circuits shall include the following control interlocks:
 - MCC motor circuit breaker.

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- Motor field whole current isolator if used.
- Field emergency stop pushbutton if used.
- As a minimum, the plant PLC/SCADA control system shall provide the following motor monitoring functions:
 - Motor running current (A) and real power (kW).
 - Motor speed (rpm) / frequency (Hz).
 - Type of alarm and fault/trip.

4.3. Soft Starters

Motors which may cause the supply transformer voltage to drop by more than 5% during start up shall be driven by soft starters (except where a VSD is selected).

Soft starters shall comply with AS/NZS 60947.4.2 and be rated as per Table 2 or better for the required kW output of the motor.

Table 2 - Soft Starter Rating Requirements

Operation	Minimum Requirement
Bypass operation	6 starts per hour
Without Bypass operation (i.e. under test operation)	4 starts per hour with a 5 minute run time for each start
Start Current	400% of Motor Full Load Current

Soft Starters shall have the following features:

- Soft starter circuits shall include:
 - Protective device – typically a moulded case circuit breaker; however, fuses may be used where appropriate. The device shall be selected to suit the design requirements.
 - Line Contactor.
 - Fast-acting fuse - A fast-acting fuse shall be installed where required by the soft-starter manufacturer and where necessary to achieve Type 2 coordination.
 - Electronic reduced voltage Soft Starter unit.
 - Externally provided 24 VDC control supply.
 - Communication interface to the plant PLC/SCADA system for monitoring of all alarms and operating parameters.
 - Bypass Contactor:
 - Integrated internal bypass shall be used where the selected soft starter model includes a factory-fitted internal bypass that is suitable for the intended duty.
 - External bypass shall be provided where the soft starter model does not include an internal bypass or where the manufacturer specifies external bypass for the selected frame or current rating.
 - All bypass contactors shall be rated for motor full-load current, short-time withstand, duty cycle and mechanical endurance.
 - Thermal Protection:
 - Motors $\leq$ 50 kW.

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Motor thermal protection shall be provided as a minimum by the soft starter. Separate embedded temperature sensors are not mandatory unless otherwise specified.

- Motors > 50 kW and ≤ 150 kW.

Motors shall, as a minimum, be fitted with embedded thermistors connected to the soft starter or external protection relay. The protection system shall be configured to initiate a trip in the event of an over-temperature condition to prevent motor damage.

- Motors >150 kW.

Motors shall, as a minimum, be fitted with RTDs (minimum one per phase winding) connected to the soft starter or external protection relay to provide continuous temperature monitoring, alarm and protective trip.

- Automatic restart after power supply failure.
- Optional current limit and current ramp start modes.
- Programmable start and stop parameters via a digital keypad mounted on the switchboard door panel.
- Protection for phase imbalance/loss, phase sequence/loss and starter over-temperature inclusive of visual indication of these faults.
- Ability to operate within the tolerance of the voltage and frequency of the incoming electricity supply.
- The housing for the starter units shall prevent transmission of radio frequency interference (RFI).
- Adequate screening shall be provided for control cables to suppress RFI and avoid signal disturbances to other electronic equipment and external appliances.
- Communication interface to the plant PLC/SCADA system for monitoring of all alarms and operating parameters in accordance with I-SPE-STD-013 Control Systems Design and Construction.

4.3.1. Hardware Requirements

Soft Starters supplied must meet the following construction requirements:

- Soft Starters shall be suitable for standard squirrel-cage induction motors directly coupled to the driven equipment.
- If the results of a risk assessment conducted in accordance with AS 4024 indicate that an emergency stop is required, the Soft Starter shall incorporate the required emergency stop into the motor control circuit.
- The controller shall be fully microprocessor based solid state electronic type units with all set-up and operating parameters entered/displayed via an integral keypad and digital display console.
- The Soft Starter should uniformly ramp the motor speed to the speed control setpoint device/signal.
- The controller shall be ready for operation automatically following a power failure.
- Minimum of 4 digital inputs – configurable and freely assignable
- The following controls and indications shall be provided on the MCC starter cubicle door or on the outside of an externally mounted Soft Starter enclosure as a minimum:
 - Digital indicator to show motor running current (part of the Soft Starter operator interface).
 - “Available”, “Running” and “Fault” indication. Some or all of this indication may be provided as part of the Soft Starter proprietary operator interface provided that the display is available in an “operator friendly” mode (e.g. indication lights) and does not require the operator to scroll through the interface screen display.

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4.3.2. Control & Monitoring Requirements

Soft Starters shall meet the following control and monitoring requirements:

- Local/Remote control selection:
 - When the drive is in “Local” mode, it shall be started and stopped directly by start and stop buttons on the MCC cell or keypad, with no sequence interlocking.
 - In “Remote” mode, the drive shall be started and stopped by the plant PLC/SCADA system via an interposing relay.
- The PLC/SCADA shall monitor all drive operating parameters and alarm types via dedicated Ethernet protocol and shall meet the communication protocols stated in I-SPE-STD-013 Control Systems Design and Construction.
- All Soft Starter motor starter control circuits shall include the following control interlocks:
 - MCC motor circuit breaker.
 - Motor field whole current isolator if used.
 - Field emergency stop pushbutton if used.
- The plant PLC/SCADA control system shall provide the following motor monitoring functions:
 - Motor running current (A) and real power (kW).
 - Type of alarm and fault/trip.

4.4. LV Switchboard Requirements

VSDs or Soft Starters supplied as part of a LV Switchboard or MCC shall have upstream protection devices installed, as per the manufacturer’s recommendations.

Drive compartments shall provide clearances around the drive recommended by the drive supplier.

Control keypads for VSDs or Soft Starters shall be mounted on the escutcheon panel where fitted or on the external door where the external door acts as an escutcheon panel.

The construction and layout of the switchboard or motor control centre shall allow for the segregation needed for input and output power and control cables to limit Electro-magnetic Interference (EMI). Internal 'Layout' drawings of the switchboard or motor control centre shall be submitted to the Principal for approval prior to construction commencing.

The power cables between the VSD output terminals and the motor terminals shall be screened and terminated as per the manufacturer’s recommendations otherwise sine wave filter may be used as approved by Principal.

For complete details on LV Switchboard and MCC, refer to Standard Specification E-SPE-STD-009 Low Voltage Switchboards, Distribution Boards, and Control Panels.

4.5. Cooling

Air cooling is the primary cooling method and shall be provided by either natural convection or fan forced.

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5. Inspection and Test Plan

5.1. General

Comprehensive electrical tests shall be performed to prove correct operation of the system. All equipment that fails the tests shall be repaired and/or replaced and then re-tested until the tests are passed successfully.

All tests and inspections shall be recorded on approved report forms. Where testing involves insulation or current measurements, then actual readings shall be recorded on test report forms.

The Supplier shall submit an inspection, test and commissioning schedule at least 7 days before the commencement of testing and commissioning detailing:

- Date test is proposed for.
- Type of test and details of test.
- Equipment to be tested.
- Test equipment to be used.
- Sample forms for recording testing.

The Principal reserves the right to witness any test. The Supplier shall give written notice of intention to test, not less than seven days prior to commencing any test.

When conducting continuity and high voltage tests, particular care shall be taken to avoid subjecting semiconductor devices such as VSDs, earth leakage circuit breakers, thermistor relays and PLC inputs and outputs to a test voltage exceeding the rating of the device.

5.2. Electrical Testing

Semiconductor equipment such as VSDs and Soft Starters shall not be voltage tested.

Power circuit insulation shall be tested using a 1000 V 'Megger' or approved equivalent voltage test unit. Control wiring shall be tested at 500 V only.

High current micro-ohm resistance tests shall be carried out for feeders larger than 150 A. All power connections in the outgoing unit shall be tested. Resistance measurements shall be recorded and examined for inconsistent and unusually high readings.

5.3. Functional Testing

Switchboard and supplies to VSDs and Soft Starters shall be tested in accordance with Standard Specification E-SPE-STD-009 Low Voltage Switchboards, Distribution Boards, and Control Panels.

VSDs and Soft Starters shall be tested by monitoring speed changes of a small three phase motor while either the VSD drive input signal is varied or the Soft Starter run signal is given. The Supplier shall provide the motor.

The Supplier shall provide marked up drawings and test sheets detailing the results and extent of the above tests.

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6. Spare Parts and Special Tools

The Supplier shall provide a list of the following spares:

- Commissioning and start-up spares
- Recommended spares list for two years operation

The Supplier shall provide a list of all necessary special tools, software licences, programming cables etc. that are required to perform routine maintenance, operation and fault finding on the VSD, Soft Starter and associated equipment.

7. Preparation for Transport

The equipment shall be shipped in the largest practical sections whilst permitting ease of handling for transportation and installation.

Preparation for shipment shall protect the component parts against corrosion, dampness, breakage or vibration injury during transportation and installation.

Each shipping container shall be identified with the contents, purchase order number and item number.

Where equipment has to be split for shipping, instructions shall be provided for reassembly. Materials and special tools shall be provided for reassembly at site.

8. Definitions and Abbreviations

The following abbreviations in Table 3 apply to this Standard Specification.

Table 3 - Definitions and Abbreviations

Term	Definitions
AC	Alternating Current
AS/NZS	Australian / New Zealand Standard
Contractor	An entity engaged by Seqwater to undertake work in accordance with an agreed contract and defined scope of work.
DC	Direct Current
EDM	Electrical Discharge Machining
ELV	Extra Low Voltage
EMC	Electro-magnetic compatibility
EMI	Electro-magnetic Interference

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Term	Definitions
Employees	Means persons employed directly by Seqwater in a permanent, temporary or casual capacity.
FAT	Factory Acceptance Testing
Fit for purpose	Suitable for the intended purpose and meets the performance requirements set out in this standard and other project documents.
FLC	Full Load Current
HRC	High Rupture Current
HV	High Voltage (AS/NZS 3000: 2018 definition)
I/O	Inputs/Outputs
IEC	International Electrotechnical Commission
IP	Ingress Protection
LCD	Liquid Crystal Display
Leader	Means any Level 1, 2, 3 and 4 Leader with responsibility for managing a functional area of the business, including people management responsibilities within their functional area.
LED	Light Emitting Diode
LV	Low Voltage (AS/NZS 3000 :2018 definition)
Manufacturer / Supplier / Vendor / Original Equipment Manufacturer (OEM)	The entity that manufacturers or supplies equipment to meet the specifications of the Contractor.
MCC	Motor Control Centre
MEN	Multiple Earth Neutral
Owner / Principal / Seqwater	The entity that engages the Contractor to undertake the work and takes custody of the outcome. The Owner may delegate responsibilities to other entities to act on its behalf (e.g. a consultant).
PVC	Poly Vinyl Chloride
REX	Seqwater Electronic Document and Records Management System.
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detector
RTU	Remote Telemetry Unit
SAT	Site Acceptance Testing

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Term	Definitions
Seqwater Approval / Agreement / Acceptance	Written sign-off gained via the deviation process, as detailed in X-PRO-STD-008 Asset Standards Management and Application Procedure.
Seqwater Engineering Standard	Includes Standard Procedures and Standard Specifications and associated supporting documents such as Standard Drawings, Guidelines, Lists, Datasheets, Manuals, Registers, and Templates.
Shall / must	Indicates a mandatory requirement
Should	Indicates a recommendation
SLD	Single Line Diagram
THDv	Total Harmonic Distortion (voltage)
VSD	Variable Speed Drive
Worker(s)	Includes all permanent, temporary, and casual employees of Seqwater, and: • vocational and work experience placements • volunteers suppliers, contractors, and consultants temporarily engaged to do work for or on behalf of Seqwater.

9. Roles and Responsibilities

Table 4 - Roles and Responsibilities

Role	Responsibility
Leaders	In addition to the responsibilities of a worker, ensure compliance with this Standard Specification by those they lead.
Workers / Employees	Be aware of and comply with this standard specification

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10. References and Related Materials

The documents listed in Table 5 below, and the requirements therein, are relevant to this Standard Specification. In their latest editions, these documents form a part of this document. Note that this is not an exhaustive list of documents relevant to the works.

Seqwater undertakes regular updates of its Engineering Standards. Before utilising this document, the complete list of Seqwater Engineering Standards should be reviewed to ensure currency and applicability for the proposed works.

Table 5 - References and Related Material

Description	Location
E-DWG-STD-030 Standard Drawing: Typical LV Soft Starter Schematic Diagram	REX
E-DWG-STD-035 Standard Drawing: Typical External LV VSD Schematic Diagram	REX
PRO-01617 Engineering Standard X-PRO-STD-009 Engineering Design, Construction, Operation and Maintenance Procedure	REX
PRO-01872 Engineering Standard X-PRO-STD-002 Engineering Drawing Numbers Procedure	REX
PRO-01873 Engineering Standard X-PRO-STD-001 Asset Standards Documentation Classification and Naming Structure Procedure	REX
PRO-01874 Engineering Standard X-PRO-STD-004 Development and Review of Asset Standards Procedure	REX
PRO-02140 Engineering Standard X-PRO-STD-013 Engineering Technical Hazard Study Procedure	REX
PRO-02187 Engineering Standard X-PRO-STD-007 Drawing and Spatial Data Standards Procedure	REX
PRO-02190 X-PRO-STD-006 Equipment Numbering and Naming Convention Procedure	REX
PRO-02205 Engineering Standard X-PRO-STD-008 Asset Standards Management and Application Procedure	REX
PRO-02234 Management of Change (Technical) Procedure	REX
REG-01074 Engineering Standard X-LST-STD-001 Seqwater Preferred Equipment	REX
SPE-00342 Engineering Standard I-LST-STD-001 Control Systems Prescribed Equipment	REX
SPE-00346 Engineering Standard B-SPE-STD-003 Commissioning Requirements	REX
SPE-00352 Engineering Standard E-SPE-STD-001 Electrical Design and Construction	REX
SPE-00361 Engineering Standard I-SPE-STD-013 Control Systems Design and Construction	REX
SPE-00439 Engineering Standard E-SPE-STD-007 Power System Modelling and Arc Flash Analysis Specification	REX

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Description	Location
TEM-00224 Engineering Standard X-TMP-STD-022 Asset Standards Deviation Request Template	REX
AS 1111 ISO metric hexagon commercial bolts and screws	Intertek Inform
AS 1319 Safety signs for occupational environment	Intertek Inform
AS 1627 Metal finishing – Preparation and pre-treatment of surfaces	Intertek Inform
AS 1668 The use of ventilation and air conditioning in buildings	Intertek Inform
AS 2467 Maintenance of electrical switchgear	Intertek Inform
AS 60146 Semiconductor converters all parts	Intertek Inform
AS 60529 Degrees of protection provided by enclosures for electrical equipment (IP Code)	Intertek Inform
AS 61869 Instrument transformers	Intertek Inform
AS IEC 61800 Adjustable speed electrical power drive systems- (applicable parts)	Intertek Inform
AS IEC 61800.3 Adjustable speed electrical power drive systems - EMC requirements and specific test methods	Intertek Inform
AS/NZS 1020 The control of undesirable static electricity	Intertek Inform
AS/NZS 3000 Electrical installations (known as the Australian/New Zealand wiring rules)	Intertek Inform
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	Intertek Inform
AS/NZS 3017 Electrical installations - Verification by inspection and testing	Intertek Inform
AS/NZS 3111 Approval and test specification – Miniature overcurrent circuit breakers	Intertek Inform
AS/NZS 4024 Safety of Machinery series	Intertek Inform
AS/NZS 4836 Safe Working on or near low-voltage and extra-low voltage electrical installations and equipment	Intertek Inform
AS/NZS 60034 Rotating electrical machines	Intertek Inform
AS/NZS 60255 Measuring relays and protection equipment	Intertek Inform
AS/NZS 60947 Low-voltage switchgear and control gear (all parts)	Intertek Inform
AS/NZS 61000 Electromagnetic compatibility (EMC)	Intertek Inform
AS/NZS 61439 Low-voltage switchgear and controlgear assemblies	Intertek Inform
AS/NZS IEC 60331 Tests for electric cables under fire conditions – Circuit integrity	Intertek Inform
IEC 60073 Basic and safety principles for man-machine interface, marking and identification - coding principles for indicators and actuators	Intertek Inform

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Description	Location
IEC 60445 Basic and safety principles for man-machine interface, marking and identification – Identification of Equipment Terminals, Conductor Terminations and conductors	Intertek Inform
IEC 60715 Dimensions of low-voltage switchgear and controlgear – Standardised mounting on rails for mechanical support of switchgear, controlgear and accessories	Intertek Inform
IEEE 519 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems	Intertek Inform

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11. Changes from previous version

This Standard Specification will be regularly reviewed in accordance with the requirements of the Seqwater Controlled Document Management Procedure. Reviews will include consideration of suggestions for alteration or improvement made in accordance with Seqwater Procedure X-PRO-STD-004 Development and Review of Asset Standards. Changes made from the previous version are summarised in Table 6 below.

Table 6 - Changes from previous version

Section Number	Change
All	Document rewritten and reformatted to align with the updated Seqwater Engineering Standard Specification Template (X-PRO-STD-002). Sections rearranged, definitions merged, tables renumbered, and content structured per new template.
All	Minor technical improvements and corrections throughout document.
4.2 Variable Speed Drives	Rewritten thermal protection requirements. Added “minimum” wording, updated threshold logic, and introduced Enhanced Thermal Protection.
4.2.1 Variable Speed Drives Hardware Requirements	Added mandatory minimum one (1) programmable analogue 4–20 mA input.
4.2.2 Variable Speed Drives Control & Monitoring Requirements	Added “if used” to local isolator control interlock requirement to align with E-SPE-STD-001 specification for where local isolators are required.
4.3 Soft Starters	Rewritten thermal protection requirements. Added “minimum” wording, updated threshold logic, and introduced Enhanced Thermal Protection.
4.3 Soft Starters, Table 2	Updated minimum starts per hour from 12 to 6 for bypass operation to align with typical product capabilities and typical service need.
4.3.1 Soft Starters Hardware Requirements	Removed requirement for local speed display. Replaced with motor current.
4.3.2 Soft Starters Control & Monitoring Requirements	Added “if used” to local isolator control interlock requirement to align with E-SPE-STD-001 specification for where local isolators are required.
4.3 Soft Starter Bypass Requirements	Removed kW-based internal/external bypass rules and allowed broader use of internal bypass where supported.

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