TWEED SHIRE COUNCIL

ELECTRICAL DESIGN SPECIFICATION

EL09

VARIABLE SPEED DRIVES

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1 CITATION

This document is named "Tweed Shire Council, Electrical Design Specification EL09 - Variable Speed Drives"

2 ORIGIN OF DOCUMENT, COPYRIGHT

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3 VERSIONS

VERSION	AMENDMENT DETAILS	CLAUSES AMENDED	DATE ISSUED (The new version takes effect from this date)	Authorised by the Director of Engineering Services
1.1	Original version		1 November 2005	

4 STATUTORY REQUIREMENTS, CODES, AND STANDARDS

This Standard Specification covers the general requirements for the design, manufacture and testing of AC or DC variable speed drives.

4.1.1 General

The design must, as a minimum, comply with all of the requirements of the latest revision of the Codes and Standards listed herein.

In addition to the specific Standards listed, all equipment and components must be designed, manufactured and tested in accordance with the current revision of the relevant Australian Standards.

Where an appropriate Australian Standard does not exist, the equipment must meet the requirements of the appropriate International Standard (ISO), and in the case of there being no applicable Australian or ISO Standard, the Council will nominate or approve an alternative standard.

For the purposes of clarifying discrepancies between the various Standards and Acts regarding the definition of voltage levels, and in anticipation of proposed changes to those definitions, the following definitions must apply for the purposes of this project:

1. Extra-low Voltage not exceeding 32 V AC or 115 V DC (nominal).
2. Low Voltage exceeding extra-low voltage, but not exceeding 1,200 V AC or 1,500 V DC (nominal).
3. High Voltage exceeding low voltage.

All quantities including drawing dimensions must be expressed in terms of the International Systems (SI) of units.

4.2 Regulations, Standards and Codes

Unless specified or agreed otherwise, all equipment, installations and site work must comply with the requirements of all Statutory Authorities having jurisdiction, including the relevant clauses of the most recent revisions of all relevant Australian Standards and Codes of Practice, or in their absence, with the relevant IEC or British Standards.

Where the Act(s), Regulations or Standards require certificates of conformity or statutory approval for items or equipment, then only certified or approved, suitably identified, indelibly marked items and Equipment meeting these requirements must be supplied.

The following Standards apply:

AS 1023	Low voltage switchgear and controlgear – Protection of Electric Motors.
AS 1029	Low voltage contactors (up to and including 1,000 V AC).
AS 1042	Direct-acting indicating electrical measuring instruments and their accessories.
AS 1202	AC motor starters (up to and including 1,000 V).
AS 1359	General requirements for rotating electrical machines.
AS 1384	Transducers for electrical measurement.
AS 1675	Current transformers – Measurement and protection.
AS 1930	Circuit breaker for distribution circuits (up to and including 1,000 V AC and 1,200V DC).
AS 1939	Classification of degree of protection provided by enclosures for electrical equipment (IP Code).
AS1955	Semi-conductor converters.
AS 2005	Low voltage fuses – Fuses with enclosed fuse links.
AS/NZS 2064	Limits and methods of measurement of electromagnetic Parts 1 & 2 disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.
AS 2067	Switchgear assemblies and ancillary equipment for alternating voltages above 1 kV.
AS 2081	Electrical equipment for coal and shale mines – Electrical protection devices.
AS 2184	Low voltage switchgear and controlgear – Moulded case circuit breakers for rated voltages up to and including 600 V AC and 250 V DC.
AS 2279.2	Disturbances in mains supply networks – Limitations of harmonics caused by industrial equipment.
AS 2279.4	Disturbances in mains supply networks – Limitations of voltage fluctuations caused by industrial equipment.
AS 2768	Electrical insulating materials – Evaluation and classification based on thermal endurance.

AS 3000	Electrical installations – Buildings, structures and premises (SAA wiring rules).
AS 3116	Approval and test specification – Electric cables – Elastomer Insulated – For working voltages up to and including 0.6/1 kV.
AS 3190	Approval and test specification – Residual current devices (Current-operated earth leakage devices).
AS 3439	Low voltage switchgear and controlgear assemblies.
AS 3947	Low voltage switchgear and control gear.
IEEE 519	Harmonics.

4.3 Certification

The VSD's and all electrical components and items contained within the VSD's must be accompanied by certificates verifying compliance with the relevant Australian Standards.

5 DESIGN CRITERIA

5.1 General Design

The equipment must be designed and manufactured with an emphasis on safety, reliability and maintainability. Comprehensive diagnostic systems must be an integral part of the equipment design.

Circuits must be designed and laid out for ease of fault finding and servicing.

Control circuits must be designed so that they are "fail safe". Failure of a circuit element must cause power circuits to open, cause control circuits to signal stops and cause equipment to go to a safe condition. Fuses must not be used in circuits where blown fuses would cause transmission or reception of erroneous signals or reference voltages.

5.2 Power Supply

The application for which the motor control centre is to be used will determine the treatment of the neutral for this power supply system. This may be:

- solidly earthed, or
- impedance earthed.

5.3 Rating and Protection

All equipment must be designed for continuous operation at full load under the applicable environmental conditions. All electrical equipment must be to the latest proven design available at the time of manufacture.

All equipment used must be of a rating suitable for the duty it is to perform and capable of withstanding the maximum electrical fault conditions which can be applied to it, without damage.

Fault conditions should include, but not limited to, overloads, short circuits and ground faults.

Provision must be made in the design of equipment to prevent, as far as practical, the occurrence of an arcing fault by provision of the following:

1. adequately rated components;

2. suitable insulation techniques;
3. adequate creepage and clearance distance;
4. suitable interphase barriers;
5. suitable cable terminations.

The suitability of the equipment and the effectiveness of the protection systems must be supported by calculation and by protection grading curves showing all energy sources, protective device operation curves and short time ratings of contactors and cables. Supporting documentation must be provided for all source data. A single line diagram must show all cables, contactors, circuit breakers, fuses, overloads, overcurrent relays and earth leakage relays, their sizes, load and fault ratings.

All equipment that has an interrupting capacity less than the short circuit capacity of its supply must be protected by fault current limiters.

5.4 Noise Immunity

All cabling and wiring must be carried out so as to prevent disturbance of sensitive circuits by electro-magnetic/radio-frequency emissions with the use of variable speed drives.

Installation of these drives must be carried out in accordance with the drive manufacturer's recommendations.

Installation of cabling, wiring and components for control, instrumentation and communications must be carried out with particular attention to:

1. earthing;
2. cable/wiring routes;
3. segregation/separation;
4. shielding.

6 GENERAL CONSTRUCTION REQUIREMENTS

6.1 General

VSD's must comply with AS 3439 and the following requirements.

It is an objective of this Specification to specify items and equipment with similar technical requirements in order to minimise site inventory, reduce life cycle costs of all equipment and to enhance workforce familiarity with the items and equipment used. Components must be selected from the Preferred Equipment List specifications nominated in the scope of works so far as the performance, reliability and durability of the VSD's is not compromised. Any proposed departure from this Specification must be identified by the Tenderer and justified at the time of Tender.

6.2 Construction

The VSD's must be a fully Type Tested arrangement to AS 3439. They must be suitable for inclusion into a switchboard. The requirements of the Standard specification -EL-014 - "General Switchboard Requirements" and STD-EL-015 - "Low Voltage Switchboards"

Cubicle ventilation must be adequately sized to ensure heat generated by the variable speed drive is fully dissipated from the cubicle and the internal drive components and other apparatus included in the cubicle to not exceed the temperatures recommended by the equipment supplier. VSD enclosures should be adequately ventilated by fans mounted inside the enclosure.

The specified internal or external ambient air temperatures must be used for heat dissipation calculations, depending on which is appropriate.

A minimum clearance of 120 mm from the VSD sides to the cubicle sides and a minimum clearance of 200 mm above and below the VSD is required.

6.3 Electrical Requirements

The VSD's must conform to AS 3439 and the following requirements:

- rated currents must be as nominated in the Data Sheets;
- rated diversity factor of AS 3439 must be 1.0.

6.4 Temperature Rise

Equipment enclosures must be constructed, and the components within the enclosures must be sized, such that the temperature rise under rated operating conditions does not exceed 75% of the temperature rating of any of the components within the enclosure.

Particular attention must be paid to the temperature rise anticipated in the top functional unit in a tier containing a number of functional units, where this unit has a lower kilowatt rating than that of the lower functional units. Additionally, particular attention must be paid to this condition where electronic-type motor protection relays are utilised.

Equipment should not be located vertically one above the other unless adequate heat deflectors are provided to prevent heat from the lower equipment effecting the operation of the equipment above.

6.5 Controls and Accessibility

Control equipment other than indicating lights, push buttons, ammeters selector switches and the membrane keypad and LCD display must not be mounted on the enclosure door.

If any equipment requires removal or isolation for maintenance, inspection or servicing, it must be possible to do so with adjacent units alive. In such case, danger labels and shrouds must be provided for all terminals remaining alive at a voltage higher than 110 V AC.

All control wiring terminal blocks must be readily accessible.

All live parts above 110 V AC which are accessible when the unit cell door is open must be fully shrouded and labelled "DANGER – XXX VOLTS – ISOLATE ELSEWHERE", where "XXX" is the voltage rating of equipment to be shrouded.

Equipment must be located to allow sufficient access for the termination of motor power cables to load terminals whilst maintaining correct clearances between the cable lugs and switchboard metalwork.

7 SPECIFIC EQUIPMENT REQUIREMENTS

7.1 Equipment Design Parameters

The VSD's must be rated for the service conditions stated in the data sheets and, in addition, be rated for continuous operation at 100% motor rating. The unit must be capable of operating the specified motors without modifications to these motors.

The VSD's must be designed to minimise harmonic distortions being injected into the AC power system but, in any case, must be as stated in IEEE Publication 519. The VSD's supplier must provide a harmonic spectrum of THD current and THD voltage for their range of drives when connected to the power system. A harmonic spectrum for each drive at the main busbar must be submitted with the offer. If the anticipated THD voltage exceeds 5% and THD current exceeds 5%, the additional cost of series reactors or other harmonic minimising equipment must be included as an option. The correction effect of these options on the harmonic currents and voltages should be provided with this offer.

The VSD's output must not exceed 1000V peak with a maximum dV/dt of 500V /µ sec.

The Supplier must guarantee that nuisance tripping of upstream earth leakage protection systems must not be attributed to the operation of the VSD's for its full operating range. This guarantee shall include calculation and other documentary proof.

For the full operating range of the VSD's, audible noise emissions from the VSD's must not exceed 60 dBA one (1) metre from the source. The Supplier must provide a noise frequency analysis for the entire operating range of the VSD's, by a competent testing authority.

The VSD's must include EMI filters to limit conducted emissions being injected into the AC power supply to below the levels specified in AS 2064 Group 1 Class A. Certified Test Documentation indicating compliance to this standard is required.

Coil suppressors are to be fitted to each contactor and relay used in the VSD cubicle to eliminate electrical noise from these devices.

On VSD's where DC link reactors are used, cabling to and from the reactors must be as short as possible and kept separate from all control and low voltage wiring. The current rating of cabling to and from the DC reactors is to be a minimum of 1.35 times the full load current of the VSD.

7.2 Equipment Specification

The unit must utilise microprocessor based digital gating and control electronics. Serial communications outputs must be included for the monitoring of the unit's operation and performance.

The unit must be capable of the following features and operator interfaces:

1. input frequency/speed setting range suitable for DeviceNet connection;
2. output current suitable for DeviceNet connection;
3. straight forward set up and starting procedures;
4. comprehensive motor protection;

5. self diagnostic and protective functions;
6. fault memory for existing and previously acknowledged fault signals;
7. digital outputs (voltage free) to indicate status and fault signals. All digital outputs shall be suitable for DeviceNet connection.
8. remote start/stop functions via the plant PLC. All digital inputs shall be suitable for DeviceNet connection.
9. Door mounted key pad and display providing:
    - Primary functions, ie. Power on, system available, system fault, overload.
    - Parameter settings, ie. Accelerating / decelerating times, minimum / maximum output, frequency / speed limit and current limit.
    - Digital readouts, ie. Speed / frequency, voltage, current.
10. Minimum requirements for hardwired control shall be:
    - Stop;
    - Start;
    - Speed reference select;
    - Manual speed potentiometer;
    - Auto speed reference

7.3 Earthing

Earthing provisions for all electrical equipment must comply with the requirements for a power system IT with common earth electrode as defined by AS 3007.2.

All earthing facilities must comply with the requirements of AS 3000.

All electrical equipment must, even where not required by AS 3000, be provided with an earth termination.

Earthing of the variable speed drive must be to a separate earth stud adjacent to the drive and located not more than 300 mm from the VSD earth terminal. Earthing to the cubicle via VSD or other support bolts is not acceptable. The VSD earth stud and any earth bar supports should be welded to the cubicle structure.

Earthing of any EMI/RFI Filters specified should be bonded to the filter, preferably, using flat copper strap or braid and earthed at a point no greater than 150mm from the filter.

Doors and removable panels in enclosures must be bonded to the frame of the enclosure using flat braided conductors.

Gland plates must be solidly bonded to the main earth bar by separate earthing conductors.

8 CABLES AND WIRING

8.1 Communications

Efficient data communications must be established between the PLC and all intelligent devices used within the VSD's. In general, the VSD shall be installed in a cubicle in the relevant motor control centre. Any proposed deviation from this arrangement will require approval from Council. Where the VSD drive is mounted remotely to the PLC/Controller, ie. not in the same MCC, fibre optic cables must be used for the DeviceNet connection

Status, parameter settings and live operational data must be monitored as a minimum. In addition, it is preferred to be able to make parameter changes across this communications link.

9 PAINTING AND CORROSION PROTECTION

All enclosures must be painted and finished in high gloss enamel paint. The interior must be white, or an approved off white light colour (min. reflectance 70%). The exterior must be White unless otherwise specified.

All external welds must be ground smooth and all sharp edges and burrs must be removed.

All metal work must be thoroughly prepared for painting and must be cleaned of all rust, grease and foreign materials, etc., then primed, under-coated and finished with a high gloss baked enamel paint using materials recommended and supplied by one manufacturer.

Finish must be resilient to withstand rough handling and such that on site paint repairs can be effected quickly and easily with standard methods. Minimum thickness of coatings must be 40 microns and must completely cover all edges.

10 TESTING

10.1 General

All equipment must be fully tested and test run by the Manufacturer at the Manufacturer's facilities, in accordance with this Specification.

All tests to be carried out on the equipment must be detailed and submitted to the Council prior to the carrying out the tests and final inspection.

Certificates of all Type Tests, including test for Temperature Rise to AS 3439.1 for the enclosure must be provided.

A Pre-operational Testing Log must be prepared during the tests and must be presented to the Council prior to delivery of the VSD's. The Test Log is to consist of tabulated results of all tests undertaken as well as descriptions of the test procedures adopted.

The following tests are considered to be the minimum acceptable and any additional tests necessary to ensure the correct operation and integrity of the VSD's must be carried out and documented in the Test Log:

10.2 Routine Tests

Routine tests to AS 3439.

10.3 Sequence Testing

Sequence testing is to be carried out to prove the effectiveness of each system or device in accordance with the operations manual, the schematic diagrams and the machine design.

10.4 Injection Testing

All protection relays are to be primary injection tested to prove the effectiveness of current transformer circuitry and relays. These tests must be carried out under the following conditions:

- with all devices set to their minimum current operating setting and minimum CT current necessary to operate the associated devices;
- at three (3) points between 100 and 200 % of the CT full rated current;
- at 10 times CT rated current.
- The CT polarity is to be confirmed by the primary injection test.

10.5 Circuit Wiring

The VSD's tests must encompass all work necessary to determine that the circuit wiring is numbered in accordance with the schematic diagram and each wire is identified at both ends by the number depicted in the circuit diagram.

10.6 Insulation Measurements

Insulation tests as per specifications nominated in the scope of works.

10.7 Temperature Rise Test

Temperature rise tests to AS 3439.1.

10.8 Australian Standard's Test

All tests detailed in the appropriate Australian Standards.