



THE UNIVERSITY OF  
**AUCKLAND**  
Te Whare Wānanga o Tāmaki Makaurau  
NEW ZEALAND

## Property Services Design Standards and Guidelines

# Section 8 Electrical for Mechanical and Associated Services

Version 1.1



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## 8 Electrical for Mechanical and Associated Services

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## 8.1 Introduction

### Introduction

This section shall be specifically read in conjunction with *Section 1 About this Document* and *Section 2 Project and Building Works Requirements* of the UoA Property Services Design Standards and Guidelines.

#### 8.1.1 Purpose

The purpose of this section is to outline the standards required for the design and implementation of electrical for mechanical for all capital, minor capital and maintenance project building works.

The guidelines outlined within this section are not project specific. It is the responsibility of the consultant or designer to develop a design specific to the project design brief and objectives, as well as satisfying site specific and end user requirements.

Where departures from these guidelines are deemed necessary, these shall be reported to FM. Failure to do so could incur rectification at the expense of the installer.

#### 8.1.2 Regulations, codes and standards

Electrical services design shall comply with the requirements of the latest revision of applicable standards and regulations. Specific overarching statutory requirements include, but are not limited to:

- NZ Building Code and applicable NZ/AS Standards
- AS/NZS 3000 (Wiring Rules)
- NZ Building Act
- Health and Safety in Employment Act
- Electricity Act
- Electricity (Safety) Regulations
- Electricity Codes of Practice
- Territorial Authority Requirements.

#### 8.1.3 Applicable standards

This table lists the standards that are applicable to Electrical for Mechanical and Associated Services.

**Note:** The list is not exhaustive and if superseded by other standard(s), the latest version and/or amendment applies.

**Table 1: Electrical for mechanical and associated services standards**

Standard	No	Title
AS	2184	Low voltage switchgear and control gear - Moulded-case circuit-breakers for rated voltages up to and including 600 V ac and 250 V dc.
AS	60044.1	Instrument transformers – Current transformers
AS	60529	Degrees of protection provided by enclosures (IP Code)

Standard	No	Title
AS	60947	Low-voltage switchgear and control gear
AS	62040	Uninterruptible power systems (UPS)
AS/NZS	1359	Rotating electrical machines
AS/NZS	1429	Electric cables – Polymeric insulated
AS/NZS	1680	Interior lighting - Safe movement
AS/NZS	1768	Lightning protection
AS/NZS	2053	Conduits and fittings for electrical installations
AS/NZS	2293	Emergency evacuation lighting for buildings
AS/NZS	2430	Classification of hazardous areas
AS/NZS	3000	Electrical Installations (known as the Australia/New Zealand Wiring Rules)
AS/NZS	3008.1	Electrical installations – Selection of cables – Cables for alternating voltages up to and including 0.6/1 kV
AS/NZS	3013	Electrical installations – Classification of the fire and mechanical performance of wiring system elements
AS/NZS	3100	Approval and test specification – General requirements for electrical equipment
AS/NZS	3133	Approval and test specification – Air-break switches
AS/NZS	3191	Electric flexible cords
AS/NZS	3439	Low voltage switchgear and control gear assemblies
AS/NZS	3760	In-service safety inspection and testing of electrical equipment
AS/NZS	3820	Essential safety requirements for electrical equipment
AS/NZS	3947	Low-voltage switchgear and control gear
AS/NZS	4024	Safety of machinery
AS/NZS	4961	Electric cables – Polymeric insulated – For distribution and service applications.
AS/NZS	5000	Electric cables – Polymeric insulated
AS/NZS	61000	Electromagnetic compatibility (EMC)
AS/NZS	60269	Low-voltage fuses
AS/NZS	60598	Luminaires – General requirements and tests
AS/NZS	60702	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V
AS/NZS	60898	Electrical accessories – Circuit breakers for overcurrent protection for household and similar installations
AS/NZS	60921	Ballasts for tubular fluorescent lamps - Performance requirements
AS/NZS	61008	Residual current operated circuit breakers without integral overcurrent protection for household and similar uses (RCCBs)
AS/NZS	61009	Residual current operated circuit breakers with integral overcurrent protection for household and similar uses (RCBOs)
AS/NZS	61347	Lamp control gear - General and safety requirements
IEC	60099	Surge arresters - Part 1: Non-linear resistor type gapped surge arresters for ac systems
IEC	60255	Measuring Relays And Protection Equipment
IEC	60831	Shunt power capacitors of the self-healing type for ac systems having a rated voltage up to and including 1000 V

Standard	No	Title
NZEC	35	New Zealand Electrical Code of Practice for Power Systems Earthing
NZS	4219	Seismic performance of engineering systems in buildings
NZS	6106	Specification for capacitors for connection to power-frequency systems

#### **8.1.4 Design documentation**

In addition to design documentation as outlined within *Section 2 Project and Building Works Requirements* of the *Property Services Design Standards and Guidelines*, the consultant or designer may be requested to make available to FM to review, electrical design calculations for:

- Selection of circuit protective devices
- Prospective load current, including diversity and utilisation assumptions
- Cable sizing, including volt drop and de-rating factors
- Prospective short circuit current
- Disconnection times for protective devices
- Discrimination and cascading.

## 8.2 Abbreviations and Definitions

### Electrical for Mechanical and Associated Services abbreviations

**Table 2: Electrical for mechanical and associated services abbreviations**

Abbreviation	Description
AFFL	Above finished floor level
ACB	Air circuit breakers
AV	Audio visual
BACnet	Building Automation and Controls Network
BFGL	Below finished ground level
BMS	Building Management System
CT	Current transformer
DB	Distribution board
DOL	Direct on line
EC	Electronically Commutated (motor)
EEI	Electrical and electromagnetic interface
ELV	Extra low voltage
EMC	Electromagnetic compatibility
ESCS	Element screened and collective screen
FM	Facilities Management
GPO	General power outlet
HDPE	High density polyethylene
HMI	Human machine interface
HRC	High rupture capacity
HV	High voltage
IP	Ingress protection
ITS	Information Technology Services
LED	Light emitting diode
LV	Low voltage
MCB	Miniature circuit breaker
MCC	Motor control centre
MCCB	Moulded case circuit breaker
MEN	Multiple Earth Neutral
MIMS	Mineral-insulated metal-sheathed
MSB	Main switchboard
MSSB	Mechanical services switchboard
MSTP	Master slave token passing
MV	Medium voltage
NZCEP	New Zealand Electrical Codes of Practice
PCB	Printed circuit board
PEW	Prescribed electrical work
PLC	Programmable logic controller

Abbreviation	Description
PQM	Power quality meter
RCBO	Residual current circuit breaker with overload protection
RCCB	Residual current circuit breaker
RCD	Residual current device
UPS	Uninterruptible power supply
UPVC	Unplasticised poly vinyl chloride
VSD	Variable speed drive
WAC	Wireless area controller



## 8.3 Installation

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### General

Installations shall comply with the requirements of *Section 5 Electrical Services* of the *UoA Property Standards Design Standards and Guidelines* and the requirements detailed in this section (Section 8).

All electrical for mechanical work shall be carried out by competent contractors with a proven track record. All work shall comply with the Electrical (Safety) Regulations, the latest applicable standards and the NZ Building Code.

The consultant or designer and contractor shall be responsible for coordination with UoA nominated BMS controls engineers to ensure the mechanical services installation is successfully completed to the correct design functionality.

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### 8.3.1 Cabling and wiring

Refer to:

- *General Cabling and Wiring* in *Section 5 Electrical Services* of the *UoA Property Standards Design Standards and Guidelines*
  - Other topics in this section.
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### 8.3.2 Cable containment and support

Refer to *Section 2 Project and Building Works Requirements* of the *UoA Property Standards Design Standards and Guidelines*.

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### 8.3.3 Equipment isolation

All mechanical plant shall be provided with the local isolation facility located adjacent to the equipment in an accessible position. The isolation facility shall be labelled with the relevant Maximo asset number and circuit reference.

Isolation switches shall be rated higher than the current carrying capacity of the load and capable of load breaking, with provisions for locking as a point of isolation.

Where mechanical equipment load ratings allow, motors shall be fitted with a pluggable connection.

All isolation devices that are located in chemically corrosive or wet environments shall be rated to a minimum of IP 56.

All isolation devices mounted outdoors shall be rated to a minimum of IP 56.

Where practicable, PDL 56 series switches shall be used for mechanical services isolation provisions.

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### 8.3.4 Earthing and bonding

Refer to *Earthing, Bonding and Surge Protection* in *Section 5 Electrical Services* of the *UoA Property Standards Design Standards and Guidelines*

All exposed conductive equipment such as cable containment systems, pipework, equipment chassis, electrical control enclosures and alike, shall be bonded in compliance with the latest applicable standards.

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### **8.3.5 Circuit protection devices**

Circuit protective devices shall comply with the latest applicable standard. Refer to *Circuit protection devices in Section 5 Electrical Services* of the *UoA Property Standards Design Standards and Guidelines* for details.

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## 8.4 Mechanical Services Switchboards / Motor Control Centre

### General

All switchboards shall be compliant with the latest applicable standards.

Mechanical services switchboards (MSSB) and associated motor control panels (MCC), shall, where practicable, be provided as a dedicated switchboard.

Where practicable, MSSBs and MCCs shall be located in plant room locations and shall be compliant with the latest revision of applicable standards.

For outdoor locations, MSSBs and MCCs shall be weather proof.

### 8.4.1 Mechanical Services Switchboard / Motor Control Centre Requirements

**Table 3: Mechanical services switchboard / motor control centre requirements**

Function	Requirements
Power supply	3 phase MEN 400V 50Hz / Single phase MEN 230V 50Hz
Standard	AS/NZS 3439
Type test	IEC 61439
Busbars	<ul style="list-style-type: none"> <li>• Copper, colour coded for the respective phase / neutral conductor.</li> <li>• Sized in excess of the maximum current carrying capacity and to withstand the calculated short circuit stress conditions.</li> <li>• Neutral busbar same current carrying capacity as phase conductors.</li> </ul>
Internal separation	<ul style="list-style-type: none"> <li>• Minimum form 2x.</li> <li>• Minimum form 3b for essential power supply applications.</li> <li>• Separate functional cells for electrical distribution, motor controls, extra low voltage controls equipment.</li> </ul>
External access	<ul style="list-style-type: none"> <li>• Front panels hinged for access.</li> <li>• Rear and side panels screw fixed.</li> </ul>
Material	<ul style="list-style-type: none"> <li>• Mild steel for general conditions.</li> <li>• Stainless steel to 316L for external or harsh environmental conditions.</li> </ul>
Exterior finish	<ul style="list-style-type: none"> <li>• Powder coated to manufacturer's standard finish and colour / polyester epoxy resin paint to suit environmental conditions.</li> </ul>
Environmental condition ranges	<ul style="list-style-type: none"> <li>• 4°C to 40°C</li> <li>• Ambient humidity 10% to 85%</li> <li>• &lt;100m above sea level</li> </ul>
IP rating	Minimum IP 42 for electrical rooms; IP 54 where sprinkler protection is provided.
Metering requirement	kWh metering required for major plant equipment, as per energy metering requirements.
Mounting	Floor mounting, unless specified otherwise.
Fault level	In accordance with prevailing fault current.

Function	Requirements
Earthing arrangement	MEN TN-C-S Earth neutral unlinked.
BMS controls	As required, refer to <i>Section 7 Building Management System</i> in <i>UoA Property Standards Design Standards and Guidelines</i> .
Expansion	Provision for future expansion: spare cells for population of additional control devices, sufficient current carrying capacity for a minimum of 20% load increase.
Location / dimensions	<ul style="list-style-type: none"> <li>Located in a designated plant room or electrical cupboard at a safe distance from sources of water and other hazards.</li> <li>Dimensions to suit the room location and provide sufficient space for installation and maintenance, with separation distances to comply with the latest applicable standards.</li> <li>All parts of the assembly shall be accessible for ease of maintenance.</li> </ul>
Outdoor locations	<ul style="list-style-type: none"> <li>Weather-proof coating or fabricated in stainless steel 316L.</li> <li>Internal condensation heaters required.</li> </ul>
Documentation	<ul style="list-style-type: none"> <li>Full set of shop drawings, as-built single line diagram(s) and schematic drawings shall be provided.</li> <li>A document holder, containing a full set of drawings, shall be provided as part of the assembly.</li> </ul>

#### 8.4.2 MSSB/MCC components

MSSB/MCCs shall be provided with:

- Mains isolation facility, either isolation switch or protective device such as an ACB or MCCB which disconnects each incoming supply.
- Interface with the fire alarm system for isolation of supplies to mechanical equipment, and where required, interface to enable critical fire safety equipment. The designer shall consult with the project manager and associated fire engineer.
- For each item of mechanical plant and controls equipment installed:
  - Auto / OFF / Manual (AOM) switch. AOMs shall be mounted on the front panel and clearly labelled showing function and equipment unique identifier
  - Run, Stop and Fault indicating LEDs complete with lamp test facility
  - Protective device(s) such as circuit breaker and motor thermal overload
  - Motor starter device such as direct on-line (DOL), soft starter, variable speed drive (VSD), or connections to external starting device(s)
  - Where required, interface relays and/or contactors for other associated equipment. The designer shall consult with the project manager for requirements
  - BMS controls or interface to remote BMS controls. The designer shall consult with the project manager and BTL.

Where switchgear or control equipment is fitted for life safety or essential functions, equipment shall be accessible for service without disruption to the essential services served by the board.

### **8.4.3 Labelling**

Refer to *Maximo Plant Identification in Section 2 Project and Building Works Requirements* of the *UoA Property Standards Design Standards and Guidelines* for Maximo numbering requirements.

MSSBs, MCCs and BMS control modules shall be labelled with corresponding UoA Maximo number.

All cabling shall be identified with circuit number or unique identifier using cable markers and ferrules fitted at each termination point.

All equipment shall be identified with labels and numbers corresponding to the as-built documentation.

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### **8.4.4 Switchgear accessories**

Refer to *Section 5 Electrical Services* of the *UoA Property Standards Design Standards and Guidelines* for details.

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## 8.5 Variable Speed Drives (VSDs)

### General requirements

Variable speed drives (VSDs), shall be provided for applications where requirements include minimising high starting currents, speed control, flexibility to adjust pre-set speed. Applications include, but are not limited to:

- Air handling units
- Air conditioning system return fans
- Mechanical ventilation fans
- Mechanical services pumps, i.e. CHW, HHW and CDW. For small pump applications, such as canned rotor type pumps, VSDs may be integral to the pump.

VSDs shall be installed in compliance with the manufacturer’s recommendations, located in plant rooms with maintenance access, and near the mechanical equipment they serve.

VSDs shall be fully configured, programmed and commissioned by the nominated BMS controls contractor.

### 8.5.1 VSD Requirements

**Table 4: VSD requirements**

Function	Requirements
Power supply	3 phase MEN 400V 50Hz / Single phase MEN 230V 50Hz
Standard	AS 61800.x Adjustable speed electrical power drive systems
Manufacturer	Siemens, Vacon preferred; other manufacturers require approval by UoA
Size, rating	Rated to withstand the full load operating current of the motor without operation of the protective devices
Electrical protection	Over voltage; Under voltage; Motor short circuit protection; Motor over-current; Instantaneous over-current; Phase loss detection; Phase imbalance detection; Stall protection; VSD over-temperature; Motor winding over-temperature (via embedded thermistors, if provided); Earth fault
Motor cable length	Minimum practicable distance; < manufacturer’s recommended distance
Environmental condition ranges	<ul style="list-style-type: none"> <li>• 4°C to 40°C</li> <li>• Ambient humidity 10% to 85%</li> <li>• &lt;100m above sea level</li> </ul>
IP rating	Minimum IP 54 for surface mount
PCB protection	All printed circuit boards conformal coated for moisture and environment protection
EMC	If required, addition of EMC filters to comply with AS/NZS 61000
Efficiency	≥ 95% @ 90 to 100% load conditions
Speed control range	0 to 120% of motor rating

Function	Requirements
HMI	<ul style="list-style-type: none"> <li>Display (minimum): Motor current; Motor frequency/speed; Motor voltage; Alarms; Faults.</li> <li>Control (minimum): Manual speed adjustment; Local overload reset.</li> </ul>
BMS interface	Required for monitoring key parameters, alarms and, if required, speed control. Refer to <i>Section 7 Building Management System</i> in <i>UoA Property Standards Design Standards and Guidelines</i> .
External controls	Manual 'start', 'stop', 'off' and 'auto' (BMS); 'run' and 'fault' lamps. External controls typically located in associated switch board.
Location / dimensions	<ul style="list-style-type: none"> <li>Located in a designated plant room or electrical cupboard at a safe distance from sources or water and other hazards of source of corrosion.</li> <li>Accessible for ease of maintenance.</li> </ul>
Labelling	UoA Maximo convention, including clear identification of the equipment which they serve.
Documentation	Schematic drawings, general layout drawings, configuration list – printed and provision in electronic format.
Power interruption event	Unless specified otherwise, following a power interruption event, VSDs shall automatically restart to normal operating conditions with all program settings retained.
Continuous running	Where provided with ride-through facility, VSDs shall be configured for continuous running through short power supply voltage sags.

### 8.5.2 VSD to motor cabling

VSD to motor cabling shall:

- Be the minimum practicable length
- Be braided screened cable
- Have continuous screening with the motor power cable screen connected to earth at both ends
- Be connected to earth via proprietary cable clamps (or glands) to the metal chassis of the equipment.

### 8.5.3 VSD to BMS connectivity

VSDs shall have connectivity with the UoA BMS. Communication protocols include BACnet IP (MSTP), RS232 (Modbus) communication protocol or hardwired inputs and outputs.

Available VSD data shall be, but not limited to:

- Overload fault
- Phase failure
- Hours run
- Selector switch manual / off / auto
- Motor speed.

For further details and requirements of VSD BMS reporting, refer to *Section 5 Electrical Services* of the *UoA Property Standards Design Standards and Guidelines*.

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## 8.6 Electric Motors

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### General

All motors shall comply with the latest applicable standards.

All motors shall comply with Commission Regulation (EU) No 327/2011 and have AC motors with Efficiency class of minimum IE3. The supplier shall consider motors with efficiency of IE4 (Super-Premium Efficiency) dependent on availability.

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### 8.6.1 Requirements

Motors shall be provided:

- As type Electronically Commutated (EC) unless approved otherwise
  - Minimum IP 44
  - As continuous duty in compliance with *International Electrotechnical Commission (IEC) - S1; Continuous duty*
  - *With Airflow Coolant/Self Circulating cooling to Code IEC – 41; As insulation class E or higher for constant speed motors, not less than class H for motors driven by VSDs*
  - Vibration free, in combination with the mechanical load
  - With seismic restraints and fixed in accordance with the manufacturer's recommendations
  - With nameplate information details in English.
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### 8.6.2 Thermistors

Thermistors shall be fitted to motors greater than 11 kW which are not fitted with forced cooling and/or where speed is controlled by VSDs.

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## 8.7 Motor Starters

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### General

Where VSDs are not installed, a suitably rated motor starter shall be provided.

Selection options include direct on line (DOL), solid state starters ('soft starters') and star delta starters. Selection criteria will depend on the specific application and size of the motor. High starting currents shall be avoided for larger motors, typically greater than 11kW, where either a soft starter (preferred option) or star delta starter shall be provided.

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### 8.7.1 Requirements

Motor starters shall:

- Have overloads fitted with manual reset facility
  - Have contactor coils rated for the supply voltage
  - Have starter rating greater than the motor locked rotor current with contingency allowance for applications with high frequency of operation
  - Have overload and protection settings that comply with the motor manufacturer's guidelines
  - Be fitted with fault and run status facility, for connectivity to the BMS
  - Be provided with manual controls for 'auto', 'manual' and 'off' selection.
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## 8.8 Fire Mode Operation

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### 8.8.1 Response to fire alarm

Modes of operation for mechanical services plant in response to a fire alarm shall be in accordance with the specific requirements of the project and/or building application and in compliance with the NZ Building Code, and:

- **On UoA capital works projects**, the project Fire Engineer's fire safety report.
- **On UoA minor capital works and/or maintenance projects**, as a minimum, adopt the existing fire mode response strategy of the installed mechanical services. Pre-existing mechanical services O&M Manual shall be referred to by the designer for verification of existing fire modes.

As a general guide, mechanical services systems shall shutdown upon building fire alarm signal.

**Note:** The exception being mechanical services fire and smoke safety systems, or where otherwise specified by the UoA or Fire Engineer.

Where applicable, fire and smoke safety mechanical services systems shall be designed and installed in accordance with the requirements of the latest applicable standards.

The fire alarm signal to mechanical services plant shall be a hard-wired connection from volt free contacts within the building fire alarm panel to MSSB/MCCs. Circuit design shall be fail-safe under fault condition.

The fire alarm signal shall be connected to the BMS for remote monitoring and alarming purposes.

Upon fire alarms being de-energised, all mechanical services plant shall automatically reset to 'normal' service modes; the exception being natural gas solenoid valves and steam control valves which shall be fitted with a manual reset.

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