Project Title:

Electrical Services

for

Main Switchboard Replacement Generator Supply & Installation

at

Biloela Civic Centre, Corner of Rainbow & Prairie Street, Biloela

Client: **Banana Shire Council**

DOCUMENT PREPARED BY:

Anderson Consulting Engineers
43 Denison Street
ROCKHAMPTON. QLD. 4700
Phone: (07) 49 272077
Email: rockhampton@andersonce.com.au

Specification Identification	23165C-6
Issue	B
Date	August 2024

TABLE OF CONTENTS

ATTACHMENTS AND INCLUSIONS:

As per 901.2

Date	Revision	Details	Approved
April 2024	P1	23165C-6	
August 2024	A	23165-C	
August 2024	B	23165-C	

0900 ELECTRICAL SERVICES SCHEDULE TO ACESPEC REFERENCE SPECIFICATION

STRUCTURE OF THE SPECIFICATION

Format

General: This Specification uses a reference (2 part) format, and comprises two parts as follows:

- This Project Schedule
- The ACESPEC Reference Specification Worksections (Acespec is based on Natspec with alteration as noted)

Application: The reference Specification Worksections form part of the Specification, subject to amendments made to the Reference Specification Sections by the Project Schedule and drawings. Requirements of this Project Schedule and drawings override conflicting requirements in the reference Specification Sections. Where conflicts in requirements occur within the specifications and drawings the most onerous requirement shall be applied.

The reference Specification Sections are attached.

KEYWORDS

Clauses in the Reference Specification Worksections are called up by the keywords in the Project Schedule.

Clauses are deleted, modified or extended by noting against the keyword.

Types and Options are indicated in the Project Schedule as are any modifications to the standard worksection required for this project.

0901 ELECTRICAL SYSTEMS

0901.1 GENERAL

The electrical services associated with this sub-contract shall include the supply, fabrication, installation, connection, commissioning and testing of the complete electrical services including the following:

- New consumer's mains - Civic Centre.
- New consumer's mains – Resource Centre
- Remove existing main switchboard
- New main switchboard with proprietary automatic transfer switch and generator connection.
- Remove existing site main switchboard.
- Metering changes as nominated including arranging removal of existing meters at appropriate time during works.
- Detailed investigation of existing circuits. Each to be identified prior to relocation.
- Notify Council of any required penetrations to ceiling, walls, etc or required access panels for approval prior to proceeding.
- Provide program of works with shutdown requirements for review by Council. Ensure Council are aware of the period required for full changeover.
- Required works for new earth or determine if existing earth is suitable.
- Reuse existing colour bond hat section, screw fixed risers over new cable trays and cabling to ceiling space.
- New colour bond hat section where noted
- Standby generator and connection.
- Provide sufficient fuel for 4 hour testing and complete 4 hour load test after installation in final location
- Fill tank at completion

- Provide Seismic restraints for Generator
- Fenced generator enclosure
- Miscellaneous equipment as specified.
- Incidental works including but not limited to:
    - Cable trays, baskets, risers, catenaries and other cabling facilities.
    - Over-flashing to all penetrations through external surfaces.
    - Casting in of conduits and termination points.
    - Painting and services identification.
    - All additional works necessary to provide completely operative installations in accordance with the performance guarantee of this specification.

The sub-contractor shall make good defects, maintain and service the installation for the Defects Liability and Maintenance Period.

All works shall be completed on co-ordination with the overall building programme.

0901.2 DRAWINGS

The following drawings form part of this document.

Drawing No.	Title
23165C-E001	Single Line Diagram. New Main Switchboard
23165C-E002	Site Plan

0901.3 SUB-CONTRACTOR TERMINATION POINTS

Work covered by this specification shall be complete and fully independent within the limits of the site and structure and the following termination points (at which it shall connect to existing systems or systems installed by other trades), co-ordinate these terminations points with other trades prior to commencing any associated work.

- Connect to electricity retailer point of supply.
- Connect to existing submains and sub-circuits.

0901.4 ASSOCIATED WORKS BY OTHERS

The contractor shall be responsible for the co-ordination with other trades including for the following associated works:

By Principal:

- Costs associated with metering changes.

By Building Contractor and other Trades:

- NIL.

0901.5 SITE VISITS

Tenderers are requested to visit the site by prior appointment (minimum 24 hours notice), arranged with nominated person scheduled of tender details.

Where as installed and maintenance manuals' exist for the particular equipment, these may be viewed; arrangements to be made also with the above.

Detailed inspection of the site and plant is recommended to all tenderers so that the full scope of the required works, access and similar items may be assessed. No increase to the contract sum will be granted for required works ascertainable from careful inspection of the site, equipment and, where available, the `As installed and maintenance manuals.

0901.6 CROSS REFERENCES

General

Requirement: Conform to the following worksections included in this specification:

0901 Electrical Systems

0903 General requirements - Electrical

0911 Cable Support and Duct Systems

0921 Low Voltage Power Systems

0941 Switchboards – Proprietary

0942 Switchboards – Custom built

0991 Electrical maintenance

0901.7 CERTIFICATION

Prior to Practical completion provide compliance certification and Form 16 for the specified work. The compliance certificate shall state as follows:

> "I certify that the electrical installation to the extent it is affected by the electrical work, has been tested to ensure that it is electrically safe in accordance with the requirements of The Wiring Rules and any other Standard applying under the Electricity Safety Regulation 2013 to the electrical installation".
>
> The installation complies fully with all requirements of the contract documents as well as all relevant Standards, Acts and Regulations
>
> All systems installed as part of this sub-contract have been fully inspected, tested, commissioned and function to the specified requirements
>
> The installation is fully operational including all connections to other services (installed by other trades)
>
> Installation methods, safety and operating controls are in accordance with the manufacturer's requirements and no warranties are voided

At the end of the defects liability period, provide a second compliance certificate stating that the installation has been maintained as specified and in accordance with relevant Australian Standards throughout the defects liability period.

Also provide a Form 12 in accordance with the requirements of the Department of Housing and Public Works for all services included in the contract.

Where sub-contractors are used to complete specialist services, provide a written certificate and Form 12 for each.

All certificates shall be signed by the tradesperson responsible, with the contractor's licence number stated.

Provide one copy of each compliance certificate and Form 12 in each of the maintenance manuals.

0901.8 WARRANTIES

General:

Provide warranties for the electrical services as follows:

- 12 months on installation and equipment

Warranties shall be provided at completion of the work, commencing at the date of the relevant areas practical completion

Note: Additional warrantee period for communication cabling specified herein.

0901.9 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0901-Electrical Systems attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Design	Yes
1.3	Standards	Yes
1.4	Contract Documents	Yes
1.5	Submissions	Yes
1.6	Inspections	Yes
2	Products	
2.1	Electrical Accessories	Yes
3	Execution	
3.1	Work on Existing Systems	Yes
3.2	Switchboards	Yes
3.3	Support of Plant and Equipment	Yes

0903 GENERAL REQUIREMENTS - ELECTRICAL

0903.1 GENERAL

Conform to general requirements as specified herein.

0903.2 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0903 – General Requirements - Electrical attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	**General**	
1.1	Responsibilities	Yes
1.2	Design	Yes
1.3	Precedence	Yes
1.4	Cross References	Yes
1.5	Referenced Documents	Yes
1.6	Interpretation	Yes
1.7	Familiarisation with the site	Yes
1.8	Variation claims	Yes
1.9	Complementary documents	Yes
1.10	Contract documents	Yes
1.11	Submissions	Yes
1.12	Inspections	Yes
2	**Products**	
2.1	General	Yes
2.2	Materials and Components	Yes
2.3	Alternative products	Yes
3	**Execution**	
3.1	Samples	Yes

3.2	Shop Drawings	Yes
3.3	Off-Site Disposal	Yes
3.4	Wall Chasing	No
3.5	Fixing	Yes
3.6	Services Connections	Yes
3.7	Services installation	Yes
3.8	Building Penetrations	Yes
3.9	Concrete plinths	Yes
3.10	Support and Structure	Yes
3.11	Access for Maintenance	Yes
3.12	Vibration Suppression	No
3.13	Seismic Restraint of Non-Structural Components	Yes
3.14	Finishes to building Services	Yes
3.15	Marking and Labelling	Yes
3.16	Software	No
3.17	Warranties	Yes
3.18	Record Drawings	Yes
3.19	Operation and Maintenance Manuals	Yes
3.20	Electronic Facility and Asset Management Information	No
3.21	Tools and Spare Parts	No
3.22	Testing	Yes
3.23	Training	No
3.24	Cleaning	Yes
3.25	Periodic maintenance of Services	Yes
3.26	Post Construction Mandatory Inspections and Maintenance	No
3.27	Interruptions to Supply	Yes
3.28	Site Access	Yes
3.29	Asbestos	Yes
3.30	Fire Detectors	No

0903.3 SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS SCHEDULE

Seismic restraints to AS 1170.4 are required for this project.

The basis of the seismic restraints shall be as follows. Prior to final design compare with structural and architectural specified values.

Earthquake design category	ECD II
Importance level of structure	3
Probability factor (kp)	1.3
Hazard factor (Z)	0.06

0903.4 SUBMISSIONS SCHEDULE

General	
Submit to	Superintendents representative
Submission response times	
Shop Drawings	5 working days
Samples and prototypes	5 working days
Manufacturers' or suppliers' recommendations	5 working days
Product data	5 working days
Product/design substitution or modifications	5 working days
Electronic submissions	
Electronic copies file format	PDF
Transmission medium	Email

0903.5 CORROSION RESISTANCE SCHEDULE

Corrosivity category shall be as follows:

Exterior atmospheric corrosively category	C3

0903.6 SHOP DRAWING SCHEDULE

Shop drawing submission requirements shall be as follows:

Submission medium	Electronic
Drawing size	A1
Standard	1:50
CAD base drawings	AutoCAD (minimum version 2011)

0903.7 NOISE LEVEL SCHEDULE

Maximum noise levels shall be as follows:

Property	**A**
Externally	To relevant statutory requirements
Internally	Not exceed maximum recommendations of AS 2107

0903.8 WARRANTY SCHEDULE

Minimum warranties shall be as follows:

Warranty	**Period**
All equipment	12 months

0903.9 MAINTENANCE REQUIREMENT SCHEDULE

Minimum maintenance period shall be as follows:

Provision	**Maintenance period (months)**
All new equipment	12 months

0909 SCHEDULE OF WORKS

0909.1 GENERAL

Organize pre-start meetings with the Client to discuss suitable dates for any required shut-down work. Minimum two weeks notice shall be given to the Client after confirmation dates are suitable for shut-down work. Advise the Client the day before to ensure they shut-down their server equipment etc. Shut-downs shall be kept to a minimum and shall be completed out of normal operating hours.

0910 DEMOLITION

0910.1 GENERAL

General: Make safe for demolition, removal of switchboard, distribution boards and associated redundant equipment and wiring.

Requirement: Demolish and remove from site:

- Existing main switchboard as mentioned above.
- Existing redundant consumer mains.

The demolition shall include all associated items including cabling, timers, etc.

Hand the following equipment over to the client on removal:

- Nil

Environmental: Comply with statutory and best practice in relation to environmental issues, ensuring there is no environmental contamination due to the Works.

Asbestos: prior to commencing work on site, review the asbestos register, and confirm if any items to be removed or disturbed, contain asbestos. Ensure correct methodologies are used for its handling and removal.

0911 CABLE SUPPORT AND DUCT SYSTEMS

0911.1 GENERAL

Provide cable support and duct systems as specified herein and shown on the drawings.

0911.2 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0911 – Cable Support and Duct Systems attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Cross References	Yes
1.3	Interpretation	Yes
1.4	Submissions	Yes
2	Products	
2.1	General	Yes
2.2	Conduits	Yes
2.3	Metallic Conduits and Fittings	Yes
2.4	Non-Metallic Conduits and Fittings	Yes
2.5	Cable Duct/Trunking	No
2.6	Cable Tray Ladder Support System	No
2.7	Catenary Systems	No
2.8	Cable Pits	No
2.9	Columns	No
2.10	Power Poles	No
2.11	Custom Designed Poles/Columns	No
3	Execution	
3.1	General	Yes
3.2	Unsheathed Cables – Installation	No
3.3	Conduit Systems - Installation	Yes
3.4	Cable Support Systems - Installation	Yes
3.5	Catenary Systems - Installation	No
3.6	Cables in Trenches – Installation	Yes
3.7	Columns – Installation	No
3.8	Power Poles – Installation	No
3.9	Underground Services	Yes

0911.3 SCHEDULE OF SUBMISSIONS REQUIRED:

Item	Required
Structural Engineer certification for: - Penetrations of walls	Where not covered by standard designs.
Operation and Maintenance Manuals	At completion
Shop drawings: - Trunking routes	-
Technical data for: - Ducted wiring enclosure systems.	-

0921 LOW VOLTAGE POWER SYSTEMS

0921.1 GENERAL

Provide low voltage power systems as specified herein and shown on the drawings.

0921.2 ELECTRICAL SUPPLY

General: Connect to the existing consumer mains cabling supplying the building. Co-ordinate fully with Energy retailer for the metering changes and provide all necessary forms and assistance. Note that there are no changes to the building or load.

0921.3 RCD PROTECTION OF FINAL SUBCIRCUITS

Provide RCD protection of all final subcircuits in accordance with Australian Standards but including outlets and equipment up to 40 Amp.

0921.4 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0921 –Low Voltage Power Systems attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Design	Yes
1.3	Performance	Yes
1.4	Cross References	Yes
1.5	Standards	Yes
1.6	Interpretation	Yes
1.7	Submissions	Yes
2	Products	
2.1	Site Electricity supply	Yes
2.2	Remote Monitoring	No
2.3	Wiring Systems	Yes
2.4	Power Cables	Yes
2.5	Electrical accessories	No
3	Execution	
3.1	Site Electrical Supply	Yes
3.2	Earthing	Yes
3.3	Power Cables	Yes
3.4	Copper Conductor Terminations	Yes
3.5	Aluminium Conductor Terminations	No
3.6	Aerial Cables - Power	No
3.7	Accessories	No
3.8	Testing	Yes

0931 POWER GENERATION – ENGINE DRIVE

0931.1 GENERAL

Provide new generator system including associated equipment for a complete and conforming installation.

The generator shall be Atlas Copco, Eneraque (Megagen), or Cummins. Tender pricing shall include one of these approved options. An equivalent may be submitted for approval but pricing must include an approved option also. The generator shall also have a fuel tank of poly or stainless steel construction.

The emergency stop push button shall be in a lockable enclosure with clear vandal proof cover so the E-Stop is visible but is not accessible to general public when the generator is not in use. Key the E-Stop enclosure to match generator door keys. Ensure the client includes in their operation and maintenance manuals procedure to unlock and open this enclosure prior to any works commencing.

Complete the detailed design, manufacture, supply, delivery, installation, testing, commissioning and maintenance for nominated period of:

- One packaged diesel generator set for standby power

The engine, alternator and associated components shall be of a type in common use currently in Australia and for which spare parts and skilled maintenance are readily available.

The equipment and installation shall comply with the following minimum requirements:

- Diesel engine and alternator set capable of automatic unattended operation after automatic starting and with manual control facilities.
- Set mounted controls, instruments, gauges, etc., fixed to panels mounted on vibration isolators.
- Engine exhaust system with silencer.
- Engine cooling system utilising set mounted radiator.
- Set complete with skid type frame suitable for mounting direct on external pavement with vibration isolators between frame and engine/alternator.
- Starting battery and charger for electric start of engine.
- Provide pump/filter fuel looping system for polishing of stored fuel.
- Alarms and control equipment with remote operation and monitoring.
- Skid mount double walled day tank
- Set mounted switchboard including control panel and generator circuit breaker
- Weatherproof acoustic enclosure as schedule with corrosion-proof mountings and lockable doors for access and acoustic attenuators for cooling air inlet and outlet.
- Have built in load bank and controls to ensure that the load on the generator is not less than 30% load. Loads shall be controlled to switch off in 10% load increments (3 sections) when sufficient site load is available to this amount.
- Due to requirements to minimise vibration transfer to the building isolation shall include spring mounts for connection from motor to frame and frame to floor. Submit details of methodology prior to ordering
- Auxiliaries supply sub-circuits, 240-volt, 20 amp rated from the essential distribution board.
- Engine start/stop control wiring from phase failure relay for control of the ATS.
- Be connected to the site power supply using a remote (from generator). Provide all input and output controls for automatic operation.
- Set of recommended spare parts.
- Set of tools necessary for maintenance of plant.
- Operating and Maintenance Manuals.
- On-site testing.
- On-site training to instruct nominated personnel in the operation and general maintenance procedures of all equipment.

- Provision of 'as-installed' drawings.
- All miscellaneous work necessary for satisfactory completion of work, whether specified or not, including formation of all holes, recessed, etc., and provision of all supports and fixings and making good shall be included in the work.

Confirm exact location onsite with client prior to excavation

Manufacture: The governor shall be of Heinzmann, Woodward or equal approved manufacturer for which service and spare parts are readily available in the area.

0931.2 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0931 – Power Generation – Engine Drive attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Cross References	Yes
1.3	Standards	Yes
1.4	Interpretation	Yes
1.5	Submissions	Yes
1.6	Inspection	Yes
2	Products	
2.1	General	Yes
2.2	Alternators	Yes
2.3	Engines	Yes
2.4	Diesel Fuel Storage	Yes
2.5	Gas Supply	No
2.6	Controls	Yes
2.7	Remote Monitoring	Yes
2.8	Control Panels	Yes
2.9	Batteries and Charges	Yes
2.10	Starting	Yes
2.11	Mounting and Vibration Control	Yes
2.12	Acoustic Enclosures	Yes
2.13	Marking	Yes
2.14	Wiring Diagram	Yes
2.15	Labelling	Yes
2.16	Spare Parts and Tools	Yes
2.17	Earthing	Yes
2.18	Concrete Pad	Yes
3	Execution	
3.1	General	Yes
3.2	Permanent Test Load (Dummy Load)	Yes
3.3	Engine Cooling	Yes
3.4	Engine Air Intake	Yes
3.5	Exhaust System	Yes
3.6	Diesel Fuel System	Yes
3.7	Gas Supply System	No

3.8	Completion	Yes
3.9	Operation and Maintenance Manuals	Yes
3.10	Staff Training	Yes
3.11	Guarantee & Maintenance during defects liability period	Yes

0931.3 SCHEDULE OF SUBMISSIONS

Maintenance Manuals	Yes
Specifications of offered generator(s)	Yes
Shop drawings	Yes

0931.4 PERFORMANCE

Performance schedule

Property	**A**
Net continuous rated output (kVA) – standby	400kVA
Overload Capability	10%
Overload time duration	1 hour in 12 hours of operation
Rated output voltage (V)	415/240V
Number of phases	3
Neutral connection	Star
Earthing	In accordance with AS3010
Frequency (Hz)	50
Duty-type to AS 60034.1	Mission a critical
Voltage regulation grade to AS 60034.1	-
Compensation	-
Machine location	Outside on existing paving, inside enclosure
Altitude (m)	200
Available cooling water temperature (C)	N/A
Minimum degree of protection for enclosure (IP rating)	IP42
Other relevant site conditions - Temperature - Humidity	 45° 95%
Load acceptance	60% in 10 seconds
Start response time	100% in 60 seconds
Maximum noise level	77dB(A) at 7 metres
Location of essential distribution from where to connect auxiliary supply	Main Switchboard
Dummy load rating	30% generator capacity
Type of remote monitoring	Provide DSE890 MK11 4G Gateway module and sim card to enable remote monitoring of generator
Location of remote monitoring	-

Property	A
Day Storage Tank installed in skid mounted base	12 hours @ 100% full standby load

Provide all fuel necessary for testing and commissioning of the generator. Prior to practical completion fill the fuel tank. Filling the fuel tank during the Defects Liability Period is not required.

0931.5 FUEL POLISHING SYSTEM

Provide fuel polishing system on the generator as follows:

- 240V/415V
- M 500L/Hr
- Fuel polishing via Green-Mag fuel conditioner
- Timer for operation once a week or daily (initially set at weekly)
- 30 micron filter with water trap/alarm
- Provide visible water trap with a manual drain point
- Provide flow switch for pump protection
- Monitor dirty filter indication and provide alarm
- Single panel unit suitable for wall mounting. Mount within Generator enclosure
- Display alarms on Generator or approved equal
- IP66 rated electrical enclosure
- Provide suction and return lines to the tank
- Interlock the generator to stop polishing if the generator is running

0931.6 SYSTEM CONTROL PANEL

System control panel schedule

Property	A
Location	On Generator
Neutral switching	To AS3010
Automatic starting	On loss of mains power at site main switchboard

0941 SWITCHBOARDS – CUSTOM BUILT

0941.1 GENERAL

Provide switchboards as specified herein and shown on the drawings. Site measure and ensure the switchboard design suits the space available on site. Provide proprietary manual transfer switch such as Schneider Compact Series or approved equal.

0941.2 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0942 – Switchboards Custom Built attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Cross References	Yes
1.3	Standards	Yes
1.4	Interpretation	Yes
1.5	Submissions	Yes

1.6	Inspection	Yes
2	Products	
2.1	Custom Built Switchboard Construction	Yes
2.2	Cable Entries	Yes
2.3	Bus Trunking System Entry	Yes
2.4	Doors and Covers	Yes
2.5	Factory Finishes	Yes
2.6	Busbars	Yes
2.7	Neutral Links and Earth Bars	Yes
2.8	Internal Wiring	Yes
2.9	Terminations	Yes
3	Execution	
3.1	Assembly Installation	Yes
3.2	Assembly Entries	Yes
3.3	Marking and Labelling	Yes
3.4	Maintenance	Yes
3.5	Themographic Scans	Yes

0941.3 SWITCHBOARD SCHEDULE:

New Site Main Switchboard

Supply voltage (nominal)	415/240 Volt
Frequency	50Hz
Earthing system	Refer single line diagram
Service conditions – air temperature	-5 to + 40ºC
– humidity	Up to 100%
Prospective fault current	31kA for 1 sec.
Enclosure material	Stainless steel
Mounting	Wall and floor
Connection	Front connected
Exterior colour	To be confirmed with Superintendent at shop drawing stage. Allow grey in Tender
Door handle type	Lever type
Degree of protection (IP rating)	56
Form	3bih (Form 1 for distribution sections)
Number of poles	Refer single line diagram
Rated busbar current	Refer single line diagram
Arc fault containment	N/A
Circuit breaker type	Available as single pole, RCD circuit breakers up to 32A single phase. Schneider to match existing Shall be 10 kA type
Surge Protection device	Type II
Type of Thermo Graphic Scan required	Hand held on completion
Type Testing required	PTTA

0942 SWITCHBOARD COMPONENTS

0942.1 GENERAL

Provide switchboard components as specified herein and shown on the drawings, including a proprietary 800Amp Automatic Transfer Switch, ASCO 7000 Series or equal.

0942.2 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0943 – Switchboard Components attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Design	Yes
1.3	Cross References	Yes
1.4	Interpretation	Yes
1.5	Submissions	Yes
2	Products	
2.1	Requirements	Yes
2.2	Switch Isolator	Yes
2.3	Overload and Fault Protection Generally	Yes
2.4	Fuse Switch units	No
2.5	Auto-Transfer Switches	Yes
2.6	Moulded Case and Miniature Circuit Breakers	Yes
2.7	Electricity Distributor's Service Protective Devices	Yes
2.8	Residual Current Operated Circuit breakers (RCDO)	Yes
2.9	Air Circuit Breakers	Yes
2.10	Fuses with Enclosed Fuse links	No
2.11	Current Transformers (Protection)	No
2.12	Surge protection Devices (SPD)	Yes
2.13	Current Transformers (Metering)	Yes
2.14	Instruments and Meters	Yes
2.15	Electrical Indicating Measuring Meters	Yes
2.16	Contactors	Yes
2.17	Control Devices and Switching Elements	Yes
2.18	Semiconductor Controllers and Contactors	No
2.19	Programmable Logic Controllers (PLC)	No
2.20	Control and Protective Switching Devices or Equipment	Yes
2.21	Controller Device Interfaces	Yes
2.22	Indicator Lights	Yes
2.23	Indicating Counters	No
2.24	Alarm Annunciators	No
2.25	Audible alarm Devices	No
2.26	Extra-Low Voltage Transformers	No
2.27	Batteries and Chargers	No
2.28	Anti-condensation Heaters	No
2.29	Spare Cabinet	No
3	Execution	

3.1	Marking and Labelling	Yes
3.2	Maintenance	Yes

0942.3 MULTI FUNCTION METERS

Provide multi-function meters as indicated on the drawings and as follows:

- Meters shall be Schneider Electric PM3250 1630 digital metering system
- Select CTs to maximise accuracy of metering system

0942.4 AUTO TRANSFER SWITCH

Provide Auto Transfer Switch as indicated on the drawings, at the main switchboard.

The transfer switch shall be a break-before-make operation.

The new ATS shall be an NHP series or approved equal with 800 Amp minimum rating.

System operation will generally be as follows for automatic operation:

- Provide a signal that indicates the starting of the test mode and that the system will soon do a transfer. Provide a delay of the transfer of power to the generator by 20 seconds, at which stage provide a signal indicating that the generator is connected.
- On transfer back to Ergon, in both situations (after loss of Ergon and after generator testing) the system should be able to take the full load. At this stage provide a signal to the remote monitoring system indicating that it is again connected to mains.

ATS operation

Operating sequence shall be controlled by a micro-processor controller with the following minimum functions:

Mode	Requirement
Normal/Automatic	Automatic mains/generator and generator/mains transfer with mains preferred.
Manual	All control sequences disabled. Switches remain in position applicable when switched to manual but manual operation of both switches permitted with protection of mechanical interlock.
Off	Both switches open and remain open with control system disabled
Test	Mains/generator transfer with generator preferred.

Logic Sequence: Normal/automatic sequence shall be as follows:

Normal supply available and emergency supply not available	Normal supply switch closes
Normal supply available and emergency supply becomes available	Normal supply switch remains closed
Normal supply becomes unavailable	Normal supply switch remains closed until emergency supply is available
Emergency supply is available and normal supply is unavailable	Normal supply switch opens and emergency supply switch closes after time delay; adjustable 0-60 seconds. Set at 15 seconds minimum from the time generator supply becomes available. Refer note below.
Emergency supply is available and normal supply becomes available	Complete transfer from generator supply to normal supply after time delay; adjustable 0-120 seconds. Set at 30 seconds. Refer note below.

Provide indication lights, flags or script to indicate when connected to the normal or generator supply and when each supply is available. This shall also be sent via the monitoring system.

No break operation: 'No break' operation for ATS is not required.

Type and ratings: Equipment requirements including ratings are shown on the drawings or in schedules.

Additional Features: Provide the following as a minimum requirement for ATS.

Contacts for a low voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

A test switch to simulate a normal source failure.

Auxiliary contacts consisting of:

- One contact closed when the ATS is connected to the normal source and one contact closed when the ATS is connected to the emergency source.
- One contact to indicate normal supply available.
- One contact to indicate emergency supply available.

Terminals for connection of all field wiring.

Selective load Disconnect (for future use): A double pole contact shall be provided to operate after a time delay, adjustable 10-20 seconds prior to transfer and reset 0-20 seconds after transfer. This contact can be used to selectively disconnect specified load(s) before the transfer switch is operated. Output contacts shall be rated 6 Amps at 32 VDC or 240 VAC.

0993 FENCING

0993.1 GENERAL

Provide Colourbond Fenced enclosure, fence height to match Generator Height. Provide shop drawings of fence, including colour, prior to ordering.

Enclosure to included 2 lockable 1900 wide gates, located as shown on drawings and should open as specified. One gate location to allow refuelling.

Confirm building requirements and certification with Council prior to commencing work.

0991 ELECTRICAL MAINTENANCE

0991.1 GENERAL

Complete preventative maintenance and servicing for the contract defects liability period nominated.

0991.2 SPECIFICATION REFERENCE

Refer ACESPEC reference Worksection 0991 – electrical Maintenance attached herein, referenced subsections as follows:

Subsection	Name	Applicable
1	General	
1.1	Responsibilities	Yes
1.2	Cross References	Yes
1.3	Standard	Yes
1.4	Interpretation	Yes
1.5	Submissions	Yes
1.6	Inspection	Yes
2	Products	
2.1	General	Yes
3	Execution	
3.1	Emergency Repairs	Yes
3.2	Periodic Maintenance	Yes
3.3	End of Maintenance Period Service	Yes
3.4	Completion	Yes

0991.3 MAINTENANCE REQUIREMENT SCHEDULE

Provision	Requirement
Maintenance period	Conform to the contract requirements
Call out response time not to exceed	24 hours
Minimum number of programmed service visits during the defects liability period	2

0995 SAFE DESIGN RISK REGISTER

0995.1 GENERAL

A safe design risk register has been developed in line with Workplace Health and Safety Queensland's requirements, during the design phase of the project. The register includes identified hazards or environmental impacts and proposed control measures.

A copy of the risk register is included in Appendix A and is considered to be a living document that should be developed further by the contractor prior and during the project.

It mains the obligation of contractors and their workers to take reasonable precautions and exercise proper diligence to provide a safe workplace. If requested our office will assist where it can.

We also note further information is available.

APPENDIX A – SAFE DESIGN RISK REGISTER

Incorporating the Safety Report as per Ref 295 of the QLD Workplace Health & Safety Regulation 2011.

RISK ASSESSMENT										
Activity or Task	Hazards or Environmental Impacts	Perceived Risk			Control Measures (Eliminate, Substitute, Isolate/Engineering Controls, Administrative Controls, PPE)	Residual Risk			Person responsible for Controls	Status
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating		
Installation of new electrical service and switchboards	Muscle strain / sprain due to lifting & carrying equipment	3	2	6	•Use lifting devices such as trolleys & lifting gantries •Never lift and twist in one motion •Keep back straight during lift •Use lifting handles where supplied •If required use 2-person lift	3	1	3	contractor	
	Trips, slips & falls from uneven surfaces	3	2	6	•Use personal awareness, site walkover/driver (assess site hazards) •Control access to site, Daily Pre-start tool box meetings •Remove hazard by either the use of cable holder to raise hazard off the floor or cable covers	3	1	3	contractor	
	Establish a safe work area - set up	4	2	8	•Control access to site, Daily Pre-start tool box meetings •The use of barricades, fences, locks & site supervision	4	1	4	contractor	

	Unauthorised personnel entering work area	3	2	6	•Control access to site, Daily Pre-start tool box meetings •The use of barricades, fences, locks & site supervision	3	1	3	contractor	
	Electrocution	5	2	10	•All electrical field equipment must be tagged & tested every 3 months •Residual Current Devices (RCD's) are to be used for all extension leads & devices at the front of the circuit •Lockout Tagout process to be performed when conducting maintenance or if electrical equipment is faulty	5	1	5	contractor	
	Damage/Injury from hitting underground services i.e. Gas, water, electrical & fibre optic cables & pipes	3	3	9	•Call dial/call before you dig & assess information prior any digging commences •Conduct non-destructive digging (NDD) to 1.2mt or to the deepest identified underground utility on site by either hand auguring or vacuum extraction	3	1	3	contractor	
	Falls from heights	4	2	8	• Install appropriate fall protection e.g. Railings, harnesses, barricades • Ladders- always keep 3 points of contact on the ladder at all times	4	1	4	contractor	

	Weather - UV radiation/sun exposure/dehydration	3	2	6	•Wear long pants, long sleeve shirt, broad brimmed hat •Apply sunscreen every 4 hours •Regular drinks breaks as per the rehydration policy •Consider rescheduling work	2	1	2	contractor	
NORMAL HAZARDS/RISKS DURING ALL PHASES ARE THE RESPONSIBILITY OF THE RELEVANT PARTY DURING THE PHASE CONCERNED (E.G. CONTRACTOR DURING CONSTRUCTION, OWNER/OPERATOR DURING OPERATIONS, MAINTENANCE CONTRACTOR(S) DURING MAINTENANCE ETC.)										

SAFETY AND ENVIRONMENTAL HAZARD IDENTIFICATION/RISK ASSESSMENT

LIKELIHOOD

5	**Event will occur**	The event is a common occurrence on all projects
4	**Event almost certain to occur**	The event will probably / is likely to occur at least once during most projects
3	**Event may occur**	The event is possible to / might occur during some projects
2	**Event not likely to occur**	The event is unlikely to occur (though it could occur during similar work activities)
1	**Event rarely occurs**	The event could occur, but it is rare / only in exceptional circumstances

PROJECT (Level 1) RISK RATINGS

1-4	**Low**	*Maintain effectivements of current Controls and mange by routine procedures* *Monitoring and review schedule should be considered based on potential rapid escalation/volatility of the risk* *As required, provide risk update as relevant to governing body or management team and risk stakeholders*
5-8	**Medium**	*Within 3 months - evaluate for treatment planning requirements based on cost/benefit and resource prioritisation* *Quarterly - Review by risk owner. This includes risk treatment update (if applicable).* *As required, provide risk update as relevant to governing body or management team and risk stakeholders*
9-15	**High**	*Within 1 month - commence treatment planning for moderation* *Monthly - review by risk owner until risk is effectively moderated. This includes risk treatment status updates.* *Monthly - provide risk update as relevant to governing body or management tram and risk stakeholders*
16-25	**Extreme**	*As soon as possible (and within 1 month) commence treatment planning for moderation* *Monthly - review by risk owner until effectively moderated. This includes risk treatment status updates* *Monthly - provide risk update as relevant to governing body or management team (e.g. Project Board, Divisional Leadership Team, Executive Committee or Executive Management Team) and risk stakeholders*

	DESCRIPTOR	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
5	Event will occur	5 MEDIUM	10 HIGH	15 HIGH	20 EXTREME	25 EXTREME
4	Event almost certain to occur	4 LOW	8 MEDIUM	12 HIGH	16 EXTREME	20 EXTREME
3	Event may occur	3 LOW	6 MEDIUM	9 HIGH	12 HIGH	15 HIGH
2	Event not likely to occur	2 LOW	4 LOW	6 MEDIUM	8 MEDIUM	10 HIGH
1	Event rarely occurs	1 LOW	2 LOW	3 LOW	4 LOW	5 MEDIUM

Highest Level of Control ← → **Lowest Level of Control**

Elimination Substitution Isolation/Engineering Administration PPE

Level	Descriptor	CONSEQUENCE / SEVERITY / IMPACT
5	**Catastrophic**	*Reportable fatality (as defined by S35 Work Health * Safety Act (QLD) 2011)*
4	**Major**	*Serious injury or illness with permanent impairment (as defined by S36 Work Health & Safety Act (QLD) 2011)*
3	**Moderate**	*Lost time injury or serious injury or illness without permanent impairment (as defined by S36 Work Health & Safety Act (QLD) 2011)*
2	**Minor**	*Medical treatment injury. A full shift/workday has not been lost.*
1	**Insignificant**	*No injury. First aid treatment only. No time lost.*

ACESPEC SPECIFICATION REFERENCE

0901 ELECTRICAL SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

Refer project schedule. ***Rev 2017-01***

1.2 DESIGN

Design for durability and maintainability
Design for durability: Develop the design so the systems achieve the documented performance, reliability, service life, energy efficiency and safety requirements, and are easily maintainable.

Access for maintenance: Develop the design so the systems conform to **ACCESS FOR MAINTENANCE** in the ***0903*** *General requirements* worksection.

1.3 STANDARDS

Electrical services
Requirement: To AS/NZS 3000, unless otherwise documented.

Electrical installations
Electrical design: To AS/NZS 3000 and SAA HB 301.

Selection of cables: To AS/NZS 3008.1.1.

Degrees of protection (IP code): To AS 60529.

Electromagnetic compatibility (EMC): To AS/NZS 61000.

Rotating and reciprocating machinery noise and vibration: Vibration severity in Zone A to AS 2625.1 and AS 2625.4.

Communications systems: To AS/CA S008, AS/CA S009, AS/NZS 3008 and AS/NZS ISO/IEC 14763.2.

1.4 CONTRACT DOCUMENTS

General
Requirement: Conform to the *0903 General requirements* worksection.

1.5 SUBMISSIONS

General
Requirement: Conform to the *0903 General requirements* worksection.

Certification
Requirement: Submit certification that the plant and equipment submitted meets the requirements and capacities of the contract documents except for departures that are identified in the submission.

Operations and maintenance manuals
Requirement: Conform to the *0903 General requirements* worksection.

Products and materials
Data: Submit technical data for all items of plant and equipment, including the following:

- Assumptions.
- Calculations.
- Model name, designation and number.
- Capacity of all system elements.
- Country of origin and manufacture.
- Materials used in the construction.
- Size, including required clearances for installation.
- Certification of compliance with the applicable code or standard.

- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.
- Manufacturers' technical literature.
- Type-test reports.
- Single line diagram(s), including fault levels at switchboards, cable size and type.
- Switchboard layouts.

1.6 INSPECTION

General

Requirement: Conform to the *0903 General requirements* worksection.

Notice

Inspection: Give notice so inspection may be make of the following:

- ***Prior to final wall sheeting, after first fix.***
- ***Immediately prior to ceiling installation.***
- ***Prior to back filling of trenches.*** ***Rev 2017-01***

2 PRODUCTS

2.1 ELECTRICAL ACCESSORIES

General

Responsibilities: Provide accessories as documented and to the requirements of **LOW VOLTAGE POWER SYSTEMS**.

Proprietary equipment: If proprietary equipment is selected by the contractor, the requirements of this specification over-ride the specifications inherent in the selection of a particular make and model of accessory.

Uniformity: Provide all accessories and outlets located in close proximity of the same manufacture, size, finish and material.

Default finish: Select from the manufacturers' standard range.

3 EXECUTION

3.1 WORK ON EXISTING SYSTEMS

Demolition

General: Decommission, isolate, demolish and remove from the site all existing redundant equipment including minor associated components that become redundant as a result of the demolition.

Breaking down: Disassemble or cut up equipment where necessary to allow removal.

Recovered materials: Recover all components associated with the listed items. Minimise damage during removal and deliver to the locations documented.

Existing electrical systems

Condition of existing systems:

- If the existing condition does not conform to the requirements in the contract documents, submit proposals to rectify the deficiencies with related costing, time and other impacts.
- Subject to the rectification works on existing systems, achieve the performance in the contract documents.

3.2 SWITCHBOARDS

General

Fixing wall mounted switchboards: Fix direct to wall framing for framed wall constructed walls and to masonry or concrete walls.

Fixing floor/wall mounted switchboards: Fix to floor plinths and direct wall framing for framed wall constructed walls and to masonry or concrete walls by suitable fasteners.

Fixing floor mounted island switchboards: Fix switchboard to floors plinths by suitable fasteners able to withstand seismic events nominated in the project documents.

Seismic sensitive projects

Fixing wall and wall/floor mounted switchboards: Fix only to building structural elements or to steel framing fixed to structural elements. Do not fix to masonry infill panels.

3.3 SUPPORT OF PLANT AND EQUIPMENT

Support of roof mounted plant and equipment

Platforms: If a horizontal platform is required, or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable platform.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

Roof level support: If any of the following apply to roof level support, obtain the advice of a professional engineer:

- The total load from any unit of plant or equipment exceeds 500 kg.
- The load from a unit of plant or equipment to any single support point exceeds 100 kg.
- The average loading of plant and equipment over the area extending 1 m on all sides beyond the plant and equipment exceeds 25 kg/m².

Sloping roofs:

- Roof slope ≥ 10°: Adopt the roof material manufacturer's documented installation procedures, or seek the advice of a professional engineer.
- Roof slope < 10°: Provide appropriate continuous supporting members, compatible with the roof material, laid parallel to the span of the roof sheeting. Extend the continuous support members in both directions to the first purlin or joist that is > 1 m from the face of the plant or equipment it supports.

Support of ground level plant and equipment

Ground level:

- If the ground slope is ≥ 15° or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable slab or platform.
- In all other cases, provide proprietary plastic or concrete supports installed with falls that achieve a raised, impervious and water shedding bearing surface.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

0903 GENERAL REQUIREMENTS – ELECTRICAL

This section is based on Natspec section 0171 General Requirements.

1 GENERAL

1.1 RESPONSIBILITIES

General
Noise levels: Install systems within the limits of the contract design and documented equipment performance and as documented in the **Noise level schedule**.

Performance
Structural: If required, provide structures, installations and components as follows:

- Fixed accessways: To AS 1657.
- Structural design actions: To the AS 1170 series.

1.2 DESIGN

Design development
General: The works include development of the design beyond that documented, as required.

Design by contractor: ***Develop the design so the systems achieve the documented performance and coordinates with other building elements. Minor modifications will not be considered to be a variation to the contract*** ***Rev 2018-01*****.**
If the contractor provides design, use only appropriately qualified persons and conform to all statutory requirements.

Conflict with the documents: If it is believed that a conflict exists between statutory requirements and the documents, notify the contract administrator immediately and provide a recommendation to resolve the conflict.

1.3 PRECEDENCE

General
Order of precedence:

- The requirements of other worksections of the specification override conflicting requirements of this worksection.
- The requirements of the worksections override conflicting requirements of their referenced documents. The requirements of the referenced documents are minimum requirements.
-

1.4 CROSS REFERENCES

General
Requirement: Conform to all worksections included herein for Electrical Services. ***Rev 2018-01***
Cross referencing styles
General: Within the text, titles are cross referenced using the following styles:

- Worksection titles are indicated by *Italicised* text.
- Subsection titles are indicated by **BOLD** text.
- Clause titles are indicated by **BOLD** text.
- Subclause titles are indicated by **Bold** text.

1.5 REFERENCED DOCUMENTS

Contractual relationships
General: Responsibilities and duties of the principal, contractor and contract administrator are not altered by requirements in the documents referenced in this specification.

Current editions
General: Use referenced documents which are the editions, with amendments, current 3 months before the closing date for tenders, except where other editions or amendments are required by statutory authorities.

1.6 INTERPRETATION

Documentation conventions
Imperative mood and streamlined language: The words shall or shall be are implied where a colon is used following a keyword or within a sentence or sentence fragment.

Subject of sentences and phrases: Specification requirements are to be performed by the contractor, unless stated otherwise.

Abbreviations
General: For the purposes of this specification the following abbreviations apply:

- AS: Australian Standard.
- BCA: National Construction Code Series Volume One: Building Code of Australia Class 2 to 9 Buildings and Volume Two: Building Code of Australia Class 1 and Class 10 Buildings.
- GRP: Glass Reinforced Plastic.
- IP: Ingress protection.
- NATA: National Association of Testing Authorities.
- NCC: National Construction Code.
- NZS: New Zealand Standard.
- PCA: National Construction Code Series Volume 3: Plumbing Code of Australia.
- PVC: Polyvinyl Chloride.
- PVC-U: Unplasticised Polyvinyl Chloride. Also known as UPVC.
- SDS: Safety data sheets.
- VOC: Volatile Organic Compound.
- WHS: Work Health and Safety.

Definitions
General: For the purposes of this specification, the following definitions apply:

- Access for maintenance: Includes access for maintenance, inspection, measurement, operation, adjustment, repair, replacement and other maintenance related tasks.
- Accessible, readily: Readily accessible, easily accessible, easy access and similar terms mean capable of being reached quickly and without climbing over or removing obstructions, mounting upon a chair, or using a movable ladder, and in any case not more than 2.0 m above the ground, floor or platform.
- Attendance: Attendance, provide attendance and similar expressions mean give assistance for examination and testing.
- Contract administrator: Has the same meaning as architect or superintendent and is the person appointed by the owner or principal under the contract.
- Contractor: Has the same meaning as builder and is the person or organisation bound to carry out and complete the work under the contract.
- Default: Specified value, product or installation method which is to be provided unless otherwise documented.
- Design life: The period of time for which it is assumed, in the design, that an asset will be able to perform its intended purpose with only anticipated maintenance but no major repair or replacement being necessary.
- Documented: Documented, as documented and similar terms mean contained in the contract documents.
- Economic life: The period of time from the acquisition of an asset to the time when the asset, while still physically capable of fulfilling its function and with only anticipated maintenance, ceases to be the lowest cost alternative for satisfying that function.
- Electricity distributor: Any person or organisation that provides electricity from an electricity distribution system to one or more electrical installations. Includes distributor, supply authority,

network operator, local network service provider, electricity retailer or electricity entity, as may be appropriate in the relevant jurisdiction.

- Fire hazard properties: To BCA A2.4.
- Geotechnical site investigation: The process of evaluating the geotechnical characteristics of the site in the context of existing or proposed construction.
- Give notice: Give notice, submit, advise, inform and similar expressions mean give notice (submit, advise, inform) in writing to the contract administrator.
- High level interface: Systems transfer information in a digital format using an open system interface.
- Hot-dip galvanized: Zinc coated to AS/NZS 4680 after fabrication with coating thickness and mass to AS/NZS 4680 Table 1.
- Ingress protection: IP, IP code, IP rating and similar expression have the same meaning as IP Code in AS 60529.
- Joints:
  . Construction joint: A joint with continuous reinforcement provided to suit construction sequence.
  . Contraction joint: An opening control joint with a bond breaking coating separating the joint surfaces to allow independent and controlled contraction of different parts or components, induced by shrinkage, temperature changes or other causes. It may include unbound dowels to assist vertical deflection control.
  . Control joint: An unreinforced joint between or within discrete elements of construction which allows for relative movement of the elements.
  . Expansion joint: A closing control joint with the joint surfaces separated by a compressible filler to allow axial movement due to thermal expansion or contraction with changes in temperature or creep. It may include unbound dowels to assist vertical deflection control.
  . Sealant joint: A joint filled with a flexible synthetic compound which adheres to surfaces within the joint to prevent the passage of dust, moisture and gases.
  . Structural control joint: A control joint (contraction, expansion and isolation) in structural elements when used with applied material and finishes.
  . Substrate joint: A joint in the substrate which includes construction joints and joints between different materials.
  . Weakened plane joint: A contraction joint created by forming a groove, extending at least one quarter the depth of the section, either by using a grooving tool, by sawing, or by inserting a premoulded strip.
- Local (government) authority: A body established for the purposes of local government by or under a law applying in a state or territory.
- Low level interface: Systems transfer information via terminals and voltage free contacts.
- Manufacturer's recommendations: Recommendations, instructions, requirements, specifications (and similar expressions) provided in written or other form by the manufacturer and/or supplier relating to the suitability, use, installation, storage and/or handling of a product.
- Metallic-coated: Steel coated with zinc or aluminium-zinc alloy as follows:
  . Metallic-coated steel sheet: To AS 1397. Metal thicknesses specified are based metal thicknesses.
  . Ferrous open sections zinc coated an in-line process: To AS/NZS 4791.
  . Ferrous hollow sections zinc coated by a continuous or specialised process: To AS/NZS 4792.
- Network utility operator: The entity undertaking the piped distribution of drinking water or natural gas for supply or is the operator of a sewerage system or external stormwater drainage system.
- Obtain: Obtain, seek and similar expressions mean obtain (seek) in writing from the contract administrator.
- Pipe: Includes pipe and tube.
- Practical completion or defects free completion: The requirements for these stages of completion are defined in the relevant building contract for the project.
- Principal: Principal has the same meaning as owner, client and proprietor and is the party to whom the contractor is legally bound to construct the works.
- Professional engineer: As defined by the BCA.

- Proprietary: Identifiable by naming the manufacturer, supplier, installer, trade name, brand name, catalogue or reference number.
- Prototype: A full size mock-up of components, systems or elements to demonstrate or test construction methods, junctions and finishes, and to define the level of quality.
- Provide: Provide and similar expressions mean supply and install and include development of the design beyond that documented.
- Record drawings: Record drawings has the same meaning as as-installed drawings, as-built drawings and work-as-executed drawings.
- Referenced documents: Standards and other documents whose requirements are included in this specification by reference.
- Registered Testing Authority:
  . An organisation registered by the National Association of Testing Authorities (NATA) to test in the relevant field; or
  . An organisation outside of Australia registered by an authority recognised by NATA through a mutual recognition agreement; or
  . An organisation recognised as being a Registered Testing Authority under legislation at the time the test was undertaken.
- Required: Required by the contract documents, the local council or statutory authorities.
- If required: A conditional specification term for work which may be shown in the documents or is a legislative requirement.
- Sample: A physical example that illustrates workmanship, materials or equipment, and establishes standards by which the work will be judged. It includes samples, prototypes and sample panels.
- Statutory authority: A public sector entity created by legislation, that is, a specific law of the Commonwealth, State or Territory.
- Supply: Supply, furnish and similar expressions mean supply only.
- Tests – completion: Tests carried out on completed installations or systems and fully resolved before the date for practical completion, to demonstrate that the installation or system, including components, controls and equipment, operates correctly, safely and efficiently, and meets performance and other requirements. The superintendent may direct that completion tests be carried out after the date for practical completion.
- Tests – pre-completion: Tests carried out before completion tests, including:
  . Production: Tests carried out on a purchased item, before delivery to the site.
  . Progressive: Tests carried out during installation to demonstrate performance in conformance with this specification.
  . Site: Tests carried out on site.
  . Type: Tests carried out on an item identical with a production item, before delivery to the site.
- Tolerance: The permitted difference between the upper limit and the lower limit of dimension, value or quantity.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.
- ***Or equal: Where an item is specified by name 'or equal' it is anticipated that the named product will be used. The term 'or equal' only allows substitution where the Superintendent's Representative gives approval for the item. A request for use of an 'equal' item shall be accompanied by a comparison with the originally nominated product showing in what way the product is superior and/or the associated cost savings.*** ***Rev 2017-01***

1.7 FAMILIARISATION WITH THE SITE

Prior to submitting tenders, it is recommended that the tenderer complete the following:

- ***Detailed inspection of the site to determine the full extent of required work. It is noted that the tenderer shall make an appointment with the Principal prior to attending site.***
- ***Inspect full structural and architectural documentation of the proposed construction.***
- ***No increase in the sub-contract sum will be approved for works that could have been ascertained by the above inspections.***

1.8 VARIATION CLAIMS

Variation claims for delays and additional costs for alternative delivery methods or similar will not be granted unless the following proofs are provided by the sub-contractor.

- ***The request for pricing during the tender period indicated that the delivery times required were not reasonable.***
- ***The order for equipment was placed with the required delivery date as soon as practical after acceptance of the sub-contract***
- ***All due care was taken during the delivery period to ensure that the required delivery date was met including follow-ups***
- ***The reason for late delivery was beyond the control of the sub-contractor and the supplier***
- ***Approved alternatives are not available***
- ***Such delays affect the contract critical path***

1.9 COMPLEMENTARY DOCUMENTS

The specification and drawings are complementary documents. Requirements indicated in one but not in the other shall still form part of the sub-contract.

Any conflict between the specification and the drawings shall be brought to the attention of the Superintendent's Representative who shall decide on which will apply. No variation will be applied for the completion of the work decided as applicable.

1.10 CONTRACT DOCUMENTS

Services diagrammatic layouts

General: Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:

- Obtain measurements and other necessary information.
- Coordinate the design and installation in conjunction with all trades and architectural details.

Accurate details and dimensions shall be taken from the architectural drawings and at the site.

Levels

General: Spot levels take precedence over contour lines and ground profile lines.

Drawings and manuals for existing services

Subsurface services: Information shown on the drawings relating to underground or submerged services is accurate to the following quality level:

- Quality level to AS 5488

Warranty: No warranty is given as to the completeness or accuracy of drawings and/or manuals of existing services.

1.11 SUBMISSIONS

Requirement

General: Submit the following, as documented:

- Authority approvals: Notes of meetings with authorities whose requirements apply to the work and evidence that notices, fees and permits have been sought and paid, that authority connections are complete and that statutory approvals by the authorities whose requirements apply to the work have been received.
- Building penetrations: Details of the methods to maintain the required structural, fire and other properties to **EXECUTION**, **BUILDING PENETRATIONS**.
- Certification: Certification of conformance to documented requirements, including certification that the plant and equipment submitted meets all requirements of the contract documents and that each installation is operating correctly.

- Design documentation: Design data and certification of proposed work, if required and as documented.
- Electronic facility and asset management information: For the whole of the work to **EXECUTION**, **ELECTRONIC FACILITY AND ASSET MANAGEMENT INFORMATION**.
- Execution details: Execution programs, schedules and details of proposed methods and equipment. For building services include the following:
  . Embedded services: Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.
  . Fixing of services: Typical details of locations, types and methods of fixing services to the building structure.
  . Inaccessible services: If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.
- Marking and labelling: Samples and schedules of proposed marking and labels to **EXECUTION**, **MARKING AND LABELLING.**
- Operation and maintenance manuals: For the whole of the work to **EXECUTION**, **OPERATION AND MAINTENANCE MANUALS**.
- Products: Products and materials data, including manufacturer's technical specifications and drawing, evidence of conformance to product certification schemes, performance and rating tables and installation and maintenance recommendations.
- Records: As-built documents, photographs, system diagrams, schedules and logbooks to **EXECUTION**, **RECORD DRAWINGS**.
- Samples: Representative of proposed products and materials and including proposals to incorporate samples into the works, if any to **EXECUTION**, **SAMPLES**.
- Shop drawings: To **EXECUTION**, **SHOP DRAWINGS**.
- Substitutions: To PRODUCTS**, GENERAL, Substitutions**.
- Tests:
  . Inspection and testing plan consistent with the construction program including details of test stages and procedures.
  . Certificates for type tests.
  . Fire hazard properties: Evidence of conformance of proposed proprietary products to documented requirements for fire hazard properties.
  . Test reports for testing performed under the contract to **EXECUTION**, **TESTS**.
- Warranties: To **EXECUTION**, **WARRANTIES**.

Contractor review: Before submissions, review each submission item and check for coordination with other work of the contract and conformance to contract documents.

Submission times

Default timing: Make submissions at least 5 working days before ordering products or starting installation of the respective portion of the works.

Submission response times: Allow in the construction program for times as scheduled.
Rev 2017-01

Proposed products schedules: If major products are not specified as proprietary items, submit a schedule of those proposed for use within 3 weeks of site possession.

Identification

Requirement: Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include relevant contract document references. Include service connection requirements and product certification.

Non-conformance: Identify proposals that do not conform with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

Errors

Requirement: If a submission contains errors, make a new or amended submission as appropriate, indicating changes made since the previous submission.

Electronic submissions

Format and transmission medium as scheduled. ***Rev 2017-01***

1.12 INSPECTION

Notice

Concealment: If notice of inspection is required for parts of the works that are to be concealed, advise when the inspection can be made before concealment.

Tests: Give notice of the time and place of documented tests.

Minimum notice: As documented in the **Notices schedule**.

Light levels

Requirements: To AS/NZS 1680.2.4.

Attendance

General: Provide attendance for documented inspections and tests.

2 PRODUCTS

2.1 GENERAL

Manufacturers' or suppliers' recommendations

General: Provide and select, if no selection is given, transport, deliver, store, handle, protect, finish, adjust and prepare for use the manufactured items in conformance with the recommendations of the manufacturer or supplier.

Proprietary items/systems/assemblies: Assemble, install or fix to substrate in conformance with the recommendations of the manufacturer or supplier.

Project modifications: Advise of activities that supplement, or are contrary to the recommendations of the manufacturers or supplier.

Sealed containers

General: If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

Prohibited materials

General: Do not provide the following:

- Materials, exceeding the limits of those listed, in the Safe Work Australia Hazardous Substances Information System (HSIS).
- Materials that use chlorofluorocarbon (CFC) or hydro chlorofluorocarbon (HCFC) in the manufacturing process.

Substitutions

Identified proprietary items: Identification of a proprietary item does not necessarily imply exclusive preference for the identified item, but indicates the necessary properties of the item.

Alternatives: If alternatives to the documented products, methods or systems are proposed, submit sufficient information to permit evaluation of the proposed alternatives, including the following:

- Evidence that the performance is equal to or greater than that specified.
- Evidence of conformity to a cited standard.
- Samples.
- Essential technical information, in English.
- Reasons for the proposed substitutions.
- Statement of the extent of revisions to the contract documents.
- Statement of the extent of revisions to the construction program.
- Statement of cost implications including costs outside the contract.
- Statement of consequent alterations to other parts of the works.

Availability: If the documented products or systems are unavailable within the time constraints of the construction program, submit evidence.

Criteria: If the substitution is for any reason other than unavailability, submit evidence that the substitution:

- Is of net enhanced value to the principal.
- Is consistent with the contract documents and is as effective as the identified item, detail or method.

2.2 MATERIALS AND COMPONENTS

Consistency
General: For each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

Corrosion resistance
General: Conform to the following atmospheric corrosivity category as defined in AS 4312 and the AS/NZS 2312 series.

Galvanizing
Severe conditions: Galvanize mild steel components (including fasteners) to AS/NZS 1214 or AS/NZS 4680 as appropriate, if:

- Exposed to weather.
- Embedded in masonry.
- Exposed to or in air spaces behind the external leaf of masonry walls.
- In contact with chemically treated timber, other than copper chrome arsenate (CCA).

2.3 ALTERNATIVE PRODUCTS

Where alternative products,, from that specified, are provided the contractor shall prove them as equal by providing specified and offered alternative information for comparison. Also the contractor shall complete all design calculations to show that the alternative product will meet all requirements of the design criteria.

Obtain design criteria from the Superintendent's Representative and include calculations within the maintenance manuals. **Rev 2018-01**

3 EXECUTION

3.1 SAMPLES

General
Incorporation of samples: Only incorporate samples in the works which have been endorsed for inclusion. Do not incorporate other samples.

Retention of samples: Keep endorsed samples in good condition on site, until the date of practical completion.

Unincorporated samples: Remove on completion.

3.2 SHOP DRAWINGS

General
Documentation: Include dimensioned drawings showing details of the fabrication and installation of structural elements, services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and prepare dimensioned set-out drawings.

Record drawings: Amend all documented shop drawings to include changes made during the progress of the work and up to the end of the defects liability period.

Services coordination: Coordinate with other building and service elements. Show adjusted positions on the shop drawings.

Space requirements: Check space and access for maintenance requirements of equipment and services indicated diagrammatically in the contract documents.

Building work drawings for building services: On dimensioned drawings show all relevant:

- Access doors and panels.
- Conduits to be cast in slabs.

- Holding down bolts and other anchorage and/or fixings required complete with loads to be imposed on the structure during installation and operation.
- Openings, penetrations and block-outs.
- Sleeves.
- Plinths, kerbs and bases.
- Required external openings.

3.3 OFF-SITE DISPOSAL

Removal of material
General: Dispose of building waste material off site to the requirements of the relevant authorities.

3.4 WALL CHASING

Holes and chases
General: If holes and chases are required in masonry walls, make sure structural integrity of the wall is maintained. Do not chase walls nominated as fire-resistance or acoustic rated.

Parallel chases or recesses on opposite faces of a wall: Not closer than 600 mm to each other.

Chasing in blockwork: Only in core-filled hollow blocks or in solid blocks which are not designated as structural.

Concrete blockwork chasing table

Block thickness (mm)	Maximum depth of chase (mm)
190	35
140	25
90	20

3.5 FIXING

General
Suitability: If equipment is not suitable for fixing to non-structural building elements, fix directly to structure and trim around penetrations in non-structural elements.

Fasteners
General: Use proprietary fasteners capable of transmitting the loads imposed, and sufficient for the rigidity of the assembly.

3.6 SERVICES CONNECTIONS

Connections
General: Connect to network distributor services or service points. Excavate to locate and expose connection points. Reinstate the surfaces and facilities that have been disturbed.

Network distributors' requirements
General: If the network distributor elects to perform or supply part of the works, make the necessary arrangements. Install equipment supplied, but not installed, by the authorities.

3.7 SERVICES INSTALLATION

General
Fixing: If non-structural building elements are not suitable for fixing services to, fix directly to structure and trim around holes or penetrations in non-structural elements.

Installation: Install equipment and services plumb, fix securely and organise reticulated services neatly. Allow for movement in both structure and services.

Concealment: Unless otherwise documented, conceal all cables, ducts, trays and pipes except where installed in plant spaces, ceiling spaces and riser cupboards. If possible, do not locate on external walls.

Lifting: Provide heavy items of equipment with permanent fixtures for lifting as recommended by the manufacturer.

Suspended ground floors: Keep all parts of services under suspended ground floors at least 150 mm clear of the ground surface. Make sure services do not impede access.

Arrangement: Arrange services so that services running together are parallel with each other and with adjacent building elements.

Dissimilar metals

General: Join dissimilar metals with fittings of electrolytically compatible material.

Temporary capping

Pipe ends: During construction protect open ends of pipe with metal or plastic covers or caps.

Piping

General: Install piping in straight lines at uniform grades without sags. Arrange to prevent air locks. Provide sufficient unions, flanges and isolating valves to allow removal of piping and fittings for maintenance or replacement of plant.

Spacing: Provide at least 25 mm clear between pipes and between pipes and building elements, additional to insulation.

Changes of direction: Provide long radius elbows or bends and sets where practicable, and swept branch connections. Provide elbows or short radius bends where pipes are led up or along walls and then through to fixtures. Do not provide mitred fittings.

Vibration: Arrange and support piping so that it remains free from vibration whilst permitting necessary movements. Minimise the number of joints.

Embedded pipes: Do not embed pipes that operate under pressure in concrete or surfacing material.

Valve groupings: If possible, locate valves in groups.

Pressure testing precautions: Isolate items not rated for the test pressure. Restrain pipes and equipment to prevent movement during pressure testing.

Differential movement

General: If the geotechnical site investigation report predicts differential movements between buildings and the ground in which pipes or conduits are buried, provide control joints in the pipes or conduits, as follows:

- Arrangement: Arrange pipes and conduits to minimise the number of control joints.
- Magnitude: Accommodate the predicted movements.

3.8 BUILDING PENETRATIONS

General

Requirement: Unless specified to be completed by other trades, complete all penetrations and sealing to make good. **Rev 2018-01**

Penetrations

Requirement: Maintain the required structural, fire and other properties when penetrating or fixing to the following:

- Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.
- Membrane elements including damp-proof courses, waterproofing membranes and roof coverings. If penetrating membranes, provide a waterproof seal between the membrane and the penetrating component.

Flashings

Requirement: Provide under and over-flashings to maintain the building as waterproof. **Rev 2018-01**

Sealing

Fire-resisting building elements: Seal penetrations with a system conforming to AS 4072.1.

Non fire-resisting building elements: Seal penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustically rated, maintain the rating.

Sleeves

General: If piping or conduit penetrates building elements, provide metal or PVC-U sleeves formed from pipe sections as follows:

- Movement: Arrange to permit normal pipe or conduit movement.
- Diameter (for non fire-resisting building elements): Sufficient to provide an annular space around the pipe or pipe insulation of at least 12 mm.
- Prime paint ferrous surfaces.
- Terminations:
  . If cover plates are fitted: Flush with the finished building surface.
  . In fire-resisting and acoustic rated building elements: 50 mm beyond finished building surface.
  . In floors draining to floor wastes: 50 mm above finished floor.
  . Elsewhere: 5 mm beyond finished building surface.
  . Termite management: To AS 3660.1.
- Thickness:
  . Metal: 1 mm or greater.
  . PVC-U: 3 mm or greater.

Sleeves for cables: For penetrations of cables not enclosed in conduit through ground floor slabs, beams and external walls provide sleeves formed from PVC-U pipe sections.

3.9 CONCRETE PLINTHS

Construction

General: Provide concrete plinths as required and under all equipment located on concrete floor slabs as follows:

- Height: 75 mm or greater, as documented.
- Concrete: Grade N20.
- Finish: Steel float flush with the surround.
- Reinforcement: Single layer of F62 fabric.
- Surround: Provide galvanized steel surround at least 75 mm high and 1.6 mm thick. Fix to the floor with masonry anchors. Fill with concrete.

3.10 SUPPORT AND STRUCTURE

General

Requirement: Provide incidental supports and structures to suit the services.

3.11 ACCESS FOR MAINTENANCE

General

Requirement: Provide access for maintenance of plant and equipment.

Standards: Conform to the relevant requirements of AS 1470, AS 1657, AS/NZS 1892.1, AS 2865 and AS/NZS 3666.1.

Work Health and Safety: Conform to the requirements of the applicable Work Health and Safety regulations.

Protection from injury: Protect personnel from injury caused by contact with objects including those that are sharp, hot or protrude at low level.

Trip hazards: Do not run small services including drains and conduits across floors where they may be a trip hazard.

Manufacturer's standard equipment: Modify manufacturer’s standard equipment when necessary to provide the plant access documented.

Clearances

Minimum clearances for access: Conform to the following:

- ≥ 2100 mm clear vertically above horizontal floors, ground and platforms.

- Preferably ≥ 750 m clear, but in no case less than 600 mm horizontally between equipment or between equipment and building features including walls.
- If tools are required to operate, adjust or remove equipment, provide sufficient space so that the tools can be used in their normal manner and without requiring the user to employ undue or awkward force.
- If equipment components are hinged or removable, allow the space recommended by the manufacturer.
- Within plant items: Conform to the preceding requirements, and in no case less than the clearances recommended in BS 8313.

Elevated services other than in occupied areas

Access classifications:

- Access class A: Readily accessible. Provide clear and immediate access to and around plant items. If plant or equipment is located more than 2.0 m above the ground, floor or platform, provide a platform with handrails accessible by a stair, all to AS 1657.
- Access class B: If the plant item requiring access is located more than 2.0 m above the ground, floor or platform, provide a platform with handrails accessible by a non-vertical ladder, all to AS 1657.
- Access class C: Locate plant so that temporary means of access conforming to Work health and Safety regulations can be provided.

Temporary means of access: Make sure there is adequate provision in place which is safe and effective.

Areas in which access is restricted to authorised maintenance personnel: Provide access as follows:

- Instruments, gauges and indicators (including warning and indicating lights) requiring inspection at any frequency: Readily accessible.
- Access required monthly or more frequently: Access class A.
- Access required between monthly and six monthly: Access class A or B.
- Access required less frequently than six monthly: Access class A, B or C.

Other areas: Provide access as follows:

- Locate to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- In suspended ceilings, locate items of equipment that require inspection and/or maintenance above tiled parts. If not possible, provide access panels where located above set plaster or other inaccessible ceilings. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.
- Do not locate equipment requiring access above partitions.
- Instruments, gauges and other items requiring inspection at any frequency: Readily accessible.
- Labelling: If equipment is concealed in ceilings, provide marking to **MARKING AND LABELLING**, **Equipment concealed in ceilings**.

Facilities for equipment removal and replacement

Requirement: Provide facilities to permit removal from the building and replacement of plant and equipment, including space large enough to accommodate it and any required lifting and/or transportation equipment. Arrange plant so that large and/or heavy items can be moved with the minimum of changes of direction.

Facilities for access

Equipment behind hinged doors: Provide doors opening at least 150°.

Equipment behind removable panels: Provide panels with quick release fasteners or captive metal thread screws.

Removable panels: Provide handles to permit easy and safe removal and replacement.

Insulated plant and services: If insulation must be removed to access plant and services provide access for maintenance, arranged so it can be repeatedly removed and replaced without damage.

Electrical and controls

Electrical equipment: Provide clearances and access space to AS/NZS 3000.

Switchboards and electrical control equipment: Locate near the main entrance to plant space. Arrange plant so that, to the greatest extent possible, switchboards are visible from the plant being operated.

Control panels: Locate near and visible from the plant controlled.

3.12 VIBRATION SUPPRESSION

General
Requirement: Minimise the transmission of vibration from rotating or reciprocating equipment to other building elements.

Standard
Rotating and reciprocating machinery noise and vibration: Vibration severity in Zone A to AS 2625.1 and AS 2625.4.

Speeds
General: If no maximum speed is prescribed do not exceed 1500 r/min for direct driven equipment.

Connections
General: Provide flexible connections to rotating machinery and assemblies containing rotating machinery. Isolate pipes by incorporating sufficient flexibility into the pipework or by use of proprietary flexible pipe connections installed so that no stress is placed on pipes due to end reaction.

Inertia bases
General: If necessary to achieve the required level of vibration isolation, provide inertia bases having appropriate mass and conforming as follows:

- Construction: Steel or steel-framed reinforced concrete. Position foundation bolts for equipment before pouring concrete.
- Supports: Support on vibration isolation mountings using height saving support brackets.

Vibration isolation mountings
General: Except for external equipment that is not connected to the structure of any building, support rotating or reciprocating equipment on mountings as follows:

- For static deflections < 15 mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.
- For static deflections ≥ 15 mm: Spring mountings.

Selection: Provide mountings selected to achieve 95% isolation efficiency at the normal operating speeds of the equipment.

Installation: Set and adjust vibration isolation mounting supports to give clearance for free movement of the supports.

Spring mountings: Provide freestanding laterally stable springs as follows:

- Clearances: ≥ 12 mm between springs and other members such as bolts and housing.
- High frequency isolation: 5 mm neoprene acoustic isolation pads between baseplate and support.
- Levelling: Provide bolts and lock nuts.
- Minimum travel to solid: ≥ 150% of the designated minimum static deflection.
- Ratio of mean coil diameter to compressed length at the designated minimum static deflection: ≥ 0.8:1.
- Snubbing: Snub the springs to prevent bounce at start-up.
- Vertical resilient limit stops: To prevent spring extension when unloaded, to serve as blocking during erection and which remain out of contact during normal operation.
-

3.13 SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS

General

Buildings designated as either Earthquake Design Category II or III shall have mechanical components restrained against seismic forces as detailed in AS 1170.4. ***Rev 2019-06***

Referenced documents. ***Rev 2019-06***
AS 1170.4 – Minimum Design Loads on Structures – Part 4: Earthquake Loads. ***Rev 2017-01***

Electrical Components

The following mechanical components and their connections shall be designed for seismic restraints as detailed in AS 1170.4:

1. Emergency electrical systems (including battery racks)

2. ***Life safety system components.***
3. ***Containments Systems (such as cable systems)***
4. ***Utility and service interfaces.***
5. ***Lighting fixtures.***
6. ***Electrical panel boards and dimmers.*** ***Rev 2019-06***

Coordination

All components that are connected to building structure shall be coordinated with the relevant trade. Connection details and the mass of components and allow for the seismic design of the structural elements. ***Rev 2019-06***

Seismic Restraint Design

Design and install all systems, plant and equipment, fixings, supports, mountings, hangers and attachments in accordance with AS 1170.4

The Contractor shall design seismic restraints in accordance with AS 1170.4, based on equipment selected. Seismic restraints are to be designed by an RPEQ and the seismic restraint design and associated Form 15 are to be submitted for review as part of the mechanical services shop drawings. ***Rev 2019-06***

Seismic Mounts

Vibration isolation mounts, including spring mounts and rubber mounts, shall be restrained against both horizontal and vertical motion. Mounts shall be capable of withstanding the earthquake forces in accordance with AS 1170.4. ***Rev 2019-06***

Where seismic mounts are not practical, restrain equipment with all directional seismic snubbers, capable of withstanding the earthquake forces in accordance with AS 1170.4.

Rev 2019-06

3.14 FINISHES TO BUILDING SERVICES

General

Requirement: If exposed to view (including in plant rooms), paint building services and equipment.

Surfaces painted or finished off-site:

Exceptions: Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish documented.

Standard: Conform to the recommendations of AS/NZS 2311 Sections 3, 6 and 7 or AS/NZS 2312.1 Sections 6, 7 and 8, as applicable.

Powder coating

Standard: Conform to the following:

- Aluminium for architectural applications: To AS 3715.
- Other metals: To AS 4506.

Painting systems

New unpainted interior surfaces: To AS/NZS 2311 Table 5.1.

New unpainted exterior surfaces: To AS/NZS 2311 Table 5.2.

Paint application

Coats: Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Make sure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture and free of runs, sags, blisters or other discontinuities.

Combinations: Do not combine paints from different manufacturers in a paint system.

Protection: Remove fixtures before starting to paint and refix in position undamaged when painting is complete.

Low VOC emitting paints

Paint types: To the recommendations of AS/NZS 2311 Table 4.2.

3.15 MARKING AND LABELLING

General

Requirement: Mark and label services and equipment for identification purposes as follows:

- Locations exposed to weather: Provide durable materials.
- Pipes, conduits and ducts: To AS 1345 throughout its length, including in concealed spaces.
- Cables: Label to indicate the origin and destination of the cable.

Consistency: Label and mark equipment using a consistent scheme across all services elements of the project.

Label samples and schedules

Submission timing: Before marking or labelling.

Schedule: For each item or type of item include the following:

- A description of the item or type of item for identification.
- The proposed text for marking or labelling.
- The proposed location of the marking and labelling.

Electrical accessories

Circuit identification: Label isolating switches and outlets to identify circuit origin.

Operable devices

Requirement: Mark to identify the following:

- Controls.
- Indicators, gauges, meters.
- Isolating switches.

Equipment concealed in ceilings

Location: Provide a label on the ceiling, indicating the location of each concealed item requiring access for routine inspection, maintenance and/or operation. In tiled ceilings, locate the label on the ceiling grid closest to the item access point. In flush ceilings, locate adjacent to closest access panel. Items to be labelled include but are not limited to:

- Fire detectors

Underground services

Survey: Accurately record the routes of underground cables and pipes before backfilling. Include on the record drawings.

Records: Provide digital photographic records of underground cable and pipe routes before backfilling. Include in operation and maintenance manual.

Location marking: Accurately mark the location of underground cables and pipes with route markers consisting of a marker plate set flush in a concrete base, engraved to show the direction of the line and the name of the service.

Markers: Place markers at ground level at each joint, route junction, change of direction, termination and building entry point and in straight runs at intervals of not more than 100 m.

Marker bases: 200 mm diameter x 200 mm deep, minimum concrete.

Direction marking: Show the direction of the cable and pipe run by means of direction arrows on the marker plate. Indicate distance to the next marker.

Plates: Brass, aluminium or stainless steel with black filled engraved lettering, minimum size 75 x 75 x 1 mm thick.

Plate fixing: Waterproof adhesive and 4 brass or stainless steel countersunk screws.

Marker height: Set the marker plate flush with paved surfaces, and 25 mm above other surfaces.

Marker tape: Where electric bricks or covers are not provided over underground wiring, provide a 150 mm wide yellow or orange marker tape bearing the words WARNING – electric cable buried below, laid in the trench 150 mm below ground level.

Labels and notices

Materials: Select from the following:

- Cast metal.
- For indoor applications only, engraved two-colour laminated plastic.
- Proprietary pre-printed self-adhesive flexible plastic labels with machine printed black lettering.

- Stainless steel or brass minimum 1 mm thick with black filled engraved lettering.

Emergency functions: To AS 1319.

Colours: Generally to AS 1345 as appropriate, otherwise black lettering on white background except as follows:

- Danger, warning labels: White lettering on red background.
- Main switch and caution labels: Red lettering on white background.

Edges: If labels exceed 1.5 mm thickness, radius or bevel the edges.

Labelling text and marking: To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents and in operating and maintenance manuals.

Lettering heights:

- Danger, warning and caution notices: Minimum 10 mm for main heading, minimum 5 mm for remainder.
- Equipment labels within cabinets: Minimum 3.5 mm.
- Equipment nameplates: Minimum 40 mm.
- Identifying labels on outside of cabinets: Minimum 5 mm.
- Isolating switches: Minimum 5 mm.
- Switchboards, main assembly designation: Minimum 25 mm.
- Switchboards, outgoing functional units: Minimum 8 mm.
- Switchboards, sub assembly designations: Minimum 15 mm.
- Self-adhesive flexible plastic labels:
  . Labels less than 2000 mm above floor: 3 mm on 6 mm wide tape.
  . Labels minimum 2000 mm above floor: 8 mm on 12 mm wide tape.
  . Other locations: Minimum 3 mm.

Label locations: Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.

Fixing: Fix labels securely using screws, rivets, proprietary self-adhesive labels or double-sided adhesive tape and as follows:

- If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
- Use aluminium or monel rivets for aluminium labels.

3.16 SOFTWARE

General

Requirement: Provide the software required for the operation and management of building services systems and equipment.

3.17 WARRANTIES

General

Requirement: If a warranty is documented, name the principal as warrantee. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Warranty period: Start warranty periods at acceptance of installation.

Approval of installer: If installation is not by manufacturer, and product warranty is conditional on the manufacturer’s approval of the installer, submit the manufacturer’s written approval of the installing firm.

3.18 RECORD DRAWINGS

General

Requirement: Show the following:

- Installed locations of building elements, services, plant and equipment.

- Off-the-grid dimensions and depth if applicable.
- Any provisions for the future.

Recording, format and submission

Progress recording: Keep one set of drawings on site at all times, expressly for the purpose of marking changes made during the progress of the works.

Drawing layout: Use the same borders and title block as the contract drawings.

Quantity and format: Conform to format schedules for shop drawings**.**

Scale: as installed drawings shall be drawn at a standard scale (1:100, 1:200, 1:250, 1:500 or 1:1000) unless agreed otherwise. ***Rev 2019 - 01***

Endorsement: Sign and date all record drawings.

Accuracy: If errors in, or omissions from, the record drawings are found, amend the drawings and re-issue in the quantity and format documented for **SUBMISSIONS.**

Date for submission: Not later than 2 weeks after the date for practical completion.

Services record drawings

General: To **General** and **Recording, format and submission** and the following:

- Contents: As for the respective shop drawings.
- Extensions and/or changes to existing: If a drawing shows extensions and/or alterations to existing installations, include sufficient of the existing installation to make the drawing comprehensible without reference to drawings of the original installation.
- Detention: If on-site detention tanks or pondage are provided, include the volume required on the drawing and the permitted flow rate to the connected system.
- Domestic cold water or fire mains: Show the pressure available at the initial connection point and the pressure available at the most disadvantaged location on each major section of the works.
- Stormwater: If storm water pipes are shown, include the pipe size and pipe grade together with the maximum acceptable flow and the actual design flow.

Diagrams: Provide diagrammatic drawings of each system including the following:

- Controls.
- Principal items of equipment.
- Single line wiring diagrams.
- Acoustic and thermal insulation.
- Access provisions and space allowances.
- Fixings.
- Fixtures.
- Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.

Subsurface services: Record information on underground or submerged services to the documented quality level, conforming to AS 5488.

3.19 OPERATION AND MAINTENANCE MANUALS

General

Authors and compilers: Personnel experienced in the maintenance and operation of equipment and systems installed, and with editorial ability.

Referenced documents: If referenced documents or technical worksections require that manuals be submitted, include corresponding material in the operation and maintenance manuals.

Subdivision: By installation or system, depending on project size.

Contents

Requirement: Include the following:

- Table of contents: For each volume. Title to match cover.
- Directory: Names, addresses, email addresses and telephone and facsimile numbers of principal consultant, subconsultants, contractor, subcontractors and names of responsible parties.
- Record drawings: Complete set of record drawings, full size.

- Drawings and technical data: As necessary for the efficient operation and maintenance of the installation. Include:
  . Switchgear and controlgear assembly circuit schedules including electrical service characteristics, controls and communications.
- Installation description: General description of the installation.
- Systems descriptions and performance: Technical description of the systems installed and mode of operation, presented in a clear and concise format readily understandable by the principal's staff. Identify function, normal operating characteristics, and limiting conditions.
- Systems performance: Technical description of the mode of operation of the systems installed.
- Baseline data: To AS 1851 and AS/NZS 1668.1.
- Documentation to AS 1851 including the schedule of essential functionality and performance requirements.
- Digital photographic records to **Underground services**.
- Equipment descriptions:
  . Name, address, email address and telephone and facsimile numbers of the manufacturer and supplier of items of equipment installed, together with catalogue list numbers.
  . Schedules (system by system) of equipment, stating locations, duties, performance figures and dates of manufacture. Provide a unique code number cross-referenced to the record and diagrammatic drawings and schedules, including spare parts schedule, for each item of equipment installed. Equipment schedules in tabular form including the equipment designation used on the drawings, manufacturer's name and contact details, equipment name plate data, function of item, associated system and capacity data.
  . Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
  . Supplements to product data to illustrate relations of component parts. Include typed text as necessary.
- Certificates:
  . Certificates from authorities.
  . Copies of manufacturers' warranties.
  . Product certification.
  . Test certificates for each service installation and all equipment.
  . Test reports
  . Test, balancing and commissioning reports.
  . Control system testing and commissioning results.
- 7 day record of all trends at commissioning.
- Operation procedures:
  . Manufacturers' technical literature as appropriate.
  . Safe starting up, running-in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure.
  . Control sequences and flow diagrams for systems installed.
  . Legend for colour-codes services.
  . Schedules of fixed and variable equipment settings established during commissioning and maintenance.
  . Procedures for seasonal changeovers.
- Maintenance procedures:
  . Detailed recommendations for periodic maintenance and procedures, including schedule of maintenance work including frequency and manufacturers' recommended tests.
  . Manufacturer's technical literature as appropriate. Register with manufacturer as necessary. Retain copies delivered with equipment.
  . Safe trouble-shooting, disassembly, repair and reassembly, cleaning, alignment and adjustment, balancing and checking procedures. Provide logical step-by-step sequence of instructions for each procedure.

. Schedule of spares recommended to be held on site, being those items subject to wear or deterioration and which may involve the principal in extended deliveries when replacements are required. Include complete nomenclature and model numbers, and local sources of supply.
. Schedule of normal consumable items, local sources of supply ,and expected replacement intervals up to a running time of 40 000 hours. Include lubrication schedules for equipment.
. Schedules for recording recommissioning data so that changes in the system over time can be identified.
. Instructions for use of tools and testing equipment.
. Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.
. Safety data sheets (SDS).
. Instructions and schedules conforming to AS 1851, AS/NZS 3666.2, AS/NZS 3666.3 and AS/NZS 3666.4.

- Maintenance records:
  . Prototype service records conforming to AS 1851 prepared to include project specific details.
  . Prototype periodic maintenance records and report to AS/NZS 3666.2, AS/NZS 3666.3 and AS/NZS 3666.4 as appropriate, prepared to include project specific details.
  . For hard copies: In binders which match the manuals, loose leaf log book pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed log book pages recording the operational and maintenance activities performed up to the time of practical completion.
  . Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.
- Emergency information: For each type of emergency, including fire, flood, gas leak, water leak, power failure, water failure, system or sub system failure, chemical release or spill, include the following:
  . Emergency instructions.
  . Emergency procedures including:
    * Instructions for stopping or isolating.
    * Shutdown procedures and sequences.
    * Instructions for actions outside the property.
    * Special operating instructions relevant to the emergency.
    * Contact details relevant to the emergency.

Emergency information manual

Form of emergency information: Provide one of the following:

- An index and coloured tabs identifying emergency information for each type of emergency within the Operation and maintenance manual.
- A separate Emergency manual containing copies of emergency information from the main Operation and maintenance manual.

Format – electronic copies

Scope: Provide the same material as documented for hardcopy in electronic format.

Quantity and format: Conform to **SUBMISSIONS , Electronic submissions**.

Printing: Except for drawings required in the **RECORD DRAWINGS** clause provide material that can be legibly printed on A4 size paper.

Format – hard copy

General: A4 size loose leaf, in commercial quality, 4 ring binders with hard covers, each indexed, divided and titled. Include the following features:

- Cover: Identify each binder with typed or printed title *OPERATION AND MAINTENANCE MANUAL*, to spine. Identify title of project, volume number, volume subject matter, and date of issue.
- Dividers: Durable divider for each separate element, with typed description of system and major equipment components. Clearly print short titles under laminated plastic tabs.

- Drawings: Fold drawings to A4 size with title visible, insert in plastic sleeves (one per drawing) and accommodate them in the binders.
- Pagination: Number pages.
- Ring size: 50 mm maximum, with compressor bars.
- Text: Manufacturers' printed data, including associated diagrams, or typewritten, single-sided on bond paper, in clear concise English.

Number of copies: 3.

Date for submission

Draft submission: The earlier of the following:

- 4 weeks before the date for practical completion.
- Commencement of training on services equipment.

Final submission: Within 2 weeks after practical completion.

3.20 ELECTRONIC FACILITY AND ASSET MANAGEMENT INFORMATION

Provide electronic facility and asset management information as scheduled. ***Rev 2017-01***

3.21 TOOLS AND SPARE PARTS

Spare parts

General: Provide spare parts listed in the appropriate worksections.

Replacement: Replace spare parts used during the maintenance period.

Tools and spare parts schedule

Submission timing: At least 8 weeks before the date for practical completion.

Requirement: Prepare a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

- Checking receipt, marking and numbering in conformance with the spare parts schedule.
- Packaging and delivery to site.
- Painting, greasing and packing to prevent deterioration during storage.
- Referencing equipment schedules in the operation and maintenance manuals.
- Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.

Replacement: Replace spare parts used during the maintenance period.

3.22 TESTING

Attendance

General: Provide attendance on tests.

Testing authorities

General: Except for site tests, have tests carried out by a Registered testing authority.

Test instruments: Use instruments calibrated by a Registered testing authority.

Test reports

General: Indicate observations and results of tests and conformance or non-conformance with requirements.

Notice

Inspection: Give sufficient notice for inspection to be made of the commissioning and completion testing of the installation.

Controls

General: Calibrate, set and adjust control instruments, control systems and safety controls.

Circuit protection

General: Confirm that circuit protective devices are sized and adjusted to protect installed circuits.

Completion tests
General: Test the works under the contract to demonstrate conformance with the documented performance requirements of the installation.

Functional checks: Carry out functional and operational checks on energised equipment and circuits and make final adjustments for the correct operation of safety devices and control functions.

Type test reports: Required, as evidence of conformance of proprietary equipment.

Sound pressure level measurements: Conform to the following:

- Correction for background noise: To AS/NZS 2107 Table B1.
- External: To AS 1055.1.
- Internal: To AS/NZS 2107.
- Measurement positions: If a test position is designated only by reference to a room or space, do not take measurements less than 1 m from the floor, ground or walls.
- Sound pressure level analysis: Measure the sound pressure level and the background sound pressure level over the full range of octave band centre frequencies from 31.5 Hz to 8 kHz at the designated positions.
- Sound pressure levels: Measure the A-weighted sound pressure levels and the A-weighted background sound pressure levels at the designated positions.

Certification
General: On satisfactory completion of the installation and before the date of practical completion, certify that each installation is operating correctly.

3.23 TRAINING

General
Duration: Instruction to be available for the whole of the commissioning and running-in periods.

Format: Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.

Operation and maintenance manuals: Use items and procedures listed in the final draft operation and maintenance manuals as the basis for instruction. Review contents in detail with the principal's staff.

Certification: Provide written certification of attendance and participation in training for each attendee. Provide register of certificates issued.

Demonstrators
General: Use only qualified manufacturer's representatives who are knowledgeable about the installations.

Maintenance
General: Explain and demonstrate to the principal's staff the purpose, function and maintenance of the installations.

Operation
General: Explain and demonstrate to the principal's staff the purpose, function and operation of the installations.

Seasonal operation
General: For equipment requiring seasonal operation, demonstrate during the appropriate season and within 6 months.

3.24 CLEANING

Final cleaning
General: Before the date for practical completion, clean throughout, including all exterior and interior surfaces except those totally and permanently concealed from view.

Labels: Remove all labels not required for maintenance.

3.25 PERIODIC MAINTENANCE OF SERVICES

General

Requirement: During the maintenance period, carry out periodic inspections and maintenance work as recommended by manufacturers of supplied equipment, and promptly rectify faults.

Emergencies: Attend emergency calls promptly.

Annual maintenance: Carry out recommended annual maintenance procedures before the end of the maintenance period.

Maintenance period: The greater of the defects liability period and the period documented in the **Maintenance requirements schedule**.

Maintenance program

General: Submit details of maintenance procedures and program, relating to installed plant and equipment, 6 weeks before the date for practical completion. Indicate dates of service visits. State contact telephone numbers of service operators and describe arrangements for emergency calls.

Maintenance records

General: Record in binders provided with the Operation and maintenance manuals.

Referenced documents: If referenced documents or technical worksections require that log books or records be submitted, include this material in the maintenance records.

Certificates: Include test and approval certificates.

Service visits: Record comments on the functioning of the systems, work carried out, items requiring corrective action, adjustments made and name of service operator. On completion of the visit, obtain the signature of the principal's designated representative on the record of the work undertaken.

Site control

General: Report to the principal’s designated representative on arriving at and before leaving the site.

3.26 POST-CONSTRUCTION MANDATORY INSPECTIONS AND MAINTENANCE

General

Requirement: For the duration of the defects liability period, provide inspections and maintenance of safety measures required by the following:

- AS 1851.
- Other statutory requirements applicable to the work.

Records: Provide mandatory records.

Certification: Certify that mandatory inspections and maintenance have been carried out and that the respective items conform to statutory requirements.

Annual inspection: Perform an annual inspection and maintenance immediately before the end of the defects liability period.

3.27 INTERRUPTIONS TO SUPPLY

General

NO UNSCHEDULED INTERRUPTIONS to any site services shall occur – including electricity, telephones, water, fire services, refrigeration – and the contractor shall ensure full care is taken to avoid such interruptions.

Any required interruptions shall be fully discussed between all parties and the interruptions shall be planned to be of minimum time period and of minimum number. Obtain written confirmation for the interruptions prior to the event.

This clause does not require live work or that Workplace Health and Safety requirements are not to be adhered to.

Provide temporary power supplies or other temporary services as nominated to maintain services to the site as required.

3.28 SITE ACCESS

General

Follow all site requirements regarding contractor sign-in for access to the site and for obtaining of keys.

3.29 ASBESTOS

General

Prior to commencing on site, obtain and review the Asbestos Management Plan. Comply with requirements of this plan throughout the project.

Where penetrating or removing asbestos, employ a Class A asbestos remover.

Also employ an independent asbestos surveyor to certify work completed. Include all necessary air monitoring, etc. Provide certificates at completion.

3.30 FIRE DETECTORS

General

During periods where construction is being undertaken and smoke detectors are installed, provide covers over detectors to ensure dust does not enter the detector. Also isolate zones where work is being undertaken.

Alarms caused due to failure to carry this out will be charged to the contract/sub-contract.

Where detectors have not been suitably protected, clean and recalibrate units. ***Rev 2017-01***

0911 CABLE SUPPORT AND DUCT SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide cable support, trunking and duct systems, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to all worksections included herein for electrical services. ***Rev 2017-01***

1.3 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definitions apply:
- Cable support: Cable tray, cable ladders and cable mesh cable support systems.

1.4 SUBMISSIONS

Certification
General: Submit structural engineer's certification for the following:
- Fabricated columns.
- Flange assemblies at the base of columns.
- Footings for columns.
- Rag bolt assemblies for column support.

Operation and maintenance manuals
Requirement: Submit all operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Shop drawings
Cable support and duct systems: Submit shop drawings showing the following:
- Cable tray and trunking routes.
- Layout of cable supports and enclosures on the current architectural background coordinated with the structure and other services.
- Layout of underground conduits, pits and drainage trenches.
- Invert levels for underground conduits.
- Depth of burial for cables and conduits.
- In situ pits.
- Provision for expansion and ground movement.
- Fabricated columns.
- Footing for columns.

Products and materials
Cable support and duct systems: Submit technical data for the following:
- Ducted wiring enclosure systems.
- Cable support systems.
- Proprietary pits.
- Proprietary columns.
- Load calculations for aerial cable supports.

2 PRODUCTS

2.1 GENERAL

Marking
Identification: Marked to show the following:
- Manufacturer's identification.
- Product brand name.
- Product type.
- Quantity.
- Product reference code and batch number.
- Date of manufacture.

2.2 CONDUITS

General
Standards: To AS/NZS 2053.3, AS/NZS 61386.1, AS/NZS 61386.21, AS/NZS 61386.22 and AS/NZS 61386.23.

Communications cabling: To AS/NZS ISO/IEC 14763.2.

Type
General: Rigid.

Sizes
Requirement: Conform to the following:
- Underground: ≥ 25 mm.
- Telecommunications: ≥ 25 mm.
- Other locations: ≥ 20 mm.

Fasteners
Surface mounted: Double sided fixed.

Colour
Conduits generally: Light orange.

Telecommunications systems conduits: White.

Galvanized water pipe
Medium or heavy: To AS 1074.

2.3 METALLIC CONDUITS AND FITTINGS

General
Standards: To AS/NZS 61386.21 and AS/NZS 61386.23.

Type
General: Screwed steel conduit with medium protection outside and inside to AS/NZS 61386.21.

Exposed to dampness or moisture: Steel conduit with high protection outside and inside to AS/NZS 61386.21.

Laid underground: Steel water pipe with protection outside and inside to AS/NZS 61386.21.

Joining
Steel conduit: Screwed joints and ends.

Fasteners
Saddles: Conform to the following:
- Internal: Zinc plated.
- External: Hot-dipped galvanized.

Corrosion protection
Steel conduits: Paint ends and joint threads with zinc rich organic primer to AS/NZS 3750.9.

2.4 NON-METALLIC CONDUITS AND FITTINGS

General
Standards: To AS/NZS 2053.3, AS/NZS 61386.21, AS/NZS 61386.22 or AS/NZS 61386.23.

Number of joints: Use minimum number of joints, subject to commercially available lengths.

Bends: Where practical, conduit changes of direction shall be by solid formed large radii bends. ***Rev 2017-01***

Flexible conduit

Requirement: Provide flexible conduit to connect with equipment and plant subjected to vibration. If required, provide for adjustment or ease of maintenance. Use the minimum possible length ***and not more than 500mm.*** ***Rev 2017-01***

Associated fittings

Type and material: Same as the conduit.

Wall boxes on PVC-U conduits: For special size wall boxes not available in PVC-U, provide prefabricated earthed metal boxes.

Fixings: Fixings shall be installed along the length of the conduit at the minimum of 1000m for horizontal runs and 2000mm for vertical runs using two fixings per saddle. Select suitable fixings for each type of surface the saddles arte to be fixed to. ***Rev 2017-01***

Inspection-type fittings

Requirement: Use only in accessible locations and where exposed to view.

Joints

Locations: Install flexible couplings at structural expansion joints with saddles close to the coupling.

At all times where possible install conduit out of direct sunlight. Where conduits are exposed to sunlight they shall be stabilized and be guaranteed for this type of installation for a minimum of 15 years. ***Rev 2017-01***

Type: Cemented or snap-on joints.

2.5 CABLE DUCT/TRUNKING

General

Standards: To AS/NZS 4296.

Communications cabling: To AS/NZS ISO/IEC 14763.2.

Cable duct

Type: Unless otherwise specified, use rigid PVC ducts of suitable design with readily removable covers. Size ducts to accommodate a 100% increase in the number of cables to be installed.

Metal ducts: Construct metal ducts from minimum 1.0mm thick pre-formed galvanised steel with removable cover. Duct to be electrically continuous and earthed.

Joints: Fix ducts to ensure a close finish of duct against building surface. Cut square all joints and butt ducts against building features, ceilings and mounting blocks to avoid gaps.

Cable straps: Fit suitable straps within ducts installed on walls or ceilings to ensure cables remain in ducts when covers are removed.

Do not provide joints in wiring within ducts.

Cable joints accessibility: Install ducts where they will be accessible after installation.

Edges: Round off sharp edges and provide PVC bushes or the like for cable entries into metallic ducting. Ducts shall be surface mounted unless otherwise indicated.

Support: Support ducts within 100mm of each end and at intervals not exceeding 400mm where ducts are below 3000mm from floor level. Fix ducts in accessible ceiling spaces at intervals not exceeding 1000mm.

Expansion joints: Provide expansion joints in ducts at 7500mm intervals and at building expansion joints. Expansion joints in PVC ducts may be of the type using PVC straps across the joint glued to the duct on one side of the joint only. Use glue recommended by the duct manufacturer. Expansion joints in metal ducts to have approved fish plates, metal thread screws and washers. ***Rev 2017-01***

Covers for accessible locations: Screw-fixed or clip-on type removable only with the use of tools.

Accessories: Purpose-made to match the duct system.

Proprietary trunking systems

General: Provide proprietary skirting duct, wall duct, floor duct and service column systems, incorporating segregation, if used for multiple services. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic trunking.

Accessories and outlets: Proprietary fasteners and mountings facilities.

Covers: Screw-fixed or clip-on type, removable only with the use of tools.

2.6 CABLE TRAY/LADDER SUPPORT SYSTEMS

General

Standard: To NEMA VE-1.

Type tests: To NEMA VE-1.

Manufacture: Provide proprietary cable support, fittings and accessories from a single manufacturer for the same support system.

Selection: Select cable supports in conjunction with support system installation to achieve the loading and deflection requirements.

Spare capacity: Minimum 50%.

Support

Power cables: Conform to the following:

- Overhead suspension: Trapeze or centre rail structure.
- Wall supported: Wall bracket with full access from one side of the cable support.

Communications cables: Conform to the following:

- Overhead suspension: Single sided.
- Wall supported: Wall bracket with full access from one side of the cable support.

Orientation: Provide tray/ladder support to support cables on top of trays with a minimum of 150mm clearance above and at least one clear side for access, for future cable access.

Rev 2017-01

Dimensions: To the preferred dimensions nominated in NEMA VE-1.

Material finish: Metallic-coated to AS 1397, Grade G2, Coating Class Z275.

Finishes: Paint in areas exposed to public view, confirming final colour prior to ordering. Supports shall also be galvanised and painted (where exposed). Treat all cut edges or welds to prevent corrosion. ***Rev 2017-01***

Covers: Ventilated flat covers to cable support systems installed in accessible locations.

2.7 CATENARY SYSTEMS

General

Catenary systems: May be used within suspended ceiling spaces instead of cable tray and ladder systems.

Wire: Stainless steel or coated galvanized cable and couplings.

2.8 CABLE PITS

General

Cable draw-in pits: Provide cable draw-in pits, as documented. Sizes given are internal dimensions.

Bed pits on minimum 100mm gravel aggregate after compaction to prevent them from sinking.

Seal around cables within conduits at pits to prevent water ingress into buildings from outside.

Rev 2017-01

Proprietary cable pits

Pits ≤ 1200 x 1200 mm: Proprietary concrete or polymer moulded pits.

In situ construction

Pits > 1200 x 1200 mm: Provide either of the following:

- Proprietary cable pits.
- Construct walls and bottoms from rendered brickwork or 75 mm thick reinforced concrete. Incorporate a waterproofing agent in the render or concrete.

Pit covers

General: Provide pit covers to suit external loads. Fit flush with the top of the pit.

Standard: To AS 3996.

Weight: < 40 kg for any section of the cover.

Lifting handles: Provide a lifting handle for each size of cover section.

Drainage

General: Provide drainage from the bottom of cable pits, either to absorption trenches filled with rubble or to the stormwater drainage system.

Seal around the conduit entry to prevent waster ingress.

Absorption pits: Minimum size 500W x 500L x 1000D mm. the top of absorption pits shall be below the bottom of the pit being drained. ***Rev 2017-01***

2.9 COLUMNS

General

Columns: Conform to the following for fabricated columns more than 2400 mm high which are designed to support accessories outdoors.

Standards

Public lighting poles: AS 1798.

Concrete structures: AS 3600.

Steel structures: To AS 4100.

Structural design of columns: To AS/NZS 4676.

Hot-dipped galvanized (zinc) coatings on ferrous articles: To AS/NZS 4680.

Design

General: Tapped hot-dipped galvanized steel, aluminium or concrete columns, designed, manufactured and tested by a specialist manufacturer.

Mounting: Conform to the following:

- Steel and aluminium columns: Base plate mounting, suitable for mounting on rag bolt assemblies.
- Concrete columns: Direct mounting in the ground.

Footings: Provide footings and rag bolt assemblies detail designed by a professional engineer and independently certified.

Site specifics: Take into consideration the design wind category and the soil conditions.

Dimensions: To AS 1798.

Rag bolt assemblies: Galvanized threaded steel of cross-sectional area designed to support each column taking into account the wind loads expected to act on the column and the luminaires mounted on the column. Set the rag bolt assemblies in the concrete footings. Cut holding bolts within 3 threads above top of base plate top lock nuts.

Base sealing: Seal space under pole base plate with grout.

Maintenance access: Provide pole stirrups secured to either side of the column for access to accessories. Locate the first stirrup greater than or equal to 3 m above ground level.

Electrical connections: For hollow metal or concrete poles provide a recess fitted with a flush mounted lockable or screw fixed cover at the base of the column for access to cable connections and equipment.

Cable support: For connections higher than 3 m, provide a catenary wire cable support system unless cable and anchor methods at the ends of the cable suspension are designed for unsupported cable suspension.

Drainage: Provide adequate drainage at the column base.

2.10 POWER POLES

Hardwood poles

Requirement: Conform to the requirements of AS/NZS 3000, the network distributor's standards and the Service and Installation Rules.

Selection: Dressed, natural, round poles with all sapwood removed.

Capping: Galvanized steel, domed cap extending 25 mm down the sides. Fix with galvanized steel nails.

Termite and fungus treatment: To 600 mm above ground level.

Cable support at point of supply

Requirement: Bolts and support service hooks fixed to the pole for the support of overhead insulated-aerial bundled cables as required by the network distributor and the Service and Installation Rules.

Accessories: Provide the accessories for any additional poles used in the provision of overhead services.

Steel poles

General: Hot-dipped galvanized round steel poles to conform with the requirements of AS/NZS 3000, the network distributor's standards and the Service and Installation Rules.

Capping: Galvanized steel, domed cap extending 25 mm down the sides. Fix with galvanized steel screws.

Drainage: Provide adequate drainage at the column base.

2.11 CUSTOM DESIGNED POLES/COLUMNS

General

Requirement: Provide columns designed, manufactured and tested by a specialist manufacturer.

Standards: To the network distributor's standards and to the Service and Installation Rules.

Construction

General: Hot-dip galvanize steel columns and fittings after fabrication. Powder coat or anodise aluminium columns and fittings after fabrication.

Drainage: Provide adequate drainage at the column base.

Bases and footings for custom designed columns

Requirement: Provide bases to custom designed columns as documented.

Bases: Provide mounting bases for rag bolt assembly fixing to reinforced concrete footings.

Footings: Provide footings and rag bolt assemblies detail designed by a professional engineer and independently certified.

Site specifics: Design for the site wind category and the soil conditions.

Dimensions: To AS 1798.

Rag bolt assembly: Cut holding bolts within 3 threads above top of base plate top lock nuts.

Base fixing: Galvanized holding down nut with galvanized lock nut above.

Design of footing and rag bolt assemblies: Undertake design by a professional engineer and provide independent certification.

Base sealing: Seal space under pole base plate with grout.

Finish: Paint, colour as documented.

Cable support at point of supply

Requirement: Bolts and support service hooks fixed to the pole for the support of overhead insulated-aerial bundled cables as required by the network distributor and the Service and Installation Rules.

Accessories: Provide bolts, support hooks and any other support accessories for any additional poles used in the provision of overhead services.

Overhead to underground cable facilities: Provide access and cable support for conduit and cable systems connecting the unprotected overhead service cable to the facility underground cable duct system.

Accessory mountings: Provide adjustable mountings, to suit accessories. Include provision for rigidly clamping each item in position, once adjusted correctly.

Maintenance access: Provide pole stirrups secured to either side of the column for access to accessories. Locate the first stirrup greater than or equal to 3 m above ground level.

Electrical connections: For hollow metal or concrete poles if a continuous conduit system is not utilised, provide a recess fitted with a lockable or screw fixed flush mounted cover at the base of the column for access to cable connections and equipment.

Cable support: If cable and anchor methods at the ends of the cable suspension are not designed for unsupported cable suspension, provide a catenary wire cable support system for connections higher than 3 m.

Service connection: Provide pole mounted equipment including weatherproof box and service fuses at the service connection point as required by the network distributor.

3 EXECUTION

3.1 GENERAL

Fire isolation
Requirement: Provide fire-stop sealing where electrical services pass through fire-resisting walls, floors or ceilings.

Wall boxes in fire-resisting walls: Provide fire-resisting barriers behind wall boxes in fire-resisting walls if the integrity of the fire-resistance level has been altered.

3.2 UNSHEATHED CABLES – INSTALLATION

General
Requirement: Provide permanently fixed enclosure systems, assembled before installing wiring.

Draw wires: Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

3.3 CONDUIT SYSTEMS – INSTALLATION

Inspection fittings
Location: Locate in accessible positions.

Draw cords
General: Provide 5 mm^2 polypropylene draw cords in conduits not in use.

Draw-in boxes
General: For conduits in accessible locations provide draw-in boxes as follows:

- In straight runs at > 30 m: Spacing ≤ 30 m.
- At changes of level or direction.

Underground draw-in boxes: Provide gasketed covers and seal against moisture. Install in accessible pits.

Expansion
General: Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.

Rigid conduits
General: Install in straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings.

Routes
Set-out: If exposed to view, install conduits in parallel runs with right angle changes of direction.

Bends: Install conduits with no more than 2 right angled bends per cable draw-in run.

Concealed conduits: Run conduits concealed in wall chases, embedded in floor slabs or installed in inaccessible locations directly between points of termination, minimising the number of sets. Do not provide inspection fittings. Use large radius bends or elbows.

Overhead conduits in mechanical plant rooms: If overhead conduits service mechanical equipment installed on plinths in plant rooms, provide support and protection. Alternatively, use cable support system.

Painting
Conduits exposed to view: Paint to match surrounds as documented.

Conduits in roof spaces
Location: Locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

Conduits in concrete slabs
Route: Do not run in concrete toppings. Do not run within pretensioning cable zones. Cross pretensioning cable zones at right angles. Route to avoid crossovers and minimise the number of conduits in any location.

Parallel conduit spacing: ≥ 50 mm apart.

Conduits in mechanical plant room slabs: Avoid installation of conduits in plant room slabs (boiler rooms, mechanical plant rooms and tank rooms) if conduits and cables are likely to experience high temperatures, be subject to core hole drilling, drilling of large anchor bolt points or where exact plant locations are unknown at time slab is poured.

Minimum cover: The greater of the conduit diameter and 20 mm.

Construction joints: Provide sleeving over conduit to allow movement of the conduit across the joint due to any slab movement.

Fixing: Fix directly to the top of the bottom layer of reinforcing.

Conduits in hollow-block floors

Location: Locate conduits in the core-filled sections of precast hollow-block type floors.

Conduits in columns

Number and size of conduits in columns: As determined by the structural engineer.

Bends: Enter columns with radius sweep bends greater than or equal to 150 mm. Do not use elbows.

Chasing: Do not chase columns.

Flexible conduits

Flexible conduits shall be medium duty PVC with proprietary fittings. Flexible conduits shall not be used for continuous straight runs or replace solid sweep bends and shall be a maximum of 500mm unless agreed by the Superintendent's Representative. ***Rev 2018-02***

3.4 CABLE SUPPORT SYSTEMS – INSTALLATION

General

Standard: To NEMA VE-2.

Design: Support cable support systems as follows:

- Horizontal runs:
  - . Concealed cable support system: At spacing which is less than length of cable support section.
  - . Visible cable support: Loaded deflection ≤ span/200.
- Vertical runs: To manufacturer's recommendation, taking into account the weight of cables installed.

Fixing to building structure

General: Fix supports to the building structure or fabric with threaded rod hangers greater than or equal to 8 mm attached to hot-dip galvanized U-brackets, or by means of proprietary brackets.

Cable fixing

General: Provide strapping or saddles suitable for fixing cable ties.

Inside bend radius

Requirement: At least 12 times the outside diameter of the largest diameter cable carried.

Cable protection

General: Provide rounded support surfaces under cables where they leave trays or ladders.

Clearances

Access requirement: At least 150 mm free space above and at least 600 mm free space on at least one side of cable tray and ladders.

From hot water pipes: > 200 mm.

From boilers or furnaces: > 500 mm.

Electromagnetic interference (EMI): Locate support systems for electrical power cabling and communication cabling to minimise electromagnetic interference.

3.5 CATENARY SYSTEMS – INSTALLATION

General

Routes: Catenary systems shall be run parallel with walls wherever practical. ***Rev 2017-01***

Anchoring: Anchor catenary systems to the structure. Do not fix to any part of a suspended ceiling system.

Design loads: Design catenary systems to support the proposed load of the cables with a spare capacity of 50% loading.

Fixing: Fix cables to the catenary system so that no cable is under stress due to tension or compression. Use proprietary fasteners that allow cables to be added or removed without destroying the integrity of the system.

3.6 CABLES IN TRENCHES – INSTALLATION

Sand bed and surround

General: Conform to the *0223 Service trenching* worksection.

Sand bed and surrounds: Provide at least 150 mm clean sharp sand around cables and conduits installed underground.

Sealing ducts and conduits

General: Seal buried entries to ducts and conduits with waterproof seals as follows:

- Spare ducts and conduits: Immediately after installation.
- Other ducts and conduits: After cable installation.

3.7 COLUMNS – INSTALLATION

General

Requirement: Provide columns including in situ reinforced concrete footings as documented in the **Columns schedule**.

Columns set in the ground: Set columns in the ground to AS 1798 requirements and to the manufacturers' requirements.

Soil suitability: If the soil is unsuitable, consider alternative pole types and mount in concrete or on rag bolt assemblies set in concrete footings.

3.8 POWER POLES – INSTALLATION

Standards

General: To the Service and Installation Rules and to the network distributor's standards for the project environment and for the selected aerial arrangement.

Hardwood poles

Requirement: Set poles directly in the ground.

Planting depth: 1600 mm minimum or as required by AS/NZS 3000, the network distributor's standards and the Service and Installation Rules.

Support: Baulk and stay to suit the design loads.

Cable protection: Protect cables and conduits installed on the exterior of the pole to a height of 2000 mm above and 150 mm below ground using either galvanized water pipe or 3.2 mm thick hot-dip galvanized channel.

Steel poles

Requirement: Set round steel poles directly in the ground to AS 1798 requirements and to manufacturers' requirements.

Soil suitability: If the soil is unsuitable, consider alternative pole type and mount in concrete or on rag bolt assemblies set in concrete footings.

Custom designed poles/columns

General: Install columns as documented, including the provision of in situ reinforced concrete.

3.9 UNDERGROUND SERVICES

Preparation: Before commencing excavation complete the following:

Mark the proposed route using spray marker and obtain approval from the Superintendent's Representative

Locate all existing underground services using a professional underground locating provider. Any services cut or damaged during excavation shall be repaired or replaced by the contractor without variation to the contract

Where in public spaces obtain approvals from relevant Authorities and comply with their requirements

Saw cut existing concrete and bitumen surfaces in a straight line. Provide traffic management and/or alternative arrangements including hoardings, trench covers and other equipment as necessary to provide save access to public and staff

Excavation: Excavate trenches free of sharp material to install cables and conduits to required depths in accordance with relevant Australian Standards taking into account conduit dimensions plus bedding. Conduits shall be located a minimum of 600mm below finished level (including power, communications and other services). Trenching shall be completed in suitable lengths to enable backfilling and reinstatement within the same day unless agree by the Superintendent's Representative.

Backfilling and reinstatement: Provide a minimum of 50mm bedding sand completely around all conduits Trenches shall be backfilled in loose layers not exceeding 200mm and compacted to achieve 95% of standard maximum dry density obtained in accordance with AS1289 E5.7.1. In areas such as car parks and internal roadways 98% of standard maximum dry density is required. Backfill material and compaction of car parks and internal roadways shall match the area prior to excavation.

Rock and sharp objects or any other material that could damage conduit is not permitted in backfill within 200mm of conduit.

Reinstate surfaces to match those previously existing including:

- ***Garden areas: backfill the top 200mm with top soil***
- ***Lawn areas: backfill the top 100mm with loam soil and top up with loam during the defects liability period to compensate for any settling of the backfill.***
- ***Bitumen surfaces: complete compaction including minimum 150mm deep road base below the final bitumen layers. Bitumen is to match existing surface. Complete the repair procedure in accordance with standards used by the Queensland Main Roads requirements.***
- ***Concrete: provide reinforcing steel and concrete to match existing surface. Provide dowling to connect to surrounding concrete to prevent subsiding and cracking.***

Remove excess soil from the site unless directed otherwise.

Provide orange plastic marking tape 300mm above all underground services marked:

" CAUTION – ELECTRIC CABLE BURIED BELOW" or similar to meet Australian Standard requirements.

Underground cable route: Locate all underground cables using:

Brass route markers permanently located at maximum 50 metre spacings, at all changes of directions, pits and entry to buildings. Marker plates shall be engraved with directional arrows and type of services (e.g. 'Power', 'Comms' etc). Install markers wherever possible on permanent concrete and bitumen surfaces. Where not possible, install markers on 200 x 200 concrete blocks set 25mm above the existing grassed surface. As installed drawings showing measurements to centre line of services from permanent markers (e.g. corner of building, other services, pits etc.).

Conduits: Supply and install conduits as indicated on the drawings and for all underground services. Conduits shall be as follows:

Power cabling, Fire, MATV, Security and others: HD PVC

Communications, Telephone cabling: ACA approved

Lay all conduits with a drainage fall of minimum 1:100.

Provide a polypropylene draw cord in each unused conduit.

Pits: Supply and install pits as shown on the drawings and scheduled in the specification.

Drain the lowest external pit in any series using a minimum 50mm diameter drain pipe. Connect the drain to storm water. Where storm water connection is not available - drain to absorption pits to specification noted herein. Fill pit with coarse gravel and cover with a reinforced concrete slab. ***Rev 2017-01***

0921 LOW VOLTAGE POWER SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide low voltage power systems, as documented.

1.2 DESIGN

Electrical system design
Fault protection: Automatic disconnection to AS/NZS 3000 clause 2.4.
Fire-resisting protection: Provide for switchboards and associated electrical conductors to BCA C2.13.
Maximum demand: Calculation method to AS/NZS 3000 Appendix C.

1.3 PERFORMANCE

Network supply
General: Liaise with the electricity distributor and provide network connection, as documented.
Program: Schedule the works and statutory inspections to suit the construction program.
Prospective fault current: Determine, from the electricity distributor, the prospective fault current and fault protection requirements.
Supply system: 400 V, 3-phase, 4-wire, 50 Hz, multiple earth neutral (MEN) system.

Embedded generator supplies
General: Provide embedded generator supplies, as documented.

Distribution system
General: Provide power distribution system elements, as documented.

Surge protection devices (SPD)
General: Provide surge protection devices, as documented.

1.4 CROSS REFERENCES

General
Requirement: Conform to all worksections included herein for electrical services. ***Rev 2017-01***

1.5 STANDARDS

General
Requirement: To AS/NZS 3000 Part 2, unless documented otherwise.
Electrical design: To AS/NZS 3000 and SAA HB 301.
Electrical equipment: To AS/NZS 3100.
Fire and mechanical performance classification: To AS/NZS 3013.
Selection of cables: To AS/NZS 3008.1.1.
Distribution cables: To AS/NZS 4961.
Degrees of protection (IP code): To AS 60529.
Electromagnetic compatibility (EMC): To AS/NZS 61000.
Communications systems: To AS/CA S008, AS/CA S009, AS/NZS 3080 and AS/NZS ISO/IEC 14763.2.

Testing
Standard: To AS/NZS 3017.

1.6 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

- RCD: Residual current device.
- SPD: Surge protection device.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Embedded generator: Electricity generator connected to the local electrical distribution network.
- Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.
- High voltage: Exceeding low-voltage.
- Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.

1.7 SUBMISSIONS

Design documentation

Low voltage power systems: Submit the following information for each main, submain and final subcircuit for which calculation is the responsibility of the contractor:

- Single line diagram.
- Fault levels at switchboards.
- Maximum demand calculations.
- Cable and conductor cross sectional area and insulation type.
- Cable operating temperature at design load conditions.
- Voltage drop calculations at design load conditions.
- Protective device characteristics.
- Discrimination and grading of protective devices.
- Prospective short circuit current automatic disconnection times.
- Earth fault loop impedance calculations for testing and verification.
- Stringing calculations for aerial cables.

Final subcircuits: May be treated as typical for common route lengths, loads and cable sizes.

Certification

- Certification of conformance to AS/NZS 3000, for electrical services.

Operation and maintenance manuals

Requirement: Provide all operational and maintenance documentation necessary to operate and maintain the systems installed.

Samples

Low voltage power systems: Submit samples of all visible accessories and equipment.

Cabling accessories: Submit switched socket outlets, light switch plates and other accessories.

Shop drawings

General: Submit shop drawings of the following:

- Cable routes.
- Busduct systems including routes, dimensions and connection details.

Tests

Site tests: Submit results as follows:

- Installation: To AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017.
- Connections to electricity networks: To AS 4741.

2 PRODUCTS

2.1 SITE ELECTRICITY SUPPLY

General

Responsibilities: Provide site electricity supplies, as documented. Connect project electrical facilities to the network distributors external site electricity supply.

LV supplies from dedicated substations

LV transformer output supply: To AS/NZS 3000 and the Service and Installation Rules.

Requirement: Provide short circuit and overload protection at the transformer secondary supply using fault current limiting circuit breakers with adjustable overload and short circuit current setting features, if secondary output supply protection is required.

Circuit breakers: Include full discrimination and cascade protection and grade with the electricity distributor's incoming supply protection system and the downstream site protection devices.

Consumers mains

Requirement: Provide consumers mains, associated services and all necessary fault and overload current protection equipment to AS/NZS 3000 Section 3, the electricity distributor's standards and the Service and Installation Rules.

Protected consumers mains: Provide short circuit and overload protection, where required by the electricity distributor.

Alternative power supplies

General: Provide alternative power supplies, as documented.

Metering

Retail: Provide metering to the requirements of the electricity retailer, the electricity distributor and as documented.

Private: Provide private metering, as documented.

Photovoltaic metering: As documented.

2.2 REMOTE MONITORING

General

Common alarm: Provide for common alarm to be connected into a remote monitoring system.

BMS interface: Provide an interface to enable a building management system to monitor system output, monitor system alarms.

2.3 WIRING SYSTEMS

General

Requirement: Provide wiring and site cable reticulation systems appropriate to the installation conditions and the function of the load.

Type: Re-wireable system.

Neutral conductors: Same size as the corresponding active conductors. Rate the neutral conductor size for the maximum harmonic currents.

Cable support system: Conform to the *0911 Cable support and duct systems* worksection.

2.4 POWER CABLES

Standards

Polymeric insulated cables: To AS/NZS 5000.1.

Aerial cables:

- Copper conductors: To AS 1746.
- Aluminium conductors: To AS 3607 or AS 1531.

Cable

Requirement: Select multi-stranded copper cables.

Default insulation: V-75 for up to 16mm^2, X-90 for above. ***Rev 2017-01***

Default sheathing: 4V-75.

Minimum size: Conform to the following:

- Lighting subcircuits: 1.5 mm^2.
- Power subcircuits: 2.5 mm^2.
- Submains: 6 mm^2.

Voltage drop: Select final subcircuit cables within the voltage drop parameters dictated by the route length and load.

Fault loop impedance: Provide final subcircuit cables to satisfy the requirements for automatic disconnection under short circuit and earth fault/touch voltage conditions.

Underground residential distribution (URD) systems: Cables to AS/NZS 4026.

Distribution cables: To AS/NZS 4961.

Colours

Conductor colours: For fixed wiring cables, provide coloured conductor insulation or at least 150 mm of close fitting coloured sleeving at the termination points of each conductor.

Active conductors in single phase circuits: Red.

Active conductors in polyphase circuits:

- A phase: Red.
- B phase: White.
- C phase: Blue.

Sheath: White.

Aluminium mains and submains

Requirement: Use aluminium mains and submains only where documented.

Nominal cable size: ≥ 95 mm^2.

2.5 ELECTRICAL ACCESSORIES

General

Style: Provide accessories of the same style and from the same manufacturer, as documented.

Socket outlets - generally

Standards:

- General: To AS/NZS 3112.
- Industrial: To AS/NZS 3123.

Socket outlet properties: Provide sockets conforming to the following or as documented:

- Type: Integral switched socket outlet.
- Material: High impact plastic.
- Size: Standard single gang.
- Current rating: 10 A.
- Pin arrangement: Mount outlets with the earth pins at the 6 o'clock position.

Clipsal 2000 or HPM Excel and match light switches, communication outlets, etc. ***Rev 2017-01***

Labelling: Power outlets shall be identified using Clipsal ID plugs or approved equal.

Plastic switched socket outlets

Colour: White electrical unless noted otherwise. ***Rev 2017-01***

Mounting configuration: Horizontal.

Weatherproof socket outlets

Where noted on the drawings as weatherproof the outlet shall be IP56. ***Rev 2017-01***

Combined RCD switched socket outlets

Type: Integral RCD unit with double switched socket outlet.

Colour: White electrical.

RCD trip current: Conform to the following:

- General light and power: 30 mA Type II to AS/NZS 3190.
- Patient treatment areas: 10 mA Type I to AS/NZS 3190, as documented.

Multi-switch socket outlets on grid mounted panels

Type: Separate switch and socket outlets grid mounted on propriety or custom designed panels.

Material: As documented.

Colour: As documented.

Panel finishes: As documented.

Plugs – 230 volt

Requirement: Insulated type to AS/NZS 3112 with integral pins.

230 volt combination switch and permanently connected cord outlet

Type: Three terminal flush mounted switch and flex-lock insert assembly.

Colour: White electrical.

Neon Indicator: Provide neon indicator to match existing.

Flex-lock assembly: Match and securely grip the size and type of flexible cable used.

Mounting configuration: Horizontal.

Installation couplers

Standard: to AS/NZS 61535.

Permanently connected equipment

General: Provide final subcircuit to permanently connected equipment, as documented.

Isolating switch: Locate adjacent to equipment ***in an easily accessible position***. ***Cabling to permanently connected equipment shall be circular or cables enclosed in anaconda or PVC hose (not corrugated conduit)*** ***Rev 2018-04***

Mounting:

- Internal installations: Flush mount.
- ***External installations: Weatherproof (IP56) surface mounted.*** ***Rev 2017-01***
- ***Do not mount isolators on equipment.*** ***Rev 2018-04***

Coordination: Coordinate with equipment supplier.

Wall/ceiling mounted equipment: Conceal final cable connection to equipment, ***but ensure the switch is readily accessible, and not located behind equipment.*** ***Rev 2017-01***

Isolating switches

Standard: To AS/NZS 3133.

Emergency stop switches

Standard: To AS/NZS IEC 60947.5.5.

Type: Mushroom head with latch and twist releaser.

3-phase outlets

Standard: To AS/NZS 3123.

Type: Surface mounted Integral switched socket outlet with flap lid on the outlet.

Material: High impact plastic.

IP rating: IP56.

Size: To suit current rating and pin configuration nominated in the project documents.

Colour: Grey.

Current rating: 5 pin, 20 A, 400 V a.c.

Switch mechanism: Rotating type.

Pin arrangement: Five round pins mounted with earth pins at the 6 o'clock position, neutral pins in the centre and the red, white and blue phases in a clockwise sequence when viewed from the front of the outlet.

Plug: Provide a matching plug top for each outlet.

Ceiling sweep fans

Standard: To AS/NZS 60335.2.80.

Horizontal clearance: ≥ 1200 mm from blade tip to wall cupboards or shelves that require access by ladder or steps.

Size: 1200 mm diameter unless otherwise documented.

Mounting height: Use the longest proprietary suspension rod so that the height from the blades to the finished floor level is more than 2200 mm.

Mounting location: To avoid stroboscopic effect, do not mount fans below luminaires.

Speed regulators, capacitive and electronic: Flush mounted with OFF position.

3 EXECUTION

3.1 SITE ELECTRICITY SUPPLY

General

Electrical systems: Connect to the electricity distributor's supply, as documented and provide the equipment necessary to meet the electricity distributor's requirements.

3.2 EARTHING

Earthing systems
Protective earthing system with a multiple earth neutral (MEN) connection: To AS/NZS 3000 Section 5 and as documented.

Earth electrodes
General: Provide electrodes to AS/NZS 3000 clause 5.3.6.

Bonding
General: Provide equipotential bonding to AS/NZS 3000 clause 5.6.

Earth and bonding clamps
General: Provide proprietary earthing and bonding clamps.

Standard: To AS 1882.

3.3 POWER CABLES

Cable installation
Classifications: To AS/NZS 3013.

Handling cables: Report damage to cable insulation, serving or sheathing.

Stress: Do not use installation methods that exceed the cable's pulling tension. Use cable rollers for cable installed on tray/ladders or in underground enclosures.

Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.

Cable joints: Locate in accessible positions in junction boxes and/or in pits.

Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

Tagging
General: Identify multicore cables and trefoil groups at each end with stamped non-ferrous tags clipped around each cable or trefoil group.

Marking
General: Identify the origin of all wiring by legible indelible marking.

Submains and final sub-circuits
Installation: Provide the following:

- Cables with diameter less than 13 mm: Run in conduit, cable ducts or support on cable trays or ladders.
- Single core cables of 3 phase circuits : Install unenclosed single core cables of diameter greater than 13 mm laid on cable tray in trefoil (RWB) or quadrofoil (RWBN) groups.
- Cables for lighting systems: Run in conduit, cable ducts, suspend on catenary systems or support on cable trays or ladders.
- Accessible concealed spaces: Install thermoplastic insulated and sheathed cables.
- Inaccessible concealed spaces: Install cable in PVC-U conduit.
- Roof spaces: Install cable below heat insulation and sarking. If not protected from high ambient roof space temperatures by thermal insulation, derate the cables, to AS/NZS 3008.1.1 Table 27, for an assumed ambient temperature of 55^{o} C.
- Accessible ceiling voids: Support and enclose cables on ceiling surfaces or ceiling suspension systems.
- Plastered or rendered masonry: Install cable in PVC-U conduit.
- Double sided face brick partition: Install cable in PVC-U conduit installed within the brick wall by slotting bricks or using any pathways provided in the brick.
- Stud framed walls with bulk insulation: Install cables in PVC-U conduit.
- Stud framed walls without bulk insulation: Thermoplastic insulated and sheathed cables allowing rewirability.
- Horizontal cable trays or ladders: Fix cables using proprietary nylon cable ties or straps, cable saddles or clips at 2000 mm intervals.
- Vertical cable risers: Fix cables using proprietary nylon cable ties or straps, cable saddles or clips at 1000 mm intervals.
- Plant rooms: Install cable in heavy duty PVC-U conduit or on tray or in duct.

3.4 COPPER CONDUCTOR TERMINATIONS

General

Requirement: Other than for small accessory and luminaire terminals, terminate copper conductors to equipment, with compression-type lugs of the correct size for the conductor. Compress using the correct tool or solder.

Within assemblies and equipment

General: Loom and tie together conductors from within the same cable or conduit from the terminal block to the point of cable sheath or conduit termination. Neatly bend each conductor to enter directly into the terminal tunnel or terminal stud section, allowing sufficient slack for easy disconnection and reconnection.

Alternative: Run cables in PVC-U cable duct with fitted cover.

Identification: Provide durable numbered ferrules fitted to each core, and permanently marked with numbers, letters or both to suit the connection diagrams.

Spare cores: Identify spare cores and terminate into spare terminals, if available. Otherwise, neatly insulate and neatly bind the spare cores to the terminated cores.

3.5 ALUMINIUM CONDUCTOR TERMINATIONS

General

Conductor surface preparation: Remove oxide as follows:

- Wire brush surfaces to be connected.
- Immediately apply oxidation inhibiting abrasive grease containing zinc or similar particles. Thoroughly cover the surfaces and work the grease between the strands of stranded conductors.

Fittings: Unless joint contact surfaces are factory tinned or factory pre-filled with oxidation inhibiting abrasive grease, prepare as for conductors.

Aluminium-to-aluminium jointing

Compression method: Conform to the following:

- Provide aluminium or aluminium alloy crimp lugs or ferrules to suit the size and shape of the conductors.
- Use compression dies selected to suit lugs or ferrules, with hexagonal dies for stranded conductors and indent dies for solid conductors.
- Fill lugs or ferrules with oxidation inhibiting abrasive grease.
- Insert conductors into lugs or ferrules, driving out excess grease.
- Apply dies to provide at least 2 indentations at each joint or termination.

Termination of electro-tinned aluminium lug: Bolt the palm of the lug to terminals using a stainless steel bolt and nut with a large diameter stainless steel flat washer and two Belleville spring cup washers.

Bolted joints: Tighten to the Belleville spring cup manufacturer's recommended tension requirements. Do not over tension or destroy the ability of the cup washers to maintain the correct tension of the joint. Allow for thermal expansion of the joint.

Fusion weld method: Make joints by fusion welding with aluminium lugs. Protect cable insulation from heat by fixing substantial heat sinks to the cable near the joint. After completion of the weld, wire brush the joint and file sharp projections smooth.

Aluminium-to-copper jointing

Method: Use compression method, as for **Aluminium-to-aluminium jointing**.

Connector types: Select from the following:

- Bi-metal: Lug or pin type with cast copper palm or pin, friction welded to an aluminium barrel section, subsequently factory filled with oxidation inhibiting abrasive grease.
- Termination of electro-tinned aluminium lug: Bolt the palm of the lug to the copper busbar or terminal by means of a stainless steel bolt and nut with a large diameter stainless steel flat washer and two Belleville spring cup washers.

Bolted joints: Tighten to the Belleville spring cup manufacturer's recommended tension requirements. Do not over tension or destroy the ability of the cup washers to maintain the correct tension of the joint. Allow for thermal expansion of the joint.

3.6 AERIAL CABLES – POWER

Aerial cables

Tension: String and tension cables to meet the project specific design criteria.

Aerial connection – poles

For change of direction < 5°: Pin insulators mounted on horizontal cross arms.

For change of direction > 5° and < 30°: Shackle insulators secured by hooks on single cross arm and bolts on cross arms or elsewhere.

For termination or change in direction > 30°: Use separate cross arm.

Bundled conductors: To AS 3766.

Aerial connection – building attachment

General: Provide proprietary up-stands, as required to achieve required clearances.

Attachment: Shackle insulators and supports securely bolted to building structure.

Building entry: Angle conduit upwards at a minimum angle of 45°.

3.7 ACCESSORIES

Installation

General: Install accessories and conceal cabling in walls in conformance with the following:

- Rendered masonry partition: Flush wall box, with conduit chased into wall.
- Double sided face brick partition: Vertically mounted flush wall box, with conduit concealed in cut bricks.
- Face brick external cavity wall: Flush wall box, with thermoplastic insulated cables in conduit run in cavity and tied against inner brick surface, or thermoplastic sheathed cables run in cavity.
- Stud partition: Flush plate secured to proprietary support bracket or wall box.
- Fire walls: Flush wall box, with conduit built into wall. Provide additional fire protection around wall boxes, where necessary to maintain fire-resistance rating.

Location: Confirm final location of all outlets and equipment on site, before installation.

Spacing from adjacent horizontal surface: ≥ 75 mm to the centre of accessory socket.

Default mounting heights to centre of accessory plate:

- Outlets: 300 mm.
- Switches and controls: 1100 mm.

Accessories: Flush mounted, except in plant rooms.

Common face plates: Mount adjacent flush mounted accessories under a common faceplate.

Restricted location: Do not install wall boxes across junctions of wall finishes.

Surface mounting: Proprietary mounting blocks.

Installation of ceiling mounted accessories

Connections for appliances: Flush mounted outlets on the ceiling next to support brackets.

Mounting: Mount appliances independent of ceiling tiles and suspended ceiling suspension system. Fix directly to concrete slab or to roof structure above ceiling.

Connections for fixed equipment: Provide concealed permanent connections.

Fixing: For equipment and appliances heavier than 30 kg, provide support through the suspended ceiling to the building structure. Brace appliances that have excessive bending moments, are heavy or vibrate, to prevent horizontal movement, e.g. operating theatre shadowless lights.

Installation couplers

Standard: To AS/NZS 3000 and AS/NZS 61535.

Location: Accessible.

3.8 TESTING

Site tests

Inspection: Visually inspect the installation to AS/NZS 3000 before testing. Record on a checklist.

Ventilation: Test and verify the installation to AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017. Record the results of all tests.

Electricity networks: Test and verify the connections to electricity networks to AS 4741. Record the results of all tests.

0941 SWITCHBOARDS – PROPRIETARY

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide switchboards, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to all worksections included herein. ***Rev 2017-01***

1.3 STANDARDS

General
Standards: To AS/NZS 3000, and AS/NZS 3439.3 or AS/NZS 61439.3.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definitions apply:

- Fault current limiters: Circuit opening devices designed or selected to limit the instantaneous fault current.
- Rated currents: Continuous uninterrupted current ratings within the assembly environment under in-service operating conditions.
- Rated short-circuit currents: Maximum prospective symmetrical root mean square (r.m.s.) current values at rated operational voltage, at each assembly incoming supply terminal.

1.5 SUBMISSIONS

Operation and maintenance manuals
Requirement: Submit operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Products and materials
Data for proprietary assemblies: Submit the following:

- Makes, types and model numbers of items of equipment.
- Overall dimensions.
- Fault level.
- IP rating.
- Rated current of components.
- Number of poles and spare capacity.
- Mounting details.
- Door swings.
- Paint colours and finishes.
- Access details.
- Schedule of labels.

Type tests: Submit type test certificates from a registered testing authority for components, functional units and assemblies including internal arcing-fault tests and factory test data. Verify that type tests and internal arcing-fault tests, if any were carried out at not less than the designated fault currents at rated operational voltage.

Alterations to TTAs: Submit records of alterations made to assemblies since the tests.

Tests
Standard: To AS/NZS 3439.1 or AS/NZS 61439.1.

Routine tests: Submit results, as follows:

- Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.
- Dielectric testing: 2.5 kV r.m.s. for 15 s.

1.6 WORKSHOP DRAWINGS

Submit three (3) sets of workshop drawings for specified switchboards. Drawings shall:

- ***Include elevations, sections and single line diagram***
- ***Include major equipment listing and busbar dimensions and numbers***
- ***Be prepared by a competent draftsperson as an AutoCAD file that can be read by the latest version of AutoCAD. Also provide copies of drawings in pdf format***
- ***Include all elevations and sections to show the full details of the equipment***
- ***Comply with the requirements of AS 1100 and AS 1104***
- ***Be in metric dimensions***
- ***Be submitted in time to permit modifications to be made without delaying the contract. Allow minimum of seven (7) days for review and checking.***
- ***Be thoroughly checked as complying with the contract documents, suitable for its intended use and location and signed off by the sub-contractor prior to submission to the Superintendent. Construction shall not commence prior to receiving examined drawings from the Superintendent.***
- ***Be amended as necessary to be included as an 'as installed' drawing at completion of the project*** ***Rev 2017-01***

1.7 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Factory assembly completed, with busbars exposed and functional units in place.
- Assembly ready for routine testing.
- Assembly installed before connection.
- Assembly installed and connected.

2 PRODUCTS

2.1 GENERAL

Switchboard DESIGN

Switchboards shall be designed by an experienced switchboard designer who is familiar with all required Acts, Regulations and Codes relevant to the switchboard and type of installation in which it will be installed.

Where the switchboard connects directly to the Supply authority system (e.g. main switchboard) the board shall comply fully with the requirements of that Supply authority.

Provide enclosure for switchboard using panels, doors etc. to provide the specified level of segregation and protection.

Supporting frames shall be constructed of welded steel sections with welding ground smooth. Provide brackets and mounting panels for supporting the switchboard and cladding so that each component can be removed separately for future modifications.

Fix equipment mounting panels to threaded inserts located inside the enclosure at the rear of mounting panels.

Panels shall have machine folded angles, corners and edges. Provide stiffening to panels and doors where necessary to prevent drumming and distortion.

For floor mounted assemblies provide 75mm high, steel plinth along the length of the switchboard base.

Lifting provisions shall be provided for all switchboards with a volume greater than 0.5m3 or if necessary to locate the switchboard.

Where switchboards are to be flush or semi-flush, provide facing flange with minimum width of 32mm. The frame shall be the same material as the switchboard and be constructed to provide an even gap of not more than 1mm between the switchboard and flange.

Doors: Switchboard doors shall be hung using heavy duty, chromium plated, steel hinges which allow removal of the door when open only and minimum 135º swing.

Provide chromium plated, lockable door handle to each door. Where doors are greater than 600mm high, also provide latching bars and guides at the top and bottom of the board.

Where boards are recessed or semi-recessed handles shall be flush type otherwise handles shall be lever type.

Locks shall be provided on all doors and shall be L&F 92268. Provide minimum two (2) keys per board.

Provide approved moulds and strip seals to meet specified IP rating. Provide proof of seal rating on request.

Removable panels: Removable panels shall be as for doors but with chromium plated D handles, fixing studs, knurled, slotted and captivated nuts.

Cable entries: Provide removable gland plates minimum 2mm thick aluminium for cable entry and glands. Glands shall be suitably sized for specified cables (including future cables shown) plus 100%.

Escutcheons: For distribution boards and distribution board sections of main switchboards, provide hinged escutcheons that swing at least 90º and can be removed when open. For other sections provide removable escutcheons. Escutcheons shall be white and have neat cut-outs for circuit breaker handles and the like.

Switchboard finishes: Prior to painting prepare all metal surfaces which are to be painted. Unprotected steel shall have all rust removed, treated and then primer coat applied. Galvanised steel shall be cleaned, acid treated, zinc phosphate painted, rinsed and degreased. Aluminium shall be cleaned by immersion in acid solution, caustic etched and primer coat applied.

Other treatments proven to provide suitable preparation of the same or better standard will be accepted only on the Superintendent's approval.

Stainless steel where specified shall be grade 316.

Paint switchboards on inside and outside. Escutcheons shall be white unless nominated elsewhere. Exterior colours shall be as nominated in the schedule.

Allow for non-standard colour in tender where a specific colour is not scheduled.

Busbars: Provide busbars as required within the switchboards, derated in accordance with AS 3000 Section C. Busbars shall be sufficiently supported to prevent damage by the nominated perspective fault current.

Insulate all active and neutral busbars including any joints. Also, colour code active, neutral and earth busbars.

All spare pole positions shall have insulated boots over.

Neutral and earth links: Provide full sized neutral and earth links (i.e. one termination per installed cable) with terminal numbers clearly marked for all incoming, outgoing and MEN links. Where cables are larger than 10mm2 provide bolt connections.

Neutral and earth cables shall be terminated in tunnels which correspond to the circuit breaker pole number.

All spare pole positions shall have insulated boots over.

The switchboard design shall incorporate requirements set out by the Queensland Electricity Connection and Metering Manual, Section 7.14.2 Accessibility of Neutral Connections.

Switchboard wiring: Provide wiring for all switchboard controls, meters etc in not less than 1mm stranded, copper, XLPE cables to suit the required current carrying capacity of the circuit. Select colour coding to meet Australian Standards.

Provide wiring supports including ducting to neatly bunch and support cabling. Ducts shall be PVC with removable lid. Also provide flexible wiring looms for equipment on hinged panels and protective grommets where cables pass through cut-outs in the switchboard.

All control cabling shall be marked with permanently connected (not stick-on) markers at each end to match wiring diagrams which should be mounted inside the cabinet.

Labels: Provide screw connected, traffolyte labels for each component of the switchboard (e.g. main isolator, bus zone, supply for DB1 etc.). Label distribution sections with numbers to enable cross-referencing with circuit schedules installed. Clearly label switchboards (name/number) on front of door.

CFS units shall also include label to nominate the switch size and installed fuse size.

Schedules: Provide typed schedules for general light and power. Also provide 'as installed' A3 laminated drawings (Light on front and power on back with circuit numbering matched to the circuit breakers). Mount inside the distribution section on a screw fixed chain.

At the site main switch board provide a laminated copy of the site single line diagram. Update all existing site single line diagrams where the work includes the extension of existing systems. ***Rev 2017-01***

Enclosure

Material: Refer schedule. ***Rev 2017-01***

Separation

Form: Refer schedule. ***Rev 2017-01.***

Busbars

Busbar fault rating: As scheduled. ***Rev 2017-01***

Spare capacity

Default spare poles: ≥ 50%. ***Rev 2017-02***

Surge protection

General: Provide surge protection, ***as scheduled.*** ***Rev 2017-01***

Arcing Fault Currents:

Unless noted in the works section of the specification, for switchboards rated at 800A or greater, provide arc fault protection in accordance with AS 3000 Sections 2.5.5.1 and 2.5.5.2 and as follows:

- ***Internal separation shall be minimum 3bih and IP rating of minimum IP4X***
- ***Application of AS3439.1 and AS 3439.2 for installation or separation of supply conductors up to the line side of the protective device/s.*** ***Rev 2017-01***

Earthing

General: Make provision for the connection of the communications earth terminal (CET) at switchboard earth bar to AS/CA S009.

Doors

Switchboard doors shall be hung using heavy duty, chromium plated, steel hinges which allow removal of the door when open only and minimum 135º swing.

Provide chromium plated, lockable door handle to each door. Where doors are greater than 600mm high, also provide latching bars and guides at the top and bottom of the board.

Where boards are recessed or semi-recessed handles shall be flush type otherwise handles shall be lever type.

Locks shall be provided on all doors and shall be L&F 92268. Provide minimum two (2) keys per board.

Provide approved moulds and strip seals to meet specified IP rating. Provide proof of seal rating on request. ***Rev 2017-01***

IP rating

Refer schedule. ***Rev 2017-01***

Equipment layout

General: Position equipment to provide safe and easy access for operation and maintenance. Group devices by function.

Compartments: Separate shipping sections, subsections, cable and busbar zones, functional unit modules and low voltage equipment compartments using vertical and horizontal steel partitions which suit the layout and form of separation.

Form 1 enclosures: Separate into compartments with partitions at 1.8 m maximum centres.

Equipment on doors: Set out in functional unit groups and to allow access without the use of tools or keys.

Segregation

General: Segregate BCA emergency equipment from non-emergency equipment with metal partitions designed to prevent the spread of a fault from non-emergency equipment to emergency equipment.

Removable panels: Removable panels shall be as for doors but with chromium plated D handles, fixing studs, knurled, slotted and captivated nuts.

Cable entries: Provide removable gland plates minimum 2mm thick aluminium for cable entry and glands. Glands shall be suitably sized for specified cables (including future cables shown) plus 100%.

Escutcheons: For distribution boards and distribution board sections of main switchboards, provide hinged escutcheons that swing at least 90º and can be removed when open. For other sections provide removable escutcheons. Escutcheons shall be white and have neat cut-outs for circuit breaker handles and the like.

Switchboard finishes: Prior to painting prepare all metal surfaces which are to be painted. Unprotected steel shall have all rust removed, treated and then primer coat applied. Galvanised steel shall be cleaned, acid treated, zinc phosphate painted, rinsed and degreased. Aluminium shall be cleaned by immersion in acid solution, caustic etched and primer coat applied.

Other treatments proven to provide suitable preparation of the same or better standard will be accepted only on the Superintendent's approval.

Stainless steel where specified shall be grade 316.

Paint switchboards on inside and outside. Escutcheons shall be white unless nominated elsewhere. Exterior colours shall be as nominated in the schedule.

Allow for non-standard colour in tender where a specific colour is not scheduled. ***Rev 2017-01***

Supporting structure

Assemblies:

- Wall mounted: ≤ 2 m^2.
- Floor mounted: > 2 m^2.

Ventilation

General: Required to maintain design operating temperatures at full load ***and minimize condensation.*** ***Rev 2017-01***

Components: Refer Section 0943 Switchboard components. ***Rev 2017-01***

Tests

Requirement: To AS/NZS 3439.1 or AS/NZS 61439.1.

3 EXECUTION

3.1 GENERAL

Fixing

Requirement: Before making inter-panel connections, fix assemblies and metering equipment enclosures into position, level and plumb.

For wall mounting provide minimum four (4) proprietary fixing points selected for the type of wall to rigidly fix into position.

Floor mounted switchboards shall be level and plumb adjusted using packing plates under the plinth. Fix the base to the floor with proprietary fixings selected for the type of floor. Where the unit is also installed on a wall, fix to wall as above. ***Rev 2017-01***

Cable entries

General: Neatly adapt one or more cable entry plates, if fitted, to accept incoming cable enclosure. Provide the minimum number of entry plates to leave spare capacity for future cable entries. Do not run cables into the top of weatherproof assemblies.

Single core cables: Pass separately through non-ferrous gland plates. Do not provide ferrous metal saddles.

Cable enclosures
Requirement: Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire-resistance level of the cable are maintained.

Cable supports
Requirement: Support or tie mains and submains cables within 200 mm of terminations. Provide cable supports suitable for stresses resulting from short circuit conditions.

3.2 MAINTENANCE

General
Standard: To AS 2467.

3.3 THERMOGRAPHIC SCANS

Thermal scans shall be completed by a thermographic scan specialist, experienced in the required work to be undertaken.

For sites where total maximum demand exceeds 200A or where otherwise specified, complete thermographic scans by a specialist (who produces printable pictures of results) of all switchboards and distribution boards, provide report, rectify faults found and rescan to confirm all items are operating correctly.

For smaller installations (i.e. under 100A) or where not specifically nominated, complete thermoscans with hand held apparatus and printed pictures are not required.

Scans shall be completed with all available equipment functioning (including air conditioning plant etc.).

Provide written certificate at completion to confirm that scans have been completed, listing any rectification work undertaken. ***Rev 2017-01***

0942 SWITCHBOARDS – CUSTOM-BUILT

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide custom-built switchboards and distribution pillars, as documented.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- *0171 General requirements*.
- *0901 Electrical systems*.
- *0921 Low voltage power systems*.
- *0943 Switchboard components*.

1.3 STANDARD

General
Standards: To AS/NZS 3000, and AS/NZS 3439.1 or AS/NZS 61439.1.

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- TTA: Type-tested assemblies.
- NTTA: Non type-tested assemblies.
- PTTA: Partially type-tested assemblies.

Definitions
General: For the purposes of this worksection the following definitions apply:
- Custom-built assemblies: Low voltage switchgear and controlgear assemblies manufactured to order and incorporating either purpose built or proprietary components or either purpose built or proprietary bus-bar assemblies.
- Fault current limiters: Circuit opening devices designed or selected to limit the instantaneous fault current.
- Incoming busbars: Busbars connecting incoming terminals to line side terminals of main switches.
- Main circuit supply busbars: Busbars connecting incoming functional unit terminals, or incoming busbars where no main switches are included, to outgoing functional unit terminals or outgoing functional unit tee-offs.
- Proprietary assemblies: Low voltage switchgear and controlgear assemblies available as a catalogue item, consisting of the manufacturer's standard layout and equipment. Minor modifications are permissible to accommodate equipment and accessories, whilst retaining standard format.
- Rated currents: Continuous uninterrupted current ratings within the assembly environment under in-service operating conditions.
- Rated short-circuit currents: Maximum prospective symmetrical root mean square (r.m.s.) current values at rated operational voltage, at each assembly incoming supply terminal.
- Tee-off busbars: Busbars connecting main busbars to incoming terminals of outgoing functional units.

1.5 SUBMISSIONS

Design documentation
Calculations: Submit the following:

- Detailed certified calculations verifying design characteristics.
- Design calculations of non-type-tested and non-proprietary busbar assemblies.

Standard: To AS 60890.

Operation and maintenance manuals

Requirement: Submit operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Products and materials

Type tests: Submit certificates for components, functional units and assemblies. Verify that type tests and internal arcing-fault tests, if any, were carried out at not less than the designated fault currents at rated operational voltage.

Alterations to TTAs: Submit records of alterations made to assemblies since the tests.

Switchboard product data: Submit the following:

- Makes, types and model numbers of items of equipment.
- Type test certificates for components, functional units and assemblies including internal arcing-fault tests and factory test data.

Shop drawings

General: Submit three (3) set of workshop drawings for specified switchboards. Drawings shall:

- ***Include elevations, swctions and single line diagram***
- ***Include major equipment listing and busbar dimensions and numbers***
- ***Be prepared by a competend draftsperson as an AutoCAD file that can be read by the latest version of AutoCAD. Also provide copies of drawings in pdf format***
- ***Include all elevations and sections to show the full details of the equipment***
- ***Comply with the requirements of AS 1100 and AS 1104***
- ***Be in metric dimensions***
- ***Be submitted in time to permit modifications to be made without delaying the contract. Allow minimum of seven (7) days for review and checking.***
- ***Be thoroughly checked as complying with the contract documents, suitable for its intended use and location and signed off by the sub-contractor prior to submission to the Superintendent. Construction shall not commence prior to receiving examined drawings from the Superintendent.***
- ***Be amended as necessary to be included as an 'as installed' drawing at completion of the project*** ***Rev 2019-01***

Shop drawings shall include:

- Types, model numbers and ratings of assemblies.
- Design calculations of non-type tested and non-proprietary busbar assemblies.
- Overall dimensions.
- Rated current of components.
- Number of poles and spare capacity.
- Mounting details.
- Paint colours and finishes.
- Access details.
- Schedule of labels.
- Component details, functional units and transient protection.
- Detailed dimensions.
- Shipping sections, general arrangement, plan view, front elevations and cross-section of each compartment.
- Projections from the assembly that may affect clearances or inadvertent operation, such as handles, knobs, arcing-fault venting flaps and withdrawable components.
- Fault level and rated short circuit capacity characteristics.
- IP rating.

- Fixing details for floor or wall mounting.
- Front and back equipment connections and top and bottom cable entries.
- Door swings.
- External and internal paint colours and paint systems.
- Quantity, brand name, type and rating of control and protection equipment.
- Construction and plinth details, ventilation openings, internal arcing-fault venting and gland plate details.
- Terminal block layouts and control circuit identification.
- Single line power and circuit diagrams for all new and modified switchboards.
- Details of mains and submain routes within assemblies.
- Busbar arrangements, links and supports, spacing between busbar phases and spacing between assemblies, the enclosure and other equipment and clearances to earthed metals.
- Dimensions of busbars and interconnecting cables in sufficient detail for calculations to be performed.
- Form of separation and details of shrouding of terminals.
- Labels and engraving schedules.

Tests

Standard: AS/NZS 3439.1 or AS/NZS 61439.1.

Routine tests: Submit results as follows:

- Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.
- Dielectric testing: NTTAs and PTTAs: 2.5 kV r.m.s. for 15 s.

1.6 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Fabrication and painting completed.
- Factory assembly completed, with busbars exposed and functional units in place.
- Assembly ready for routine testing.
- Assembly installed before connection.
- Assembly installed and connected.

2 PRODUCTS

2.1 CUSTOM-BUILT SWITCHBOARD CONSTRUCTION

Switchboard design

Switchboards shall be designed by an experienced switchboard designer who is familiar with all required Acts, Regulations and Codes relevant to the switchboard and type of installation in which it will be installed.

Where the switchboard connects directly to the Supply authority system (e.g. main switchboard) the board shall comply fully with the requirements of that Supply authority.

Provide enclosure for switchboard using panels, doors etc. to provide the specified level of segregation and protection.

Supporting frames shall be constructed of welded steel sections with welding ground smooth. Provide brackets and mounting panels for supporting the switchboard and cladding so that each component can be removed separately for future modifications.

Fix equipment mounting panels to threaded inserts located inside the enclosure at the rear of mounting panels.

Panels shall have machine folded angles, corners and edges, Provide stiffening to panels and doors where necessary to preven drumming and distortion. ***Rev 2019-01***

Where switchboards are to be flush or semi-flush, provide facing flange with minimum width of 32mm. The frame shall be the same material as the switchboard and be constructed to provide an even gap of not more than 1mm between the switchboard and flange. ***Rev 2019-01***

All control cabling shall be marked with permanently connected (not stick-on) markers at each end to match wiring diagrams which should be mounted inside the cabinet.

Labels: Provide screw connected, traffolyte labels for each component of the switchboard (e.g. main isolator, bus zone, supply for DB1 etc.). Label distribution sections with numbers to enable cross-referencing with circuit schedules installed. Clearly label switchboards (name/number) on front of door.

CFS units shall also include label to nominate the switch size and installed fuse size.

Schedules: Provide type schedules for general light and power. Also provide 'as installed' A3 laminated drawings (Light on front and power on back with circuit numbering matched to the circuit breakers). Mount inside the distribution section on a screw fixed chain.

At the site main switchboard provide a laminated copy of the site single line diagram. Update all existing site single line diagrams where the work includes the extension of existing systems.

Enclosure

Material: Refer schedule.

Separation

Form: Refer schedule. ***Rev 2019-01***

Switchboard connection

Type: Front connected.

Metering

Requirement: To the *0921 Low voltage power systems* worksection.

Main switchboard main switches

Spare capacity: Provide at least 25% spare capacity in the ratings main switch/isolators.

Busbars

General: Incorporate proprietary insulated busbar systems for the interconnection of isolators, circuit breakers and other circuit protective devices. ***Cabling between devices within the board is not acceptable.*** ***Rev 2019-01***

Busbar fault rating: ***Refer schedule.*** ***Rev 2019-01***

Spare capacity

Default spare poles: ≥ ***50%.*** ***Rev 2019-01***

Main switchboard incoming busbar: ≥ 25%.

Surge protection

General: Provide surge protection as ***scheduled.*** ***Rev 2019-01***

Earthing

General: Make provision for connection of communication systems CET at switchboard earth bar to AS/CA S009.

Arcing Fault Currents:

Unless noted in the works section of the specification, for switchboards rated at 800A or greater, provide arc fault protection in accordance with AS 3000 Sections 2.5.5.1 and 2.5.5.2 and as follows:

- ***Internal separation shall be minimum 3bih and IP rating of minimum IP4X***
- ***Application of AS 3439.1, and AS 3439.2 for installation or separation of supply conductors up to the line side of the protective device/s.*** ***Rev 2019-01***

IP Rating

Refer schedule. ***Rev 2019-01***

Equipment layout

General: Position equipment to provide safe and easy access for operation and maintenance. Group devices by function.

Connection: Front connected.

Compartments: Separate shipping sections, subsections, cable and busbar zones, functional unit modules and low voltage equipment compartments using vertical and horizontal steel partitions which suit the layout and form of separation.

Form 1 enclosures: Separate into compartments with partitions at 1.8 m maximum centres.

Equipment on doors: Set out in functional unit groups and to allow access without the use of tools or keys.

Segregation

General: Segregate BCA emergency equipment from non-emergency equipment with metal partitions designed to prevent the spread of a fault from non-emergency equipment to emergency equipment.

BMS equipment: Accommodate extra low voltage BMS equipment in a separate compartment.

Supporting structure

Assemblies:

- Wall mounted: Maximum 2 m^2.
- Floor mounted: Greater than 2 m^2.

Ventilation

General: Required to maintain design operating temperatures at full load ***and to minimise condensation within the board.*** ***Rev 2019-01***

Enclosure materials

General: Fabricate from sheet metal of rigid folded and welded construction. Obtain approval for non-welded forms of construction.

Material: Metallic-coated sheet steel to AS 1397.

Material thickness:

- Diagonal dimension:
  - . < 900 mm: Minimum 1.6 mm.
  - . ≥ 900 mm: Minimum 2.0 mm.

Coating class:

- Indoor assemblies: Z200.
- Outdoor assemblies: Z450.
- ***Stainless steel where specified shall be grade 316.*** ***Rev 2019-01***

Insect proofing

General: Cover ventilation openings with non-combustible and corrosion resistant 1 mm mesh.

Equipment mounting panels

General: To support the weight of mounted equipment.

Metallic panels: Construct from metal greater than or equal to 3 mm thick with heavy metal angle supports or plates bolted or welded to enclosure sides.

Non-metallic panels: Provide non-metallic to support the weight of the mounted equipment and design the mounting structure for stability and stiffness.

Non-metallic boards: To IEC 60893-1.

Equipment fixing

Spacing: Provide 50 mm minimum clearance between busbars for the following:

- Lifts, fire services and building emergency services.
- General installation services busbars.
- Equipment.

Mounting: Bolts, set screws fitted into tapped holes in metal mounting panels, studs or proprietary attachment clips. Provide accessible equipment fixings which allow equipment changes after assembly commissioning.

Installation: For lightweight equipment, provide combination rails and proprietary clips.

Earth continuity

General: Strip painted surfaces and coat with corrosion resistant material immediately before bolting to the earth bar. Provide serrated washers under bolt heads and nuts at painted, structural metal-to-metal joints.

Construction

Lifting provisions: For assemblies ***where required for locating the switchboard or*** with shipping dimensions exceeding 1800 mm high x 600 mm wide, provide fixings in the supporting structure and removable attachments for lifting. ***Rev 2019-01***

Supporting structure: Provide concealed fixings or brackets to allow mounting and fixing of assemblies in position without removing equipment.

Floor-mounting: Provide mild steel channel plinth, galvanized to class Z600, with toe-out profile, nominal 75 mm high x 40 mm wide x 6 mm thick, for mounting complete assemblies on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Prime drilled holes with zinc rich organic primer to AS/NZS 3750.9.

2.2 CABLE ENTRIES

General

Requirement: Provide cable entry facilities within assembly cable zones for incoming and outgoing power and control cabling. Provide sufficient clear space within each enclosure next to cable entries to allow incoming and outgoing cables and wiring to be neatly run and terminated, without unnecessary bunching or sharp bends.

Glands shall be suitably sized for specified cables (including future cables shown) plus 100%. ***Rev 2019-01***

Neutral and earth cables shall be terminated in tunnels which correspond to the circuit breaker pole number. ***Rev 2019-01***

Cover and gland plates

Cover plates: Provide 150 mm maximum width cover plates butted together and covering the continuous cable entry slot.

Gland plates: Provide removable gland plates fitted with gaskets to maintain the degree of protection.

Materials: Conform to the following:

- Generally: 1.5 mm thick steel, 5 mm thick composite material or laminated phenolic.
- For MIMS cables and cable glands: 6 mm thick brass.

2.3 BUS TRUNKING SYSTEM ENTRY

General

Requirement: Provide entry plates with close tolerance cut-out to accommodate busbars, fitted with a flange bolted and sealed to assembly enclosure to maintain assembly IP rating. Earth the busway enclosure to the assembly protective earth conductor. Fit busway flanges at assembly manufacturer's premises and retain for transportation.

2.4 DOORS AND COVERS

General

Requirement: Provide lockable doors with a circuit card holder unless enclosed in cupboards.

Door layout

Maximum width: 900 mm.

Minimum swing: At least ***135***°. ***Rev 2019-01***

Door stays: Provide stays to outdoor assembly doors.

Adjacent doors: Space adjacent doors to allow both to open to 90° at the same time.

Door construction

Protection: Provide single right angle return on all sides and fit suitable resilient sealing rubber to provide the documented IP rating and prevent damage to paintwork. ***Provide proof of seal rating on request.*** ***Rev 2019-01***

Hinges: Provide the following:

- Generally: Corrosion-resistant pintle hinges or integrally constructed hinges to support doors.
- For removable doors: Staggered pin lengths to achieve progressive engagement as doors are fitted.
- For doors higher than 1000 mm: 3 hinges.
- ***Where doors are greater than 600mm high, also provide latching bars and guides at the top and bottom of the board.*** ***Rev 2019-01***

- For non lift-off doors: Restraining devices and opposed hinges.

Door hardware: Provide the following:

- Corrosion resistant lever-type handles, operating a latching system with latching bar and guides strong enough to withstand explosive force resulting from fault conditions within the assembly.
- Dual, edge mounted, corrosion resistant T handles with provision for key locking cylinder.
- Captive, corrosion resistant knurled thumb screws as an alternative to handles.
- ***Where boards are recessed or semi-recessed handles shall be flush type otherwise handles shall be level type.*** ***Rev 2019-01***

Locking: Incorporate cylinder locks in the latching system. Key alike, 2 keys per assembly. ***Locks shall be provided on all doors and shall be L&F 92268.*** ***Rev 2019-01***

Door mounted equipment: Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Earthing: Maintain earth continuity to door mounted indicating or control equipment with multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the door.

Covers

Maximum dimensions: 900 mm wide and 1.2 m^2 surface area.

Fixing: Fix to frames with at least 4 fixings, using corrosion-resistant acorn nuts with serrated washers.

Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion-resistant D type handles.

Also provide fixing, studs, knurles, slotted and captivated nuts. ***Rev 2019-01***

Escutcheons

General: For doors enclosing circuit breakers, provide escutcheon plates as barriers between operating mechanisms and live parts.

Escutcheon plates

General: Provide plates or removable covers with neat circuit breaker toggle cut-outs allowing interchangeability of 1, 2 and 3 pole circuit breakers. Provide corrosion-resistant lifting handles or knobs. Provide unused circuit breaker toggle cut-outs with blanking infill pole covers.

Maximum dimensions: 900 mm wide and 1.2 m^2 surface area.

2.5 FACTORY FINISHES

General

Standard: To AS 2700.

Extent: Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanized, electroplated, or anodised surfaces and to ventilation mesh covers.

Finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish.

Factory finish colours

Mounting structure (brackets): To match enclosure.

Paint switchboards on inside and outside. Escutcheons shall be white unless nominated elsewhere. Exterior colours shall be as nominated in the schedule.

Allow for non-standard colour in tender where a specific colour is not scheduled. ***Rev 2019-01***

Doors: To match enclosure.

Plinths: Black.

2.6 BUSBARS

General

Requirement: Provide main circuit supply busbars within assemblies, extending from incoming supply terminals to the line side of protective equipment for outgoing functional units and for future functional units.

Standards: To AS 60890.

Custom-built busbar construction

Material: Hard-drawn high-conductivity electrolytic tough pitched copper alloy bars, designation 110.

Temperature rise limits - active and neutral conductors:

- Maximum rated current temperature rise limits: 65 ± 1.5°C by type test or calculation to AS 60890.
- Maximum short-circuit withstand current temperature rise limits: 160°C.

Cross section: Rectangular. Remove sharp edges of rectangular busbar by filing the edge or use radiused edges.

Supports: Sufficient to withstand thermal and magnetic stresses due to maximum prospective fault currents.

Support material: Non-hygroscopic insulation capable of holding busbars at 105°C.

Proprietary busbars

Type: Multi-pole proprietary insulated busbar assemblies or busbar systems, verified for short circuit capacity and temperature rise-limits by type tests.

Phase sequence

General: For main busbars and connections to switching devices, set-out phase sequence for phases A, B and C, from left-to-right, top-to-bottom and front-to-back when viewed from the front of the assembly.

Colour coding

General: Provide 25 mm minimum width colour bands permanently applied to busbars at 500 mm maximum intervals with at least one colour band for each busbar section within each compartment.

Active busbars: Red, white and blue respectively for the A, B and C phases.

Neutral busbar: Black.

MEN link: Green-yellow and black.

Protective earth busbar: Green-yellow.

Restrictions: Do not provide adhesive type colour bands.

Current carrying capacity

Active conductors: Take into account thermal stresses due to short circuit current, assuming magnetic material enclosures located indoors in well-ventilated rooms and 90°C final temperature.

Neutral conductors: Size to match incoming neutral conductor current carrying capacity.

Protective earth conductors: Size for at least 50% of the rated short circuit withstand current for 100% of the time duration.

Tee-off busbars current rating

For individual outgoing functional units: Equal to maximum frame size rating of the functional unit.

For multiple functional units: Equal to the diversity factors of AS/NZS 3439.1 or AS/NZS 61439.1, based on frame size rating.

MEN links

MEN links > 10 mm^2 in cross-section: Bolted removable busbar links stamped MEN LINK, located in the incoming compartment, between neutral and earth busbars.

Fault current limiters

General: Rate busbars connected to fault current limiters to 100% of the indicated fault current limiter circuit breaker frame size or fuse base rating.

Busbar links

General: For current transformers, provide removable busbar links less than or equal to 450 mm long.

Cable connection flags

General: Provide and support busbar flags for equipment with main terminals too small for cable lugs. Provide flags sized to suit cable lug termination, with current rating of at least the maximum equipment frame size.

Phase isolation: Provide phase isolation or barriers between flags where the minimum clearance distances phase-to-phase and phase-to-earth are below the component terminal spacing.

Future extensions

General: Pre-drill the main circuit supply busbar for future extensions and extend busbar droppers into future functional unit locations.

All spare pole positions shall have insulated boots over. ***Rev 2019-01***

Jointing

General: Use multiple bolted joints on all overlapping busbars with a minimum of two bolts per joint.

Type: High tensile steel bolts, washers and nuts, with lock nuts or spring washers. Do not use tapped holes and studs or the like for jointing current carrying sections.

Custom-built busbar insulation

Active and neutral busbars and joints: Select from the following:

- Polyethylene: At least 0.4 µm thick with dielectric strength of 2.5 kV r.m.s for 1 minute, applied by a fluidised bed process in which the material is phase coloured and directly cured onto the bars.
- Close fitting busbar insulation mouldings at least 1 mm thick.
- Heat shrink material: Only on rounded edge busbars.

Taped joints: Apply non-adhesive stop-off type tape, coloured to match adjacent insulation and half lapped to achieve a thickness at least that of the solid insulation.

Damaged insulation: Repair damaged insulation before energising.

2.7 NEUTRAL LINKS AND EARTH BARS

Terminals

General: Provide terminals for future circuits.

Links

Assembly capacity > 36 poles: Provide neutral links and earth bars at the top and bottom of the circuit breaker section.

Assembly capacity ≤ 36 poles: Provide links and bars at the point of entry of incoming supply cables.

Mounting: Mount neutral links on an insulated base.

Control circuits: Provide separate neutral links and earth bars.

Labels: Provide labels for neutral and earth terminals.

Cables > 10 mm^2: Provide bolts or studs.

Communications earth: Make provision for connection of communications systems earth at switchboard earth bar to AS/CA S009.

Neutral and earth cables shall be terminated in tunnels which correspond to the circuit breaker pole number. ***Rev 2019-01***

The switchboard design shall incorporate requirements set out by the Queensland Electricity Connection and Metering Manual, Section 7.14.2 Accessibility of Neutral Connections.

Rev 2019-01

2.8 INTERNAL WIRING

Wiring

Cable type: 0.6/1 kV copper cables. Provide V-90HT insulation where directly connected to active and neutral busbars.

Cable interconnections

General: For the main circuit supply, provide cable interconnections as follows:

- ≥ 1.5 mm^2 internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1. Provide cables with current ratings suitable for the internal assembly ambient air temperature and for temperature rise limits of equipment within the assembly.
- Run cables clear of busbars and metal edges.
- Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.
- Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.
- Provide for installation of wiring for future equipment without removal of existing equipment.
- Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams. Mark to AS/NZS 4383 series.
- Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.
- For equipment mounted on hinged doors run cables on the hinge side to avoid restricting the door opening. Bundle cables with spiral wrap PVC and secure to door.
- If recommended by device manufacturers, provide shielded wiring.

- ***Also provide protective grommets where cables pass through cut-outs in the switchboard.***
Rev 2019-01

Adjacent circuit breakers: If suitable proprietary multi-pole busbar assemblies are available to link adjacent circuit breakers, do not provide cable interconnections.

Cables > 6 mm²

Terminations:

- Tunnel terminals: Single cables.
- Other connection points or terminals: ≤ 2 cables.

Doors: Do not run cables to hinged doors or removable panels.

Supports:

- Spacing at enclosure: ≤ 200 mm from a termination.
- Spacing generally: ≤ 400 mm.
- Strength: Capable of withstanding forces exerted during fault conditions.

Single core cables rated ≥ 300 A: Do not provide ferrous type metal cable saddles.

Terminals marked: Terminate marked cables for connection to external controls in correspondingly marked terminals within the assembly.

Control and indication circuits

General: Provide conductors sized to suit the current carrying capacity of the particular circuit.

Minimum size: 1 mm^2 with 32/0.2 stranding.

Cable colours

General: Colour code wiring as follows:

- A phase: Red.
- B phase: White.
- C phase: Blue.
- Neutral: Black.
- Earthing: Green-yellow.

2.9 TERMINATIONS

Submains, light and power circuits

General: Connect direct to the control equipment terminals.

Shipping breaks: Provide terminal blocks for interconnecting wiring on each side of shipping breaks.

3 EXECUTION

3.1 ASSEMBLY INSTALLATION

Fixing

General: Before making inter-panel connections, fix assemblies and metering equipment enclosures into position, level and plumb.

For wall mounting provide minimum four (4) proprietary fixing points selected for the type of wall to rigidly fix into position. ***Rev 2019-01***

Floor mounted switchboards shall be level and plumb adjusted using packing plates under the plinth. Fix the base to the floor with proprietary fixing selected for the type of floor. Where the unit is also installed on a wall, fix to wall as above. ***Rev 2019-01***

3.2 ASSEMBLY ENTRIES

Cable entries

General: Neatly adapt one or more cable entry plates, if fitted, to accept incoming cable enclosure. Provide the minimum number of entry plates to leave spare capacity for future cable entries. Do not run cables into the top of weatherproof assemblies.

Single core cables rated > 300 A: Pass separately through non-ferrous gland plates. Do not use ferrous metal saddles.

Cable enclosures
General: Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire rating of the cable are maintained.

Cable supports
General: Support or tie mains and submains cables within 200 mm of terminations. Provide cable supports suitable for stresses resulting from short circuit conditions.

Bus trunking system entry
General: Provide entry plates with close tolerance cut-out to accommodate busbars, fitted with a flange bolted and sealed to assembly enclosure to maintain assembly IP rating. Earth the busway enclosure to the assembly protective earth conductor. Fit busway flanges at assembly manufacturer's premises and retain for transportation.

3.3 MARKING AND LABELLING

General
Switchboard assembly: Label in conformance with AS/NZS 3439.1 or AS/NZS 61439.1 including the following:

- Size and type of all incoming and outgoing mains and submains.
- Emergency operating procedures.

3.4 MAINTENANCE

General
Standard: To AS 2467.

Requirement: Carry out the following:

- Rectify faults, make adjustments and replace consumable and faulty materials and equipment within 24 hours of notification.
- Monthly inspections and maintenance work to maintain the assembly, including battery systems.

3.5 THERMOGRAPHIC SCANS

Thermal scnas shall be completed by a thermographic scan specialist, experienced in the required work to be undertaken.

For sites where toal maximum demand exceeds 200A or where otherwise specified, complete thermographic scans by a specialist (who produces printable pictures of results) of all switchboards and distribution boards, provide report, rectify faults found and rescan to confirm all items are operating correctly.

For smaller installations (i.e. under 100A) or where not specifically nominated, complete thermoscans with hand held apparatus and printed pictures are not required.

Scans shall be completed with all available equipment functioning (including air conditioning plant etc.).

Provide written certificate at completion to confirm that scans have been completed, listing any rectification work undertaken. ***Rev 2019-01***

0991 ELECTRICAL MAINTENANCE

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Maintain the electrical systems for the documented maintenance period so that the performance, reliability, service life, energy efficiency and safety of the system is equal to or better than that at the beginning of the maintenance period, in parallel with and including:

- Periodic and statutory maintenance, cleaning and replacement of consumables.
- Emergency repairs.
- Condition reporting.

Maintenance period: As documented.

In the event of major faults occurring, as defined by the Superintendent, the maintenance free period shall be extended a further period, equal to the full original defects liability period from the date of rectification. ***Rev 2017-01***

1.2 CROSS REFERENCES

General

Requirement: Conform to all worksections included herein for electrical services. ***Rev 2017-01***

1.3 STANDARD

General

Electrical services to:

- AS/NZS 3000

- AS 2293

- AS 1851

Maintenance required

Minimum level: To code requirements and the manufacturer's recommendations. ***Rev 2017-01***

1.4 INTERPRETATION

Definitions

General: For the purpose of this worksection the following definition applies:

- Consumable: Materials or components intended to be replaced within the service life of the associated plant or equipment.
- Periodic maintenance: Planned routine maintenance of plant and equipment (proactive), including fire safety measures and statutory requirements.
- Repairs: Unplanned/corrective maintenance (reactive).
- Replace/replacement: Replacement of components on a regular cycle on a like for like basis, e.g. repainting, replacement of air conditioning plant.

1.5 SUBMISSIONS

Certification

Annual certification: Inspect and submit certification for all items required to be inspected annually under statutory requirements including, but not limited to, fire detection and alarms, emergency evacuation lighting and early warning and intercommunication systems (EWIS).

Records

Maintenance records: Complete maintenance records to a minimum standard as nominated by Australian Standards and Codes and nominated in other sections included herein. ***Rev 2017-01***

Periodic maintenance and performance report: At the frequency documented, submit reports summarising the maintenance performed and the performance of the electrical services in the

preceding period. Set out the report in a form that permits comparison with previous reports. Include the following as minimum requirements:

- Dates and number of site labour hours for periodic maintenance. Exclude travelling time.
- Dates, number of site labour hours and nature of work for emergency repairs. Exclude travelling time.
- Dates and number of site labour hours for defects liability rectification if within the defects liability period. Exclude travelling time.
- Peak load and load profile for electrical power consumed, where metering equipment allows. Where no appropriate metering equipment exists, provide copies of electricity accounts from the electricity service provider.
- Results of recommissioning if scheduled for the period.

1.6 INSPECTION

Notice

Requirement: Give notice so that an inspection may be held simultaneously with the final programmed maintenance visit.

2 PRODUCTS

2.1 GENERAL

Product selection

Proprietary items: Select products, as consumables or replacement items, of the same make, model and type as those being replaced.

Substitutions: Where the existing product is no longer available, provide products with at least the same performance, energy profile and construction characteristics.

Light fittings and ballasts: If fluorescent tubes or ballasts change due to obsolescence, provide changes so that the performance of the system is equal to or better than the existing, e.g. equal or lower energy consumption or changing to electronic ballasts that improves lamp life.

3 EXECUTION

3.1 EMERGENCY REPAIRS

General

Requirement: Respond to call outs for breakdowns or other faults requiring emergency repairs . Rectify faults and replace faulty materials and equipment.

Remedial work: Carry out any remedial work, including temporary work, necessary to restore each system to safe and satisfactory operation. Verify each system is operating correctly before leaving the site. Do not leave the plant in an unsafe condition.

Temporary work: Promptly replace temporary work with permanent rectification.

Contact details

General: Provide contact details including mobile phone numbers for normal working hours and emergency call outs.

Response time

Emergency repair: Attend site for emergency service within the documented response time.

Response period: Starts at the time of notification to the contractor’s nominated contact point.

3.2 PERIODIC MAINTENANCE

General

Routine visits: Make routine service visits at the frequency documented. Service items of equipment in conformance with the maintenance schedules in the operation and maintenance manuals.

Notification of defects: When defects in the installation are identified, give notice.

Requirement: Provide maintenance work including, but not limited to, the following:

- Attend to reported defects and complaints.

- Check for and repair corrosion.
- Check for and rectify any unsafe conditions.
- Replace faulty or damaged parts and consumable components.
- Check anti-vibration supports, brackets and clamps, holding down bolts and flexible connections, for deterioration and for freedom of movement of assembly.
- Safety signs maintenance: To AS 1319.

Cleaning

Requirement: At the end of the maintenance period:

- Remove waste and clean all parts of the installation.
- Remove temporary protective coatings, packaging and labels.
- Clean interior of switchboards, switchgear, contactors and other electrical contacts to remove dust and foreign matter.

Lighting fittings: Clean the interior of luminaires, including diffusers and louvres, annually for non-air conditioned buildings and every three years for air conditioned buildings. For large air conditioned buildings, schedule areas of the building where a third of the fittings are cleaned each year.

Electrical systems

Requirement: Perform the following:

- Check for hot joints, burnt insulation and burnt contacts.
- Check electrical connections for tightness.
- Check operation of all electrical components and systems.
- Check indicating lights and replace defective lamps.
- Check overload settings.
- Check and report any changes to controls and wiring.
- Provide maintenance in conformance with manufacturer's recommended maintenance program.

Standards

Electrical equipment generally: To AS/NZS 3760.

Switchboards: To AS 2467.

Power generator - photovoltaic

Stand-alone power systems: Maintain the system to AS/NZS 4509.1 during the defects liability period.

Grid connected systems: Maintain the system to AS/NZS 5033 Appendix C during the defects liability period.

Power generator – diesel

Call out: Respond to call outs for breakdowns or other faults requiring corrective maintenance. Attend on site within 24 hours of notification. Rectify faults and replace faulty materials and equipment.

Switchboards

Standard: To AS 2467.

General: Carry out the following:

- Check for hot joints and burnt insulation. Carry out a thermal scan of joints and cable terminations by use of an infrared temperature detector or cameras and repair any joints showing high temperatures.
- Rectify faults, make adjustments and replace consumable and faulty materials and equipment within 24 hours of notification.
- Monthly inspections and maintenance work to maintain the assembly, including battery systems.

Emergency evacuation lighting

Requirement: To AS/NZS 2293.2.

Interval: Carry out the 6-monthly procedures before practical completion and again before the end of the maintenance period.

Fire detection and alarms

Operational and maintenance manual: To AS 4428.4.

Maintenance and records: To AS 1851.

Routine service process and procedures: To AS 1851 clause 6.2.

Baseline data: Provide baseline data to AS 1851.

Emergency warning and intercommunication
Standard: To AS 1851.

Routine service process and procedures: To AS 1851 clause 6.2.

Baseline data: Provide baseline data to AS 1851.

Electronic security
Standard: To AS/NZS 2201.1.

Breakdown call outs: Attend on site within 24 hours of notification. Rectify faults and replace faulty materials and equipment.

Frequency of routine visits: ≤ 3 monthly.

Maintenance period performance monitoring:

- Monitor: Access control system.
- Investigate: Causes of alarms.
- Alarm report: < 2 days after alarm.

False alarms:

- Notification of false alarms: On the first working day after a false alarm, submit notification of the circumstances surrounding the false alarm and action necessary to prevent similar occurrences.
- Alterations due to false alarms: Carry out alterations necessary to eliminate false alarms due to the following:
  . Technical faults, selection, siting or aiming of devices.
  . Environmental conditions evident at the time of installation.

System provider
Electronic security system provider: A licensed security organisation only.

3.3 END OF MAINTENANCE PERIOD SERVICE

General
Requirement: Within a month of the end of the maintenance period, undertake all work scheduled to be carried out on an annual basis and the second visit scheduled carried out on a six monthly. ***Rev 2017-01***

3.4 COMPLETION

Maintenance records
Service records: Record maintenance undertaken in the schedules in the operation and maintenance manuals.

Maintenance reports: Prepare maintenance reports as documented.

Restitution after maintenance tasks
Requirement: Restore removed, damaged, contaminated or soiled services and building elements when the maintenance task is complete.

Standard: Equal to the condition of the original installation.