Project Title:

Electrical Services

for

MAIN SWITCHBOARD REPLACEMENT

at

Rainbow Street Sports Complex
Rainbow Street, Biloela

Client: **Banana Shire Council**

Architect:

DOCUMENT PREPARED BY:

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Specification Identification	23165R-2
Issue	A – Tender Issue
Date	April 2024

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ATTACHMENTS AND INCLUSIONS:

Drawings Refer section 0901.2 herein

Tender Form

Date	Revision	Details	Approved
05/12/23	P1	Preliminary	
23/04/24	A	Tender Issue	

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 contract shall include the detailed design supply, fabrication, installation, connection, commissioning and testing of the complete electrical services including the following:

- Connect to Ergon point of supply, coordinate final connection with Ergon
- New consumer's mains
- New main switchboard
- Remove existing site main switchboard
- Extend submains distribution to new main switchboard
- Install accessible void with hinged, lockable door for connection and/or extension of existing cabling
- Make safe existing electrical services to control panel beside main switchboard
- Relocate water services located where new site main switchboard is to be situated
- Miscellaneous equipment as specified
- Incidental works including but not limited to:
    - Trenching, backfilling and reinstatement of final surfaces after installation of underground conduits
    - 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

All installers shall be appropriately experienced and licensed. It is the responsibility of the contractor to ensure the final installation is fully in accordance with all relevant codes, standards and acts.

Where documents indicate clashes with other services, existing services that need to remain but are not shown, outlet locations that don't match equipment locations, ratings or number of phases or similar. This shall be brought to consultants' attention prior to ordering equipment or commencing installation.

Refer also Section **0903**, Clauses 1.2 Design and 1.10 Contract Documents.

Where the contractor fails to complete the above and suitably resolve before installation, they shall rectify the installation at nil variation cost.

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

0901.2 DRAWINGS

The following drawings form part of this document.

Drawing No.	Title
23165R-E001	ELECTRICAL SERVICES – Site Plan, Elevations
23165R-E002	ELECTRICAL SERVICES – Single Line Diagram, Switchboard Layout

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 new Ergon point of supply
- Finish at extension of existing circuits to new main switchboard

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

0933 Power generation photovoltaic

0941 Switchboards – Proprietary

0943 Switchboard Components

0951 Lighting

0962 Television distribution systems

0971 Emergency evacuation lighting

0991 Electrical maintenance

0901.7 CERTIFICATION

Prior to Practical completion provide compliance certification and Form 12 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 2002 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	Cross References	Yes
1.4	Referenced Documents	Yes
1.5	Standards	Yes
1.6	Contract Documents	Yes
1.7	Submissions	Yes
1.8	Inspection	Yes
2	Products	
2.1	Electrical Accessories	Yes
3	Execution	
3.1	Work on Existing Systems	Yes
3.2	Installation	Yes
3.3	Support of Plant and Equipment	Yes
3.4	Commissioning	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	No
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 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

0903.4 CORROSION RESISTANCE SCHEDULE

Corrosivity category shall be as follows:

Exterior atmospheric corrosively category	C3

0903.5 SHOP DRAWING SCHEDULE

Shop drawing submission requirements shall be as follows:

Submission medium	Electronic
Drawing size	A1
Standard	1:100
CAD base drawings	AutoCAD (minimum version 2011)

0903.6 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

0903.7 WARRANTY SCHEDULE

Minimum warranties shall be as follows:

Warranty	**Period**
All equipment	12 months

0903.8 MAINTENANCE REQUIREMENT SCHEDULE

Minimum maintenance period shall be as follows:

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

0905 SCHEDULE OF WORKS

0905.1 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.

0909 DEMOLITION

0909.1 GENERAL

General: Make safe for demolition, removal of swithcboard and associated redundant equipment and wiring.

Requirement: Demolish and remove from site:

- Existing cabling and switchboards as mentioned above.

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.

Provide accessible and lockable hinged door void access, where the current Switchboard is located, to allow connection and/or extension of existing circuits to the Site Main Switchboard. Extend cables if necessary

Provide mechanical protection to existing cables on cable tray to Control Panel, located beside site main switchboard

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	Yes
2.6	Cable Tray Ladder Support System	Yes
2.7	Catenary Systems	No

2.8	Cable Pits	Yes
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	Yes
3.3	Conduit Systems - Installation	Yes
3.4	Cable Support Systems - Installation	Yes
3.5	Catenary Systems - Installation	Yes
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**
Operation and Maintenance Manuals	At completion
Shop drawings: - Switchboards	- YES

0911.4 PIT SCHEDULE: (FOR INFORMATION ONLY)

Title (Refer Drawings)	**Type and Dimensions (minimum)**	**Cover**
P1	900Lx900Wx900D (internal) electrical pit. CJP590 Mascot Engineering GPC pits.	Minimum class C concrete infill covers to suit. Mascot Engineering or equal. Lids shall identify service.
Note: Pits in roadway need to be finished flush with the final surface		

Pits shall be installed to manufacturer's recommendations suitable for minimum Class B, 80kN.

All pits and pit groups shall have minimum 150mm wide and deep reinforced concrete surrounds flush with finished surface levels. All pits shall have brass cable direction markers.

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: Co-ordinate fully with Ergon for the connection and provide all necessary forms and assistance.

Arrange and coordinate supply connection and metering with energy retailer. There shall be one supply authority meter in the new main switchboard.

0921.3 RCD PROTECTION OF FINAL SUBCIRCUITS

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

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 protection systems	Yes
2.6	Busducts	Yes
2.7	Electrical accessories	Yes
3	Execution	
3.1	Site Electricity Supply	Yes
3.2	Earthing	Yes
3.3	Power Cables	Yes
3.4	Mineral insulated metal sheathed cable (MIMS)	No
3.5	Fire-resisting cable	No
3.6	Copper conductor terminations	Yes
3.7	Aluminium conductor terminations	No
3.8	Private aerial cables – power	Yes
3.9	Busduct installation	No
3.10	Accessories	Yes
3.11	Testing	Yes
3.12	Spare parts	No
3.13	Completion	Yes
3.14	Maintenance	Yes

0941 SWITCHBOARDS – CUSTOM BUILT

0941.1 GENERAL

Provide switchboards as specified herein and shown on the drawings.

0941.2 SPECIFICATION REFERENCES

Refer ACESPEC reference Worksection 0941 – Switchboards- Proprietary 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	Workshop Drawings	Yes
1.7	Inspection	Yes
2	Products	
2.1	General	Yes
3	Execution	
3.1	General	Yes
3.2	Maintenance	Yes
3.3	Thermographic Scans	Yes

0941.3 SWITCHBOARD SCHEDULE:

New Main Switch Board

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	16kA for 1 sec.
Enclosure material	Zincaneal steel
Mounting	Concrete Plith
Enclosure Size	2000H x 1400W **(Note 1)**
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)	5 (56)
Form	1
Number of poles	Refer single line diagram
Rated busbar current	Refer single line diagram (minimum 200A, unless noted otherwise)
Busbar fault current rating	16kA for 1 sec
Circuit breaker type	Shall match type installed in the site main switchboard to enable cascading of circuit breaker protection. **(Note 2)** Available as single pole, RCD circuit breakers up to 25A single phase Schneider, NHP, IPD Group, Eaton or approved equal. Shall be 10 kA type.
Exit and Emergency lighting test facility	No
Surge Protection Device	Type II

Note 1: If boards are larger than that nominated, advise at tender time.

Note 2: Designs are based on single pole RCD/circuit breaker units for single phase supplies and four pole RCD/circuit breaker units for three phase supplies. Where larger units are to be provided, increase switchboard pole numbers to maintain numbers of spare poles.

Note 3: Provide reinforced concrete plinth minimum 50mm above surrounds and minimum 50mm beyond switchboard base

0943 SWITCHBOARD COMPONENTS

0943.1 GENERAL

Provide switchboard components as specified herein and shown on the drawings.

0943.2 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	No
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	Yes
2.11	Current Transformers (Protection)	No
2.12	Surge protection Devices (SPD)	Yes
2.13	Current Transformers (Metering)	Yes
2.14	Instruments and Meters	No
2.15	Electrical Indicating Measuring Meters	Yes
2.16	Contactors	No
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	No
2.22	Indicator Lights	No

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

Multi-function Meters

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

- Meters shall be Crompton Instruments Integra 1630 digital metering system or approved equal
- Select CTs to maximise accuracy of metering system

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	4 hours
Minimum number of programmed service visits during the defects liability period	1

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 remains 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

General

Requirement: Provide the electrical services, as documented.

Summary: **Refer project schedule.** ***Rev 2022-4***

Performance

Requirement: 400 V, 3-phase, 4-wire, 50 Hz multiple earth neutral (MEN) system.

Performance criteria: Meet the performance criteria, as documented.

Fault level protection: To withstand the prospective fault level of the incoming supply at the equipment location.

Site electricity supply

Responsibilities: Provide site electricity supplies as documented. Connect project electrical facilities to the network distributor's external site electricity supply.

High voltage supplies

Network distributor's protection devices: Determine the protection equipment type and protection curves for overload, short-circuit and earth fault currents.

Prospective fault current: Determine the high voltage prospective fault current.

High voltage network: To AS/NZS 3000, the network distributor's requirements and the supply authority Service and Installation rules.

High voltage protection: Provide high voltage short-circuit and overload protection for incoming main switches, ring main feeders, spur feeders and incoming supplies to transformers.

High voltage protection devices: Either switch fuse or circuit breaker type devices. Include full discrimination and cascade protection and grade with the network distributor's incoming supply protection system and the downstream site protection devices.

Protection report: Before ordering the equipment, submit a fault and protection report detailing the location and size of transformers, location and type of protection equipment, cable sizes and type, over-current and earth-fault current curves coordinated with upstream protection devices including the network distributor protection equipment curves and cable I^2t curves.

Low voltage supplies

Low voltage transformer output supply: To AS/NZS 3000 and the network distributor's requirements.

Low voltage protection: Provide low voltage 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. Alternatively, if approved by the network distributor, where no secondary output protection is provided, provide appropriate sized high voltage protection on the incoming supply to transformers.

Low voltage circuit breakers: Include full discrimination and cascade protection and grade with the incoming transformer supply protection system and the downstream site protection devices.

Switchboards

Responsibilities: Provide main switchboard(s) and local distribution boards as documented and to the requirements of the following worksections:

0941 Switchboards – proprietary.

0942 Switchboards – custom-built.

Electrical protection equipment: Include all necessary electrical protection equipment, electrical components and the local network distributor's tariff metering equipment to the requirements of *0943 Switchboard components*.

Large switchboards: Manufacture switchboards of module sizes to allow access and manoeuvrability through the project site and into switchrooms.

Overload and fault protection on all submains: Provide circuit breaker protection equipment coordinated to allow cascade and discrimination protection between upstream and downstream cable protection devices to AS/NZS 3000.

Electricity distributor's low voltage service protective device: To AS/NZS 3000, the network distributor's requirements and the supply authority Service and Installation rules.

For service protective devices > 100 A: Provide fault current limiting circuit breakers with adjustable overload and short-circuit current facilities and full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems, if required.

Electrical cable systems

Responsibilities: Provide the following cabling systems:

Power cables: Provide cable systems as documented and to the requirements of *0921 Low voltage power systems*.

Communications cables: Provide cable systems as documented and to the requirements of Australian Communications and Media Authority (ACMA) and *0961 Information and communications technology (ICT) systems*.

Communications and sound systems: Provide separate cable systems. Do not use any part of the power system cable support systems.

Lighting

Responsibilities: Provide lighting systems as documented and to the requirements of the following worksections:

0951 Lighting.

0971 Emergency evacuation lighting.

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

Alternative power supplies

Responsibilities: Provide alternative power supplies as documented and to the requirements of the following worksections:

0931 Power generation – engine driven.

0933 Power generation – photovoltaic.

0937 Uninterruptible power supply.

Communications systems

Responsibilities: Provide communication systems as documented and to the requirements of *0961 Information and communications technology (ICT) systems*.

Security systems

Responsibilities: Provide security systems as documented and to the requirements of *0981 Electronic security*.

Lightning protection

Responsibilities: Provide lightning protection as documented and to the requirements of *0979 Lightning protection.*

1.2 DESIGN

General

Requirement: To DESIGN in *0171 General requirements*.

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 *0171 General requirements*.

Operating environment

Requirement: Provide equipment suitable for the environment in which it operates and as documented.

Energy efficiency

Requirement: To BCA J6.

Seismic restraint
Requirement: To **SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS** in *0171 General requirements*.

1.3 CROSS REFERENCES

General
Requirement: Conform to the following:

0171 General requirements.

0911 Cable support and duct systems.

0921 Low voltage power systems.

0941 Switchboards – proprietary.

0942 Switchboards – custom-built.

0961 Information and communications technology (ICT) systems.

0951 Lighting.

0971 Emergency evacuation lighting.

0981 Electronic security.

1.4 REFERENCED DOCUMENTS

General
Requirement: Conform to *0171 General requirements*.

1.5 STANDARDS

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

Electrical installations
Electrical design: To AS/NZS 3000.

Selection of cables: To AS/NZS 3008.1.1.

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

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

Rotating and reciprocating machinery noise and vibration: Vibration severity in Zone A to ISO 20816-1 and ISO 10816-3.

Communications systems: To AS/CA S008, AS/CA S009, AS/NZS 11801.1 and AS/NZS 14763.2.

1.6 CONTRACT DOCUMENTS

General
Requirement: Conform to *0171 General requirements*.

1.7 SUBMISSIONS

General
Requirement: Conform to *0171 General requirements*.

Calculations
Requirement: Submit calculations, as documented.

Certification
Plant and equipment - proposed: Submit certification that the plant and equipment proposed meet the requirements and capacities documented. If proposed plant and equipment departs from performance or other requirements documented, submit details to **SUBSTITUTIONS** in *0171 General requirements*.

Plant and equipment - installed: Submit certification that each plant and equipment installation is operating correctly.

Operation and maintenance manuals
Requirement: Conform to *0171 General requirements*.

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 conformance to 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.

1.8 INSPECTION

General

Requirement: Conform to *0171 General requirements*.

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 2022-04***

2 PRODUCTS

2.1 ELECTRICAL ACCESSORIES

General

Requirement: Provide accessories, as documented.

Proprietary equipment: If proprietary equipment is selected by the contractor, the requirements of this specification override 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 documented 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.

Services in existing buildings

Existing ceilings: If the existing ceilings are to be retained, take care when installing new services.

Existing building: Survey the available space and ascertain the optimum services runs based on the existing floor joist layout and services layouts. Provide all bends, droppers and other items necessary to complete the installation, as documented.

3.2 INSTALLATION

Switchboards

Wall mounted switchboards: Fix direct to masonry or concrete walls, or to the wall framing of framed wall construction, using suitable fasteners.

Floor/wall mounted switchboards: Fix to floor plinths and direct to masonry or concrete walls, or to the wall framing of framed wall constructions, using suitable fasteners.

Floor mounted island switchboards: Fix to floor plinths, using suitable fasteners able to withstand seismic events nominated in the project documentation.

Wall and floor/wall mounted switchboards in seismic sensitive projects: Fix only to building structural elements or to steel framing fixed to structural elements, using suitable fasteners. Do not fix to masonry infill panels.

3.3 SUPPORT OF PLANT AND EQUIPMENT

General

Requirement: To **SUPPORT OF PLANT AND EQUIPMENT** in *0171 General requirements*.

3.4 COMMISSIONING

General

Requirement: Provide commissioning as documented. Conform to *0171 General requirements* and SA TS 5342.

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 coordination 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

Where scheduled provide earthquake restraints.

Design and install all systems, plant and equipment, fixings, supports, mountings, hangers and attachments in accordance with AS 1170.4 – Minimum Design Loads on Structures – Part 4: Earthquake Loads. CRITERIA: **Rev 2017-01**

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. ***Rev 2022 - 01***
- 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.

To prevent risks associated with fixing covers and penetrating cables, mechanical protection, covers and flashings to cable trays/ladders and ducts are not to be secured directly to the cable reticulation installation which supports or encloses electrical cables. The use of proprietary cable tray systems, which incorporate the attachment of mechanical protection/covers within the design, without the use of fixings direct to the tray/ladder cable zone, should be considered. For all electrical reticulation solutions involving cable trays, ladders and ducts, permanent signage, with wording 'Warning, electrical cables within', must be attached to covers without impacting cables or resulting in sharp protrusions into the cable zone ***Rev 2021-01***

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 ***0911 Cable support and duct systems*** worksection. ***Rev 2020-01***

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 the following: ***Rev 2023-04***

- *0171 General Requirements*
- *0773 Building Management Systems*
- *0901 Electrical Systems*
- *0911 Cable Support and Duct Systems*
- *0991 Electrical Maintenance*

1.5 STANDARDS

General
Requirement: To AS/NZS 3000 Part 2, unless documented otherwise.
Electrical design: To AS/NZS 3000 (2018)
Electrical equipment: To AS/NZS 3100 (2022)
Fire and mechanical performance classification: To AS/NZS 3013 (2005)
Selection of cables: To AS/NZS 3008.1.1 (2017)
Distribution cables: To AS/NZS 4961 (2003)
Degrees of protection (IP code): To AS 60529 (2004)
Electromagnetic compatibility (EMC): To AS/NZS 61000.
Communications systems: To AS/CA S008 (2020), AS/CA S009 (2020), AS/NZS 11801.1 (2019) and AS/NZS 14763.2 (2020).

Testing
Standard: To AS/NZS 3017 (2022).

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.

1.7 SUBMISSIONS

Certification
Requirement: Submit certification of conformity to AS/NZS 3000 (2018), for electrical services.

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: Submit manual to **COMPLETION, Operation and maintenance manuals.**

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 and cable pits.
- Busduct systems including routes, dimensions and connection details.

Tests
Site tests: Submit results as follows:
- Installation: To AS/NZS 3000 (2018)Section 8 using the methods outlined in AS/NZS 3017 (2022)
- Connections to electricity networks: To AS 4741 (2010) ***Rev 2023-04***

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 (2018) 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 (2018) 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: To the requirements of the electricity retailer and the electricity distributor.

Private: Provide energy measurement to BCA (2022) J9D3 and as documented.

Photovoltaic metering: Provide energy measurement to BCA (2022) J9D3 and 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 allow a building management system to monitor system output, monitor system alarms.

2.3 WIRING SYSTEMS

General

Requirement: Wiring and site cable reticulation sytems: Appropriate to the installation conditions and the function of the load. Include the following:

- Undergrround services.
- Above-ground services.
- In-building services.

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: To *0911 Cable support and duct systems*.

2.4 POWER CABLES

Standards

Polymeric insulated cables: To AS/NZS 5000.1 (2005)

Aerial cables:

- Copper conductors: To AS 1746 (1991).
- Aluminium conductors: To AS 3607 (1989) or AS 1531 (1991)

Cable

Requirement: Select multi-stranded copper cables.

Default insulation: ***V-75***

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 (2008).

Distribution cables: To AS/NZS 4961 (2003)

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.

Neutral conductors: Black.

Earthing conductors: Green-yellow. ***Rev 2023-04***

Sheath: White.

Aluminium mains and submains

Requirement: Use aluminium mains and submains only where documented.

Nominal cable size: ≥ 95 mm^2.

2.5 ELECTRICAL PROTECTION SYSTEMS

General

Requirement: Provide the following protection systems, as documented:

- ***Fault protection to AS/NZS 3000 (2018) clause 2.4.***
- ***Overcurrent to AS/NZS 3000 (2018) clause 2.5.***
- ***Residual current to AS/NZS 3000 (2018) clause 2.6.***
- ***Overvoltage to AS/NZS 3000 (2018) clause 2.7.***
- ***Undervoltage to AS/NZS 3000 (2018) clause 2.8.***
- ***Arc fault detection to AS/NZS 3000 (2018) clause 2.9.*** ***Rev 2023-04***

2.6 BUSDUCTS

Systems

Type: Proprietary type-tested systems made up of integral lengths and fittings containing solid busbar conductors and housins, assembled in sections to form complete fully enclosed and insultated low impedance power distribution systems.

Standard: To AS/NZS 61439.6 (2016).

Selection

Ratings:

Selected to meet nominated current ratings and, if used as consumer mains, to match the electricicty network authority's substation equipment.

Degree of protection: For complete assembly, at least the following:

- ***Indoor use: IP40.***
- ***Weatherproff (partial exposure): IP54.***
- ***Outdoor use: UP55.***

Indoor system accessories

For current ratings ≤400 A: Provide fuse, fuse switch or circuit breaker type plug-in connection boxes. Provide interlocks so that plug-in boxes can be safely installer or removed on an energised system.

Provide plug-in boxes so that earthing to the busduct housing is achieved before connection of active conductors.

For current ratings > 400 A: Provide bolt on accessible T-off boxes.

Expansion joints: Provide expansion joints, to allow for thermal expansion and contraction of the busduct system.

End caps: Provide end caps or covers to fully enclose ends of busducts not connected to equipment. ***Rev 2023-04***

2.7 ELECTRICAL ACCESSORIES

General

Requirement: Provide accessories of the same style and from the same manufacturer, as documented. ***Rev 2023-04***

Socket outlets - generally

Standards:

- General: To AS/NZS 3112 ***(2017).*** ***Rev 2023-04***
- Industrial: To AS/NZS 3123 ***(2005).*** ***Rev 2023-04***

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.

Ironclad socket outlets

Type: Integral switched socket outlet.

Material: Diecase metal or cast iron.

Color: Grey. ***Rev 2023-04***

Weatherproof socket outlets

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

Colour: Grey ***Rev 2023-04***

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 ***(2016).*** ***Rev 2023-04***
- Patient treatment areas: 10 mA Type I to AS/NZS 3190 ***(2016),*** as documented. ***Rev 2023-04***

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 **(2017)** with integral pins. ***Rev 2023-04***

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 ***(2011).*** ***Rev 2023-04***

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 ***(2020).*** ***Rev 2023-04***

Emergency stop switches

Standard: To AS/NZS IEC 60947.5.5 ***(2015).*** ***Rev 2023-04***

Type: Mushroom head with latch and twist releaser.

3-phase outlets

Standard: To AS/NZS 3123 ***(2005).*** ***Rev 2023-04***

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.

Appliances

Connection: Shorten lead to minimum length for plug connections.

Isolating switches: To AS/NZS 3000 (2018). ***Rev 2023-04***

Ceiling sweep fans

Standard: To AS/NZS 60335.2.80. ***(2016)*** ***Rev 2023-04***

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 ***(2018)*** Section 5 and as documented. ***Rev 2023-04***

Earth electrodes
General: Provide electrodes to AS/NZS 3000 ***(2018)*** clause 5.3.6. ***Rev 2023-04***

Bonding
General: Provide equipotential bonding to AS/NZS 3000 ***(2018)*** clause 5.6. ***Rev 2023-04***

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

Standard: To AS 1882 ***(2002).*** ***Rev 2023-04***

3.3 POWER CABLES

Cable installation
Classifications: To AS/NZS 3013 ***(2005).*** ***Rev 2023-04***

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 ***(2017)*** Table 27, for an assumed ambient temperature of 55^{o} C. ***Rev 2023-04***
- 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: ***Install*** thermoplastic insulated and sheathed cables allowing rewirability. ***Bush all knock-outs in stell framing to prevent cable damage. Earth metal stud frames to the electrical erathing system.*** ***Rev 2023-04***
- 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 MINERAL INSULATED METAL SHEATHED CABLE (MIMS)

General
Requirement: Maintain manufacturer's seals until joint or termination is made. Remove moisture by heating cable ends.

Seals

Temporary seals: Fit temporary seals to the open ends of cut cables that are not immediately used.

Terminations: Fit termation seals at ends of cable runs as soon as the cable has been cut to length, stripped back, and the moisture driven out.

Through joints: same fire-resistance level as the cable.

Sheath earthing

General: If MIMS cables enter metal enclosures, earth sheaths to non-ferrous plates secured to the enclosures. Where sheaths terminate at plates, fully insulate, colour code, and fix the conductors to the enclosures.

Bonding

General: Bond metal sheaths of single core cables in multi-phase circuits with proprietary earth bonding clips or clamps.

Earth sheath return (ESR) systems

General: If used, conform to AS/NZS 3000 (2018) clause 3.16.

Separation

General: Separate MIMS cables from thermoplastic sheathed (TPS) cables and PVC-U conduits by at least 25 mm.

Eddy currents

General: Arrange single core cable entries into non-ferrous metal gland plates to minimise eddy currents.

Vibration

Connections with vibrating equipment: Loop cables in a complete circle next to the point of connection.

MIMS cable terminations

MIMS cable systems: Test the insulation resistance as follows:

- ***At the time of termination.***
- ***24 hours later.***

Cable installation: Install cables on cable trays and fix using copper saddles or straps. Provide PVC serving if cables are subject to moisture or corrosive interaction with other materials.

Rev 2023-04

3.5 FIRE-RESISTING CABLES

Protection
General: If exposed to mechanical damage, provide protection to AS/NZS 3013 (2005).

Rev 2023-04

3.6 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.

3.7 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

Compression method: Conform to **Aluminium-to-aluminium jointing**. ***Rev 2023-04***

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.

3.8 *PRIVATE* AERIAL CABLES – POWER *Rev 2023-04*

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 ***(1990).*** *Rev 2023-04*

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°.

3.9 BUSDUCT INSTALLATION

General

Standard: To AS/NZS 61439.6 (2016).

Horizontal runs: Support busducts at maximum internals of 2 m, with adjustable hangers and steel angle supports. Provide runs that are straight and level. Install hangers at least 300 mm from joint centres. Secure busducts to angle supports with proprietary clamps.

Vertical runs: Support with a combination of fixed and spring type hangeers to allow for expansion and contraction of the busduct system.

Fittings: Provide elbows, offsets and junctions for changes in direction. If necessary, provide weatherproof covers and gaskets. *Rev 2023-04*

3.10 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 ***(2018)*** and AS/NZS 61535 ***(2011).*** ***Rev 2023-04***

Location: Accessible.

3.11 TESTING

Site tests

Inspection: Visually inspect the installation to AS/NZS 3000 ***(2018)*** before testing. Record on a checklist. ***Rev 2023-04***

Verification: Test and verify the installation to AS/NZS 3000 ***(2018)*** Section 8 using the methods outlined in AS/NZS 3017 ***(2022).*** Record the results of all tests. ***Rev 2023-04***

Electricity networks: Test and verify the connections to electricity networks to AS 4741 ***(2010).*** Record the results of all tests. ***Rev 2023-04***

Dummy load tests

General: If electrical tests are required and the actual load is not available, provide a dummy load equal to at least 75% of the design load. ***Rev 2023-04***

3.12 SPARE PARTS

General

Spare parts: As documented. ***Rev 2023-04***

3.13 COMPLETION

Operation and maintenance mauals

Requirement: Prepare a manual that includes details necessary to operate and maintain the equipment and systems installed. ***Rev 2023-04***

3.14 MAINTENANCE

General

Requirement: Provide maintenance as documented. Confirm to 0991 Electrical maintenance. ***Rev 2023-04***

0933 POWER GENERATION – PHOTOVOLTAIC

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide photovoltaic generating system(s), as documented.

System components
Requirement: Incorporate the following **where specified in the project schedule**:

- Photovoltaic array.
- Regulator.
- Battery system.
- Inverter.
- Connection to low voltage power system.

Design
Irradiation data: Australian Bureau of Meteorology.

System provider
Requirement: An installer with the Clean Energy Council accreditation.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following **as applicable**:

- *0903 General requirements*.
- *0773 Building management systems*.
- *0901 Electrical systems*.
- *0911 Cable support and duct systems*.
- *0921 Low voltage power systems*.
- *0941 Switchboards – proprietary*.
- *0942 Switchboards – custom-built*.
- *0943 Switchboard components*.
- *0979 Lightning protection*.

1.3 STANDARDS

General
Requirement: For the purpose of this worksection, the following standards relating to stand-alone systems are also applicable to network connected systems:

- Stand-alone power systems: To AS/NZS 4509.1 and AS/NZS 4509.2.
- Grid connected systems: To AS 4777.1 and AS/NZS 4777.2.
- IEC 61836.

1.4 INTERPRETATION

Definitions
General: For the purpose of this worksection the definitions given in AS/NZS 4509.2 apply.

1.5 SUBMISSIONS

Operation and maintenance manuals
Standard: To AS/NZS 4509.1.

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

Rebate application
General: Submit complete timely application documentation for a grant under the appropriate Rebate Program.

Note that the Renewable Energy Certificates (REC) will be assigned to the contractor, the assignment of this credit should be considered as part of the tender. ***Rev 2018-02***

Shop drawings
General: Submit shop drawings, to a scale that best describes the detail, showing the following:
- General arrangement of equipment.
- Single line schematic showing the interconnection with the building electrical system.
- Access clearances for operational maintenance and dismantling.
- Electrical single line diagram and general arrangement for the complete system.
- Control diagrams.
- Support details.

Technical data
General: Submit technical data including the following:
- Technical description and specifications of each component.
- Calculations and assumptions for all selections and systems.
- Type test reports.

Detailed Design and Shop drawings
General: Submit shop drawings indicating the following:
- Site Plan (showing all adjoining Streets and North Point);

- Electrical Reticulation Single Line Diagram of Site showing connection of PV Generating Plant into Existing Reticulation System.

- Location of Inverter(s), Data Logger and Electricity Consumption meters.

- Location of All Cable Routes

- Parts Schedule of all Equipment.

- Roof mounting and support details

- Local Supply Authority Contact Details

- Single line schematic showing the interconnection with the building electrical system.

- Access clearances for operational maintenance and dismantling.

- Electrical single line diagram, and general arrangement for the complete system.
- Control diagrams. ***Rev 2018-02***

Tests
General: Before the date of practical completion submit test reports from manufacturers or suppliers verifying the performance of safety and control functions of each system.

2 PRODUCTS

2.1 SYSTEM SELECTION

General
Selection: To meet the system requirements, as documented.
Marking: To AS/NZS 5033.

2.2 PHOTOVOLTAIC MODULE

General
Selection: To AS/NZS 4509.2, AS/NZS 5033 and as documented.

Array
Encapsulation: Required.
Toughened glass: Required.
Protection rating: ≥ IPX6.
Integral bypass diode protection: Required.

Cells
Type: Crystalline.
Standard: To IEC 61215.
Efficiency: ≥ 12%.

2.3 REGULATOR

General
Selection: To AS/NZS 4509.2 and as documented.
Function: Charge cycle control including:
- Low battery voltage disconnect.
- Pulse width modulation.
- ≥ 3 step series regulation.

Display: LCD display of:
- Battery voltage.
- Charge current.
- Ampere hours in and out.
- Load current.

Alarms: Visible and audible low and high battery voltage alarms.
Transient protection: Required.

2.4 BATTERY SYSTEM

General
Selection: To meet the documented performance.
Blocking diodes: Required.
Service life: ≥ 10 years.

Standards
General: To AS 2676 and AS 4086.1.

2.5 INVERTER

General
Selection: To meet the documented performance.
Waveform: True Sine wave.
Waveform quality: To AS 4777 series.
Voltage regulation: ± 8%.
Harmonic distortion of output current:< 4%.
Frequency regulation: ± 1%.
Efficiency: ≥ 90% at 10% load.
Protection: Overload, short circuit and transient required.
Automatic no-load shutdown: Required.
Display:
- Output power.
- Grid stability.

Standards
General: To AS/NZS 4777.2.

Synchronisation
Requirement: Self commutation modules which automatically synchronise the inverter supply frequency and phase angle to the low voltage network or other embedded generator system.

2.6 CONTROL SYSTEM

Control panel

General: Provide photovoltaic system control panels, switchgear and controlgear assemblies to the *0942 Switchboards – custom-built* and *0943 Switchboard components* worksections and as documented.

PV switch disconnectors: Non polarity sensitive switch disconnectors to AS/NZS 5033 clause 4.3 for both circuit breakers and disconnect devices used to isolate PV panels.

2.7 PHOTOVOLTAIC METERING

General

Requirement: Provide photovoltaic metering equipment to meter the energy that is exported back to the grid to the requirements of the electricity distributor.

2.8 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.

3 EXECUTION

3.1 INSTALLATION

General

Standard: To AS/NZS 5033.

Photovoltaic array

Location: As documented.

Orientation: Fixed to AS/NZS 4509.2.

Tilt: Fixed to AS/NZS 4509.2 and AS/NZS 4509.1.

Wind loading: To AS/NZS 1170.2.

PV array disconnectors: Cable connections to the disconnector to manufacturer's requirements.

Lightning protection: Connect to photovoltaic array support system.

Regulator

Location: As documented.

Battery system

Standard: To AS 4086.2.

Location: As documented.

Enclosure: To AS/NZS 4509.2.

Support: Mount in proprietary battery holders or on purpose-built stands constructed of timber or other corrosion resistant material.

Inverter

Location: As documented.

Standard: To AS 4777.1.

Low voltage connection

General: Connect to low voltage power system as documented.

Surge diversion: Required.

Earthing

Standard: To AS/NZS 5033.

Support

Roof mounted plant and equipment: Supports as documented.

Horizontal roof platforms and large area roof mounted equipment: Engage a structural engineer to document suitable platforms.

Ground level mounted plant and equipment: Support as documented.

3.2 COMPLETION

Completion tests

General: To AS/NZS 4509.1 and AS/NZS 5033.

Warranties

General: Provide manufacturer's and installer's warranties, as documented.

3.3 MAINTENANCE

General

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 H during the defects liability period.

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.

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 61439.3. ***Rev 2021-05***

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 61439.1. ***Rev 2021-05***

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 AS/NZS 61439 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 61439.1. ***Rev 2021-05***

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***

0943 SWITCHBOARD COMPONENTS

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide switchboard components, as documented.

1.2 DESIGN

Statutory authority's equipment
General: Liaise with the electricity distributor about the **installation. Also complete coordination** with their protective and control equipment. ***Rev 2018-04***

1.3 CROSS REFERENCES

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

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- ATS: Auto-transfer
- MSB: Main switchboard
- SPD: Surge protection device.

1.5 SUBMISSIONS

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

Products and materials
Requirement: Submit manufacturer's technical data for all components.

2 PRODUCTS

2.1 REQUIREMENTS

General
Selection: To AS/NZS 3000 clause 1.7 and Section 2.

Rated duty: Uninterrupted.

Rated making capacity (peak): ≥ 2.1 x fault level (r.m.s.) at assembly incoming terminals.

Utilization category: To AS/NZS IEC 60947.1 clause 4.4 and the recommendations of Annex A.
- Circuits consisting of motors or other highly inductive loads: At least AC-23.
- Other circuits: At least AC-22.

Coordination: Select and adjust protective devices to discriminate under overload, fault current, and earth fault conditions.

Enclosure: IP4X minimum.

2.2 SWITCH-ISOLATOR

General
Standard: To AS/NZS IEC 60947.1 and AS/NZS IEC 60947.3.

Poles: 3.

Operation: Independent manual operation including positive ON/OFF indicator.

Shrouding: Effective over range of switch positions.

Fault make/fault break switch-isolators

Rated breaking capacity: To AS/NZS IEC 60947.3 Table 3.

Rated short-time withstand current: As defined in AS/NZS IEC 60947.1 clause 4.3.6.1 and the manufacturer's recommendation for the prospective fault current conditions.

Rated short-circuit making capacity: As defined in AS/NZS IEC 60947.1 clause 4.3.6.2, to conform to the manufacturer's recommendation for the prospective fault current conditions.

Rated short-circuit breaking capacity: To AS/NZS IEC 60947.1 clause 4.3.6.3 and the manufacturer's recommendation for the prospective fault current conditions.

Load make/load break switch-isolators

Rated making and breaking capacity: As defined in AS/NZS IEC 60947.1 clause 4.3.5 to conform to AS/NZS IEC 60947.3 Table 3 and the manufacturer's recommendations for the prospective fault current conditions.

Rated short-time withstand current: As defined in AS/NZS IEC 60947.1 clause 4.3.5, to conform to the manufacturer's recommendation for the current conditions.

2.3 OVERLOAD AND FAULT PROTECTION GENERALLY

General

Requirement: Provide overload and fault protection devices, including full discrimination and cascade protection, and grade with the electricity distributor's incoming supply protection system and the downstream site protection devices.

2.4 FUSE SWITCH UNITS

General

Standard: To AS/NZS IEC 60947.1 and AS/NZS IEC 60947.3.

Operation: Provide an extendable operating handle.

Type: Fuse switches shall be ABB Slimline or IPD Modstack unless noted otherwise. Provide fuse links in each fuse switch unit. ***Rev 2017-01***

Fuse links

Requirement: Isolate when switch contacts are open.

Provide three sets of spare fuse links for each size installed and mount in the switchboard. ***Rev 2017-01***

2.5 AUTO-TRANSFER SWITCHES

General

Standard: To AS/NZS IEC 60947.1 and AS/NZS IEC 60947.6.1.

Type: 3 pole automatic type with supervisory circuits which initiate and restore the changeover transfer operation.

Load side connections: Segregate from incoming side.

Classification: To AS/NZS IEC 60947.6.1:

- Contactors: PC.
- Circuits: CB.

Utilization category: To AS/NZS IEC 60947.6.1 clause 5.4.

Interlocks: Provide electrical and mechanical interlocks. If circuit breaker is used, provide for isolation of each circuit breaker.

2.6 MOULDED CASE AND MINIATURE CIRCUIT BREAKERS

General

Moulded case breakers: To AS/NZS IEC 60947.1 and AS/NZS IEC 60947.2.

Miniature circuit breakers: Interrupting capacity classification to AS/NZS 60898.1 or AS/NZS 3111.

- For general building services: Type C.
- For motor protection: Type D.

Operation: Independent manual operation including positive ON/OFF indicator.

Trip type: Conform to the following:

- Moulded case breakers: Adjustable thermal, fixed magnetic.
- Miniature circuit breakers: Fixed thermal and fixed magnetic.

Isolation facility: Required.

Current limiting: Moulded case breakers required.

Mounting: Mount circuit breakers so that the ON/OFF and current rating indications are clearly visible with covers or escutcheons in position. Align operating toggles of each circuit breaker in the same plane.

Clip tray chassis: For miniature overcurrent circuit breakers, provide clip tray assemblies capable of accepting single, double or triple circuit breakers and related busbars. Provide moulded clip-on pole fillers for unused portions.

Utilisation category: Moulded case breakers:

- Final subcircuits category: Category A.
- Mains and submains: Category B.

Trip settings: Set as documented, seal, and label.

Interchangeable trip units: Connect trip units so that trip units are not live when circuit breaker contacts are open.

Fault current limiting circuit breakers: Select breaker frame sizes from one manufacturer's tested range of breakers to give cascade and discrimination protection within the switchboard and downstream switchboards as required.

Circuit breakers for distribution boards shall have a complete range available up to 100A on a single bus size and have single pole combined RCD units up to 25 amps, single phase.

Provide all auxiliary devices as required for the system to operate fully.

Circuit breakers shall be of the same manufacture and type throughout the installation including distribution boards and switchboard sections for distribution. ***Rev 2017-01***

2.7 ELECTRICITY DISTRIBUTOR'S SERVICE PROTECTIVE DEVICES

General

Low voltage service protective devices: To AS/NZS 3000, the electricity distributor's requirements and the Service and Installation Rules.

Service protective devices > 100 A: Provide fault current limiting circuit breakers with adjustable overload and short circuit current facilities with full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems.

2.8 RESIDUAL CURRENT OPERATED CIRCUIT BREAKERS (RCBO)

General

Standard: To AS/NZS 3190.

Integral non-overload protection type: To AS/NZS 61008.1.

Integral overload protection type: To AS/NZS 61009.1.

Modular type: To AS/NZS IEC 60947.2.

- Type I for patient treatment areas.
  - . Default tripping current: 10 mA.
  - . Switched neutral: Required.
- Type II.
  - . Default tripping current: 30 mA.

2.9 AIR CIRCUIT BREAKERS

General

Standard: To AS/NZS IEC 60947.1 and AS/NZS IEC 60947.2.

Type: Open construction, withdrawable 3 pole, front connected.

Utilisation category: Category B.

Closing operation: Provide independent manual operation with trip free closing mechanisms and positive mechanically operated ON and OFF indication.

Opening operation: Provide independent manually operated release for opening.

Auxiliary switch contacts: Provide contacts with minimum rated operational current of 6 A at 240 V, 50 Hz. Provide at least one spare normally-open and one spare normally-closed contacts. Provide shunt trip release coil circuits with an early-make/late-break series connected auxiliary contact.

Protection system: Provide a fully adjustable solid state protection system integral to the circuit breaker and incorporating a solid state protection relay.

Locking: Provide for locking of circuit breakers in either the open or closed position.

Operating mechanism charging: Manual.

Electrical interlock: Control circuitry of functional units with normally-opened and normally-closed auxiliary contacts.

Mechanical Interlock: Provide cable or bar interlocks.

Interlock keys: Provide captive type coded key with squared face and alphabetical or numerical coded operating face to operate the electrical and mechanical interlocks as required.

Door interlock: Except for compartment doors that serve only as covers, provide interlocks to prevent compartment doors being open if the circuit breakers are closed.

Abnormal operations: Provide circuit breakers which preclude the following operations:

- Slow closing or opening of contacts.
- Manual independent hand closure, if springs fail.
- Release of charged springs while contacts are closed.

Maintenance: Provide for slow closing of the circuit breaker mechanism during disconnected maintenance.

Withdrawable type

Mounting: Mount circuit breaker on a withdrawable carriage for racking in or withdrawing, and for positively fixing the unit into any of the 3 following positions:

- Connected.
- Test/isolated.
- Disconnected.

Auxiliary contacts: Provide contacts which are disconnected in the isolated position and connected in the test position.

Interlocking: Provide interlocking which prevents the circuit breaker being racked in or withdrawn unless it is in a tripped condition and prevents the circuit breaker being closed unless located in either the connected or test/isolated position. Provide stored energy devices which are automatically discharged by any racking operation.

Shutters: Provide automatic shutters, which can be locked, covering busbar and incoming/outgoing circuit connections and labelled BUSBARS and CIRCUIT respectively.

Earthing: Provide earthing connection between withdrawable carriage and assembly earth busbar which makes before, and breaks after, other contacts on the circuit breaker carriage.

2.10 FUSES WITH ENCLOSED FUSE LINKS

General

Standards: To IEC 60269-1 and IEC 60269-2.

Fuses with fuse links for the protection of semiconductor devices: To IEC 60269-4.

Fuses with fuse links used as fault current limiters: Coordinate fuse type and rating with the protection switchgear manufacturer’s recommendation if used downstream of the fault current limiters. Provide labels adjacent to the fuse holder stating FAULT CURRENT LIMITER and fuse size.

Fuse links: Enclosed, high rupturing capacity type mounted in a fuse carrier.

Breaking range and utilisation category:

- Distribution/general purpose: gG.
- Motors: gM.

Fuse holders: Mount fuse holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Barriers: Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.

Spare fuse links: Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips within the spares cabinet.

Spare fuse holder carriers: Provide 3 spare fuse holder carriers for each size of fuse holder carrier on each assembly. Mount spares on clips within the spares cabinet.

Busbar mounted fuse holders: Provide fuse carriers with retaining clips, minimum fuse holder 32 A.

Protection of final subcircuits

General: Provide series connected surge filter comprising metal oxide varistor based primary SPDs, a low pass LC filter and secondary metal oxide varistor based SPDs.

Maximum discharge current (I_{max}): 20 kA (8/20 µs) phase to neutral and 10 kA neutral to earth.

Voltage protection level (U_p): < 600 V at 3 kA and < 700 V at 500 A.

Visual indicator: Provide visual indication of SPD status.

Maximum continuous operating voltage (U_c): 340 V a.c.

Enclosure and installation: House SPD in electrical switchboard or panel.

Enclosure mounting: DIN rail mounted.

2.11 CURRENT TRANSFORMERS (PROTECTION)

General

Standard: To AS 60044.1.

Type: Cast resin encapsulated window type with busbar clamping devices.

Rated short time current: At least the short time current equivalent to the assembly fault level.

Rated short time: At least the maximum time setting of the related protective relay. Minimum 1 s.

Rated primary current: Equal to assigned current rating of the associated functional unit.

Rated secondary current: 5 A. Connect star point to earth.

Interposing transformers: Provide to the protective relay manufacturer's recommendations.

Characteristics: Conform to the protective relay manufacturer's recommendations.

Test links: Provide test terminals and current transformer secondary shorting links in accessible positions within instrument panels. Provide a set of DIN rail mounted test links, consisting of screw clamped slide links and earth links, for each current transformer group.

Installation: Install transformers to permit easy removal.

Removable links: Provide removable links of minimum lengths for transformers fitted on busbar systems.

Markings: Mount transformers in the assembly enclosure, so that polarity markings and nameplate details are readily viewed right side up without removing the transformers.

2.12 SURGE PROTECTION DEVICES (SPD)

General

Standard: To IEC 61643-11 and IEC 61643-12.

Installation: To AS/NZS 3000 Appendix F.

SPD's shall be connected to the busbar via circuit breaker as recommended by the surge protection device manufacturer (which is typically a D curve breaker) located on the first poles adjacent supply connection. Alternatively, where a circuit breaker cannot be used, a fuse may be used on approval by the superintendent. ***Rev 2021-01***

Supply and install cabling for connection of SPD's which shall be minimized in length and sized in accordance with manufacturer's recommendations. ***Rev 2017-01***

Primary protection

General: Provide shunt connected metal oxide varistor based SPDs between each phase and neutral at assembly incoming supply terminals, on the load side of incoming functional units. ***Each phase and neutral MOV shall be able to be individually replaced.*** ***Rev 2017-01***

Type I SPD

Surge rating (I_{max}) per phase to neutral: ≥ 150 kA.

Surge rating (I_{max}) neutral to earth if remote from the MEN earthing system: ≥ 100 kA.

Residual voltage: < 800 V at 3 kA.

Visual indicator: Provide visual indication of SPD status and life visible from the switchboard front panel.

Alarm contacts: Provide one set of normally closed dry contacts indicating status.

Enclosure and installation: House SPD in a metal enclosure and protect with a suitable rated circuit breaker. ***Rev 2018-02***

Type II SPD

Surge rating (I_{max}) per phase to neutral: ≥ 100 kA.

Surge rating (I_{max}) neutral to earth if remote from the MEN earthing system: ≥ 100 kA.

Nominal discharge current: 40 kA (8/20µs).

Residual voltage: < 800 V at 3 kA.

Visual indicator: Provide visual indication of SPD status and life visible from the switchboard front panel.

Alarm contacts: Provide one set of normally closed dry contacts indicating status.

Enclosure and installation: House SPD in a metal enclosure and protect with a suitable rated circuit breaker or 63A HRC fuse.

Secondary protection

General: Provide shunt connected metal oxide varistor based SPDs between each phase and neutral and a gas discharge tube between neutral and earth at assembly incoming supply terminals, on the load side of incoming functional units and upstream of RCD devices.

Type III SPD

Surge rating (I_{max}) per phase to neutral: ≥ 50 kA.

Surge rating (I_{max}) neutral to earth: ≥ 20 kA.

Residual voltage: < 800 V at 3 kA.

Visual indicator: Provide visual indication of SPD status and life.

Alarm contacts: Provide one set of normally closed dry contacts indicating status.

Enclosure and installation: House SPD in a metal enclosure and protect with a suitable rated circuit breaker or 32A HRC fuse. Connecting lead lengths should not exceed 300 mm.

Combined primary and secondary surge reduction filter protection

General: Provide series connected surge reduction filter comprising metal oxide varistor or triggered spark gap based primary SPDs, a low pass LC filter and secondary metal oxide varistor based SPDs.

Surge rating (I_{max}) per phase to neutral primary protection: ≥ 100 kA.

Surge rating (I_{max}) neutral to earth if remote from the MEN earthing system: ≥ 100 kA.

Residual voltage: < 600 V at 20 kA.

Visual indicator: Provide visual indication of SPD status and life.

Alarm contacts: Provide one set of normally closed dry contacts indicating status.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

Protection of final subcircuits

General: Provide series connected surge filter comprising metal oxide varistor based primary SPDs, a low pass LC filter and secondary metal oxide varistor based SPDs.

Operating voltage (U_n): 220 – 240V at 50 Hz.

Maximum discharge current (I_{max}): 20 kA (8/20 µs) phase to neutral and 10 kA neutral to earth.

Voltage protection level (U_p): < 600 V at 3 kA and < 700 V at 500 A.

Visual indicator: Provide visual indication of SPD status.

Maximum continuous operating voltage (U_c): 340 V a.c.

Enclosure and installation: House SPD in electrical switchboard or panel and protect with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

Enclosure mounting: DIN rail mounted.

2.13 CURRENT TRANSFORMERS (METERING)

Standard

Measurement current transformers: To AS 60044.1.

Test links
General: Provide test links for connection of calibration instruments and meters and for shorting of current transformer secondaries.

Energy meters, maximum demand meters, ammeters and protection relays: Provide with rail-mounted links consisting of screw-clamped slide links and an earth link.

Test studs
General: For energy and demand meters provide rail-mounted potential test studs or plug connections next to associated current transformer links. Provide at least one set of test studs for each compartment.

Accuracy classification
Energy measurements: Class 0.5.

Indicating instruments: Class 3.

Ratings
Rated short time current: At least the short time withstand current equivalent of the circuit in which the transformer is installed.

Rated primary current: At least equal to the current rating of the functional unit.

Secondary windings: Rated at 5 A, burden of 0.4 Ω (10 VA) with star point earthed.

Type
General: If practicable, cast resin encapsulated window-type with busbar clamping devices. Otherwise wound-primary type with mounting feet.

Installation
General: Install transformers to permit easy removal.

Removable links: Provide removable links of minimum length for transformers fitted on busbar systems.

2.14 INSTRUMENTS AND METERS

Electricity meters (watthour meters)
Standards:

- Socket mounting system: To AS 1284.4.
- Electronic: To AS 62053.21.

Electricity meters: Class 0.5.

3-phase metering: Polyphase meters suitable for balanced 3 phase, 4 wire loads.

1 or 2 phase metering: Single phase meters.

Current rating: To suit load and overload conditions. Provide direct connect meters suitable for current range of 15 to 100 A and meters with current transformers suitable to 5 A secondary.

Register: Provide a direct reading register of the large figure type. Mark on the scale the metering transformer ratios and the multiplying factor applied to the meter constant.

Covers: Seal main covers.

2.15 ELECTRICAL INDICATING MEASURING METERS

General
Standard: To the IEC 60051 series.

Accuracy: Conform to the following:

- Indicating Instruments and accessories: ≤ Class 1.5.
- Thermal maximum demand indicators: Class 3.
- Power factor meters, phase angle meters and synchroscopes: 2 electrical degrees maximum error.
- Transducers: Class 0.5.

Mounting: Flush mount.

Meter size:

- Minimum: 96 mm square bezel type.
- If located on Form 3 and Form 4 motor starter enclosures: 76 mm square bezel type.

Labels: If associated exclusively with one phase, label meters RED, WHITE, or BLUE as applicable.

Meter potential protection devices: Group together behind associated meter cover or hinged door, preferably next to current transformer test links.

Accessories: Mount next to associated instruments, inside cabinets.

Transducers: If necessary for transducer operation, provide auxiliary supply. Connect outputs to dedicated rail-mounted isolating type terminals.

Multi-function meters: Provide LCD display multi-function power meter to suit three (3) phase power. The meter shall be suitable for a range of 0-500 amps and 0-500 volts and display the following readings as a minimum:

- ***kWhr***
- ***power factor***
- ***frequency***
- ***voltage***
- ***current (present, maximum and average)***
- ***VA (present, maximum and average)***
- ***Watts (present, maximum and average)***
- ***Neutral current measurement***

Rev 2017-01

Multifunction meters shall be supply authority approved, certified NMI type ***Rev 2018-03***

2.16 CONTACTORS

General

Standard: To AS/NZS IEC 60947.4.1.

Type: Enclosed, block type, air break, electromagnetic.

Poles: 3.

Rated operational current: The greater of:

- Full load current of the load controlled.
- ≥ 16 A.

Mechanical durability: 10 million cycles to AS/NZS IEC 60947.4.1.

Electric durability: ≥ 1 million operations at AC-22 to AS/NZS IEC 60947.4.1.

Mounting: Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Auxiliary contacts: Provide auxiliary contacts with at least one normally-open and one normally-closed separate contacts with rating of 6 A at 230 V a.c., utilisation category AC-1.

Slave relay: If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

2.17 CONTROL DEVICES AND SWITCHING ELEMENTS

Standards

General: To AS/NZS IEC 60947.1 and AS/NZS IEC 60947.5.1.

Switching elements:

- Electrical emergency stop device with mechanical latching function: To AS/NZS IEC 60947.5.4.
- Electromechanical control circuit devices: To AS/NZS IEC 60947.5.1.
- Proximity switches: To AS/NZS IEC 60947.5.2.

Rotary switches

General: Cam operated type with switch positions arranged with displacement of 60°.

Off position: Locate at the 12 o'clock position. Test positions must spring return to off position.

Rated operational current: At least 6 A at 230 V a.c.

Escutcheon plates: Provide rectangular plates securely fixed to the assembly panel. Identify switch position and function.

Time switches

Type: 7 day fully programmable with holiday override function.

Daylight saving switch: Required.

Mains failure operation: 100 hour minimum operating capacity.

Contact rating: ≥ 16 A at 230 V a.c. resistive load.

Construction: Provide readily accessible means of adjustment. Provide operational settings which are clearly visible when switch cover is fitted.

Dial: Digital with hour and minute display.

Override switch (manual): Required.

Control relays

Standard: To AS/NZS IEC 60947.5.1.

Requirement: Provide heavy duty fixed mounted type 3 relays.

Operation: Suitable for continuous operation.

Construction: Plug-in types. Receptacle bases with captive clips which can be operated without using tools.

Type: Modular block.

Contact elements: Electrically separate, double break with silver alloy, non-welding contacts.

Configuration: For standard relays, provide assemblies with ≥ 2 sets of contacts and expandable to 8 sets of contacts in the same assembly. Provide at least one normally-open and one normally-closed contact.

Plug-in types: If required provide the following:

- Receptacle bases with captive clips which can be operated without using tools.
- Changeover type contacts to allow either normally-open or one normally-closed configuration.

Control relay selection table

Relay type	Minimum mechanical life (million operations)	Base	Minimum contact rating	Inter-changeable	Minimum number of contact elements
1	5	Plug-in	$1.25I_L$	Yes	2
2	10	Plug-in	5 A at 240 V	Yes	2
3	10	Fixed mounting	5 A at 240 V	Yes	4

Time delay relays

Adjustable range: Adjustable over the full timing range with timing repeatability within ± 12.5% of nominal setting.

Electronic relays: Incorporate light emitting diodes indicating energisation states of relays.

Synchronous relays

General: Provide synchronous motor drive type relay fitted with anti-stalling device which protects gearing during normal operation.

Phase failure relays

General: Provide separate solid-state phase failure relays conforming to the following:

- Detect less than 85% of normal voltage.
- Detect single phase failure.
- Detect reverse phase sequence after an appropriate time delay.
- Automatic reset on detection of normal power supply.

Sensing circuit: To reject induced voltage spikes and disturbances with frequencies other than 50 Hz.

Back-up protection: Provide high rupturing capacity fuses to each phase.

Push-buttons

Type: Oil-tight, minimum 22 mm diameter, or 22 x 22 mm.

Rated operational current: At least 4 A at 240 V a.c.

Emergency stop devices with mechanical latching: To AS/NZS IEC 60947.5.5.

Marking: Identify functions of each push-button. For latched STOP or EMERGENCY STOP push-buttons, provide label with instructions for releasing latches.

2.18 SEMICONDUCTOR CONTROLLERS AND CONTACTORS

General

Requirement: Provide semiconductor controllers and contactors rated for the characteristics of the controlled load.

Standard: To AS/NZS IEC 60947.4.3.

2.19 PROGRAMMABLE LOGIC CONTROLLERS (PLC)

General

Requirement: Provide complete programmable logic controllers including central processing unit, input/output modules and mounting hardware, as follows:

- Modular in construction and of the same manufacture, with interchangeable peripherals and software.
- Provided with an integral power supply of sufficient capacity to satisfy the requirements of the central processing unit and input/output module combinations which can be located within the mounting hardware.
- Designed and constructed to operate in electrically noisy environments.
- Located in the low voltage control section of the associated functional unit.

Central processing units

General: Provide the following:

- Separate run, monitor and program functions.
- Operating system: Stored in non-volatile memory.
- Programmed software: Stored so that loss of power to the unit for a period up to 1 year will not cause corruption of data and will allow automatic restarting and correct operation immediately on power restoration.

Inputs and outputs (minimum):

- External inputs: 24.
- External outputs: 16.
- Internal relays: 128.

Input/output modules

Status: Clearly identified and indicated by a light emitting diode.

Diodes: Not obscured by assembly wiring.

Analog input: 4 to 20 mA or 0 to 10 V d.c., opto-isolated.

Analog output: 4 to 20 mA or 0 to 10 V d.c., into a burden of ≥ 600 Ω.

Digital input: 24 V d.c., opto-isolated.

Digital output: Volt-free relay contacts or opto-isolated solid state switches for switching an output load of at least 2 A at 24 V a.c. or d.c.

Programmer

Operation: Using ladder logic, allowing for editing without the need to re-enter the whole program. Include test and monitoring functions which facilitate testing, running and debugging of software and provide for input/output number check.

Hand-held programmers: Provide moulded connectors and 2 m connection cable.

2.20 CONTROL AND PROTECTIVE SWITCHING DEVICES OR EQUIPMENT

General

Standard: AS/NZS IEC 60947.6.2.

2.21 CONTROLLER DEVICE INTERFACES

General

Requirement: Provide interfaces between equipment and control systems including the following:

- Programmable logic controllers.
- Metering systems.
- Building management systems.

Standard: To AS/NZS 62026.1, AS/NZS 62026.2, AS/NZS 62026.3 and AS/NZS 62026.5.

Actuator sensor interface: To AS/NZS 62026.2. Provide control system components with an actuator sensor interface. The actuator sensor interface may be integrated into field devices, or be used in separate modules.

Devicenet: Provide control system components with a devicenet connection based controller-device interface, suitable for use on a Controller Area Network to AS/NZS 62026.3.

Smart distributed system (SDS): Provide control system components with a SDS controller-device interface, suitable for use on a Controller Area Network to AS/NZS 62026.5.

Seriplex: Provide a Seriplex interface and communications system between single or multiple controllers and control circuit devices or switching elements.

2.22 INDICATOR LIGHTS

Standard

General: To AS/NZS IEC 60947.5.1.

LED indicators

Requirement for light units: Integrated LEDs.

Voltage range: 12 V a.c. and 12 V d.c. to 30 V d.c.

Body type: Plastic.

Rating: IP66.

Lens type: Plastic.

Terminals: Screw fixing.

2.23 INDICATING COUNTERS

General

Requirement: Provide the following:

- At least 6 digits.
- Digits at least 3.5 mm high.
- Continuous duty rated.
- Non-reset type.
- 500 V surge diverters.

2.24 ALARM ANNUNCIATORS

General

Requirement: Provide the following:

- Labelled annunciator illuminated windows, to indicate status and alarm conditions.
- Lamp test acknowledge-mute and reset individual push-buttons.
- Audible alarm and associated logic circuitry.

Mode of operation

General: Provide the following functions:

- Fault conditions: To initiate flashing of appropriate annunciator lamps and sounding of audible alarms.
- Operation of acknowledge and mute buttons: To silence audible alarms and change annunciator lamps to the steady state on condition.
- Window: To extinguish only when fault condition has been cleared and alarm reset push-button has been activated.
- Subsequent alarms on other inputs: To reactivate the audible alarm and flash the appropriate annunciator lamp.
- Resetting: After correction of the fault condition, provide on-site choice of either automatic resetting or manual resetting at the annunciator panel.

Type

General: Extra-low voltage, solid state, flush mounted, window type.

Lamps

General: Provide annunciators with 2 extra-low voltage lamps per window.

Rated voltage of lamps: 105% of the annunciator system voltage.

Replacing: Changeable from front of panel without affecting condition of annunciator.

Vibration: Provide lamps which do not disconnect due to vibration.

Extra-low voltage power supply

General: Provide an extra-low voltage power supply for the alarm annunciator.

Windows

Nominal size: 15 x 35 mm.

Engraving: Filled in black.

- Background colours: White for status monitoring, red for alarms and shutdown functions.

2.25 AUDIBLE ALARM DEVICES

Sound level

General: Not less than the greater of the following:

- 65 dB(A) at 1 m.
- 15 dB(A) above ambient sound levels at any location in designated areas.

2.26 EXTRA-LOW VOLTAGE TRANSFORMERS

General

Requirement: Provide the following:

- Centre tap on secondary winding.
- Primary and secondary windings wired out on opposite sides of transformer case.
- Primary and secondary windings separated by means of an earthed screen wired out to an insulated terminal.
- Transformer rating greater than or equal to 125% of maximum output load, taking account of degree of ventilation and ambient temperature within assembly, and supplied load.

2.27 BATTERIES AND CHARGERS

General

Requirement: Provide a battery and charger system for circuit breaker tripping, closing and automatic changeover switch operation. Locate within the switchroom or switchboard assembly.

Standards

General: To AS/NZS IEC 60947.5.1.

Valve regulated sealed lead-acid batteries: To AS/NZS 4029.2.

Vented nickel-cadmium batteries: To AS 3731.1.

Chargers: To AS 4044 Type 2.

Circuit breaker operation

General: Provide a d.c. supply for circuit breaker operation from battery system and charger.

Performance

General: Capable of 10 consecutive air-circuit breaker or moulded case circuit breaker operations for the designated quantity of circuit breakers. Each operation consists of open-close of main contacts for 0.5 s duration, with 1 s intervals between operations, and minimum discharge current of 4 A, with batteries in 50% discharge condition. Maintain a minimum terminal voltage of 80% of rated voltage at the completion of the 10 operations.

System voltage: 110 V d.c.

Battery chargers

Type: Free standing, floor mounted, ventilated cabinet type with separate charger and battery subsections.

Degree of protection: IP42.

Tapping: Provide tappings on the transformer to permit adjustment over a range of 95% to 105% of secondary winding voltage on open circuit.

Circuitry: Solid state, micro-processor type, constant voltage, fully automatic, incorporating a smoothing network to give an output wave form at least as smooth as that of a 3-phase bridge system, and automatic boost and float charge functions to ensure maximum battery life and rated performance. Provide facilities for manual boost and test.

Maximum design transient: 70% of the component manufacturer's peak inverse ratings.

Instruments, controls and indicators: Group for ease of operation. Provide analog or digital instruments for the following:

- Charger output current.
- System voltage.
- Load current.

a.c. input protection: Miniature circuit breakers. Protect outgoing tripping supply with a 2 pole d.c. miniature circuit breaker.

Alarm indication: Provide alarm indication to monitor the following:

- a.c. supply.
- Boost charge on.
- Charge fail.
- Low battery voltage.
- High battery voltage.
- Low electrolyte for vented cells.
- Earth fault, secondary side.

Safety signs and labels

Standard: To AS 2676.1.

Safety signs: Provide cautionary, regulatory and emergency safety signs to charger enclosure and switchroom.

2.28 ANTI-CONDENSATION HEATERS

General

^{2}Rating: Provide heaters rated at not less than 20 W/m^2 of total external area including top of weatherproof enclosure.

Type: Black heat type with surface temperature less than or equal to 50°C, mechanically protected and thermostatically controlled.

2.29 SPARES CABINET

General

Requirement: Provide a spares cabinet with main name plate, labelled shelves and non-lockable door. Size for storing racking handles, special tools, spare lamps, spare fuse links and other equipment necessary for satisfactory assembly operation.

Location: Either of the following:

- Incorporated into assembly enclosure.
- Wall mounted in main switchroom.

Finish: To match switchboard assembly.

3 EXECUTION

3.1 MARKING AND LABELLING

General

Requirement: Provide labels including control and circuit equipment ratings, functional units, notices for operational and maintenance personnel, incoming and outgoing circuit rating, sizes and origin of supply and kW ratings of motor starters.

Labels on assembly exteriors

Manufacturer's name: Required.

Assemblies: Label with essential markings.

Designation labels: For other than main assemblies, provide designation label stating source of electrical supply. Identify separate sections of enclosures.

Assembly controls: Label controls and fault current limiters, including the following:

- Circuit designation for main switches, main controls and submains controls.

- Details of consumer's mains and submains.
- Use different colours on labels to distinguish operational requirements such as normal operation, operation under fire or emergency conditions.
- Incoming busbar or cable rating to first tee-off.
- Fuse link size.

Labels on assembly interiors

General: Provide labels for equipment within assemblies. Locate so that it is clear which equipment is referred to, and so that lettering is not obscured by equipment or wiring.

Moulded case circuit breakers: If circuit breaker manufacturer’s markings are obscured by operating handle mechanisms or motor operators, provide additional markings open to view on, or next to, the circuit breaker.

Arrestors: Label each group of primary arrestors, stating their purpose and the necessary characteristics.

Danger, warning and caution notices

Busbars: If polymer membrane coating is used without further insulation, provide warning notices on the front cover near the main switch or local main switch and on rear covers, indicating that busbars are not insulated.

Fault current limiters: In assembly sections containing fault current limiter fuses provide caution notices fixed next to the fault current limiters, stating that replacement fuse links are to match the installed fuse link ratings, make and characteristics. Provide separate label stating make and fault current limiting fuse ratings.

Externally controlled equipment: To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch.

Stand-by power: Provide warning notices stating that assemblies may be energised from the stand-by supply at any time.

Anti-condensation heaters: To prevent accidental switching off, provide caution notices for anti-condensation heaters.

Insulation and shrouding: For insulation or shrouding requiring removal during normal assembly maintenance, provide danger notices with appropriate wording for replacement of insulation shrouding before re-energising assemblies.

Positioning: Locate notices so that they can be readily seen, next to or, if impracticable, on busbar chamber covers of functional units and behind the front cover of functional units. Provide circuit identification labels in the cabling chamber of each functional unit, located next to external terminations.

Schedule cards

General: For general light and power distribution assemblies, provide schedule cards of minimum size 200 x 150 mm, with printed text showing the following as-installed information:

- Submain designation, rating and short-circuit protective device.
- Light and power circuit numbers and current ratings, cable sizes and type and areas supplied.
- Mounting: Mount schedule cards in a holder fixed to the inside of the assembly or cupboard door, next to the distribution circuit switches. Protect with hard plastic transparent covers.

Single-line diagrams

Main switchboards and distribution switchboard assemblies: Provide single-line diagrams.

Format: Non-fading print, at least A3 size, showing the system as installed.

Mounting: Enclose in a non-reflective frame and wall mount close to assembly.

Marking cables

General: Identify the origin and cable size of wiring with legible indelible marking.

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

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

3.2 MAINTENANCE

General
Standard: To AS 2467.

0951 LIGHTING

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide lighting and control systems, as documented.

1.2 CROSS REFERENCES

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

1.3 STANDARDS

General
Air-handling luminaires: To AS/NZS 60598.2.19.

EMC compliance: To AS/NZS CISPR 15.

Energy efficiency for ballasts and lamps: To AS/NZS 4783.2.

Fixed general purpose luminaires: To AS/NZS 60598.2.1.

Floodlights: To AS/NZS 60598.2.5.

Harmonic limits: AS/NZS 61000.3.2.

Luminaires, general requirements and tests: To AS/NZS 60598.1.

Luminaires: To AS/NZS 60598.1.

Luminaires for swimming pools: To AS/NZS 60598.2.18.

Luminaires for use in clinical areas of hospitals and health care buildings: To AS/NZS 1680.2.5 and AS/NZS 60598.2.25.

Luminaires with built-in transformers for filament lamps: To AS/NZS 60598.2.6.

Portable general purpose luminaires: To AS/NZS 60598.2.4.

Recessed luminaires: To AS/NZS 60598.2.2.

Road lighting luminaires: To SA/SNZ TS 1158.6.

Radio interference limits: To AS/NZS CISPR 15.

Minimum energy performance standards (MEPS)
General: To AS/NZS 4782.2, AS/NZS 4783.2, AS 4934.2.

Self-ballasted lamps: To AS/NZS 4847.2.

1.4 INTERPRETATION

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

- CCT: Correlated colour temperature.
- CFL: Compact fluorescent lamps.
- CRI: Colour rendering index.
- DALI: Digital addressable lighting interface.
- EEI: Energy efficiency index.
- ELV: Extra low voltage.
- EMC: Electromagnetic compatibility.
- HID: High intensity discharge.
- ILCOS: International lamp coding system.
- LED: Light-emitting diode.
- PIR: Passive infra-red.

- PLC: Programmable logic controllers.
- RCD: Residual current device.
- UPS: Uninterruptable power supply.

Definitions

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

- Control system (lighting): A lighting control system comprising a combination of some or all of the following:
  . Automatic sensing and control components.
  . Timers.
  . Manual overrides.
  . Programming using a computer interface.
- Incandescent lamp: Lamps covered in AS/NZS 4934. 2 including both tungsten filament and tungsten halogen types.
- Proprietary luminaires: Luminaires available as a catalogue item.

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

Lighting: Submit technical data on the following:

- Luminaires.
- Lamps.
- Ballasts.
- Power factor correction equipment.
- Lighting control systems.
- All accessories.

Type test: Submit photometric test results from a registered testing authority as evidence of luminous efficacy for the applicable CCT for the following:

- Light-emitting diode luminaires.
- Light-emitting diode lamp replacement modules.

Samples

Lighting: Submit samples of all luminaires and accessories complete with lamp, control gear and three core flex and plug.

Shop drawings

Lighting: Submit shop drawings for the following:

- Lighting columns.
- Lighting column mounting bases.
- Non-proprietary luminaires.
- Non-standard fixing brackets.

2 PRODUCTS

2.1 PROPRIETARY LUMINAIRES

General

Requirement: Provide proprietary luminaires complete with lamps, luminaire control equipment, lighting control equipment, and accessories as documented. Provide lamps of the same type from the same brand and country of manufacture.

Self-ballasted lamps: To AS/NZS 60968 and AS/NZS 60969.

Proprietary equipment
General: The requirements of this worksection for lamps, ballasts and luminaire control equipment over-ride the specifications inherent in the selection of a particular make and model of luminaire.

Colour ***Rev 2017-01***

General: confirm colour of lumiaires prior to ordering

2.2 FLUORESCENT LAMPS

Standards
Fluorescent lamps: To AS/NZS 4782.1 and AS/NZS 4782.2.

Compact fluorescent lamps: To AS/NZS 4847.1 and AS/NZS 4847.2.

Single capped fluorescent lamps: To AS/NZS 60901.

Properties
Colour rendering: Group 1B to AS/NZS 1680.1.

Linear and circular lamp type: T8 (26 mm diameter) or T5 (16 mm diameter), triphosphor, TL84, as documented.

Compact fluorescent lamps types: Four-pin, non-integrated type.

2.3 FLUORESCENT LAMP BALLASTS

Linear and circular lamp types
General: Provide electronic fluorescent lamp ballasts for fluorescent lamp lighting systems selected for compatibility with the lamp and control method.

Electronic fluorescent lamp ballasts: Conform to the following:

- To AS/NZS 61347.2.3 and AS/NZS 60929.
- Current total harmonic distortion: < 15%.
- Soft start.
- Number of ballasts: Provide separate ballasts for each lamp or integral dual ballasts as an alternative for dual lamp fittings.

Ballast performance measurement – fluorescent lamps: To AS/NZS 4783.1.

CFL lamp types
General: Provide electronic fluorescent lamp ballasts for CFL lighting systems selected for compatibility with the lamp and control method.

- Electronic fluorescent lamp ballasts: To AS/NZS 61347.2.3and AS/NZS 60929.
- Current total harmonic distortion: < 15%.
- Number of ballasts: Provide separate ballasts for each lamp or integral dual ballasts as an alternative for dual lamp fittings.

Ballast performance measurement – fluorescent lamps: To AS/NZS 4783.1.

Fluorescent lamp power factor correction
General: Provide power factor correction on all luminaires to a minimum power factor of 0.9 lagging.

2.4 DISCHARGE LAMPS (HID)

Standards
High pressure mercury vapour: To IEC 60188.

High pressure sodium vapour: To IEC 60662.

Low pressure sodium vapour: To IEC 60192.

Metal halide lamps: To IEC 61167.

Lamp controlgear for HID lamps: To AS/NZS 61347 and AS/NZS 60923.

Discharge lamp ballasts
General: Provide ballasts for lighting systems selected for compatibility with the lamp and control method.

High-pressure mercury vapour, low-pressure sodium vapour, high-pressure sodium vapour and metal halide type: Conform to AS/NZS 61347 and AS/NZS 60923.

Metal halide type:

- ≤ 150 W: Reactors or electronic controlgear.
- > 150 W indoor: To the lamp manufacturer's recommendation.
- > 150 W outdoor: To the lamp manufacturer's recommendation.

Igniters: If documented, provide igniters which cut out when lamp ignites and after pre-determined time period if lamp fails to ignite.

Instant restrike igniters: If required, provide instant restrike igniters for instant restart of suitable HID lamps to the manufacturer's requirements.

HID power factor correction

General: Provide power factor correction on all luminaires to a minimum power factor of 0.9 lagging.

Capacitors

Standard: To AS/NZS 61048 and AS/NZS 61049.

Integral fuses

General: Provide integral fuses for reactive high intensity discharge (HID) lamp ballasts.

2.5 LIGHT-EMITTING DIODES (LEDS) LUMINAIRES

General

Requirement: Provide light emitting diode (LED) luminaires, as documented.

Light-emitting diode luminaires

General: Light-emitting diode luminaires include integral LEDs, reflectors, lenses, heatsinks and drivers.

Performance: Provide LED luminous efficacy of the LED luminaire at normal operating temperature in its normal position and enclosure of > 60 lumens per watt.

Life of the LED in the complete luminaire: L70 to IES LM-80-2008, unless documented.

Colour: CRI > 80.

Light-emitting diode lamp replacement modules

Performance: Conform to the following:

- Reflector lamps: Provide luminous efficacy of the LED replacement modules at operating temperature in normal position and enclosure of > 40 lumens per watt where the quoted beam angle is the angle between the points of 50% of maximum luminous intensity.
- Linear fluorescent lamps: Provide luminous efficacy of replacement modules of > 80 lumens per watt.

2.6 CONTROL GEAR ENCLOSURE

General

Requirement: Provide controlgear support enclosure within the body of the luminaire, except where remotely mounted controlgear is documented or required by the manufacturer.

Enclosures and controlgear mounting assemblies: Provide heat dissipation facilities to dissipate heat from the luminaire.

Controlgear enclosure: Form a barrier against direct contact with live parts of the controlgear and the area of the luminaire containing the lamp and lamp support holders.

Separate controlgear enclosures: If separate controlgear enclosures external to the luminaire are required, conform to the above requirements.

Fixing: Screw fixed.

2.7 WIRING

External flexible cords

Recessed luminaires: Provide flexible cord in conformance with the following:

- Length: ≥ 1.5 m.
- Cross sectional area: 0.75 mm^2.
- Type: 3-core V75 (minimum) PVC/PVC, connected to a 10 A 3-pin moulded plug to AS/NZS 3112 or multi-pin plug, as documented.

Other fittings: Provide external flexible cord in conformance with the following:

- Cross sectional area: ≥ 1 mm^2.

2.8 LIGHTING CONTROL

General

Requirement: Provide the following as documented:

- Lighting switches.
- Dimmers.
- Automatic control systems.

Manual controls

General: Provide manual control of luminaires into groups, zones and to individual devices, as documented.

Digital control system

General: Provide a proprietary, microprocessor-based system to control lighting under automatic and user interface control, as documented.

Control wiring: To control system manufacturers' recommendation, with distinctive sheath colour.

Controllers and contactors: Provide controllers and contactors rated for the characteristics of the controlled load and to AS/NZS IEC 60947.4.3.

Dimmer control: Provide electronic dimmer controls compatible with the lighting control system and as documented.

Direct current interface for proximity sensors and amplifiers: To AS/NZS IEC 60947.5.6.

Controller interfaces: Provide interfaces between lighting control systems and other control systems as documented in the **Controller interface schedule**.

External lighting

Where external lighting is shown on the drawings to be automatically controlled by time clock and/or daylight switch, the time switching system shall be capable of –

(i) Limiting the period the system is switched on to between 30 minutes before sunset and 30 minutes after sunrise is determined or detected including any pre-programmed period between these times: and

(ii) Being overridden by a manual test switch for a period of up to 30 minutes, after which the time switch must resume control.

Locate the manual test switch within the supply distribution board.

Daylight switching to be Clipsal 56 Series.

Label test switch with permanently fixed traffolyte labels. ***Rev 2017-01***

2.9 REMOTE MONITORING

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.

2.10 ACCESSORIES

General

Manufacturer: If of a similar finish, provide electrical accessories from the same manufacturer throughout the project and for interchangeability of subcomponents such as switch modules in wall plates.

Lighting outlets

Pin arrangement: Conform to the following:

- Standard: 3 flat pin with looping terminal.
- Luminaires with integral emergency light or special switching: If required, a 4 or 5 pin plug or a second lighting outlet plug of alternative pin configuration to differential the functions or supply.

Lighting switches

General: Provide light switches, as documented.

Standard: To AS/NZS 3133.

Type: Unbreakable polycarbonate rocker.

Colour: White.

Minimum: 10 A, 230 V a.c.

Labelling

Light switches shall be identified using Clipsal ID plugs or approved equal. ***Rev 2017-01***

Fluorescent lamp circuit switches: 10 A or 15 A, 230V a.c. to suit circuit load.

Plantroom switches: Industrial type, rated IP56.

Key switches

General: Provide key switches as documented.

Run-on timer switches

General: Provide run-on timer switches as documented.

Delay: Adjustable to 20 minutes.

Dimmer switches

General: Provide integral dimmer/switch units as documented.

Proximity switches

General: Provide proximity switches as documented.

Standard: To AS/NZS IEC 60947.5.2.

Daylight switches

General: Provide integral photo electric switch units as documented.

Performance: Adjustable between 50 and 1000 lux in internal applications and 2 to 100 lux in external applications

Time delay: > 2 minutes.

Illumination differential: > 50 lux.

Motion detector switches

General: Provide motion detection sensors which cover designated areas as documented.

Timer: Incorporate ON timers adjustable between 1 and 5 minutes minimum and 30 minutes and 2 hours maximum.

Control function: Provide manual/OFF/automatic control switch. If manual switches are used in association with motion sensors, wire the switch so that it can turn the lights OFF but not override the motion switch to turn the lights ON.

Standard: To AS 2201.3.

Type: Passive infra-red (PIR).

Manual time delay switches

General: Provide manual time delay relay switches as documented.

Type: Electronic.

Duration: Adjustable between 5 minutes and 15 minutes.

Indicator light: Required. Activated when artificial illumination is OFF.

2.11 POLES

General: Provide poles, footing, etc. for specified pole top luminaires.

Wind loading: wind loading on the poles is to be calculated from AS/NZS 4676 – Structural design requirements for utility services poles and AS 1170.2- – SAA Loading Code Part 2 Wind Loads. The natural frequency of the pole is to be calculated considering varying diameters and thicknesses over the height of the pole and using a 1.1 safety factor for the mass at the top of the pole. A second order analysis is to be performed.

Deflection: Pole deflection at serviceability wind speeds shall be less than 3.3%.

Foundation bolts: A galvanised foundation bolt assembly complete with positioning template and two (2) nuts and washers per bolt is to be provided to suit each pole base plate. The underside of the base plate is to be grouted in accordance with this specification grouting

procedure and to the supervisor's satisfaction. Grout performs a structural function in the design of the pole and stability of the pole may be undermined if it is neglected.

Access doors: Flush fitting access doors are to be provided to access cables etc. The pole section with the access door is to be reinforced and analysed accordingly - Method for verification of structural design by calculation or a recognized finite element analysis package. Poles housing more than eight sets of control gear are to have a vented bottom access door.

Design calculations: Pole manufacturers are to submit a fully documented computer print-out verifying structural adequacy and conformance to current Australian Standards and the specification. Print-outs are to be available showing all input parameters including drag coefficients, cross-sectional properties and design assumptions authorized by a qualified structural engineer and include a statement of compliance with all aspects of this specification. Calculations shall prove pole section capacity, access door reinforcing and foundation bolt suitability.

Grouting procedure: The underside of all pole base plates shall be grouted within seven (7) days of installing the pole. For the period between pole installation and grouting, it remains the contractor's responsibility that the foundation bolts, pole and other items are not damaged.

Grouting the underside of pole base plates services the following functions:

- ***Grouting plays a significant part in the structural capacity of the pole and foundation bolts in resisting high wind forces***
- ***Preventing injury to persons through electrocution caused by handling or tampering with exposed cables***
- ***Preventing damage to electrical cables by vermin***

Failure to follow this procedure could void structural certification and pole manufacturer's warranty and ultimately cause premature failure of the structure. Non-shrink grout with a minimum strength of 32MPa at 28 days is to be installed as shown

Identification plates: Provide and install on each pole an engraved or stamped brass identification plate specifying the light fitting type, lamp type and lamp wattages.

Permanently fix plate to pole. Provide sample plate for acceptance by the Superintendent's Representative prior to final ordering. ***Rev 2017-01***

3 EXECUTION

3.1 RE-USE OF LUMINAIRES

Modifications and refurbishing

General: Modify and refurbish existing luminaires to manufacturer's current recommendations. Test for conformance with current Australian Standards before returning to service. Provide test results.

Component replacement: Starter and lamp.

Diffuser: Clean.

3.2 SUPPORTS

General

Requirement: Install luminaires on proprietary supports by means of battens, trims, noggings, roses and packing material.

Suspended luminaires

Rods: Steel pipe suspension rods fitted with gimbal joints.

Chains: Electroplated welded link chain.

Levelling wire: Stainless steel.

Levelling: Adjust the suspension system length so that the lighting system is level and even.

Horizontal tolerance: ± 3 mm between luminaires within the same area.

Surface mounted luminaires

General: Fit packing pieces to level luminaires and prevent distortion of luminaire bodies. Provide packing strips to align end to end luminaires.

Fixing: Conform to the following:

- Generally: Provide 2 fixings at each end of fluorescent luminaires.
- Luminaires less than 150 mm: A single fixing at each end in conjunction with 1.6 mm backing plates may be used.
- Provide battens and support for the fitting.
- Do not direct fix into plasterboard.

Recessed luminaries

General: Install recessed luminaries in trimmed openings in the suspended ceiling.

Standard: To AS 2946.

3.3 WIRING CONNECTION

Recessed luminaires

General: Connect recessed luminaires to a plug socket outlet.

Lighting tracks

General: For low voltage transformers located remotely from the track, size the cable between the transformer and the track to give a voltage drop of less than 5% between the transformer and the track at the rated current of the transformer.

3.4 ACCESSORIES

Installation

General: Install accessories and conceal cabling to the *0921 Low voltage power systems* worksection.

3.5 COMPLETION

General

Requirement: Before the date of practical completion carry out the following:

- Verify the operation of all luminaires.
- Adjust aiming and controls for all luminaires under night time conditions.
- Replace lamps which have been in service for a period greater than 50% of the lamp life as published by the lamp manufacturer.

0962 TELEVISION DISTRIBUTION SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide a system suitable for the reception and distribution of analog and digital television, video, radio and sound signals, as documented.

Designer: Network operator's Approved Design Partner.

1.2 SYSTEM DESCRIPTION

System type

Type: As documented.

Performance requirements

General: To AS/NZS 1367.

Capacity: Provide the distribution system with the installed capacity to accommodate a minimum of 30% additional outlets.

Signal sources

Free-to-air (FTA) antennae system: Provide FTA antennae system terminating at the premises cabling interface.

Network operator: Provide for the connection of the network operator's system terminating at the premises cabling interface as documented.

Local signal source: Provide television input sockets at the premises cabling head-end for the distribution of in-house television channels on separate channels of the network.

Service entry

General: Provide service entry facilities to suit signal sources, head end equipment and distribution systems.

Location: As documented.

Head end equipment

General: Provide head end equipment to suit signal sources, distribution systems and documented performance.

Location: As documented.

Distribution system

General: Provide a cabling distribution network from the head end equipment to each network distribution tap.

FTA distribution taps: Provide FTA distribution taps.

Network distribution taps: For systems designed for more than one network operator provide individual distribution taps for each network operator. Co-locate the taps with FTA taps in groups to facilitate selected connection or changes to outlet feeders.

Location: Group all equipment as documented.

Outlets

General: Provide outlets and feeders from distribution tap(s) as documented.

Quantity: Provide separate sockets for each source and service.

1.3 CROSS REFERENCES

General

Requirement: Conform to the following:

- *0901 Electrical Systems*.
- *0903 General requirements - Electrical*
- *0911 Cable support and duct systems*.

- *0921 Low voltage power systems*.

1.4 STANDARDS

General

System design and performance: To AS/NZS 1367.

Application: For the purposes of this worksection, AS/NZS 1367 applies to all building types.

Earthing and segregation: To AS/NZS 3000.

Safety requirements: To AS/NZS 1367 Section 2.

Electromagnetic compatibility: To AS/NZS 1367 Section 3.

1.5 INTERPRETATION

Abbreviations

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

- BER: Bit error ratio.
- MER: Modulation Error Ratio.
- COFDM: Coded Orthogonal Frequency Division Multiplexing.
- QAM: Quadrature Amplitude Modulation.
- QPSK: Quadrature Phase Shift Keying.
- PAL: Phase Alternating Line.
- MATV: Master Antenna Television.
- SMATV: Satellite Master Antenna Television.

Definitions

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

- MATV (Master Antenna Television): System that primarily provides access to terrestrial television signals but may also carry radio services. Terrestrial signals may be distributed at their original frequency or shifted to a more convenient frequency. In-house services may also be provided by modulating base band signals from an appropriate source.
- SMATV – L Band: MATV system where satellite signals are distributed in native L Band QPSK at the Intermediate Frequency delivered by the LNB.
- SMATV – QAM: MATV system where satellite signals received at the dish are transmodulated at the headend and distributed as QAM at frequencies below 860 MHz.

1.6 SUBMISSIONS

Certification

Requirement: Submit certification of conformance of product installation to AS 1367.

Documentation

Standard: To AS/NZS 1367 Appendix D.

Operation and maintenance manuals

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

Products and materials

Requirement: Submit product data for all system components.

Records

Record drawings: Submit drawings, including minimum and maximum signal frequency (channel) and levels at the input and output of amplifiers, splitters, taps, tap ports and outlets.

Correspondence with network operators: Submit copies of correspondence and notes of meetings with all subscription network operators.

Service agreements: For each service provider, submit service agreements for execution by the principal.

Samples

System components: Submit samples that are visible after installation, including but not limited to:

- Outlets.
- Labelling.

Shop drawings
General: Before commencing the work, submit the following in conformance with AS/NZS 1367 clause D3 and D4:

- Schematic diagram, proposed location of all components and interconnecting cabling.
- Antennae types and their method of mounting.

Design documentation
General: Before commencing the work, submit the following:

- Design frequencies.
- Free-to-air reception quality report, citing methods used for determination. Address all signals that the system is to receive.
- Calculations of signal levels at outlets and at the input and output of amplifiers, splitters and taps.

Tests
Requirement: Submit results of system testing.

1.7 SYSTEM DESIGN

Design system to accommodate signals within the range 45 MHz to 820MHz using a tap-off distribution system.

Before completing the final design, measure the on-site signal levels of the nominated services and note the existence and direction of any ghosting sources.

Before commencing the installation, submit to the Superintendent details of the proposed final design, including expected signal levels at all outlets and showing the configuration of equipment required to meet the specified performance.

1.8 PERFORMANCE

At each outlet the picture received on a domestic TV receiver shall not be noticeably different from the picture received when the receiver is connected directly to the antenna and shall be free from discernible cross-modulation, inter-modulation, ringing, noise or other distortion.

2 PRODUCTS

2.1 FREE-TO-AIR ANTENNA

General
Standard: To AS 1417.
Material:

- Boom: Galvanized steel.
- Elements: Aluminium ≥ 12 mm.

Connection: F type to IEC 60169-24.
Mounting hardware: Proprietary to suit antenna.

2.2 ACTIVE EQUIPMENT

Masthead amplifier(s)
Selection: To meet system performance requirements.

Head end amplifier(s)
Selection: To meet system performance requirements.

Distribution amplifiers
Selection: To meet system performance requirements.

2.3 PASSIVE EQUIPMENT

Splitters
Selection: To meet system performance requirements.

Couplers
Selection: To meet system performance requirements.

Taps
Selection: To meet system performance requirements.

2.4 SURGE PROTECTION DEVICES (SPD)

General
Requirement: Provide all mode metal oxide varistor based series connected SPD to protect equipment in racks and cabinets, as documented.

Standard: To AS 4262.1 and AS 4262.2.

Surge rating (I_{max}): ≥ 20 kA (8/20 µs) phase to neutral and 10 kA neutral to earth.

Voltage protection level (U_p):

- < 600 V at 3 kA.
- 700 V at 500 A.

Visual indicator: Provide visual indication of SPD status.

Enclosure and installation: House SPD in a electrical switchboard or panel and protect with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

2.5 COAXIAL CABLE

Types
Standard: To AS/NZS 1367 clause 5.11.

General: Minimum RG6 dual shield.

Underground: Flooded type.

Connectors
Coaxial: F type to IEC 60169-24.

2.6 OUTLETS

General
Outlet type:

- PAL type socket on the front and F type socket on the rear for terrestrial FTA services and down converted satellite services.
- PAL type on the front and F type on the rear for terrestrial FTA services and an F type on the front and on the rear for satellite services.
- F type socket on the rear and on the front for satellite services.
- F type socket on the rear and on the front for cable services.
- PAL type on the front and F type on the rear for terrestrial FTA services and an F type on the front and on the rear for cable services.
- PAL type socket on the front for FM radio services.

Outlet plate: Style, material and colour to match adjacent power and switch plates.

2.7 EXTERNAL COMPONENTS

General
Degree of weather protection: IPX4 to AS 60529.

3 EXECUTION

3.1 GENERAL

Network connection
Requirement: Arrange with the network operator(s) for the connection of their network. Conform to the network operators' requirements.

Free-to-air antennae
Installation: To AS 1417.

Survey: Confirm location and height of Free-to-air (FTA) antenna by on-site measurements.

3.2 DISTRIBUTION EQUIPMENT

General
Enclosure: Locate all active and passive distribution equipment in proprietary purpose built enclosures, located as documented.

3.3 COAXIAL CABLE

General
Standard: To AS/NZS 1367 Appendix H.

Bending radius: Conform to the minimum bending radius manufacturer’s recommendations for the size of cable.

Coaxial cable table

Cables	Conduit (minimum)
2 No. double shielded RG6	20 mm
1 No. RG6 tri or quad shield	25 mm
1 No. double shielded RG11	32 mm

3.4 OUTLETS

Installation
Mounting: Flush mount.

Screening: Fully screen all outlets.

Outlet fly leads
General: Following commissioning of the system, provide 1500 mm fly leads to all outlets.

3.5 TESTING

General
Extent: Test 100% of the system to demonstrate compliance with all documented requirements. Carry out tests required by regulatory authorities and tests necessary to demonstrate compliance with the performance and other requirements of the specification and submit results to the Superintendent. Also include results in the maintenance manuals.

Test and record signal levels of each service at every outlet.

Provide the equipment, apparatus and materials necessary to perform the tests including field strength meter and portable TV receiver.

Where testing or application shows the system to be deficient correct the system and replace components without extra cost to the contract, as necessary to achieve compliance.

Setup: Use locally generated test signals to provide static conditions for level measurements.

Carrier-to-noise measurements: Required.

0971 EMERGENCY EVACUATION LIGHTING

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide single point monitored emergency lighting and exit signs, as documented.

1.2 CROSS REFERENCES

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

1.3 STANDARDS

General
System design, installation and operation: AS 2293.1.

Inspection and maintenance: To AS/NZS 2293.2.

Emergency escape luminaires and exit signs: To AS 2293.3.

1.4 SUBMISSIONS

Operation and maintenance manual
Standard: To AS 2293.1, Section 8.

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

Products and materials
Emergency evacuation lighting: Submit technical data for each type of luminaire and exit sign including the following:

- Maximum luminaire spacing for a given mounting height.
- Luminaire classification to AS 2293.3.

Samples
Emergency evacuation lighting: Submit samples of all luminaires and exit signs.

Shop drawings
General: For each custom-built luminaire and exit sign, submit the following:

- Construction details.
- Overall dimensions.
- Wiring arrangement.

Tests
General: Submit type test data.

2 PRODUCTS

2.1 SINGLE-POINT SYSTEM LUMINAIRES

General
Visual indicator lights: Provide a red indicator, readily visible when the luminaire is in its operating location, which indicates that the battery is being charged.

Inverter system: Provide protection of the inverter system against damage in the event of failure, removal or replacement of the lamp, while in normal operation.

Local test switches: Provide a momentary action test switch, accessible from below the ceiling, on each luminaire to temporarily disconnect the mains supply and connect the battery to the lamp.

Common test switches: Provide a common test switch on the local distribution board which disconnects main supply to the luminaires and tests for discharge performance and automatically reverts to normal operating mode after testing.

Monitored system

Data connection: Provide internal monitoring facilities and provision for the connection of data cabling to a central monitoring computer.

Batteries

Type: Lead-acid or nickel-cadmium batteries capable of operating each lamp at its rated output continuously for at least 2 hours during commissioning tests and 1.5 hours during subsequent tests.

Battery life: At least 3 years when operating under normal conditions at an ambient temperature of between 10ºC and 40°C and subject to charging and discharging at 6 monthly intervals.

Marking: Indelibly mark each battery with its date of manufacture.

2.2 MONITORING SYSTEM

Proprietary systems

General: Provide proprietary systems with full compatibility between the monitoring system, operating software and the luminaries selected.

Testing facilities: Provide automatic and manual testing facilities for testing lamp condition and for battery discharge testing.

Remote monitoring: As documented.

3 EXECUTION

3.1 SINGLE POINT SYSTEM

Power supply

General: Provide an unswitched active supply to each luminaire and exit sign, originating from the test switch control panel.

Data monitoring

General: If a monitoring system is documented, provide a data cable system from each single-point luminaire and connect to the monitoring computer.

Test switch

General: Provide a timed test switch at each distribution board.

Function: To energise emergency lights and exit signs and then to automatically reset controls after a maximum of 2 hours.

3.2 MARKING AND LABELLING

Labelling

General: Label each luminaire with a unique identifying number. Provide a label which is permanently fixed, indelible and readable at a distance of 1 m. ***Numbering shall match other exit and emergency lighting labelling used for the site, otherwise provide new numbering system.*** ***Rev 2017-01***

Emergency evacuation lighting schedule: Record the number and luminaire location in an emergency evacuation lighting schedule included in the operation and maintenance manual.

3.3 MOUNTING

General: Where practical mount exit lights immediately above door head height rather than on ceilings. Refer AS 2293 re requirements for mounting heights. ***Rev 2017-01***

3.4 TESTS

General

Requirement: Carry out tests, including out-of-hours tests, to demonstrate the emergency and evacuation system's performance. Include the following:

- Test components for correct function and operation.

- Demonstrate illumination performance on site, to at least the level stated in the manufacturer's recommendations for performance for that device.
- Test operation of battery discharge test and control test switch functions, including discharge and restoration.
- Demonstrate system functions under mains fail condition.
- Demonstrate operation of the battery and charger including a full discharge/recharge over the designated time.

Complete all tests to prove the system is operating correctly as required by the Australian Standards and provide test certificates as required. During the defects liability period and maintenance period, carry out testing of exit and emergency lighting in accordance with AS 2293.

Where the defects liability and maintenance period is for six (6) months, carry out the 6 monthly testing at the end of the period. Where the defects liability and maintenance period is for twelve (12) months, carry out both 6 monthly tests and 12 monthly tests.

Provide log books for test results. ***Rev 2017-01***

Mains supply

General: Before commissioning, make sure mains supply has been continuously connected for at least 24 hours.

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.