Electrical standard specification

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General electrical requirements

1 Change Log

Revision	Date	Changes
A	1/03/2013	Initial Draft for Review Workshop 1
В	12/04/2013	SW and Onstream standards content added for review and
		incorporation
С	28/05/2013	SW ETS01, ETS03 and ETS04 incorporated as applicable
D	28/06/2013	Onstream telecommunications standard incorporated as applicable
E	4/07/2013	Workshop 4 Review
F	28/06/2013	Final Review Input
1	30/07/2013	TasWater 1 st Release.

2

General electrical requirements General electrical requirements

2.1 General

Performance

Supply system: 400V, 3-phase, 4-wire, 50 Hz.

Performance criteria: Meet the performance criteria, as documented.

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

Design

Design by contractor: 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.

2.1.1 Precedence

General

Worksections and referenced documents:

- The Electrical scope of works worksection overrides all other Electrical worksections.
- 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 excluding mandatory Australian Standards.
- The requirements of the referenced documents are minimum requirements.

2.1.2 Cross references

Cross referencing styles

Within the text:

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

2.1.3 Standards

General

Electrical services: To Part 2 of AS/NZS 3000 unless otherwise documented.

Electrical systems: To AS/NZS 3008.1.1 and SAA HB 301.

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

EMC: To AS/NZS 61000.

Telecommunications systems: To AS/ACIF S008, AS/ACIF S009, AS/NZS 3080, SAA HB 243 and SAA HB 29.

General electrical requirements

2.1.4 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.

2.1.5 Interpretation

Abbreviations

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

- AS: Australian Standard.
- BCA: Building Code of Australia
- ACMA: Australian Communications and Media Authority
- ACIF: Australian Communications Industry Forum
- EMC: Electromagnetic compatibility.
- MSDS: Material safety data sheets.
- NATA: National Association of Testing Authorities.
- NZS: New Zealand Standard.
- VOC: Volatile organic compound.
- ITP: Inspection and Testing Plan
- ITC: Inspection and Testing Checklist

Definitions

General: For the purposes of this specification, the definitions given below apply.

As a generic technical specification it is beyond the scope of NATSPEC to offer any management system to handle the approval process. Consequently definitions and directions such as 'approved' do not appear within the worksection text. Where appropriate, a prompt is given indicating an approval could be required. The extent of approval responsibilities should take into account the recommendations of the various professional bodies and should be covered in the agreement with the client.

If an approval is required prior to implementation consider nominating a Hold point, to eliminate ambiguity.

To add the definition, the following text may be useful:

- Approved: 'Approved', 'reviewed', 'directed', 'rejected', 'endorsed' and similar expressions mean 'approved (reviewed, directed, rejected, endorsed) in writing by the contract administrator'.
- Attendance: 'Attendance', 'provide attendance' and similar expressions mean 'give assistance for examination and testing'.
- Contract administrator: 'Contract administrator' has the same meaning as 'architect' or 'superintendent' and is the person appointed by the 'owner' or 'principal' 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.

General electrical requirements

- Economic life: The period of time from the acquisition of an asset to 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.
- 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.
- Hold point: The activity cannot proceed without the approval of the contract administrator.
- Hot-dip galvanized: Zinc coated to AS/NZS 4680 after fabrication with coating thickness and mass to AS/NZS 4680 Table 1.
- This applies to galvanizing after fabrication. Galvanized sheet metal and similar materials are covered by the *Metals and prefinishes* worksection.
- IP: 'IP', 'IP code', 'IP rating' and similar expression have the same meaning as 'IP Code' in AS 60529.
- 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.
- Metallic-coated: Steel coated with zinc or aluminium-zinc alloy as follows:
 - Metallic-coated steel sheet: To AS 1397. Metal thicknesses specified are base metal thicknesses.
 - AS 1397 covers a wide range of finishes, coating grades and materials. It is used throughout the building industry for cold-formed sections such as studs, ceiling sections and roofing products. Specifications to AS 1397 should preferably include the base metal thickness and coating designations e.g. '1.6 mm galvanized grade G2 steel with Z275 coating'.
 - Ferrous open sections zinc coated by an in-line process: To AS/NZS 4791.
 - Ferrous hollow sections zinc coated by a continuous or specialised process: To AS/NZS 4792.
- AS/NZS 4791 and AS/NZS 4792 exclude electrogalvanized (zinc plated) steel.
- This definition is based on the wording in the Plumbing Code of Australia (PCA) but expanded to include natural gas. The Network Utility Operator is also commonly known by names like the supply authority, water board etc.
- Network Distributor: Body responsible for the distribution and control of electricity e.g. Aurora.
- Obtain: 'Obtain', 'seek' and similar expressions mean 'obtain (seek) in writing from the contract administrator'.
- Practical completion or Defects free completion: The requirements for these stages of completion are defined in the relevant building contract for the project.
- In some states and territories, additional or alternative criteria may apply e.g. Registered Professional Engineer, Queensland (RPEQ).
- Professional engineer: A person who is listed on the National Professional Engineers Register (NPER) in the relevant discipline at the relevant time.
- Proprietary: 'Proprietary' means identifiable by naming manufacturer, supplier, installer, trade name, brand name, catalogue or reference number.
- Provide: 'Provide' and similar expressions mean 'supply and install' and include development of the design beyond that documented.
- Readily accessible: To AS/NZS 3000.
- Registered testing authority:
 - An organisation registered by the National Association of Testing Authorities (NATA) to test in the relevant field; or
 - An organisation outside 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: Means required by the documents, the local council or statutory authorities.

General electrical requirements

- If required: A conditional specification term for work which may be shown in the documents or is a legislative requirement.
- Samples: Includes samples, prototypes and sample panels.
- Statutory authority: A public sector entity created by legislation, that is, a specific law of the Commonwealth.
- Supply: 'Supply', 'furnish' and similar expressions mean 'supply only'.
- Tests:
- Pre-completion tests: Tests carried out before completion tests.
- Type tests: Tests carried out on an item identical with a production item, before delivery to the site.
- Production tests or Factory Acceptance Test (FAT): Tests carried out on a purchased item, before delivery to the site.
- Progressive tests: Tests carried out during installation to demonstrate performance in according with this specification.
- Site tests or Site Acceptance Test (SAT): Tests carried out on site.
- Completion tests: Tests carried out on completed installations or systems and fully resolved before the date for, to demonstrate that the installation or system, including components, controls and equipment, operates correctly, safely and efficiently, and meets performance and other requirements. The contract administrator may direct that completion tests be carried out after the date for practical completion.
- Tolerance: The permitted difference between the upper limit and the lower limit of dimension, value or quantity.
- Tolerance is an absolute value without a positive or a negative sign. It is commonly expressed by '± permitted deviation' so that the value of the tolerance is implicit.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.
- Witness points: Provides an opportunity to attend an activity but does not involve an obligation. The activity can proceed without approval from the contract administrator.

2.1.6 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.

Levels

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

Drawings and manuals for existing services

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

2.1.7 Inspection

Notice

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

General electrical requirements

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

Minimum notice for inspections to be made and for witnessing of tests: Conform to the Notices schedule.

Attendance

General: Provide attendance for documented inspections and tests.

2.1.8 Submissions

General

Submit to: Superintendent.

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

Program: Allow in the construction program for at least the following times for response to submissions:

- Shop drawings: 2 weeks
- Samples and prototypes: 2 weeks
- Manufacturers' or suppliers' recommendations: 2 weeks
- Product data: 2 weeks
- Product/design substitution or modification: 2 weeks

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

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

Non-compliance: Identify proposals for non-compliance with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

Errors

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

Submissions - electronic copies

File format: PDF and AutoCad DWG \geq 2007.

Transmission medium: Email if ≤ 8Mb otherwise CD/DVD/USB.

Submissions - hard copy

Quantity: 2 bound copies.

- Loose documents larger than A3: One transparency on heavyweight plastic film the same size as the standard contract drawings.
- Loose documents up to and including A3: One copy.

Standard contract drawing size: A3 or A1

Authorities

Authorities' approvals: Submit documents showing approval by the authorities whose requirements apply to the work.

Correspondence: Submit copies of correspondence and notes of meetings with authorities whose requirements apply to the work.

General electrical requirements

Building penetrations

General: If it is proposed to penetrate or fix to the following, submit details of the methods proposed to maintain the required structural, fire and other properties:

- 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.

Certification

General: Where required submit certification that the plant and equipment submitted meets all requirements of the contract documents.

Execution details

General: Before starting the installation, submit the following where not detailed:

- 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.

Inspection and testing

General: Submit an inspection and testing plan (ITP) and inspection and test check lists (ITC) which is consistent with the construction program. Include particulars of test stages and procedures. To be used at FAT's and SAT's.

Test reports: Submit written reports on nominated tests.

Materials and components

Product certification: If products must conform to product certification schemes, submit evidence of conformance.

Product data: For proprietary equipment, submit the manufacturer's product data as follows:

- Technical specifications and drawings.
- Type-test reports.
- Performance and rating tables.
- Recommendations for installation and maintenance.

Substitutions

Identified proprietary items: Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified, but indicates the necessary properties of the item. Alternatives can only be provided on approval by the Superintendent.

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

General electrical requirements

- 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.

Shop drawings

General: Include dimensioned drawings showing details of the fabrication and installation 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 submit dimensioned set-out drawings.

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

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

Submission medium: Electronic.

Drawing size: A3 or A1. Standard: PDF or AutoCad \geq 2007.

Checking: Ensure that the drawings have been checked before submission.

Building work drawings for building services: Submit detailed drawings showing all:

- 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.
- Plinths, kerbs and bases.

Technical data

Submissions: Submit technical data for all items of plant and equipment.

Data to be submitted: Include at least the following information in technical submissions:

- Assumptions.
- Calculations.
- Model name, designation and number.
- Capacity of all system elements.
- Country of origin and manufacture.
- Materials used in the construction.
- Size, including required clearances for installation.
- Certification of compliance with the applicable code or standard.
- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is
 a discrepancy between the two, substantiate the change.

General electrical requirements

- Manufacturers' technical literature.
- Type-test reports.

2.1.9 Cross references

General

Requirement: Conform to the following:

- Preferred equipment schedule.

2.2 Products

2.2.1 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 accordance with the current written recommendations and instructions of the manufacturer or supplier.

Proprietary items/systems/assemblies: Assemble, install or fix to substrate in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Project modifications: Advise of activities that supplement, or are contrary to, manufacturers' or suppliers' written recommendations and instructions.

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

Do not provide the following:

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

2.2.2 Tests

Attendance

General: Provide attendance on tests.

Testing authorities

General: Except for site tests, where nominated have tests carried out by a Registered testing authority and submit test reports.

- Reports: Submit copies of test reports, including certificates for type tests, showing the observations and results of tests and conformance or non-conformance with requirements.
- Site tests: Use instruments calibrated by authorities accredited by a registered testing authority.

2.2.3 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/NZS 2312.

Galvanizing

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

- Exposed to weather.
- Embedded in masonry.
- In contact with chemically treated timber, other than copper chrome arsenate (CCA).

2.3 Execution

General: It is expected that any works carried out as part of the electrical installation will be carried out as a minimum using recognised industry equipment and installation techniques. All equipment / consumables used in the electrical installation shall be fit for purpose and installed in line with the suppliers recommendations to ensure any equipment performance and warranties remain valid. The use of third party equipment and or materials (e.g. silicon) to rectify a short fall in performance of an installation is unacceptable. If a novel, unconventional solution, other than that specified by a supplier is required it shall be documented and supplied to TasWater for a one off approval.

2.3.1 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.

Refer to the TasWater General Contract Preliminaries for additional requirements on the handling and removal from site of hazardous materials such as, but not limited to, asbestos.

Existing electrical systems

Condition of existing systems:

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

2.3.2 Cable systems

General

Systems: Provide the following:

- Inaccessible concealed spaces: Cable in UPVC conduit.

General electrical requirements

- Face, plastered or rendered masonry surfaces: Cable in UPVC conduit.
- Walls filled with bulk thermal insulation: Cables in PVC conduit.
- Plant rooms: Cable in heavy duty UPVC conduit, or on tray or ladder or in duct.
- High presentation areas such as offices or control rooms: All cabling to be concealed behind wall finishes.

2.3.3 Installation

Installation of electrical accessories

Location: Confirm final location of all outlets and equipment on site prior to installation.

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

Default mounting heights to centre of accessory plate:

- Outlets: 600 mm.
- Switches and controls: 1100 mm.
- Above bench: 150mm above finished surface.

Flush mounting: Provide flush mounted accessories 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.

2.3.4 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.

Items of electrical equipment shall be rigidly secured in their respective positions using fixtures provided with the equipment, or as otherwise specified. Electrical equipment mounted on concrete surfaces shall be secured by means of approved anchors.

Uncoated steel bolts, screws etc shall not be used to affix electrical equipment in the following areas:

- (1) outdoor areas,
- (2) indoor situations which may be reasonably expected to be subjected to dampness
- (3) areas having atmospheres which may contain substances which would be corrosive to mild steel.

Materials which may be satisfactory depending on the environment include hot- dip galvanised steel, brass or stainless steel.

Electrical equipment shall only be attached to structural steelwork, concrete reservoirs or water tanks with the approval of TasWater's Representative and then only in the locations and with the method of attachment approved.

If approval for welding to the structural steelwork is given, such welding shall be in accordance with AS 1554.1. All finished welds shall have all slag removed by chipping and wire brushing and shall be ground if necessary.

General electrical requirements

For galvanised and zinc coated steelwork, the mounting brackets and weld areas shall be cleaned by abrading till bright steel is exposed. Two coats of zinc rich paint complying with GPC-P-14/1 such as Wattyl Galvit E90LV or Solver Zinc Rich Metal Primer shall be applied. For all other coated steelwork the coating system shall be the same as and match that originally applied.

Fasteners

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

2.3.5 Services installation

General

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: Join dissimilar metals with fittings of electrolytically compatible material.

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

2.3.6 Service Trenching

Standards Earthworks: To AS 3798.

Inspection

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

- Service trenches excavated before laying the service.
- Services laid in trenches and ready for backfilling.

Offsite disposal

Disposal location: Submit the locations and evidence of compliance with the relevant authorities for the disposal of material required to be removed from the site.

Existing services

Requirement: Before commencing service trenching, locate and mark existing underground services in the areas which will be affected by the service trenching operations. A registered cable locator shall be utilised.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

General electrical requirements

Existing surfaces

Concrete and asphalt pavements: Saw cut trench set out lines for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt pavement material between the trench set out lines, remove and dispose of off-site.

Segmental paving units: Removal: Take up segmental paving units both full and cut by hand, between the trench set out lines, and neatly stack on wooden pallets.

Concrete edging: Break out, remove and dispose of off-site.

Concrete sub base: If present, saw cut along the trench set out lines.

Grass: Neatly cut grass turf between trench set out lines into 300 mm squares. If the grass is suitable for re-use, take up and store the turf and water during the storage period, otherwise remove and dispose of it off-site.

Open Ground: In open ground, organic topsoil shall be stripped to a minimum depth of 150 mm and stockpiled for use in reinstating the surface of the trench.

Small plants, shrubs and trees: The Contractor shall not damage any trees or shrubs which are required to remain inside or outside the working area Storage: If required for re-planting, take up small plants and store. Wrap the root ball in a hessian or plastic bag with drain holes and water during the storage period.

Unsuitable vegetation: Remove and dispose of off-site.

Excavation

General: Do not excavate by machine within 1 m of existing underground services.

General: Excavate for underground services in conformance with the following:

- To required lines and levels, with uniform grades.
- Straight between access chambers, inspection points and junctions.
- With stable sides.

Trench depths

General: As required by the relevant service standard and its bedding method.

Adjacent to footings: If excavation is necessary below the zone of influence of the underside of adjacent footings, give notice, and provide support for the footings as instructed.

Obstructions: Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Dewatering: Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water. Pumping: Provide pump-out from adjacent sumps or install well points.

Unsuitable material: Remove unsuitable material from the bottom of the trench and dispose of off-site.

Backfill

Timing: Backfill service trenches as soon as possible after laying and bedding the service, if possible on the same working day.

Marking services: Underground marking tape to AS/NZS 2648.1.

General electrical requirements

Backfill material: Selected material free from stones larger than 19 mm. Backfill material to be placed in layers not exceeding 300mm in depth and each layer suitably compacted to prevent long term settlement.

Surface restoration

Pathways and paved areas generally: Provide material consistent with the surface existing before commencement of the works.

Concrete surfaces: Material: 25 MPa concrete. Surface finish and pattern: Match existing adjoining work. Minimum thickness: 75 mm or the adjacent pavement thickness, whichever is thicker. Reinforcement and dowels: If required, provide steel reinforcement with dowels into the adjacent concrete. Expansion joints: 15 mm thick preformed jointing material of bituminous fibreboard placed where new concrete abuts existing concrete and in line with joints in existing concrete. Control joints: Form control joints strictly in line with the control joints in existing concrete. Around electricity supply poles: Terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Asphalt footpaths: Match the adjoining footpath thickness. Finish: Compact to a smooth even surface.

Segmental paving units: Re-lay to match the pattern and surface levels of the existing paving. Replace damaged paving units which are unsuitable for relaying with new units of the same material, type, size and colour as the existing.

Landscaped areas: In topsoil areas: Complete the backfilling with topsoil for at least the top 100 mm.

Lawn: Re-lay stockpiled turf. If existing turf is no longer viable, re-sow the lawn over the trench and other disturbed areas.

Planted areas: Overfill to allow for settlement.

2.3.7 Building penetrations

Penetrations

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

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

2.3.8 Support and structures

General

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

2.3.9 Plant and equipment access

General

Services and equipment: Locate and arrange all services and equipment so that:

- They comply with the relevant requirements of the appropriate Occupational Health and Safety regulations.
- Services and equipment are readily accessible for inspection and maintenance and arranged so that inspection and maintenance can be carried out in a safe and efficient manner. Include the following:
 - Conform to the relevant requirements of AS 1470, AS 1657, AS/NZS 1892.1, AS 2865 and AS/NZS 3666.1.
 - The need to comply with these standards will depend on design decisions, for example the location of plant requiring elevated platforms and ladders to AS 1657 or the creation of confined spaces to AS 2865 (see clause 1.5.5 for the definition of a confined space). A

General electrical requirements

preferable solution is for the designer to avoid, or at least minimise, the need for these and for the contractor to do likewise.

- Minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- Locate plant requiring regular inspection and maintenance so it is either safely and readily accessible from floor level or provide permanent access platforms and ladders.
- In false ceilings, locate items of equipment that require inspection and 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.

2.3.10 Switchboard and Electrical Cubicle Installation

General

Switchboards and cubicles housing electrical equipment shall be installed in line with the requirements of the current version of AS/NZS 3000. In particular the switchroom shall be designed to provide the correct surroundings and safety for the switchboard as required by AS/NZS 3000.

Once the switchboard arrives on site it shall moved into position using only the method specified by the switchboard supplier. Any other method of movement shall be at the risk of the electrical contractor.

Where provision has been made on the switchboard or cubicle for lifting purposes, the Contractor shall use this provision whenever lifting is required.

Switchboards and cubicles shall be fastened to the floor or wall as appropriate by means of bolts screwed into masonry anchors. All anchors and bolts used on external cubicles shall be hot-dip galvanised or 316 stainless steel (as specified).

Outdoor switchboards and cubicles, where possible, shall be positioned such that no openings are facing the prevailing weather.

At the completion of the mechanical installation of switchboards and cubicles and prior to any electrical connections being made, all mechanical and all electrical connections shall be checked for tightness and recorded. Mechanical checks shall include for tightness of bolts holding switchboard or cubicle sections together, tightness of busbar supports and tightness of mountings of circuit breakers, composite fuse switch units, isolators and switches, fuse bases, contactors and relays. Electrical checks shall include joints in busbars and all wiring terminations. Covers shall be removed as required for these checks and shall be replaced and secured immediately after checking of connections is completed.

Any damage to painted surfaces at the completion of installation shall be reinstated. Damaged or scratched surfaces on stainless steel cubicles shall be repaired or replaced to the satisfaction of TasWater Representative.

The Contractor shall maintain the degree of vermin proofing as specified for the IP rating (including around and under the mounting plinths).

All cables entering the switchboard shall be via gland plates with correctly sized glands for each cable.

When the electrical installation around the switchboard is finished all covers etc shall be replaced to ensure the IP rating of the switchboard is maintained.

The switchboard shall be completely cleaned out of all swarf, paper, tape, cable ties, nuts, bolts, washers, documentation etc

All cables and wires shall be correctly installed in cable management systems and all covers of such replaced.

General electrical requirements

2.3.11 Motor Field Isolator Installation

General

Motor Field Isolators shall be provided, as a minimum, for all motors greater than 10A, single phase and for all 3 phase motors.

All isolators shall be positioned to ensure it can be clearly identified which motor they will isolate when operated. In addition consideration shall be given to minimising their exposure to weather but this should not compromise the identification of which isolator will isolate which motor.

2.3.12 Field Equipment Installation

General

All field equipment shall be positioned to minimise its exposure to harsh environments including the sun but at the same time positioned in an operable/ maintainable position.

All Instruments positioned outside shall be correctly IP rated and provided with weather protection consisting of a hood which prevents direct sun and rain exposure. Access to the instrument must not require a tool to remove this protection. In addition it shall be easily possible to view any instrument display in full sunlight.

Protection from the elements may consist of a weather cover which covers a number of pieces of equipment.

2.3.13 Power Factor and Harmonic Distortion

General

The power factor of, and harmonic distortion caused by, the completed electrical installation shall not exceed the limits specified in the electricity supplier's service and installation rules. Power factor correction equipment and additional harmonic filters shall be provided if required to comply with the specified limits.

2.3.14 Lightning and Transient Overvoltage Protection

General

Where required by the project specification, lightning protection of persons and buildings shall be provided in accordance with AS/NZS 1768.

Irrespective of the requirements of lightning protection of persons and buildings, all voltage sensitive equipment such as instrumentation, radios etc. which is directly connected via cabling external to the main facility shall be provided with secondary protection against damage by transient and lightning induced overvoltages in accordance with AS/NZS 1768. Refer to standard drawing - TBA

2.3.15 Marking and labelling

General

General: Mark services and equipment to provide a ready means of identification and as follows:

- Locations exposed to weather: Provide durable materials.
- Cables: Label to indicate the origin and destination of the cable.

All indoor and outdoor equipment including pumps, valves, instrumentation etc. shall be labelled with engraved traffolyte labels in line with the asset number and function (e.g. Raw Water Pump 1 SS101-PU01). These labels are to be permanently fixed with stainless steel fixings on a position next to the piece of equipment, not on the equipment itself.

Where applicable, the location of the main switchroom shall be clearly identified by a permanent sign on the entrance door or at the fire indicator board in accordance with AS/NZS 3000.

General electrical requirements

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

Electrical accessories

General: Label isolating switches and outlets to identify circuit origin.

Equipment concealed in ceilings

Location: Provide a label on the ceiling indicating the location.

Underground services

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

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

Location marking: Accurately mark the location of underground cables 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 250 mm below ground level.

Labels and notices

Materials: Select from the following:

- For indoor applications only, engraved two-colour laminated plastic.
- Stainless steel or brass \geq 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.

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.

General electrical requirements

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

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: \geq 10 mm for main heading, \geq 5 mm for remainder.
- Equipment labels within cabinets: \geq 3.5 mm.
- Equipment nameplates: \geq 40 mm.
- Identifying labels on outside of cabinets: \geq 5 mm.
- Isolating switches: \geq 5 mm.
- Switchboards, main assembly designation: ≥ 25 mm.
- Switchboards, outgoing functional units: ≥ 8 mm.
- Switchboards, sub assembly designations: \geq 15 mm.
- Other locations: \geq 3 mm.

Operable devices: Mark to provide a ready means of identification. Include the following:

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

Vapour barriers: Do not penetrate vapour barriers.

2.3.16 Warranties

General

General: If a warranty is documented or if a manufacturer's standard warranty extends beyond the end of the defects liability period, name the principal as warrantee. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Commencement: Commence warranty periods at practical completion or at acceptance of installation, if acceptance is not concurrent with practical completion.

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.

2.3.17 Record drawings

General

General: Submit record drawings. Show the 'as installed' locations of elements, plant and equipment. Show offthe-grid dimensions where applicable.

Shop drawings: Submit all documented shop drawings, including 'as installed' amendments.

Services: Show dimensions, types and location of the services in relation to permanent site features and other underground services. Show the spatial relationship to building structure and other services. Include all changes made during commissioning and the maintenance period.

Services below ground or concealed: If services and fittings are below ground or concealed, show the depth and dimensioned references that will allow the future location of the service for maintenance or expansion.

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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.

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

- Controls.
- Principal items of equipment.
- Single line wiring diagrams.
- Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.
- Wire and cable numbering.

Accuracy

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

Documents: Incorporate all modifications made during the progress of the work and testing period. Show any provisions for the future.

Endorsement: Sign and date all record drawings.

Drawing layout

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

Quantity and format

General: Conform to **SUBMISSIONS.**

Date for submission

General: Not later than 2 weeks after the date of practical completion.

2.3.18 Operation and maintenance manuals

General

General: Submit operation and maintenance manuals for the whole of the work.

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

General: Include the following:

- Table of contents: For each volume. Title to match cover.
- Directory: Names, addresses, and telephone and facsimile numbers of principal consultant, subconsultants, contractor, subcontractors and names of responsible parties.
- Complete set of electrical as-built documents including electrical schematics, cable schedules, termination drawings, equipment schedules, plc /RTU I/O listings
- Full set of site testing sheets showing which tests have been carried out and a signature confirming the test result was accepted.

General electrical requirements

- All documentation associated with acceptance of installation by Aurora energy.
- Record drawings: Complete set of record drawings, full size.
- Drawings and technical data: As necessary for the efficient operation and maintenance of the installation.
- 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.
- System software on CD/DVD for any items not contained in the Electrical Preferred Equipment Schedule.
- 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.
 - 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
 - Control system testing and commissioning results (this permits calibration and drift to be checked and tracked).
 - 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 or functional description for systems installed.
 - Schedules of fixed and variable equipment settings established during commissioning and maintenance.
- Maintenance procedures:
 - Detailed recommendations for preventative 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, 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.

Format – electronic copies

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

General electrical requirements

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

Quantity and format: Conform to **Submissions – electronic copies**.

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

Date for draft submission: The earlier of the following:

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

Date for final submission: Within 2 weeks after practical completion.

2.3.19 Commissioning and completion tests

General

FAT and SAT tests shall be completed with a nominated representative of the Principal present for all Switchboards, Control Panels and PLC/RTU Panels.

Prior to FAT and SAT tests provide evidence that pre FAT and SAT tests have been successfully completed.

At the completion of the installation or at the completion of agreed subsections of the work, the Contractor shall, in the presence of TasWater's Representative (or his nominated Inspecting Officer) conduct FAT's and SAT's on all equipment which has been supplied and/or installed as part of the Contract. The tests shall demonstrate to the satisfaction of TasWater's Representative that the installation is in accordance with the specified requirements and that the installation operates correctly.

Unless otherwise specified, equipment which has been satisfactorily performance tested or witness tested in the manufacturer's works need not be site tested except to:

- (1) check the installation and interconnections,
- (2) check for any damage or deterioration which may have occurred since the works tests and
- (3) demonstrate that the system functions in accordance with the project specification.

The provision of all necessary equipment for testing shall be the responsibility of the Contractor. All test instruments shall have current calibration certificates, if applicable, and all certificates shall be made available

General electrical requirements

for checking by the Inspecting Officer before testing commences.

All adjustable parameters shall be properly setup and recorded for each equipment or device and the record submitted to TasWater's Representative at the completion of the tests. Devices which cannot be adjusted (eg miniature circuit breakers) shall not have calibration tests performed.

Site tests shall be carried out in accordance with the relevant Standards and shall include the following where applicable:

- Insulation resistance
- Earth resistance
- Earth fault loop impedance
- Continuity
- Polarity
- Calibration checks
- Control sequencing
- Functional test

Testing shall demonstrate the integrity and correct operation of the system including protective devices and remote operations, indications and controls.

Equipment which:

- (1) is connected via a flexible power supply cord and plug and
- (2) comes under the scope of AS/NZS 3760 and
- (3) is provided by the Contractor

shall be inspected and tested in accordance with AS/NZS 3760 prior to being placed in service.

Power Factor and Harmonic Distortion

The power factor of, and harmonic distortion caused by, the complete installation shall be measured to check compliance with any specified limits.

Reports

General: Submit completed ITC's indicating observations and results of tests and compliance or non-compliance with requirements.

The results of all witnessed FAT's and SAT's shall be neatly and legibly recorded during the progress of the tests on the approved test sheets. A copy of the test sheets, co-signed by the Contractor and the Inspecting Officer, shall be handed to the Inspecting Officer on completion of the tests.

Notice

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

The Contractor shall give TasWater's Representative not less than ten (10) working days notice of his intention to undertake the tests.

At the same time or earlier the Contractor shall:

- (1) submit three (3) copies of the latest drawings and PLC program listings for the equipment to be tested where applicable and
- (2) submit for approval by TasWater's Representative two (2) copies of the proposed testing procedure and test sheets. Testing shall not commence until TasWater's
General electrical requirements Representative has approved the testing procedure and test sheets.

Controls

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

The sequencing of control circuits etc shall be checked against the control schematic drawings and not against the formalised test sheets. The test sheets shall state that the circuits were tested against the drawings and list any defects.

Circuit protection

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

Fixed residual current devices shall be tested before being placed into service to ensure that:

- (1) the tripping current is set to the appropriate value and
- (2) the unit trips in less than 40 milliseconds at a test current of 10 mA for a Type I device or in less than 300 milliseconds at a test current of 30 mA for a Type II device.

Protective units, relays etc which allow current injection or similar to check their settings shall, during testing, have each function tested and calibrated.

Units which may be adjusted (e.g. thermal overload relays) shall be adjusted to the appropriate settings in accordance with the manufacturer's written instructions. To test the accuracy of the settings, a maximum of one from each style and size of units or 5% of the total, whichever is the greater, shall be calibrated. All units shall be calibrated if the tests indicate that the settings are inaccurate and that the associated equipment is inadequately protected.

Completion tests

General: Test the works under the contract to demonstrate compliance 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.

Proprietary equipment: Submit type test reports confirming compliance of proprietary equipment.

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

Certification

General: On satisfactory completion of the installation and before the date of practical completion, submit certificates stating that each installation is operating correctly.

2.3.20 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.

General electrical requirements

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.

2.3.21 Periodic maintenance of services

General

General: 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 nominated 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 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.

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

2.4 Selections

2.4.1 Schedules

Notices schedule

Item	Minimum notice
All inspections	Minimum 5 working days unless a greater value is otherwise
	documented.

Cable support and duct systems **Cable support and duct systems**

3.1 General

3.1.1 Responsibilities

General

General: Provide cable support systems as documented.

Cable support & Protection Systems are to be designed and installed to minimise cost but at the same time provide room for future expansion

In general cables shall not be run using any other support structures such as building structural elements unless the method of support is approved by TasWater.

Cable support systems such as galvanised cable ladder, galvanised conduit and galvanised cable tray where appropriate are to be used.

PVC conduit systems may be used where not exposed to weather.

Protection of cabling at low level shall be suitable for the level of damage which could be reasonably expected (e.g. if brush cutters can be expected to be used at that point, the protection shall be substantial –such as galvanised steel top hat section and not just a plastic conduit).

3.1.2 Cross references

General

Requirement: Conform to the following:

- General electrical requirements.
- Preferred equipment schedule.

3.1.3 Submissions

Shop drawings

General: Submit shop drawings showing the following:

- Cable tray/ladder routes.
- Layout of cable supports and enclosures on the current 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.

Technical data

General: Submit technical data for the following:

- Cable support systems.
- Proprietary pits.
- Load calculations for aerial cable supports.

Cable support and duct systems

3.2 Products

3.2.1 Conduits

General

Standards: AS/NZS 2053.1, AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5, AS/NZS 2053.6, AS/NZS 2053.7 and AS/NZS 2053.8.

Telstra services: Those conduits connected to Telstra services to be Telstra approved.

Sizes

Conduits: \geq 20 mm.

Underground: \geq 50 mm.

Conduits for telecommunications: \geq 25 mm.

Conduits shall not be overfilled and the following shall not be exceeded:

Single cable	Cable cross sectional area < 50% conduit bore cross sectional area.
Two cables	Combined cable cross sectional area < 33% conduit bore cross sectional area.
Three or more cables	Combined cable cross sectional area < 40% conduit bore cross sectional area.

Fixings

Saddles: Double sided fixed. In outdoor locations, fasteners shall be made of brass, stainless steel, hot-dip galvanised or other approved corrosion resistant material. Electroplated zinc fasteners may be used for indoor locations only.

Colour

Conduits for telecommunications systems: White.

Underground conduits for LV/ELV systems: Orange (Heavy Duty).

Above ground conduits for LV/ELV systems: Grey (Medium Duty) or where exposed to UV light, Grey (Heavy Duty) UV stabilised.

Galvanized water pipe

Medium or heavy: To AS 1074.

3.2.2 Metallic conduits and fittings

General

Standards: To AS/NZS 2053.7 or AS/NZS 2053.8.

Type General: Screwed steel.

Fixings

Saddles:

- Internal: Zinc plated.
- External: Hot-dipped galvanized.

Cable support and duct systems

Corrosion protection

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

3.2.3 Non-metallic conduits and fittings

General

Standards: Non-metallic conduits and fittings: AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5 or AS/NZS 2053.6.

Solar radiation protection: Required for conduits and fittings exposed to sunlight.

Flexible conduit

General: Provide flexible conduit to connect with equipment and plant subjected to vibration. If necessary, provide for adjustment or ease of maintenance. Provide the minimum possible length.

Associated fittings

Type: The same type and material as the conduit.

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

Inspection fittings

General: Provide inspection-type fittings only in accessible locations and where exposed to view.

Joints

Type: Cemented or snap-on joints.

3.2.4 Cable tray/ladder support systems

General

System: Provide a complete cable support system consisting of trays or ladders and including brackets, fixings and accessories.

Selection: Run cables < 13 mm diameter on cable tray or ladder.

Standard: NEMA VE-1.

Type tests: To NEMA VE-1.

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

Selection: Select cable tray/ladder in conjunction with support system installation to achieve the documented loading and deflection requirements.

Spare capacity: \geq 50%.

Support: To match cable tray or ladder installed.

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

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

Covers: Provide ventilated flat covers to cable trays/ladders installed in accessible locations.

Cable support and duct systems

3.2.5 Cable pits

General

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

Cable pits shall be provided for all underground conduit runs where:

- the conduits change direction
- at intervals of not exceeding 50 m in straight runs
- at entry points outside buildings where there is a possibility of water head build up causing water to enter the building directly through the conduits

Cable pits shall be sized to the maximum size cable to ensure cables to not exceed their minimum bending radius when installed. The pit shall size shall also take into account the total number of cables entering and leaving the pit.

Proprietary cable pits

Pits \leq 1200 x 1200 mm: Provide proprietary concrete or polymer moulded pits.

In situ construction

Pits > 1200 x 1200 mm: Provide either:

- 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.

Cable pits in footpaths or where there is no vehicle traffic shall be provided with covers equivalent to Gatic light duty category.

Cable pits located where there is vehicle traffic (or loading) shall be provided with covers equivalent to Gatic heavy duty category.

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 if sub soil is not suitable for drainage.

Absorption trenches: Minimum size 300 x 300 x 2000 mm.

3.2.6 Power poles

General Material: Hardwood.

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

Desian

Cable support and duct systems

General: Provide poles designed, manufactured and tested by a specialist manufacturer.

Standards: To Network Distributor standards and service and installation rules.

Footings: Provide footings 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.

Hardwood poles

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.

Treatment: Provide termite and fungus treatment to 600 mm above ground level.

Hardwood crossarms

Material: 75 x 75 x 1500 mm minimum hardwood.

Fixing: Securely fix to pole with M20 galvanized bolts, nuts and washers.

Bracing: Provide two 5 x 40 x 690 mm galvanized steel fixed at 45 degrees to the pole below the cross arm with M12 x 75 galvanized coach screws in the pole and M12 galvanized bolts, nuts and washers in the crossarms.

Construction

General: Hot-dip galvanize columns and fittings after fabrication.

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

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.

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

Finish: Paint, colour as documented.

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 \geq 3 m above ground level.

Electrical connections: Provide a recess fitted with a flush mounted 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.

3.3 Execution

3.3.1 Communications Cabling Support Systems – installation

All communication cabling shall be run using approved support systems, for example cable tray, Catenary wire or J Hooks. Cables shall not be laid on ceiling tiles.

Cable support and duct systems

3.3.2 Conduit systems – installation

General

Where conduit is used, either PVC or galvanised, each piece of conduit shall be open ended where the cable(s) are entering or leaving the conduit. The edges of the conduit conduit shall be protected to prevent damage to the cable.

Under no circumstances shall the conduit be glanded into equipment directly including junction boxes, elbows etc. The cable shall emerge from the conduit and then be individually glanded into equipment, enclosures etc. from underneath.

Conduits shall be saddled as required by the manufacturers instructions with never less than 3 saddles. Conduit saddles and clips shall be secured using approved fasteners.

Approval shall be obtained from the TasWater Representative before any holes are drilled in any structural steelwork. Conduit saddles which are attached to steelwork shall be fixed in the approved locations only and shall be fixed by means of metal thread screws either screwed into drilled and tapped holes in the steelwork or fitted to drilled clearance holes in the steelwork and fitted with nuts and lock washers.

Conduit saddles shall not be attached to pipework.

Conduit shall, wherever possible, be run in horizontal or vertical planes, shall be grouped and generally be as inconspicuous as possible. Where conduits are required to run adjacent to non-planar surfaces, the conduits shall be shaped to closely follow the surface on which they are to run.

All conduits shall be installed with a polypropylene draw cord in place to facilitate the drawing in of cables. A draw cord shall also be left in place for future use after the cables have been drawn in.

In above ground situations adequate provision shall be made to allow the conduits to expand and contract with temperature.

Rigid conduits shall not connect directly to vibrating equipment. A short length of flexible conduit shall be provided for such connections. These conduits shall be installed in accordance with AS/NZS 3000.

Spare Capacity: Install adequate numbers and sizes of conduits to provide 50% spare capacity for all underground conduit installations. This 50% spare capacity shall take into account the cable manufacturer's recommendations for the maximum number of cables to be installed in a single conduit.

Set out

General: If exposed to view, install conduits in parallel runs with right angle changes of direction.

Bends

General: Install conduits with the equivalent of \leq 2 right angled bends per cable draw-in run. Conduit systems shall use proprietary bends and not be cut and joined to provide a change of direction.

Conduits in roof spaces

General: Locate below sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

Inspection fittings

General: Locate in accessible positions.

Draw cords

General: Provide 5 mm polypropylene draw cords in all conduits.

Cable support and duct systems

Draw-in boxes

General: Provide draw-in boxes as follows:

- In straight runs > 50m: Spacing \leq 50 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: Provide straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings.

Routes

General: Run embedded in floor slabs or installed in inaccessible locations directly between points of termination, minimising the number of sets. Do not provide inspection fittings.

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. Space parallel conduits \geq 50 mm apart.

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

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

3.3.3 Cable tray/ladder support systems – installation

General

Standard: To NEMA VE-2.

Design: Support cable trays/ladders to achieve the following:

- Concealed trays/ladders: Support spacing ≤ length of tray/ladder section.
- Visible trays/ladders: Loaded deflection \leq span/350.

Trays and ladders shall be run horizontally or vertically and parallel with the walls, floor or pipework as applicable and shall be shaped to generally follow the surfaces along which the trays and ladders are run.

Brackets shall be secured by a system approved by TasWater's Representative. The cable trays and ladders shall be supported at not greater than the manufacturer's recommended intervals.

Cable trays and ladders shall be separate from and not attached to pipework.

Cover plates shall be provided to:

- protect the cables against mechanical damage where the cable trays or ladders are installed across areas in which personnel or machinery access or the like is probable,
- protect the cables against damage by sunlight,
- reduce the effect of heat gain from solar radiation which may affect the cable current rating or;
- where specified or shown on the drawings.

Cable support and duct systems

Where cable trays or ladders are installed outdoors, any damaged surfaces shall be reinstated using zinc rich primer complying with GPC-P-14/1 such as Wattyl Galvit E90LV or Solver Zinc Rich Metal Primer. Two coats shall be applied to clean, rust free surfaces.

Fixing to building structure

General: Fix supports to the building structure or fabric by means of ≥ 8 mm threaded rod hangers attached to hot-dipped galvanized U-brackets, or by means of proprietary brackets.

Cable fixing

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

Bend radius

General: Provide bends with an inside radius \geq 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.

Earthing

General: Earth cable trays to electrical system protective earth. Provide earth bonding conductors via bolted ringlug connections between cable tray sections which are not bolted together and electrically continuous. Cable tray earth bonding conductors to be at least 6mm² or equivalent to the largest earth conductor associated with any circuit carried on the cable tray (whichever is the larger).

Access

General: Locate trays and ladders to provide \geq 150 mm free space above and \geq 600 mm free space on at least one side.

Clearances

From hot water pipes: > 200 mm.

From boilers or furnaces: > 500 mm.

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

3.3.4 Cables in trenches – installation

Sand bed and surround

General: Provide clean sharp sand \geq 150 mm above and below cables and conduits installed underground and \geq 50mm between the outside cables or conduits and the trench wall)

Sealing ducts and conduits

General: Seal buried entries to ducts and conduits with waterproof seals. Seal spare ducts and conduits immediately after installation. Seal other ducts and conduits after cable installation.

3.3.5 Power poles – installation

General

Standards: To the Network Distributors standards and service and installation rules. Shall be suited to the project environment and for the selected aerial arrangement.

Cable support and duct systems

3.4 Selections

3.4.1 Wiring enclosures and cable support systems

Cable trays/ladders schedule

Туре	
Material	Fibreglass in atmospheric corrosivity category's E-E and E-M as defined in AS/NZS 2312. Hot dipped galvanised in other areas.
Spare space	≥ 50%

Low and extra low voltage power systems 4 Low and extra low voltage power systems

4.1 General

4.1.1 Responsibilities

General

General: Provide low voltage and extra low voltage power systems as documented.

4.1.2 System description

Network supply

General: Liaise with the Network Distributor and provide network connection as documented. Submit the necessary notice to the Network Distributor.

Programme: Schedule the works and statutory inspections to suit the construction programme.

Prospective fault current: Determine, from the electricity distributor, the prospective fault current and fault protection requirements.

Embedded generator supplies

General: Provide embedded generator supplies as documented.

Distribution system

General: Provide power distribution system elements as documented.

Metering

Retail: Provide metering to the requirements of the principal, the selected electricity retailer and the network distributor.

Private: Provide private metering as documented.

Design

Design responsibilities: Conform to the definition of 'provide' in interpretations.

Design parameters: As documented. Calculated values from design contained in design schedule.

Fault protection: Automatic disconnection to AS/NZS 3000 clause 2.4.

Maximum demand: Calculation method to AS/NZS 3000 Appendix C.

Surge protection devices (SPD)

General: Provide surge protection as documented.

4.1.3 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.
- General electrical requirements.
- Preferred equipment schedule.

Low and extra low voltage power systems

- Cable support and duct systems.

4.1.4 Standards

General

General: To SAA HB 301, AS/NZS 3000.

Electrical equipment: To AS/NZS 3100.

Fire and mechanical performance classification: To AS/NZS 3013.

Selection of cables: To AS/NZS 3008.1.1.

Distribution cables: To AS/NZS 4961.

Testing Standard: To AS/NZS 3017.

4.1.5 Interpretations

Abbreviations

General: For the purposes of this worksection the abbreviations given below apply.

- RCD: Residual current device
- SPD: Surge protection device.
- MEN: Multiple earthed neutral.
- ELV: Extra low voltage.
- LV: Low voltage.
- HV: High voltage.

Definitions

Embedded generator: Electricity generator.

Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.

Low-voltage: Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.

High voltage: Exceeding low-voltage.

4.1.6 Submissions

Samples

General: Submit samples of all visible accessories and equipment, except where items have been specified by product brand and part number.

Technical data

General: 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.

Low and extra low voltage power systems

- 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.
- Certify compliance with AS/NZS 3000, for electrical services.
- Include the following as appropriate:
- Touch potential calculations.
- Touch potential automatic disconnection times.
- Stringing calculations for aerial cables.

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

Drawings

General: Submit drawings of the following:

- Cable routes.

Tests

On-site tests: Submit results as follows:

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

4.2 Products

4.2.1 Wiring systems

General

Selection: Provide wiring systems appropriate to the installation conditions and the function of the load.

4.2.2 Power cables

Standard

Polymeric insulated cables: To AS/NZS 5000.1.

Aerial cables: To AS 1746.

Cable

General: Select multi-stranded copper cable generally. Use insulated and sheathed "Orange Circular" cables unless otherwise specified.

VSD power cabling to include suitable RFI screening.

Default insulation: V-75.

Default sheathing: V-75.

Minimum size: Conform to the following:

- Extra low voltage circuits: 1mm² with 32/0.2 stranding.
- Lighting sub-circuits: 1.5 mm².

Low and extra low voltage power systems

- Power sub-circuits: 2.5 mm².
- Sub-mains: 6 mm².

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

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

Distribution cables: To AS/NZS 4961.

Colours

Cables: For fixed wiring, provide coloured conductor insulation. If this is not practicable, slide at least 150 mm of close fitting coloured sleeving on to each conductor at the termination points.

Active conductors in single phase circuits: Red.

Active conductors in polyphase circuits:

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

4.2.3 Instrumentation cabling

Digital I/O cabling from transmitters to I/O module: Overall screened (0.5mm² minimum conductor size)

Analogue I/O cabling from transmitters to I/O module: Individually screened pairs (0.5mm² minimum conductor size).

Separate Analogue and Digital signal cables.

4.2.4 Accessories

General Selections: Provide accessories, as documented.

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

Socket outlets

Standard:

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

Plastic switched socket outlets

Type: Integral switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

Low and extra low voltage power systems Pin arrangement: Mount outlets with the earth pins at the 6 o'clock position.

Mounting configuration: Horizontal.

Weatherproof socket outlets Type: Integral switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: Grey.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Combined RCD switched socket outlets

Type: Integral RCD unit with double switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

RCD trip current: 30 mA Type II to AS/NZS 3190. Alternatively provide 10 mA Type I to AS/NZS 3190 as documented in the project documents.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

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.

Current rating: 10 A.

Socket outlet switches: Required.

Pin arrangement: Mount outlets with the earth pins at the 6 o'clock position.

Plugs – 230 volt

General: Provide plugs with integral pins of the insulated type to AS/NZS 3112.

230 volt combination switch and permanently connected cord outlet Type: Three terminal flush mounted switch and flex-lock insert assembly.

Material: High impact plastic.

Size: Standard single gang.

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Low and extra low voltage power systems

Colour: White electrical.

Current rating: 10 A.

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

Mounting configuration: Horizontal.

Installation couplers Standard: to AS/NZS 61535.

Permanently connected equipment

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

Isolation: Provide isolating switch adjacent to equipment.

Coordination: Coordinate with equipment supplier.

Wall/ceiling mounted equipment: Conceal final cable connection to equipment.

Isolating switches Standard: To AS/NZS 3133.

Emergency stop switches Standard: To IEC 60947-5.5.

3-phase outlets Standard: To AS/NZS 3123.

Type: Surface mounted with flap lid on the outlet.

Material: High impact plastic.

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.

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.

Motor Field Isolators

Standard: Motor Field Isolators shall conform to the Motor Field Isolators worksection

4.3 Execution

4.3.1 Wiring Systems - Installation

General

Power, instrumentation and control cables shall be installed in accordance with AS/NZS 3000 the Electrical Scope of Works specification and applicable worksections of this standard. Data and communication cables shall

Low and extra low voltage power systems

be installed in accordance with applicable ACA and AS/ACIF Standards, the Electrical Scope of Works specification and the applicable worksections of this standard.

Different wiring systems shall be segregated in accordance AS/NZS 3000 (e.g. by installing power cables in separate conduits from control, instrumentation and data cables).

Cables shall not be installed on suspended ceilings unless the ceilings are designed to support the weight of the cables. All cables in ceiling spaces shall be adequately supported and protected in accordance with AS/NZS 3000.

Unless otherwise specified, all underground cables shall be installed in Category A heavy duty underground UPVC conduits in accordance with AS/NZS 3000.

Unless specified otherwise, cables outside of and not attached to buildings or equipment shall be installed underground in conduits with pits as specified.

Cable routes within buildings shall be run on cable ladder or through conduits as appropriate.

Using the building structure as a cable support system shall only be used for single cables running to light fittings or GPOs where the installation of a conduit or cable ladder would appear excessive. In this event the cables will be attached to the structure using an approved industrial system.

Conduits will only be used for single cables running to a single specific piece of equipment where it cannot be envisaged that second cable may be required. This does not apply to underground cable conduits. In all other cases cable ladder or cable tray shall be provided to support the cable.

Cables in cable ducts or on cable trays: Install parallel to the sides of the duct or tray. Where such cables must negotiate a bend, the centre of curvature shall generally be common for all cables and shall be determined by the largest cable of the group, so that a neat installation is obtained.

Single core cables in the same multiphase circuit: Shall be run in proximity to each other.

Control and instrumentation cables: may be bunched.

Cable Joints: Unless specified, intermediate joints in cables shall not be permitted.

Cable Handling: Cables shall be installed in a manner which is not inferior to the manufacturer's written instructions.

Cables shall be handled carefully from cable drums or spools. Kinks shall not be allowed to develop during unwinding or during installation. Unless otherwise approved by TasWater's representative, cables shall not be subjected to bending radii of less than twelve times the outside diameter of the cables or the manufacturer's recommended minimum radius, whichever is the greater, at any stage during installation of the cables.

Care shall be taken during installation of cables that the insulation and/or sheathing of the cables is not cut, abraded or otherwise damaged.

Mechanical handling devices shall grip the respective cables over a wide area and shall not cut or bruise the cable sheath during use.

Any cables which are damaged during installation shall be repaired or replaced by the Contractor to the satisfaction of TasWater's Representative at the Contractor's expense.

Cable Penetrations

All cable terminations shall be via correctly sized gland.

Low and extra low voltage power systems

PVC glands are acceptable as long as they are suitable for the environment they are exposed to

Each gland shall contain only one cable to ensure an acceptable seal is obtained.

Cables entering any equipment, enclosures etc shall do so from the bottom. Cables shall not enter from the top, sides, back or front,

Exceptions to this are:

- Cable entry to a switchboard mounted in a clean low humidity room can be through the top of a switchboard
- Multiple cables may enter through a single gland as long as:
 - The position of the enclosure is inside
 - The room conditions are dry / low humidity
 - Minimum 16 cables, each maximum 6mm diameter.

Labelling and Numbering System

Field cables shall be labelled in accordance with the numbering system specified

Individual cores of control or instrumentation cables shall be labelled with printed slip-on type full circle ferrules. The core identification shall correspond with the wiring diagrams.

Cables shall be identified at the ends by a corrosion resistant tag printed with the cable identification used on circuit diagrams. The whole system shall be proved to be UV stabilised and suitable for the environment in which it is installed.

All cables shall be numbered at both ends in line with a cable schedule at the both ends with the label clearly visible from outside the equipment, enclosure etc.

The numbering system shall ensure the number is clear and shall be suitable for the environment to prevent fading due to chemical attack or weathering

Cable numbering systems shall be one of those identified in the Electrical Installation Preferred Equipment List.

Unless otherwise specified, following cable numbering prefix system shall be followed:

Power Cables	Prefix P
Control Cables	Prefix C
Instrumentation Cables	Prefix I
Communications Cabling	Prefix D (TBC)

4.3.2 Site electricity supply

General

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

4.3.3 Earthing

Earthing systems

Standards: Provide a multiple earthed neutral (MEN) earthing system complying with AS/NZS 3000 and Network Distributor requirements as documented.

Low and extra low voltage power systems

Earthing conductor

General: Provide from the main earth bar in the main switchboard to an earth electrode. Noting conductor sizes required as of AS/NZS 3000.

Bonding

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

Wet areas: Ensure concrete reinforcement in wet areas is bonded to earthing system as required by AS/NZS 3000.

In situations where metallic pipework is accessible, both suction and delivery pipework shall be individually connected to the installation main earth bar.

Circuits and equipment

General: Provide insulated earths with all circuits, incorporated within multi-core cabling, and earth all equipment, enclosures, etc.

All equipment which forms part of the general power and lighting installation and which, under the requirements of AS/NZS 3000, is required to be earthed, shall be earthed by means of earthing conductors to the earthing bar of the relevant general power and lighting panel.

Electrodes

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

The main connections at the earth rods shall be protected against damage and corrosion in accordance with AS/NZS 3000. In addition the earthing rod shall be protected by a 300mm long, 150mm diameter PVC pipe around the earth rod up to ground level. Refer to Drawing <TBA>

Earth and bonding clamps

General: Provide proprietary earthing and bonding clamps.

Standard: To AS 1882.

4.3.4 Power cables

General

Standard: Classifications to AS/NZS 3013.

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

Stress: Ensure that installation methods do not 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: Where approved, locate in accessible positions in junction boxes and/or in pits.

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

Tagging

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

Low and extra low voltage power systems

Marking

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

Submains and final sub-circuits

General: Wiring for the general power and lighting installation shall commence at the appropriate general power and lighting distribution boards. For non-office areas the cables for general power and lighting shall be run along ducts, trays or in surface mounted rigid conduits. In office areas cables for general power and lighting shall be concealed and shall utilise wall cavities where available. Wiring connection to light fittings shall be arranged such that a fitting can be readily disconnected and/or removed without having to disconnect or remove other fittings.

Installation: Provide the following:

- Cables: Run in conduit, cable ducts or support on cable trays or ladders.
- Cables for lighting systems: Run in conduit, cable ducts, suspend on catenary systems or support on cable trays or ladders.
- Inaccessible concealed spaces: Install cable in UPVC conduit.
- In roof spaces: Install cable below heat insulation and sarking. If not protected by thermal insulation, derate the cables, to AS/NZS 3000, for an assumed ambient temperature of 55°C.
- In accessible ceiling voids: Support and enclose cables on ceiling surfaces or ceiling suspension systems.
- In walls filled with bulk thermal insulation: Install cables in PVC conduit.
- In metal stud framed walls: Install cable using TPS cable allowing rewirability. Bush all knock-outs in steel framing to prevent cable damage. Earth metal stud frames to the electrical earthing system.
- On horizontal cable trays or ladders: Fix cables using propriety nylon cable ties or straps, cable saddles or clips at 2000 mm intervals.
- In vertical cable risers: Fix cables using propriety nylon cable ties or straps, cable saddles or clips at 1000 mm intervals.
- Plant rooms: Install cable in heavy duty UPVC conduit or on tray, cable ladder or in duct.

LV /ELV circuit segregation

Separate LV control, power and earth conductors and control equipment from ELV control conductors and equipment. Provide metal partitions for segregation in shared cable ladder/tray systems.

Low and extra low voltage cabling shall NOT be run in the same conduit.

A clearance of not less than 100mm shall be maintained between power and control, instrumentation or communication cables.

4.3.5 Fire-rated cables

Protection

General: If exposed to mechanical damage, provide protection to AS/NZS 3013.

4.3.6 Copper conductor terminations

General

General: 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. Compression lugs used on control cables, instrumentation cables or small power cables shall be of the pre-insulated type, and when fitted shall support the cable insulation.

Low and extra low voltage power systems

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. Cables shall be supported as necessary at all points of termination to prevent undue mechanical strain on the terminations. Support may be by means of fittings supplied with the various items of equipment or, if these are inadequate or insufficient, additional supports, which shall be approved by TasWater's representative, shall be provided.

Alternative: Run cables in UPVC 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: Unless specified otherwise identify spare cores and terminate into spare terminals. Alternatively, if approved by the TasWater representative, neatly insulate and neatly bind the spare cores to the terminated cores.

Instrumentation Cable Screen Terminations

Screens of instrumentation cables shall be individually terminated at both ends at insulated terminals. The screen between the cable sheath and the terminal shall be insulated with heat shrink tubing. Unless otherwise specified by the equipment manufacturer or the TasWater Representative, the cable screens shall then be earthed at one end only (usually the source end) by looping an earthing conductor between terminals.

4.3.7 Aerial cables – power

Aerial cables

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

Aerial connection – poles

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

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

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

Bundled conductors: To AS 3766.

Aerial connection – building attachment

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

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

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

4.3.8 Completion tests

Site tests

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

Test and verify the installation to AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017. Test and verify the connections to electricity networks to AS 4741. Record and submit the results of all tests.

Low and extra low voltage power systems

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.

4.3.9 Spare parts

General

Spare parts: As documented.

4.4 Selections

4.4.1 Network supply

Network supply connection schedule

Network distributor	Refer to Electrical Scope of Works
Supply system type	Protective Earth Neutral (PEN)
Nominal supply voltage	230/400 V
Number of phases	3
Frequency	50 Hz
Number of wires – system	4
Earthing system	MEN
Fault level at point of supply	Refer to Electrical scope of works worksection
Network distributor protection	Provide lugs for connection.

4.4.2 Metering

Metering schedule

Electricity Retailer	Refer to Electrical Scope of works worksection
Tariffs	Refer to Electrical scope of works worksection
Private metering	Refer to Electrical scope of works worksection

4.4.3 Design

Design schedule

Voltage drop in final subcircuits	≤ 2%
Spare capacity for future use	≥ 25%

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Neutral sizing	100%
Maximum demand/diversity method	AS/NZS 3000 Appendix C Table C2 Column 3
Calculated maximum demand.	Refer to Electrical scope of works worksection
Lighting Circuits	Maximum 1800W per circuit with 30mA RCD protection.
Socket Outlets	Maximum 4 socket outlets per circuit with 30mA RCD
	nrotection .
	protocion

4.4.4 Accessories

Accessory selections schedule

Refer to Preferred equipment schedule worksection.

Switchboards – proprietary

5 Switchboards – proprietary

5.1 General

5.1.1 Responsibilities

General

General: Provide switchboards as follows and as documented.

5.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.
- Preferred equipment schedule.
- General electrical requirements.
- Low and extra low voltage power systems.
- Switchboard components.

5.1.3 Standards

General

Standards: To AS/NZS 3000 and AS/NZS 3439.1.

5.1.4 Interpretations

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Proprietary assemblies: Low voltage switchgear and control gear assemblies available as a catalogue item, consisting of manufacturer's standard layouts and equipment. That is, off the shelf. Minor modifications are permissible to accommodate equipment and accessories, whilst retaining standard format.
- Rated currents: Rated currents are 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, excluding effects of current limiting devices.

5.1.5 Submissions

Product data for proprietary assemblies

General: Submit the following:

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

Switchboards - proprietary

- 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.

Shop drawings

General: Submit shop drawings showing:

- Fault level and rated short circuit capacity characteristics.
- Front and back equipment connections and top and bottom cable entries.
- Quantity, brand name, type and rating of control and protection equipment.
- Single line power and circuit diagrams.
- Details of submain routes within assemblies.
- Labels and engraving schedules.

5.2 Products

5.2.1 General

Enclosure Refer to Switchboards – custom built worksection.

Separation Default: Form 1.

Metering

Requirement: To the Low and Extra low voltage power systems worksection.

Busbars

General: Incorporate proprietary insulated busbar systems for the interconnection of isolators, circuit breakers and other circuit protective devices.

Spare capacity

Default spare poles: $\geq 25\%$.

Surge diversion

General: Provide surge diversion as documented. Refer to Switchboard components worksection for selections.

Earthing

General: Make provision for connection of communications systems CET at switchboard earth bar to AS/ACIF S009.

Doors

General: Provide lockable doors with a circuit/document card holder unless enclosed in cupboards or in an area which is not readily accessible to the public.

IP rating

 Refer to Switchboards – custom built worksection.

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Switchboards - proprietary

Finishes

Refer to Switchboards – custom built worksection.

Supporting structure

Assemblies:

- Wall mounted: $\leq 2 \text{ m}^2$.
- Floor mounted: > 2 m².

Ventilation

General: Required to maintain design operating temperatures at full load.

5.3 Execution

5.3.1 General

Fixing

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

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 metal saddles. Provide glands for all single core cables.

Cable enclosures

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

Cable supports

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

5.3.2 Maintenance

General Standard: To AS 2467.

5.4 Selections

5.4.1 Construction requirements

Construction requirements schedule

Refer to Switchboards - custom built worksection

Switchboards – custom-built **Switchboards** – custom-built

6.1 General

6.1.1 Responsibilities

General

General: Provide switchboards as follows and as documented.

6.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works
- Preferred equipment schedule
- General electrical requirements.
- Low and extra low voltage power systems.
- Switchboard components.

6.1.3 Standard

General

Standards: To AS/NZS 3000 and AS/NZS 3439.1 and any electrical supply authority and local statutory requirements.

6.1.4 Interpretations

Abbreviations

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

- TTA: Type tested assemblies.
- NTTA: Non-type tested assemblies.
- PTTA: Partially type tested assemblies.

Definitions

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

- Custom-built assemblies: Low voltage switchgear and controlgear assemblies manufactured to order and incorporating proprietary components and proprietary bus-bar assemblies.
- Rated currents: Rated currents are 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, excluding effects of current limiting devices.

6.1.5 Tests

Routine tests Standard: To AS/NZS 3439.1.

Switchboards - custom-built

Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.

Dielectric testing: NTTAs and PTTAs: 2.5 kV r.m.s. for 15 s.

6.1.6 Inspection

Notice

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

- Factory assembly completed, with busbars exposed and functional units in place.
- Assembly ready for FAT and routine testing.

6.1.7 Submissions

Calculations

General: Submit detailed certified calculations verifying design characteristics.

Standard: To AS 3865 and AS 60890.

Type tests

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

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

Testing facility: Accredited by a NATA registered testing authority.

Routine tests

Standard: To AS/NZS 3439.1.

General: Submit reports.

Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.

Dielectric testing: NTTAs and PTTAs: 2.5 kV r.m.s. for 15 s

Technical data

Calculations: Submit design calculations of non-type tested and non-proprietary busbar assemblies.

Shop drawings

General: Submit shop drawings showing:

- Types, model numbers and ratings of assemblies.
- Component details, functional units and transient protection.
- Detailed dimensions.
- Shipping sections, general arrangement, plan view, front elevations and cross-section of each compartment.
- Projections from the assembly that may affect clearances or inadvertent operation, such as handles, knobs, arcing-fault venting flaps and withdrawable components.
- Fault level and rated short circuit capacity characteristics.

Switchboards - custom-built

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

6.2 Products

6.2.1 Custom-built switchboard construction

General

General: Provide custom-built switchboards as documented.

Outdoor switchboards

Outdoor switchboards are only to be provided where there are no other alternatives for providing an indoor switchboard. Indoor switchboards are TasWater's preferred solution.

From a layout point of view outdoor switchboards are required to be laid out in the same manner as that described for an indoor switchboard. However no matter what Form of construction they are, outdoor switchboards have the following further requirements:

- provided with a sloping rain hood which will overlap the front of the door by a minimum of 50mm
- Door hinges shall be internal once the door is closed. Heavy duty automatic door stays will be provided to prevent wind damage.
- Door closed limit/proximity switches will be provided on all doors to act as intruder monitors.
- All door openings will have a rain protection return along all edges to divert any water away from the opening.
- No equipment or cut outs are to be provided on the doors
- Behind the doors will be modules and cable zones as required on the indoor switchboards. All cabling will be bottom entry.

Form 1 switchboard design requirements

This form is only to be used for switchboards that contain a maximum of 4 drives or feeders < 4kW each or a total maximum current rating of the switchboard of 63 Amps.

- The design will be Form 1 as per AS/NZS 3439.1
- Design within the panel shall ensure that all live electrical equipment shall be touch proof (>IP2X) by design even if a protective escutcheon panel is to be provided.
- In this design all equipment with voltages > 50V will be grouped together supplied with barriers to ensure unintentional contact with live is not possible. A warning label will be supplied on these barriers.

Switchboards - custom-built

- If there are to be multiple drives incorporated in a single enclosure then an escutcheon panel will be provided to prevent unintentional touching of the live equipment but allow resetting of overloads and short circuit trips. An electrical warning sign shall be placed on the escutcheon

6.2.2 Form 2 switchboard design requirements

This form is only to be used for switchboards that contain a number drives or feeders < 4kW each or a total maximum current rating of the switchboard of < 100 Amps.

- The design will be Form 2B as per AS/NZS 3439.1
- Design within the panel shall ensure that all live electrical equipment shall be touch proof (>IP2X) by design even if a protective escutcheon panel is to be provided.
- If there are to be multiple drives incorporated in a single enclosure then an escutcheon panel will be provided to prevent unintentional touching of the live equipment but allow resetting of overloads and short circuit trips. An electrical warning sign shall be placed on the escutcheon
- Any control section shall be incorporated in its own separated module
- Any bus bars shall also be incorporated into its own section

6.2.3 Form 3/4 switchboard design requirements

General:

- Switchboard design will be form 4A or 4B as per AS/NZS 3439.1. Form 3 is not acceptable.
- A switchboard plate shall be provided containing at least the following information:
 - Rated current/voltage/frequency
 - Fault current withstand level
 - Form of construction
 - IP Rating
 - Date of construction
 - Manufacturers details
 - Main and Secondary busbar ratings
- Each separate module, cable zone, metering section, bus bar enclosure etc shall be provided with an engraved label consisting of lettering at least 6mm high
- Where either a door, cover, escutcheon or similar can be opened or removed to directly reveal an electrical hazard a suitable warning sign shall be provided on the door, cover etc.

Cable Zones:

- Cable zones shall be sized for the number of cables required to be accommodated + at least 20% spare capacity. Minimum width 400mm
- No equipment, including electronic equipment, instruments etc & bus bar connections, other than terminals shall be provided in the cable zones
- If terminals are to be positioned in the cable zones all electrical connections shall be touch proof, minimum IP2X and the cable zone must be minimum 400mm wide
- Any terminals shall be positioned so the terminal numbers can be easily read from the front of the cable zone.
- Cable support tray shall be provided to allow support of all proposed cables
- -
 - Incomer Module Sub Board:
- Each switchboard shall be supplied with an incoming module which will incorporate a circuit breaker. Isolators and fuse switches are not acceptable.

Switchboards - custom-built

- Entry to the module shall be via an external interlocking handle on the front of the module door. The interlocking handle shall be defeatable and also allow the use of a padlock when isolating
- Behind the door the incoming busbar / connections shall be protected to ensure no accidental contact is possible. >IP2X
- Incoming connections shall be sufficiently positioned and spaced to allow oversize connections to be made. At least cables 2 sizes greater than those calculated for normal current carrying capacity.
- Full vertical segregation shall be provided to ensure any work carried out on the isolated load side of the circuit breaker cannot allow any tools or equipment to come into contact with the line side equipment.
- If any other equipment is to be positioned in this section access to this equipment must ensure there is no danger of contacting live equipment

Incomer Module - Main Switchboard:

- Each Main Switchboard shall be supplied with an incoming module which shall be provided with a circuit breaker. The circuit breaker will provide overload protection for the incoming cable and short circuit protection for the switchboard. This shall be labelled the MAIN SWITCH.
- Entry to the module shall be via an external interlocking handle on the front of the module door. The interlocking handle shall be defeatable and also allow the use of a padlock when isolating.
- Behind the door a full size clear escutcheon plate on hinges shall be provided. This escutcheon shall have a cut out to allow the settings of the circuit breaker to be adjusted but prevent contact with any live parts. In addition the escutcheon shall be able to be closed and sealed with Aurora seals to prevent any un-metered connections being made to the incoming bus bar.
- Full vertical segregation shall also be provided to ensure any work carried out on an isolated load side of the circuit breaker cannot allow any tools or equipment to come into contact with the line side equipment / bus bar
- The supply conductors up to the line side of the Main Switch circuit breaker shall be protected by double insulation. In addition, suitable supplementary physical barriers, terminal covers and/or double insulation shall be provided for all bus bar and terminations on the line side of the Main Switch to ensure that this section of the incomer module is effectively a "fault free zone".
- Incoming connections shall be sufficiently positioned and spaced to allow oversize connections to be made. At least cables 2 sizes greater than those calculated for normal current carrying capacity.
- No other equipment should be positioned in this section without prior written approval from TasWater.

6.2.4 Emergency Generator Module:

- If an emergency generator connection point is required the switchboard shall be supplied with an incoming module which shall be provided with a circuit breaker. The circuit breaker will provide overload and short circuit protection for the incoming cable and short circuit protection fro the switchboard. This shall be labelled the EMERGENCY GENERATOR SWITCH.
- Entry to the module shall be via an external interlocking handle on the front of the module door. The interlocking handle shall be defeatable and also allow the use of a padlock when isolating. The generator circuit breaker shall be also interlocked with the switch board main supply circuit breaker to prevent both being in the on position at any one time.
- Behind the door a two clear escutcheon plates shall be provided. These escutcheons shall have a cut out to allow the settings of the circuit breaker to be adjusted but prevent contact with any live parts. In addition the escutcheons shall have warning labels warning of the supply feeding back from the switchboard bus bar when connected to Aurora supply. Another similar warning sign shall be affixed to the main switch load side connections warning of the possible generator supply.
- Full vertical segregation shall also be provided to ensure any work carried out on an isolated load side of the circuit breaker cannot allow any tools or equipment to come into contact with the line side equipment / bus bar

Switchboards - custom-built

- The supply conductors up to the line side of the mains supply circuit breaker shall be protected by double insulation. In addition, suitable supplementary physical barriers, terminal covers and/or double insulation shall be provided for all bus bar and terminations on the line side of the circuit breaker to ensure that this section of the incomer module is effectively a "fault free zone".
- Incoming connections shall be sufficiently positioned and spaced to allow oversize connections to be made. At least cables 2 sizes greater than those calculated for normal current carrying capacity.
- The generator connections to the switchboard bus bar must be connected so as to bypass the electricity authority metering CTs.

6.2.5 Electrical Authority CTs and Fuses Module:

- If electrical authority CTs and fuses are required to be placed in the switchboard this equipment shall be provided in its own section with its own door.
- Behind the door any open bus bar shall be positioned behind an escutcheon preventing accidental contact with live equipment including the bus bar.
- Fuses associated with this equipment shall be positioned so that they can be easily removed, without the fear of dropping them onto the bus bar and without the requirement to remove the escutcheon. An appropriate electrical hazard warning sign shall be positioned on the escutcheon warning of hazard behind.

6.2.6 General Light & Power Module:

- If the switchboard is to have a General Light & Power (GL&P) section it shall be provided in its own suitably sized module.
- The module shall have a suitably labelled door but the door shall not be interlocked with the supply
- The module shall be equipped with a main circuit breaker or isolator which shall interlock with a clear escutcheon plate. The interlock shall be defeatable.
- An appropriately rated, 3 phase, distribution board bus bar system shall be installed for distribution to the individual circuit breakers.
- The circuit breakers and any other equipment which may need to be operated or reset shall extend through the escutcheon plate but not allow contact with live parts.
- All equipment behind the escutcheon shall be insulated and be touch proof to a level > 2X
- All circuit breakers shall be clearly labelled as to what they are supplying
- No process power or control shall be derived from the GL&P section. If this is required it shall be provided from a separate section.

6.2.7 Distribution Module:

- Each sub-mains distribution circuit breaker shall be contained in its own module.
- Entry to the module shall be via an external interlocking handle on the front of the module door. The interlocking handle shall be defeatable and also allow the use of a padlock when isolating.
- The line side connection shall be touch proof, IP2X
- If available, the load side contacts shall be covered with a manufacturers shroud to prevent accidental contact
- If any other equipment is to be mounted in the module all connections shall be touch proof, IP2X
- The distribution module shall be sized and laid out to ensure all power cables can be comfortably connected to the equipment. The switchboard manufacturer shall be responsible for identifying the cable size to be connected to each module.
- Each module will have its own individual connection to the main bus bar system.

6.2.8 Drive Module:

• Each motor drive ≥ 4kW shall be provided in its own module

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- Entry to the module shall be via an external interlocking handle on the front of the module door. The interlocking handle shall be defeatable and also allow the use of a padlock when isolating.
- The line side connection shall be touch proof, IP2X
- All equipment to be mounted in the module shall ensure touch proof connections, IP2X so that any manual manipulations in the module do not present the danger of accidental electrocution
- At least 20% spare space for equipment shall be provided in the module
- The drive module shall be sized and laid out to ensure all power cables can be comfortably connected to the equipment. The switchboard manufacturer shall be responsible for identifying the cable size to be connected to each module.
- Circuit breaker and overload resets shall be possible from outside the module.
- If soft starters are to be contained in a module the soft starter control panel shall be provided on the outside of the module door.
- If the opportunity exists and TasWater agrees, small drives (< 4kW) can be installed into a multiple drive module with a single isolator which is interlocked with the main door. However a clear escutcheon plate shall be provided to allow resetting of circuit breakers and overloads without being able to touch live parts.
- Each module will have its own individual connection to the main bus bar system.

6.2.9 Control Module:

- Unless otherwise specified, all control circuits shall be < 50V
- The control module will be laied out neatly with 20% spare space for new equipment.
- Cabling around the panel shall be via plastic cable trunking which when finished will have 20% spare capacity excluding the allowance for the installation of field cabling.
- Any equipment with rated at >50V which requires open type connection will have these mechanically protected by manufactured shrouds with a warning label on them.
- If electrical equipment is to be mounted on doors the equipment shall be protected by a clear shroud to ensure equipment is provided with mechanical protection and any power connections (>50V) cannot be accidentally touched.
- All electrical connection shall be IP2X touch protected including any use of bridges between terminals.
- All terminals with connections > 50V will have their own terminal bar and not be mixed with very low voltage terminals.

Switchboard manufacturer

General: Use only switchboard manufacturers employing experienced switchboard personnel with more than 5 years experience in the design of switchboards.

Electrical protection requirements

Discrimination: All power circuit breakers / fuses shall be sized to provide full discrimination tripping within the switchboard as well as with the supply protection and any downstream protection.

Internal Arc Fault Protection: In large switchboards, > 400A, 415V, the switchboard shall be designed & constructed in line with section 2.5.5, AS 3000 in regard to switchboard internal arc faults. This shall be provided as part of the concept design.

Distribution Protection: The switchboard designer will provide documentary evidence demonstrating that protection provided on all outgoing supplies is sufficient to satisfy the earth loop impedance requirement for that circuit.

Form of separation

Default: Form 1, 2B, 4A or 4B as documented

Metering

General: Comply with the Low and extra low voltage power systems worksection.

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Spare capacity

Default spare poles: $\geq 25\%$.

Surge diversion

General: Provide surge diversion as documented. Refer to Switchboard components worksection for selections.

Earthing

General: Make provision for connection of communication systems CET at switchboard earth bar to AS/ACIF S009.

Ventilation

General: Required to maintain design operating temperatures at full load.

Layout

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

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

Form 1 enclosures: Separate into compartments by means of partitions at 1.8 m maximum centres.

Equipment on doors: Set out in a logical manner in functional unit groups, so it is accessible without the use of tools or keys.

Segregation

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

IP rating

IP56 minimum unless otherwise specified.

Enclosure materials

General: Fabricate from scheduled material of rigid folded and welded construction. Obtain approval for non-welded forms of construction.

Outdoor enclosures, corrosive environments or wet areas: 316 Stainless Steel. All fixtures and door furniture to be 316 stainless such as hinges, handles, structural members, washers, screws and bolts.

Indoor enclosures (not in wet areas): Material: Metallic-coated sheet steel to AS 1397 Powder Coated. Material thickness:

- Diagonal dimension:
 - < 900 mm: ≥ 1.6 mm.
 - · ≥ 900 mm: ≥ 2.0 mm.

Coating class:

- Indoor assemblies: Z200.
- Outdoor assemblies: Z450.

Insect proofing

General: Cover ventilation openings with non-combustible and corrosion resistant 1 mm mesh.

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Equipment mounting panels

General: To support the weight of mounted equipment.

Metallic panels: Construct from \geq 3 mm thick metal with heavy metal angle supports or plates bolted or welded to enclosure sides.

Non-metallic panels: Provide non-metallic panels selected to suit the weight of the mounted equipment and design the mounting structure for stability and stiffness.

Non-metallic boards: To IEC 60893-1.

Equipment fixing

Spacing: Provide 50 mm minimum clearance between the following:

- Busbars for lifts, fire services and building emergency services.
- General installation services, busbars and equipment.

Mounting: Bolts, set screws fitted into tapped holes in metal mounting panels, studs or proprietary attachment clips. Provide accessible equipment fixings which allow equipment changes after assembly commissioning.

Installation: For lightweight equipment, provide combination rails and proprietary clips.

Earth continuity

General: Strip painted surfaces and coat with corrosion resistant material immediately before bolting to the earth bar. Provide serrated washers under bolt heads and nuts at painted, structural metal-to-metal joints.

Construction

Lifting provisions: For assemblies with shipping dimensions exceeding 1800 mm high x 600 mm wide, provide fixings in the supporting structure and removable attachments for lifting.

Supporting structure: Provide concealed fixings or brackets to allow assemblies to be mounted and fixed in position without removing equipment.

Floor-mounting: Provide mild steel channel plinth, galvanized to class Z600, with toe-out profile, nominal 75 mm high x 40 mm wide x 6 mm thick, for mounting complete assemblies on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Prime drilled holes with zinc rich organic primer to AS/NZS 3750.9.

Ventilation: Provide ventilation to maintain design operating temperatures at full load.

6.2.10 Cable entries

General

General: Provide cable entry facilities within assembly cable zones for incoming and outgoing power and control cabling. Provide sufficient clear space within each enclosure next to cable entries to allow incoming and outgoing cables and wiring to be neatly run and terminated, without undue bunching and sharp bends.

All cables entering or leaving the switchboard shall be via correct sized cable glands through gland plates

Cover and gland plates

Cover plates: Provide 150 mm maximum width cover plates butted together and covering the continuous cable entry slot.

Gland plates: Provide removable gland plates fitted with gaskets to maintain the degree of protection. Gland plates shall be sized to ensure there is enough space for all cables. The switchboard manufacturer shall ensure
Switchboards - custom-built

they make themselves aware of how many and what size cables need to enter or leave through each gland plate and size the cable zone accordingly.

Materials: 1.5 mm thick steel, 6 mm thick brass or aluminium for single core (SDI) cables and cable glands.

6.2.11 Doors and covers

General

Requirement: Provide lockable doors with a circuit/document card holder.

Door layout

Maximum width: 900 mm.

Minimum swing: At least 135°.

Door stays: Provide stays to outdoor assembly doors.

Adjacent doors: Space adjacent doors to allow both to open to 90° at the same time.

Door construction

General:

- All external doors shall have sufficient hinges and locks to ensure a complete seal with the main cabinet.
- Door latches to be the standard electrical cabinet square or triangular key construction. The key system using a thin round pin in the middle is not acceptable
- Hinges shall be of solid construction and doors shall not be easily removable.
- Doors shall open to an angle > 135 degrees to allow easy access.

Protection: Provide single right angle return on all sides and fit suitable resilient sealing rubber to provide the documented IP rating and prevent damage to paintwork.

Hinges: Provide corrosion-resistant pintle hinges or integrally constructed hinges to support doors. For removable doors, provide staggered pin lengths to achieve progressive engagement as doors are fitted. Provide 3 hinges for doors higher than 1000 mm. Provide restraining devices and opposed hinges for non lift-off doors.

Door hardware: Provide the following:

- Corrosion resistant lever-type handles, operating a latching system with latching bar and guides strong enough to withstand explosive force resulting from fault conditions within the assembly.
- Dual, edge mounted, corrosion resistant T handles with provision for key locking cylinder.
- Captive, corrosion resistant knurled thumb screws.

Locking: Incorporate cylinder locks in the latching system. Key alike, 2 keys per assembly.

Door mounted equipment: Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Earthing: Maintain earth continuity to door mounted indicating or control equipment with multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the door.

Covers

Maximum dimensions: 900 mm wide and 1.2 m² surface area.

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Fixing: Fix to frames with at least 4 fixings. Provide corrosion-resistant acorn nuts if the cover exceeds 600 mm in width. Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion-resistant D type handles.

Escutcheons

General: For doors enclosing circuit breakers, provide escutcheon plates as barriers between operating mechanisms and live parts.

Escutcheon plates

General: Provide plates or removable covers with neat circuit breaker toggle cut-outs allowing interchangeability of 1, 2 and 3 pole circuit breakers. Provide corrosion-resistant lifting handles or knobs. Provide unused circuit breaker toggle cut-outs with blanking in-fill pole covers.

Maximum dimensions: 900 mm wide and 1.2 m² surface area.

Earthing: Maintain earth continuity to escutcheon mounted indicating or control equipment with multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the escutcheon.

6.2.12 Factory finishes

General Standard: To AS 2700.

Extent: Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanized, electroplated, or anodised surfaces and to ventilation mesh covers.

Preparation: Following fabrication, all surfaces shall be degreased in accordance with AS 1627.1. All welds and bare steel areas shall be ground to remove all surface rust, scale and weld spatter.

Bare steel and Zincseal surfaces where the phosphate coating has been damaged shall be coated with etch primer applied in accordance with the manufacturer's data sheets.

Finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish to **Factory finishes schedule.**

Factory finishes schedule

Mounting structure (brackets)	To match enclosure
Enclosure	Indoor assemblies: Orange X15
	Outdoor assemblies: Wilderness green
Escutcheons / Gear Trays	Removable equipment panels: Off white Y35
Doors	To match enclosure

6.2.13 Busbars

General

General: Provide main circuit supply busbars within assemblies, extending from incoming supply terminals to the line side of protective equipment for outgoing functional units and for future functional units.

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No busbar systems shall be extended into the cable zones to allow large cable connection easier.

Standards: To AS 3768, AS 3865 and AS 60890.

Definitions

Incoming busbars: Busbars connecting incoming terminals to line side terminals of main switches.

Main circuit supply busbars: Busbars connecting incoming functional unit terminals, or incoming busbars where no main switches are included, to outgoing functional unit terminals or outgoing functional unit tee-offs.

Tee-off busbars: Busbars connecting main busbars to incoming terminals of outgoing functional units.

Custom-built busbar construction

Material: Hard-drawn high-conductivity electrolytic tough pitched copper alloy bars, designation 110.

Temperature rise limits - active and neutral conductors:

- Maximum rated current temperature rise limits: 65 ± 1.5°C by type test or calculation to AS 3768 or AS 60890.
- Maximum short-circuit withstand current temperature rise limits: 160°C by calculation to AS 3865.

Cross section: Rectangular with radiused edges.

Supports: Sufficient to withstand thermal and magnetic stresses due to maximum prospective fault currents.

Support material: Non-hygroscopic insulation capable of holding busbars at 105°C.

Proprietary busbars

Type: Multi-pole proprietary insulated busbar assemblies or busbar systems, verified for short circuit capacity and temperature rise-limits by type tests.

Phase sequence

General: For main busbars and connections to switching devices, set-out phase sequence for phases A, B and C, from left-to-right, top-to-bottom and front-to-back when viewed from the front of the assembly.

Colour coding

General: Provide 25 mm minimum width colour bands permanently applied to busbars at 500 mm maximum intervals with at least one colour band for each busbar section within each compartment.

Active busbars: Red, white and blue respectively for the A, B and C phases.

Neutral busbar: Black.

MEN link: Green-yellow and black.

Protective earth busbar: Green-yellow.

Restrictions: Do not provide adhesive type colour bands.

Current carrying capacity

Active conductors: Take into account thermal stresses due to short circuit current, assuming magnetic material enclosures located indoors in well-ventilated rooms and 90°C final temperature.

Neutral conductors: Size to match incoming neutral conductor current carrying capacity.

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Protective earth conductors: Size for at least 50% of the rated short circuit withstand current for 100% of the time duration.

Tee-off busbars current rating

For individual outgoing functional units: Equal to maximum frame size rating of the functional unit.

For multiple functional units: Equal to the diversity factors of AS/NZS 3439.1, based on frame size rating.

MEN links

MEN links > 10 mm² in cross-section: Bolted removable busbar links stamped MEN LINK, located in the incoming compartment, between neutral and earth busbars.

Amend to suit the supply authority or project specific requirements.

Fault current limiters

General: Rate busbars connected to fault current limiters to 100% of the indicated fault current limiter circuit breaker frame size or fuse base rating.

Busbar links

General: For current transformers, provide removable busbar links \leq 450 mm long.

Cable connection flags

General: Provide and support busbar flags for equipment with main terminals too small for cable lugs. Provide flags sized to suit cable lug termination, with current rating of at least the maximum equipment frame size.

Phase isolation: Provide phase isolation between flags where the minimum clearance distances phase-to-phase and phase-to-earth are below the component terminal spacing.

Future extensions

General: Pre-drill the main circuit supply busbar for future extensions and extend busbar droppers into future functional unit locations.

Jointing

General: Use multiple bolted joints on all overlapping busbars with a minimum of two bolts per joint.

Type: High tensile steel bolts, washers and nuts, with lock nuts or spring washers. Do not use tapped holes and studs or the like for jointing current carrying sections.

Custom-built busbar insulation

Active and neutral busbars and joints: Select from the following:

- Polyethylene: At least 0.4 mm thick with dielectric strength of 2.5 kV r.m.s for 1 minute, applied by a fluidised bed process in which the material is phase coloured and directly cured onto the bars.
- Close fitting busbar insulation mouldings at least 1 mm thick.
- Heat shrink material: Only on rounded edge busbars.

Taped joints: Apply non-adhesive stop-off type tape, coloured to match adjacent insulation and half lapped to achieve a thickness at least that of the solid insulation.

Damaged insulation: Repair damaged insulation before energising.

6.2.14 Neutral links and earth bars

Terminals

General: Provide terminals for future circuits.

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Links

Assembly capacity > 36 poles: Provide neutral links and earth bars at the top and bottom of the circuit breaker section.

Assembly capacity \leq 36 poles: Provide links and bars at the point of entry of incoming supply cables.

Mounting: Mount neutral links on an insulated base.

Control circuits: Provide separate neutral links and earth bars.

Labels: Provide labels for neutral and earth terminals.

Cables > 10 mm²: Provide bolts or studs.

Communications earth: Make provision for connection of communications systems earth at switchboard earth bar to AS/ACIF S009.

6.2.15 Internal wiring

Wiring

General: Cable type: 0.6/1 kV copper cables. Provide V-90HT insulation where directly connected to active and neutral busbars.

Cable interconnections

General: For the main circuit supply, provide cable interconnections as follows:

- ≥ 1.5 mm² internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1. Provide cables with current ratings suitable for the internal assembly ambient air temperature and for temperature rise limits of equipment within the assembly.
- Run cables clear of busbars and metal edges.
- Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.
- Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.
- Provide for installation of wiring for future equipment without removal of existing equipment.
- Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams. Mark to AS/NZS 4383.
- All internal wires shall be labelled at both ends with a unique identifier.
- Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.
- For equipment mounted on hinged doors run cables on the hinge side to avoid restricting the door opening. Bundle cables with spiral wrap PVC and secure to door.
- If recommended by device manufacturers, provide shielded wiring.
- Segregate LV and ELV cabling as much as practicable in Switchboards and Panels.

Adjacent circuit breakers: If suitable proprietary multi-pole busbar assemblies are available to link adjacent circuit breakers, do not provide cable interconnections.

Cables > 6 mm²

Terminations:

- Tunnel terminals: Single cables.
- Other connection points or terminals: ≤ 2 cables.

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Doors: Do not run cables to hinged doors or removable panels.

Supports:

- Spacing at enclosure: ≤ 200 mm from a termination.
- Spacing generally: \leq 400 mm.
- Strength: Capable of withstanding forces exerted during fault conditions.

Single core cables rated \geq 300 A: Do not provide ferrous type metal cable saddles.

Terminals marked: Terminate marked cables for connection to external controls in correspondingly marked terminals within the assembly.

Control and indication circuits

General: Provide conductors sized to suit the current carrying capacity of the particular circuit.

Minimum size: 1 mm² with 32/0.2 stranding.

RTU to control terminals: Minimum 0.5mm² with 7/0.30 stranding.

Cable colours

General: Colour code wiring as follows:

- A phase: Red.
- B phase: White.
- C phase: Blue.
- Neutral: Black.
- Earthing: Green-yellow.

LV Control Wiring (> 50VAC)

- Active: Red (connected from red phase)
- Neutral: Black

ELV Wiring

- +24VDC or +12VDC: Orange (fixed DC voltage wiring)
- 0VDC: Grey (fixed DC voltage wiring)
- Switched Digital/Control and Analog: Purple (includes +24VDC control wire switched via a contact)
- 24VAC: White with a red stripe (and black with a white stripe where earth referenced). The stripe can be either solid or dashed.

6.2.16 Terminations

Submains, light and power circuits

General: Connect direct to the control equipment terminals.

Shipping breaks: Provide terminal blocks for interconnecting wiring on each side of shipping breaks.

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Execution 6.3

6.3.1 Assembly installation

Fixing

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

6.3.2 **Assembly entries**

Cable entries

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

Single core cables rated > 300 A: Pass separately through non-ferrous gland plates. Do not use metal saddles.

Cable enclosures

General: Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire rating of the cable are maintained.

Cable supports

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

6.3.3 Marking and labelling

General

General: Label the switchboard assembly in conformance with AS/NZS 3439.1 including the following:

- Size and type of all incoming and outgoing mains and submains.
- Emergency operating procedures.

6.3.4 Completion

Maintenance

Standard: To AS 2467.

General: Carry out the following:

Provide thermograph testing of all switchboard terminations at maximum load - as scheduled.

Rectify faults, make adjustments and replace consumable and faulty materials and equipment within 24 hours of notification.

Selections 6.4

Construction requirements 6.4.1

Construction requirements schedule

ltem	Description	
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Switchboards – custom-built			
Item	Description		
Construction material	Outdoor, corrosive environments or wet areas: 316 Stainless Steel. All fixtures and door furniture to be 316 stainless such as hinges, handles, structural members, washers, screws and bolts.		
	Indoor enclosures (not in wet areas): Material: Metallic- coated sheet steel to AS 1397 Powder Coated.		
Factory finishes	Sheet Steel: Powder Coat.		
	316 Stainless Steel: None unless otherwise noted in the <i>Electrical scope of works</i> worksection.		
Fault rating	Main Switchboard: ≥ 25kA		
	Distribution Switchboard: ≥ 10kA		
	Unless otherwise noted in the <i>Electrical scope of works</i> worksection.		
Form of separation (minimum)	Refer to <i>Electrical scope of works</i> worksection.		
Special service condition	Normal service conditions as per AS3439.1 clause 6.		
Door locks	Outdoor assembly: TasWater master keyed as per General Preliminaries requirements.		
Limiting overall dimensions (width, height, depth)	None unless otherwise noted in the <i>Electrical scope of works</i> worksection.		
Future circuits required	≥ 25% spare poles		
Shunt surge protection	Required.		
Metering	Refer to <i>Electrical scope of works</i> worksection.		
Smoke Seal	Required for indoor switchboards		
IP rating	Outdoor enclosures or wet areas: IP56 minimum.		
	Indoor enclosures (not in wet areas): IP42 minimum.		
Future bus bar extension required	Main Switchboards: Yes		
	Distribution Switchboards: No.		
Connection	Front Connection		
Anti condensation heaters	Required		

ltem	Description	
Supporting structure	General: Floor mounted	
	Front access area < $2m^2$: Wall mounted	

Switchboard components

7 Switchboard components

7.1 General

7.1.1 Responsibilities

General

General: Provide switchboard components as follows and as documented.

7.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.
- Preferred equipment schedule.
- General electrical requirements.

7.1.3 Design

Statutory authority's equipment

General: Liaise with the supply authority with regard to the installation and coordinate with their protective and control equipment.

7.1.4 Submissions

Technical data

General: Submit technical data for all components.

7.1.5 Interpretation

Abbreviations

General: For the purposes of this specification the following abbreviation applies:

- ATS: Auto-transfer switch
- MSB: Main switchboard
- SPD: Surge protection device.

7.2 Specific control arrangements

7.2.1 General

General: In the following situations control switches and indication shall be provided as detailed.

Motor control and indication

For each motor provide:

- Manual/Off/Auto switch with aux contact to indicate in Auto.
- Duty indicator light where required
- Running indicator light

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Switchboard components

- Fault indicator light
- Fault reset push button where required

Where indication via SCADA is required provide each of the following outputs to the local RTU/PLC:

- Motor fault via common voltage free contact for:
 - Thermal overload on Motor Circuit Breaker,
 - Thermal switches when provided on motor.
 - Thermistors when provided on motor.
 - Soft Starter fault when applicable.
 - VSD fault when applicable.
- Run feedback from Motor Contactor via voltage free contact.
- Motor current via 4-20mA current transducer
- Failed to start derived from RTU/PLC logic
- Auto/Not in Auto via Manual/Off/Auto aux voltage free contact.

Valve control and indication

For each valve provide:

- Auto/Man/Off switch with aux contact to indicate in Auto.
- Open Push Button
- Fully Open indicator light
- Close Push Button
- Fully Closed indicator light
- Fault indicator light

Where indication via SCADA is required provide each of the following outputs to the local RTU/PLC:

- Valve fully open via limit/proximity switch when provided on valve or via output status where applicable.
- Valve fully closed via limit/proximity switch when provided on valve or via output status where applicable.
- Valve failed to open derived from RTU/PLC logic when feedback available.
- Valve failed to close derived from RTU/PLC logic when feedback available.
- Valve position via 4-20mA current transducer when available.
- Auto/Not in Auto via Auto/Man/Off aux voltage free contact.

7.3 Products

7.3.1 General

General

Selection: To comply with the requirements of AS/NZS 3000 clause 1.7 and Section 2.

Rated duty: Uninterrupted.

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

Switchboard components

Utilisation category: To AS 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.

7.3.2 Switch-isolator

General

Standard: To AS 60947.1 and AS/NZS 3947.3 .

Poles: 3.

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

Shrouding: Effective over range of switch positions.

Rated breaking capacity: \geq rated full load current.

Fault make/fault break switch-isolators

Rated breaking capacity: To AS/NZS 3947.3 Table 3.

Rated short-time withstand current: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Rated short-circuit making capacity: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Rated short-circuit breaking capacity: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Load make/load break switch-isolators

Rated breaking capacity: To AS/NZS 3947.3 Table 3.

Rated short-time withstand current: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Rated making capacity: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Rated breaking capacity: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

7.3.3 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.

Switchboard components

7.3.4 Fuse-switch units

Operation: Provide an extendable operating handle.

Fuse links: Isolate when switch contacts are open. Provide 3 phase sets of high rupturing capacity (HRC) fuse links.

7.3.5 Auto-transfer switches

General

Standard: To AS 60947.1 and AS/NZS 3947.6.1.

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

Load side connections: Segregate from incoming side.

Classification:

- Contactors: PC.
- Circuits: CB.

Utilization category: To AS/NZS 3947.6.1 clause 4.4.

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

The following hardwired contacts shall be provided from the Transfer Switch:

Power Supply From	Power Supply To	Power Status
Utility	Transfer Switch	Voltage free contact, fail safe.
Generator	Transfer Switch	Voltage free contact, fail safe.
Transfer Switch	Switchboard	Voltage free contact, fail safe.

In addition provide an Automatic Transfer Switch Fault (including Not in Auto) voltage free contact, fail safe.

ATS control functionality

Under voltage: Adjustable detection to set the operating point and hysteresis for transfer initiation.

Nominal settings:

- Drop out 85% of nominal voltage (minimum adjustable range 80%-95%).
- Cut in: 90% of nominal voltage (minimum adjustable range 85%-95%)

Automatic start delay for generator: Adjustable to prevent nuisance generating set starts

Nominal setting:

- 5 seconds (minimum adjustable range 0-10 seconds).

Automatic transfer delay for generator: Adjustable to allow the generator set to stabilise before the load is automatically transferred.

Nominal setting:

- 15 seconds (minimum adjustable range 5-30 seconds).

Automatic re-transfer delay: Adjustable to ensure that the mains supply has stabilised before the load is re-transferred.

Switchboard components

Nominal setting:

- 5 minutes (minimum adjustable range 1-30 minutes).

Automatic stop delay: Adjustable to allow generator set to run unloaded for a period of time before shutdown.

Nominal setting:

- 5 minutes (minimum adjustable range 0-10 minutes).

Test function: The transfer switch control arrangement shall provide "Test" functionality to start and run the generator and safely transfer the load with normal mains supply connected.

7.3.6 Moulded case and miniature circuit breakers

General

Moulded case breakers: To AS 60947.1, AS 2184 and AS 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: Motor circuit breakers with integral thermal overload.

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

Trip type: Conform to the following:

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

Isolation facility: 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.

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.

7.3.7 Electricity distributor's service protective devices

General

Requirement: Provide low voltage service protective devices 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 with full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems.

Switchboard components 7.3.8 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 60947.2.

Type: Type II.

Default tripping current: 30 mA.

7.3.9 Air circuit breakers

General

Standard: To AS 60947.1 and AS 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 circuit breakers to be locked in the open position.

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

Operating mechanism charging: Manual.

Mechanical Interlock: Provide with captive type coded key with squared face key with alphabetical or numerical coded operating face.

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.

Switchboard components

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 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.

7.3.10 Fuses with enclosed fuse links

General

Standards: To AS 60269.1, AS 60269.2.0 and AS 60269.2.1.

Fuses with fuse-links for the protection of semiconductor devices: To AS 60269.4.0.

Fuses with fuse-links used as fault current limiters: Co-ordinate 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.

Switchboard components

7.3.11 Circuit breaker integral protective relays

General

Requirement: Provide integral protective relays which provide for tripping in the event of relay operation, and for manually resetting. Provide operation indicators with a set of change over voltage free alarm contacts, for connection to an alarm circuit.

Mounting

Integral type: Readily accessible for viewing and adjustment with doors and covers in position.

External type: Flush.

7.3.12 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 recommendations of the protective relay manufacturer.

Test links: Provide test terminals and current transformer secondary shorting links in accessible positions within instrument panels. Provide a set of DIN-type 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.

7.3.13 Surge protection devices (SPD)

General

Standard: To IEC 61643.11 and IEC 61643.12.

Installation: To AS/NZS 3000 Appendix F.

Primary protection

General: Provide shunt connected metal oxide varistor based SPDs between each phase and neutral at assembly incoming supply terminals. Primary protection SPDs shall be installed after the main switch but prior to any RCD devices. Generally, primary protection SPDs shall be installed adjacent to the MEN link for the electrical installation.

Switchboard components

Surge Rating: $I_{max} \ge 100$ kA per phase to neutral.

Surge Rating: $I_{max} \ge 100$ kA neutral to earth if remote from the MEN earthing system.

Residual Voltage: U_p < 1000 V at 3kA.

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: SPD's should be protected by a suitably rated circuit breaker or HRC fuse and be installed in accordance with the manufacturer's recommendations regarding clearances and segregation from other components. SPD's shall have appropriate SPD product safety standards approval or be suitably housed and segregated in a metal enclosure.

Secondary protection

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

Surge Rating: $I_{max} \ge 40$ kA per phase to neutral.

Surge Rating: $I_{max} \ge 40$ kA neutral to earth.

Residual Voltage: U_p < 800 V @ 3kA.

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: SPD's should be protected by a suitably rated circuit breaker or HRC fuse and be installed in accordance with the manufacturer's recommendations regarding clearances and segregation from other components. SPD's shall have appropriate SPD product safety standards approval or be suitably housed and segregated in a metal enclosure. Connecting lead lengths should not exceed 300mm.

Sensitive equipment protection

General: In addition to Primary protection at the point of entry, provide a series connected surge filter comprising metal oxide varistor based primary SPDs, a low pass LC filter and secondary metal oxide varistor based SPDs.

Surge Rating: $I_{max} \ge 20$ kA per phase to neutral primary protection.

Residual Voltage: Up < 600 V at 3kA.

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: SPD's should be protected by a suitably rated circuit breaker equal to or less than the load current rating of the SPD and be installed in accordance with the manufacturer's recommendations regarding clearances and segregation from other components. SPD's shall have appropriate SPD product safety standards approval or be suitably housed and segregated in a metal enclosure.

7.3.14 Current transformers (metering)

Standard

Measurement current transformers: To AS 60044.1.

Switchboard components

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.

Туре

General: If practicable, cast resin encapsulated window-type with busbar clamping devices. Otherwise woundprimary 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.

7.3.15 Instruments and meters

Electricity meters (Watthour meters)

Standard:

- 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.

Switchboard components

7.3.16 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: 96mm 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 railmounted isolating type terminals.

Ammeters and voltmeters

Standard: To IEC 60051.2.

Ammeters: Conform to the following:

- Type: Moving iron type oil dampened for motor starter circuits, 90°.
- Overscale: For ammeters subject to motor starting currents, overscale to at least 5 x full load current.
- Selector switches: 4-position type with positions designated R/W/B/OFF. Mount under or beside relevant ammeters.
- Connection: Current Transformer connected.

Voltmeters: Conform to the following:

- Type: Moving iron, 90°.
- Specify type e.g. direct connected, or VT connected; range, transfer switch.
- Selector switches: 7-position voltage transfer type for measurement of phase-to-phase and phase-toneutral voltages with off. Mount under or next to relevant voltmeters.

Maximum demand indicators

General: Provide a meter in each phase with 15 minute response time. Provide for sealing the reset mechanism. Provide a combination 3-point indicator consisting of an instantaneous red ammeter pointer, a red maximum demand slave pointer with external reset facility, and a white maximum demand pointer.

Instantaneous type: Combined type with bi-metal maximum demand ammeter element and moving iron instantaneous ammeter element.

Thermal type: Combined type with bi-metal maximum demand ammeter element.

Wattmeters and varmeters Standard: To IEC 60051.3.

Switchboard components

General: Suitable for balanced 3 phase, 4 wire loads. Connect to measurement transducers.

Frequency meters

Standard: To IEC 60051.4.

Type: Either an analogue type, or vibrating reed type with 7 reeds.

Analogue type: Graduated in 0.1 Hz increments.

Scales:

- Analogue: Graduated 45/65 Hz.
- Vibrating reed: Horizontal reed bar graduated 47/53 Hz.

Synchroscopes

Standard: To IEC 60051.5.

General: Continuously rated, rotating vane type movement, with spring loaded bearings and silicon fluid dampening, positive and negative arrows, black pointer and 12 o'clock marking.

Scales: 360.

Phase angle meters Standard: To IEC 60051.5.

General: Provide for 3 phase, 4 wire balanced loads.

Scales: 0.5 leading to 0.5 lagging.

Hours-run meters

General: 6 figure (minimum), horizontal linear digits dial with last digit read-out in 0.1 hour increments.

7.3.17 Contactors

General Standard: To AS 60947.4.1.

Type: Enclosed, block type, air break, electro-magnetic.

Poles: 3.

Rated operational current: The greater of:

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

Mechanical durability: 10 million cycles to AS 60947.4.1.

Electric durability: \geq 1 million operations at AC-22 to AS 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.

Switchboard components

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

7.3.18 Control devices and switching elements

Standards

General: To AS 60947.1 and AS 60947.5.1.

Switching elements:

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

Standards: To AS 60947.5.1.

Operation: Suitable for continuous operation. Provide relays selected in conformance with the **Control relay** selection table.

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

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.

On site conversion: Provide contact blocks readily convertible to either normally-open or normally-closed contacts.

Switchboard components

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 < 85% and > 115% of normal voltage.
- 5 second delay on over and under 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 3947.5.5.

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

7.3.19 Semiconductor controllers and contactors

General

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

Standard: To AS/NZS 3947.4.3.

Switchboard components

7.3.20 Indicator lights

LED indicators

Requirement for light units: Integrated LEDs.

Voltage range: 12VAC and 12VDC to 30VDC.

Body type: Plastic.

Rating: IP66.

Lens type: Plastic.

Terminals: Screw fixing.

7.3.21 Indicating counters

General

General: Provide the following:

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

7.3.22 Extra-low voltage transformers

General

General: 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 ≥ 125% of maximum output load, taking account of degree of ventilation and ambient temperature within assembly, and supplied load.

7.3.23 Batteries and chargers

Standards

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.

General

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

Circuit breaker operation

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

Switchboard components

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: 24 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% – 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 analogue 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.

7.3.24 Anti-condensation heaters

General

Rating: Provide heaters rated at not less than 20 W/m² of total external area including top of weatherproof enclosure.

Switchboard components

Type: Black heat type with surface temperature \leq 50°C, mechanically protected and thermostatically controlled.

7.4 Execution

7.4.1 Marking and labelling

General

General: 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 consumers 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.

Switchboard components

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 typewritten text showing the following as-installed information:

- Submain designation, rating and short-circuit protective device.
- Light, control 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 and submain assemblies: Provide single-line diagrams.

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

Mounting: Enclose in a non-reflective PVC frame and mount in assembly.

Marking cables

General: Identify the origin of all wiring by means of 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 nonferrous tags clipped around each cable or trefoil group.

7.4.2 Discrimination and Cascading

Ensure discrimination and cascading of protective devices.

7.5 Selections

Refer to Preferred equipment schedule worksection.

Control & marshalling panels 8 Control & marshalling panels

8.1 General

8.1.1 Responsibilities

General

General: Provide control and marshalling panels as follows and as documented.

8.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works
- Preferred equipment schedule
- General electrical requirements.
- Low and extra low voltage power systems.
- Switchboards custom built (only referenced sections)
- Switchboard components

8.1.3 Standard

General Standards: To AS/NZS 3000.

8.1.4 Inspection

Refer to Switchboards – custom built worksection

8.1.5 Submissions

Shop drawings

General: Submit shop drawings showing:

- Bill of materials.
- Detailed dimensions.
- General arrangement, plan view and front elevations.
- IP rating.
- Fixing details for floor or wall mounting.
- Door swings.
- External and internal paint colours and paint systems.
- Construction and plinth details and gland plate details.
- Terminal block layouts and control circuit identification.
- Single line power and circuit diagrams.
- Labels and engraving schedules.

Control & marshalling panels

8.2 **Products**

Surge diversion

General: Provide surge diversion as documented. Refer to Switchboard components worksection for selections.

Earthing

General: Make provision for connection of communication systems CET at panel earth bar to AS/ACIF S009 if required.

Layout

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

Outdoor enclosures, corrosive environments or wet areas: Shall be provided with an external weatherproof door with all controls mounted on the inner hinged escutcheon panel: Set out in a logical manner in functional unit groups, so it is accessible without the use of tools or keys.

Indoor enclosures (not in wet areas): Shall have all controls mounted on the hinged outer door. Set out in a logical manner in functional unit groups, so it is accessible without the use of tools or keys.

IP rating

Refer to Switchboards - custom built worksection.

Enclosure materials Refer to Switchboards – custom built worksection.

Insect proofing Refer to Switchboards – custom built worksection.

Equipment mounting panels

General: To support the weight of mounted equipment.

Metallic panels: Construct from \geq 3 mm thick metal with heavy metal angle supports or plates bolted or welded to enclosure sides.

Equipment fixing

Mounting: Bolts, set screws fitted into tapped holes in metal mounting panels, studs or proprietary attachment clips. Provide accessible equipment fixings which allow equipment changes after assembly commissioning.

Installation: For lightweight equipment, provide combination rails and proprietary clips.

Earth continuity

Refer to Switchboards - custom built worksection.

Construction Refer to *Switchboards – custom built* worksection.

8.2.1 Cable entries

General

Refer to Switchboards – custom built worksection.

The enclosures shall be suitably sized for all expected cabling to enter from the bottom and provide 30% free space both inside the enclosure and with regard to cable entry once installed.

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Control & marshalling panels

Cover and gland plates

Refer to Switchboards – custom built worksection.

8.2.2 Doors and covers

General

Requirement: Provide doors with a document holder.

Locking outdoor assemblies: Provide TasWater keyed locks.

Locking indoor assemblies: Locks not required, tool access only.

Door layout

Refer to Switchboards – custom built worksection.

Door construction

Protection: Provide single right angle return on all sides and fit suitable resilient sealing rubber to provide the documented IP rating and prevent damage to paintwork.

Door mounted equipment: Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Earthing: Maintain earth continuity to door mounted indicating or control equipment with multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the door.

Covers

Maximum dimensions: 900 mm wide and 1.2 m² surface area.

Fixing: Fix to frames with at least 4 fixings.

Escutcheons

Refer to Switchboards – custom built worksection.

Escutcheon plates

Refer to Switchboards – custom built worksection.

8.2.3 Factory finishes indoor assemblies

General

Refer to Switchboards – custom built worksection.

Finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish to **Factory finishes schedule**.

Factory finishes schedule

Mounting structure (brackets)	To match enclosure
Enclosure	Indoor assemblies: Beige/Grey.
Escutcheons	Off white Y35
Doors	To match enclosure

Control & marshalling panels		
Mounting structure (brackets)	To match enclosure	
Plinths	Hot Dipped Galvanised	

8.2.4 Neutral links and earth bars

Terminals

Refer to Switchboards - custom built worksection.

Links

Refer to Switchboards – custom built worksection.

8.2.5 Internal wiring

Wiring Refer to Switchboards – custom built worksection.

Cable interconnections

Refer to Switchboards – custom built worksection.

Cables > 6 mm²

Refer to Switchboards – custom built worksection.

Control and indication circuits

Refer to Switchboards - custom built worksection.

Cable colours

Refer to Switchboards – custom built worksection.

8.2.6 Terminations

Submains, light and power circuits Refer to Switchboards – custom built worksection.

8.3 Execution

Refer to Switchboards – custom built worksection.

8.3.1 Assembly installation

General

Panels should be kept out of direct sunlight and if at all possible be mounted on the southern side of building structures etc. to limit exposure to direct sunlight.

Fixing

Refer to Switchboards – custom built worksection.

Control and Marshalling Panels shall have proprietary external fixing systems which maintain the IP integrity of the enclosure. The preferred method is with external mounting brackets welded to the side of the enclosure.

Control & marshalling panels

The enclosures shall be mounted so that they are provided with an air gap, minimum 5mm, between the enclosure and the surface they are mounted on.

Cable entries

Refer to Switchboards – custom built worksection.

All unused cabling holes are to be sealed with proper gland blanks to ensure a correct seal.

Cable enclosures

Refer to Switchboards – custom built worksection.

Cable supports

Refer to Switchboards – custom built worksection.

8.3.2 Completion

Maintenance

Refer to Switchboards – custom built worksection.

8.4 Selections

8.4.1 Construction requirements

Construction requirements schedule

Item	Description
Form of separation (minimum)	Form 1.
Limiting overall dimensions (width, height, depth)	None unless otherwise noted in the <i>Electrical scope of works</i> worksection.
Future requirements	≥ 25% spare space
Anti condensation heaters with thermostat	Indoor assemblies (not in wet areas): Not required. Outdoor assemblies or in wet areas: Required. Where a 230VAC connection is not easily available and approved a Rittal Condensate Discharge module part number SZ 2459.000 may be installed on the inside rear base of the panel at the lowest point in lieu of anti-condensation heater.

Motor field isolators

9 Motor field isolators

9.1 General

9.1.1 Responsibilities

General

General: Provide motor field isolators as follows and as documented.

9.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works
- Preferred equipment schedule
- General electrical requirements.
- Low and extra low voltage power systems.
- Switchboards custom built (only referenced sections)
- Switchboard components

9.1.3 Standard

General Standards: To AS/NZS 3000.

9.1.4 Inspection

Refer to Switchboards – custom built worksection

9.1.5 Submissions

Shop drawings

General: Submit shop drawings showing:

- Bill of materials.
- Detailed dimensions.
- General arrangement, plan view and front elevations.
- IP rating.
- Fixing details for mounting.
- Gland entry details.
- Labels and engraving schedules.

9.2 Products

General

Standard: To AS 60947.1 and AS/NZS 3947.3 .

Poles: 3 (Provides isolation of all three phases when operated)

Motor field isolators

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

Shrouding: Effective over range of switch positions.

Rated continuous current: \geq full load current rating of the motor.

Rated breaking current: ≥ prospective stalled motor current.

Isolator enclosures to have DIN rail mounted inside for equipment and additional terminals

Earth Terminals: provide terminals for connection of incoming and outgoing earth conductor

Neutral Terminals: provide terminals for connection of incoming and outgoing neutral conductor if required

Terminals: all terminals associated with the isolator are to be capable of connecting cables which are two sizes larger than that normally associated the size of the motor they are designed to isolate.

Auxiliary Contacts: provide one normally open (i.e. open in the Isolator Off position) contact which is early break and late make.

Layout

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

Colour of isolator actuator to be red with yellow surround.

Isolator actuator shall be padlockable in the 'Off' or 'Isolated' position. It is preferred to have multiple padlockable points however one is acceptable. The 'Off' position shall require the isolator handle to be in the horizontal plane while the 'On' position shall be in the vertical plane. The isolation actuator is to be as flat as possible with the front cover of the isolator enclosure to minimise the possibility of damage. The isolator actuator penetration shall be sealed in line with the IP rating of the enclosure.

Environments with direct exposure to rain: The isolator enclosure opening shall be provided with a flange which typically extends 10mm out from the front of the enclosure and then bends 90 degrees and extends 5mm parallel with the front of the enclosure away from the isolator handle. This flange is to run continually around the opening of the enclosure. Other methods of sealing the opening may be accepted depending on their design.

All seals are to be one piece, and made of neoprene or similar, but if a join is required this shall be a welded type join to maintain intended level of seal.

IP rating

IP 65 minimum (IP66 preferred)

All electrical connections shall be provided with at least IP2X protection when the isolator enclosure is opened

Enclosure materials

No direct exposure to external elements (Sun or Rain), corrosive atmospheres, chemicals or washdown: High Impact Polycarbonate

No direct exposure to external elements (Sun or Rain) but exposure to corrosive atmospheres, chemicals or washdown: High Impact Polycarbonate compatible with the corrosive atmospheres and/or chemicals present.

Direct exposure to the elements (Sun or Rain): Marine Grade 316 stainless steel

Motor field isolators

Isolator fixing

Mounting of all isolators shall be via external feet / brackets / mounting points which ensure mounting is external to the IP rated part of the enclosure.

Securing of the isolator enclosure front cover shall be via captive screws. The number of screws shall be at least 4 and more if the enclosure size requires it. The position of the cover securing screws shall be such that they cannot compromise the IP rating of the enclosure.

9.2.1 Cable entries

General

A minimum of 3 pre-manufactured cable entry points shall be provided; power in, power out & control. Cable entry is to be bottom entry only via glands, not direct on to conduit.

9.2.2 Neutral links and earth bars

Terminals Refer to Switchboards – custom built worksection.

Links Refer to Switchboards – custom built worksection.

Wiring Refer to Switchboards – custom built worksection.

Cable interconnections

Refer to Switchboards - custom built worksection.

Cables > 6 mm²

Refer to Switchboards – custom built worksection.

Control and indication circuits

Refer to Switchboards – custom built worksection.

Cable colours

Refer to Switchboards - custom built worksection.

9.3 Execution

Refer to Switchboards - custom built worksection.

9.3.1 Assembly installation

Fixing Refer to *Switchboards – custom built* worksection. Assembly entries

Cable entries

Refer to Switchboards - custom built worksection.

Cable supports

Refer to Switchboards – custom built worksection.

Motor field isolators

9.3.2 Completion

Maintenance

Refer to Switchboards - custom built worksection.
PLC/RTU enclosures

10 PLC/RTU enclosures

10.1 General

10.1.1 Responsibilities

General

General: Provide PLC/RTU Enclosures as follows and as documented.

10.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.
- Preferred equipment schedule.
- General electrical requirements.
- Low and extra low voltage power systems.
- Switchboards custom-built (only referenced sections)
- Switchboard components.

10.1.3 Standard

General Refer to Switchboards – custom built worksection.

10.1.4 Abbreviations

RTU: Remote Telemetry Unit

PLC: Programmable Logic Controller

10.1.5 Definitions

RTU has the same meaning as PLC in the context of this worksection. Refer to schedules or drawings for equipment selections.

10.1.6 Interpretations

Definitions

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

- Rated currents: Rated currents are 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, excluding effects of current limiting devices.

PLC/RTU enclosures

10.1.7 Inspection

Notice

Refer to Switchboards - custom built worksection.

10.1.8 Submissions

Functional tests General: Submit reports.

Shop drawings

General: Submit shop drawings showing:

- Types, model numbers and ratings of assemblies.
- Component details, functional units and transient protection.
- Detailed dimensions.
- General arrangement, plan view, front elevations and cross-section of each compartment.
- Projections from the assembly that may affect clearances or inadvertent operation, such as handles, knobs.
- Fault level and rated short circuit capacity characteristics.
- IP rating.
- Fixing details for floor or wall mounting.
- Front and back equipment connections and top and bottom cable entries.
- Door swings.
- External and internal paint colours and paint systems.
- Quantity, brand name, type and rating of control and protection equipment.
- Construction and plinth details, ventilation openings and gland plate details.
- Terminal block layouts and control circuit identification.
- Single line power and circuit diagrams.
- Labels and engraving schedules.

10.2 Products

10.2.1 Enclosure construction

Separation Default: Form 1.

Metering General: Comply with the Low and extra low voltage power systems worksection.

Spare capacity Default spare poles: $\geq 25\%$.

Surge diversion

General: Provide surge diversion as documented. Refer to Switchboard components worksection for selections.

PLC/RTU enclosures

Earthing

General: Make provision for connection of communication systems CET at switchboard earth bar to AS/ACIF S009.

Layout

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

Equipment on doors: Set out in a logical manner, so it is accessible without the use of tools or keys.

Enclosure materials

Refer to Switchboards - custom built worksection.

Insect proofing

Refer to Switchboards - custom built worksection.

Equipment mounting panels

Refer to Switchboards – custom built worksection.

Equipment fixing

Refer to Switchboards - custom built worksection.

Earth continuity Refer to Switchboards – custom built worksection.

Construction Refer to Switchboards – custom built worksection.

10.2.2 Cable entries

General Refer to Switchboards – custom built worksection.

Cover and gland plates Refer to Switchboards – custom built worksection.

10.2.3 Doors and covers

General Refer to Switchboards – custom built worksection.

Door layout Refer to Switchboards – custom built worksection.

Door construction Refer to Switchboards – custom built worksection.

10.2.4 Factory finishes

General Required: When scheduled.

PLC/RTU enclosures

Standard: To AS 2700.

Extent: Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanized, electroplated, or anodised surfaces and to ventilation mesh covers.

Finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish to **Factory finishes schedule**.

Factory finishes schedule

Mounting structure (brackets)	To match enclosure
Enclosure	Indoor assemblies: Grey/Beige
	Outdoor assemblies: Wilderness green
	Assembly interior: White
Escutcheons	Removable equipment panels: Off white Y35
Doors	To match enclosure
Plinths	Black

10.2.5 Neutral links and earth bars

Terminals

Refer to Switchboards - custom built worksection.

Links

Integral with moulded circuit breaker distribution enclosure.

Mounting: Mount neutral links on an insulated base.

Control circuits: Provide separate neutral links and earth bars.

Labels: Provide labels for neutral and earth terminals.

Communications earth: Make provision for connection of communications systems earth at switchboard earth bar to AS/ACIF S009.

MEN links

Provide: Comply with AS3000.

10.2.6 Internal wiring

Wiring Refer to Switchboards – custom built worksection.

Cable interconnections Refer to Switchboards – custom built worksection.

Document No: TASTEM03 Unless Stamped this document is Uncontrolled Electrical Standard Specification

PLC/RTU enclosures

Control and indication circuits Refer to Switchboards – custom built worksection.

Cable colours Refer to Switchboards – custom built worksection.

10.2.7 Terminations

Submains, light and power circuits Refer to Switchboards – custom built worksection.

10.2.8 Coaxial cable

Standard: To AS/NZS 1367 Appendix G.

Radio to Surge Diverter: Low Loss RG58.

Surge Diverter to Antennae: Low Loss RG213 or LMR.

Conduit: Install coaxial cable in conduit or inside antennae pole in the field.

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

Connectors to suite equipment scheduled.

10.2.9 Cat 6 Patch Leads

All patch leads to be Cat 6 Shielded.

Application class to AS/NZS 3080 clause 6.3: E.

Balanced system to AS/NZS 3080 clause 7 (data): Category 6.

Termination: RJ45.

10.2.10 Power supplies

Size: To suit load.

Equipment: Refer to Preferred equipment schedule and Electrical Scope of Works.

10.2.11 Batteries

Size: To provide minimum 4 hours backup at full load.

Equipment: Comprising $12V \ge 7A$ -h sealed lead acid batteries to suit scheduled Power supply and load.

10.3 Execution

10.3.1 Assembly installation

Fixing

General: Fix assemblies and enclosures into position, level and plumb.

PLC/RTU enclosures

10.3.2 Assembly entries

Cable entries

Refer to Switchboards - custom built worksection.

Cable enclosures

Refer to Switchboards – custom built worksection.

Cable supports

Refer to Switchboards – custom built worksection.

10.3.3 Marking and labelling

General

Refer to Switchboards - custom built worksection.

10.3.4 Functional Tests

FAT of the RTU should be verified for all functional requirements. Include testing of all control circuits included but not limited to:

- Inputs and Outputs
- Relays

SAT of the RTU should be verified for all functional requirements. Include testing of all control circuits included but not limited to:

- Inputs and Outputs
- Relays
- Field devices
- Communication error rates (bit error rate).

FAT's and SAT's shall be recorded in the ITC's. Provide in electronic format.

10.3.5 Completion

Maintenance

Refer to Switchboards - custom built worksection.

10.4 Selections

10.4.1 Construction requirements

Construction requirements schedules

Item	Description
Voltage / Phases	230V AC 50Hz single phase unless otherwise noted.

PLC/RTU enclosures

Construction material	Refer to Switchboards – custom built worksection.
Factory finishes	Sheet Steel: Powder Coat. 316 Stainless Steel: None unless otherwise noted in the <i>Electrical scope of works</i> worksection.
Fault rating	≥ 10kA
Special service conditions	Normal service conditions as per AS3439.1 clause 6.
Form of separation	Form 1
Circuit breaker mounting	Within proprietary moulded insulated cover with DIN rail.
Door locks	Outdoor assembly: TasWater master keyed as per General Preliminaries requirements.
Limiting overall dimensions (width, height, depth)	None unless otherwise noted in the <i>Electrical scope of works</i> worksection.
Spare space	≥ 25%
Surge diversion	Required as per typical drawing TBA I/O WIRING DIAGRAM EXAMPLES and <i>Preferred equipment schedule</i> worksection.
	Coaxial surge protection required on each antenna connection.
Connection	Front connection
IP rating	Refer to Switchboards – custom built worksection.
Metering	As per Electrical scope of works worksection.
Anti condensation heaters	Required with thermostat control to 18°C. To suit enclosure size.
Ventilation	Outdoor units: Provide cross ventilation vent. Maintain IP rating. Insect proof.

PLC/RTU enclosures

Supporting structure	Indoor units: < 1m ² wall mounted.
	Indoor units: $\geq 1m^2$ floor mounted
	Outdoor units: Pole mounted. Pole to be hot dip galvanised with suitable concrete pad mount and structural supports.
Terminals	Pre-terminate all RTU I/O points on terminals.
Duct	≥ 50% spare space.

Equipment schedule

Refer to Scope of works and Preferred equipment schedule worksections for selections.

PLC/RTU hardware and software

11 PLC/RTU hardware and software

11.1 General

11.1.1 Responsibilities

General

General: Provide PLC/RTU hardware and software as follows and as documented.

11.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.
- Preferred equipment schedule.
- General electrical requirements.
- Low and extra low voltage power systems.

11.1.3 Standard

General Programmable controllers: IEC61131

11.1.4 Abbreviations

PLC: Programmable Logic Controller

RTU: Remote Telemetry Unit

11.1.5 Definitions

RTU has the same meaning as PLC in the context of this worksection. Refer to schedules or drawings for equipment selections.

11.1.6 Submissions

Technical data General: Submit technical data for all components.

11.2 Products

11.2.1 General

General

Comply with Preferred equipment schedule and Electrical scope of works worksections.

PLC/RTU hardware and software

11.2.2 PLC and RTU Hardware

General

Shall be as scheduled.

General: Provide complete programmable logic controllers including central processing unit, input/output modules and mounting hardware, and which are 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.

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. Provide 80mA ceramic quick blow fuses with integral indicator on both positive and negative input connections.

Analog output: 4 to 20 mA or 0 to 10 V d.c., maximum loop resistance of 600Ω . For resistance higher than 600Ω use a loop repeater.

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

Digital output: Via interposing relay or solid state switch. Interposing relay maximum 30mA coil current

11.3 Execution

11.3.1 PLC and RTU software and programming

General

Calculations and data processing: Shall typically be completed in the RTU/PLC and not SCADA.

Consequential alarming management: Shall be completed in ClearSCADA and not in the RTU/PLC.

Sequential programming shall be constructed as follows in order to manage the size of programs to an acceptable level and to separate functions within the program applications.

- Each section of a major process, plant function or drive shall have a separate program for easy identification and program readability. See CP-30 Example 8 below.

PLC/RTU hardware and software

- Each Program block of code shall have adequate text descriptions to enable easy understanding of its purpose and function. See CP-30 Example 4 below.

Program module segregation shall be based on equipment. For example if there are three pumps then there should be a separate program module created for each pump as opposed to 3 pump programs in the same program module.

Programs shall be easily readable and contain text descriptions to identify the functions of the program and its variables. The intent is to ensure that the program content can be understood from the text descriptions.

Retained variables

Configure PLC/RTU so all set points and variables are retained on loss of power.

Programming languages

Programs shall be written in the following languages and order:

- ISaGRAF
 - All main programs shall be written in Function Block Language
 - All Functions and Function Blocks should be written in Structured Text. Structured text enables function or function block code to be transportable between vendor platforms with only minor modifications required.
- Non ISaGRAF PLCs with vendor IEC compliant programming software.
 - All main programs shall be written in Function Block Language or Ladder.
 - All Functions and Function Blocks should be written in Structured Text.

Common code.

Common process code if not supplied as an add-on shall contain:

- Real time Clock.
- 0.1s 1s, 1m, 1h, 23:59 rising edge timing pulses.
- I/O card identity and status e.g. (Good or Failed) for each I/O card.
- Quality status on each I/O card Channel (Good or Bad).
- PLC rack identity status (OK or Failed) for each I/O rack.
- PLC rack communications status (OK, Bad (CRC Errors) or Failed).
- PLC/RTU Power supply Status, Voltage and Current Levels where available.
- Battery Voltage, Temperature, Current and Low Alarm where possible for the PLC/RTU type.
- CPU status including
 - Running
 - Halted
 - Error
 - Configuration Error

PLC/RTU hardware and software

 CPU Scan time per resource should be set at an iteration cycle fraction that equals a sub multiple of 1 second for timing purposes e.g. if the actual program cycle time was 65ms set the program cycle time to extend to100ms.

11.3.2 Variables

Internal variable names

Shall be preceded by a letter to identify the variable type. Variables and I/O points should have easy to understand description fields.

- Real variable: rVariableName
- Integer variable: iVariableName
- String Variable: sVariableName
- Boolean Variable: bVariableName

I/O variables

Kingfisher RTU as per default name allocation.

SCADAPack Variable names shall be preceded by a letters to identify the variable type as follows:

PLC variable types can be either the default name allocation or a defined tag name

Master device or stand alone device examples:

- Digital Input: di1
- Digital Output: do1
- Analogue Input Real: ai8r
- Analogue Input Integer: ai8i
- Analogue Output Real: ao1r
- Analogue Output Integer: ao1i

Slave device 1 examples:

- Digital Input: sl01di1
- Digital Output: sl01do1
- Analogue Input Real: sl01ai8r
- Analogue Input Integer: sl01ai8i
- Analogue Output Real: sl01ao1r
- Analogue Output Integer: sl01ao1i

Variable Types

All analogue variable types shall be short real number format except where a program object Integer format is required.

Physical I/O points where the native format is not a real type should be mapped to a real internal variable.

Scaling of variables

Variables shall be scaled in the following precedence:

- At the physical input.
- In ISaGRAF.

PLC/RTU hardware and software

Totalisation

Shall be double integer type.

11.3.3 RTU & SCADA Communications

Peer to Peer (RTU to RTU): Use TasWater standard developed code.

Communication protocol: DNP3 shall be used for communication from RTU to RTU and RTU to SCADA system.

Communication between devices contained on site shall use Ethernet (10/100 Base-T) as the communication medium.

11.3.4 Radio Links for RTU Telecommunications

This section describes the specific requirements for SCADA/telemetry radio links within the 300 MHz to 1000 MHz frequency range; either spread spectrum, or narrow band using simple modulation techniques (e.g. 4-FSK, BPSK, QPSK). Radio links which fall outside this frequency range and/or function (e.g. backhaul microwave links, wireless access points, last-mile high capacity links), shall be subject to other design criteria which is detailed in the project-specific documentation.

Where radio end equipment for a particular link is co-located with other radio equipment, for example at a shared telecommunications facility, the potential exists for radio frequency interference to degrade TasWater or other users' services. Such installations require more detailed consideration than described here and will typically be identified in the project-specific documentation or discussed with TasWater where identified by the Contractor.

Design Documentation

Radio links shall be designed to maximise availability of the telemetry network. The following list describes the minimum required design documentation deliverables for a point-to-point (PTP) radio link. Note that a single hop (repeater-to-remote) in a point-to-multipoint (PTMP) network is classified as a PTP link:

- Radio path profile, identifying obstructions for Non Line of Sight paths.
- Radio path link budget

Design Specification

It is difficult to be prescriptive about design specifications for generic radio links as each link is subject to unique topographic and operational constraints. As a general rule the radio path link budget for the type of links under discussion, over terrestrial paths, should be constructed to yield the following fade margin:

- Fade Margin ≥ 25 dB

If it is not possible to achieve the minimum fade margin at design time then the Project Manager shall be advised. Field testing, specification of alternative equipment or design, or relaxing of the fade margin requirement may be prescribed for the specific situation.

Field Testing Requirements at Commissioning

Commissioning requirements specific to the radio link are described below. These are in addition to the usual electrical commissioning tests.

PLC/RTU hardware and software

- *Received Signal Strength (RSS) in dBm* shall be measured at the receiver terminal and recorded, at each end of the link. Measurements shall be made with test equipment with valid calibration certification. Alternatively if the end equipment provides built-in RSS measurement then that facility may be used.
 - If significant discrepancy exists between design and measured RSS, which degrades the required minimum fade margin, then the discrepancy shall be highlighted and reported to the Project Manager.
- A Bit Error Rate (BER) test shall be run end-to-end for thirty (30) minutes. A loopback test (loopback at the far-end physical data interface) is also acceptable instead of an end-to-end test. The test data shall be a Pseudo-random Bit Sequence (PRBS). Calibrated and certified equipment shall be used to perform the test. Alternatively if the end equipment provides built-in BER testing then that facility may be used. It should be noted in that case that internal BER test software does not usually test the physical data interface and may not implement a PRBS and is therefore a less stringent test.

A successful BER test is indicated by the following results.

- BER < 1 × 10⁻⁶
- Errored Seconds = 0

If the test is unsuccessful then potential causes for error shall be investigated.

Antenna Types

Standard radio installation:

For radio a 450MHz system a 6 element (9dBd) Yagi as a minimum shall be utilised at remote sites to meet the required fade margin. Higher gain antennas must be used if near site obstructions or site elevation reduces fade margin below 25dB.

Vandal proof radio installation:

For radio a 450MHz system in a designated vandal area a RFI TLA-400 series unity gain low profile antenna as a minimum shall be utilized, although a higher gain antenna must be used if near site obstructions or site elevation reduces fade margin below 25dB.

Standard NextG modem installation:

For NextG modem installations the minimum antenna would be that supplied with the modem within the cabinet, signal dependant. Higher gain external antennas (e.g. RFI COL2195) must be used if near site obstructions or site elevation reduces fade margin below 25dB.

Vandal proof NextG modem installation:

For NextG modem installations in a designated vandal area an RFI CSM900 panel mount antenna should be used as long as the signal strength is sufficient.

Mast requirements:

RF Mast design shall provide for wind loading appropriate to the site antenna and cabling to be located on or within the mast.

Antenna Installations (except vandal proof installations)

The antennas and clamps used must be aluminium or galvanised iron. The antenna shall be mounted at least 4m above ground level and not able to be reached by a 2m tall adult standing on any surrounding structure or tree.

PLC/RTU hardware and software

The antenna shall be mounted vertically polarised and aligned to point directly at the appropriate radio repeater sites with the drain hole within the antenna element facing the ground for moisture drainage.

The RF cabling must be looped to remove any strain on the RF connectors.

All antenna installation works shall comply with OH&S working from heights procedure; a JSA must be completed by the installer and provided to TasWater prior to any site works, overhead cables clearance must be maintained away from any communications or power cables in the area. Free space must be allocated for the antenna and mast this must not protrude on roadway, overhead wires, outside the boundary of the easement, or anywhere that could be considered a safety hazard. If an antenna cannot be lowered from the ground, then an appropriate elevated platform vehicle or scaffolding must be used. Extra care must be taken when handling the antenna and masts where there are overhead electrical cables. Antenna shall not be mounted within approach limits of power lines, to be safe, maintain 2m clearance from exposed electrical power lines This clearance should be maintained to personnel and antenna elements during installation.

For antennas less than 6m high, the mast may be fixed to the site cubicle, the antenna mast extending above the cubicle shall be galvanised and at least 32mm in diameter. The antenna mount fixed to the cubicle shall be at least 38mm in diameter and powder coated steel and to match the colour of the cubicle. The height of the antenna mounting shall be at least 300mm above the height of the cabinet. The mounting plates shall also be powder coated steel to match the colour of the cubicle. For antennas between 6 and 12m, the mast must be galvanized steel free standing and on an independent foundation suitable for the purpose. Trees near the antenna, especially directly in front of the antennae will cause low signal strength. This will become worse when the tree is wet. Trees should be kept trimmed.

Antenna RF Feeder cable shall be RG213 or RG8 for lengths of up to 10m, RG8 cable must used for cable lengths above 10m due to its lower attenuation and LDF4-50 for lengths from 10-20m. Cable calculations should be completed in conjunction with path loss at each site so as to maintain a fade margin of > 25dB. A bulkhead lightning arrestor shall be fitted and suitably earthed. A solid earth must be provided to the common ground point. The feeder RF Coaxial Cables shall be terminated with an N-Type Male connector and connected to the lightning arrestor. A coaxial fly lead must be provided with an N-Type Male connector to the lightning arrestor and the radio.

All external antenna connections are to be wrapped in self amalgamating tape.

Once the RF feeder installation is complete a Standing Wave ratio (SWR) test is to be conducted resulting in "nil" reverse power.

Radio Repeater Installations

Provide radio repeater installations as documented.

Equipment Requirements

All telecommunications equipment installed shall be A-Tick approved.

11.3.5 SCADA polling

Definitions: Class 0 (Background integrity poll); Class 1 (Unsolicited) Class 2 (Stored with time stamp till polled or buffer exceeded).

Execution:

- Class 0: Poll every 5 minutes (all points returned Class 0, 1, 2 and 3).

PLC/RTU hardware and software

- Class 1: Points involved with events and status changes (i.e. most points) set to Class 1 and enable "unsolicited reporting".
- Class 2: Non critical points (e.g. totalisers, some analog values) set to Class 2, report by exception with suitable dead bands. Minimum buffer size 1000 events. Size buffer to suit project.
- Class 3: Points involved with peer to peer communications

11.3.6 System points

System point RTU data: Use TasWater standard developed code.

11.3.7 Program documentation

Functional descriptions shall contain:

- Alarm conditions and tag names.

I/O and SCADA point identification: Tag, variables and SCADA points shall be entered into the provided spreadsheet template. Submit for approval.

Flow Chart: A flowchart or functional description shall be provided to identify the program operation. The flowchart shall be produced n Microsoft Office or AutoCAD

11.3.8 Submissions

A draft copy of the PLC/RTU program shall be supplied for review and final approval and a copy of the program shall be provided to TasWater in electronic format on completion of the project.

11.3.9 Completion

Maintenance

General: Carry out the following:

Rectify faults, make adjustments and replace consumable and faulty materials and equipment within 24 hours of notification.

11.3.10 Marking and labelling

General

General: Provide labels including rack and equipment identification.

11.3.11 Functional Tests

FAT of the RTU should be verified for all functional requirements to reduce commissioning time.

SAT of the RTU should be verified for all functional requirements. Include testing of all software functions including:

- Inputs and Outputs

FAT's and SAT's shall be recorded in the ITC's. Provide in electronic format.

PLC/RTU hardware and software

11.4 Selections

Refer to Preferred equipment schedule worksection.

11.5 **Programming Examples**

General

Comments: Provide detailed comments for each variable, function and discrete section of code.

11.5.1 Kingfisher CP30

All new projects developed on a Kingfisher CP-30 shall utilise the TasWater programming template containing common process code. TRIM Link to be advised.

For all CP-30 programming note the following:

- All DNP variables need to have their Quality bit set manually. This can easily be done in a Structured Text Language(STL) Programmable Organisational Unit (POU) by including the following line for each point (with appropriate changes for object type and address) ... DNPBI1024.flags := 1;
- All Binary Output points (SCADA to RTU) are to be reset in the RTU after a suitable time delay. Don't rely on ClearSCADA to reset it will set the bit only.
- If Function Block Diagram (FBD) language used in a POU do NOT use edge-triggered ladder logic inputs (i.e. -|p|- or -|n|-) as they can cause unpredictable behaviour. Always use a normal input followed by an r_trig or f_trig FB as appropriate.
- Each DNP event variation object shall be configured as 'with time / without status'

The following are examples the expected code structure

Example 1 Mapping of SCADA DNP Points to I/O Points



Example 2 Mapping of I/O Points to SCADA DNP Points with scaling and description using Structured Text

PLC/RTU hardware and software

(* ST program To Convert Analogue I/O to DNP variables ranged O-Range in EU *)

(* Kingfisher AI10 Analogue Input Card 1 *)

DNPAI0.value := (ANY_TO_REAL (SL34AI10AI1.value)/546.13); (* RW Inlet Flow 0-601/s DNPAI1.value := (ANY_TO_REAL (SL34AI10AI2.value)/10922.0); (* Actifloc Filter Diffe DNPAI2.value := (ANY_TO_REAL (SL34AI10AI3.value)/327.68); (* Town WaterOutlet Flow DNPAI3.value := (ANY_TO_REAL (SL34AI10AI3.value)/327.68); (* EW Inlet Flow 0-300/s DNPAI4.value := (ANY_TO_REAL (SL34AI10AI5.value)/468.1); (* Cl2 Drum 1 Weight 0-7 DNPAI5.value := (ANY_TO_REAL (SL34AI10AI6.value)/468.1); (* Cl2 Drum 1 Weight 0-7 DNPAI5.value := (ANY_TO_REAL (SL34AI10AI6.value)/468.1); (* Cl2 Drum 2 Weight 0-7 DNPAI5.value := (ANY_TO_REAL (SL34AI10AI6.value)/468.1); (* Cl2 Drum 2 Weight 0-4 DNPAI7.value := (ANY_TO_REAL (SL34AI10AI6.value)/468.1); (* Cl2 Drum 2 Weight 0-4 DNPAI7.value := (ANY_TO_REAL (SL34AI10AI8.value)/13653.0); (* Alum Tank Level 0-2.4) (* Kingfisher AI10 Analogue Input Card 2 *)	* r Pressure 0-3m * 0-1001/s * 0kg * 0kg * m *
DNPAI8.value := (ANY_TO_REAL (SL35A110AI1.value)/4096.0); (* TW Storage Level 0-8 DNPAI9.value := (ANY_TO_REAL (SL35A110AI2.value)/25206.0); (* Flouride Tank Level DNPAI10.value := (ANY_TO_REAL (SL35A110AI3.value)/327.68); (* Blower Pressure 0-10 DNPAI11.value := (ANY_TO_REAL (SL35A110AI3.value)/2553.6); (* Actifloc Tank Level DNPAI12.value := (ANY_TO_REAL (SL35A110AI5.value)/25206.0); (* Poly Dose Tank Level DNPAI13.value := (ANY_TO_REAL (SL35A110AI6.value)/25206.0); (* Poly Dose Tank Level DNPAI14.value := (ANY_TO_REAL (SL35A110AI5.value)/25206.0); (* Poly Batch Tank Leve DNPAI14.value := (ANY_TO_REAL (SL35A110AI7.value)/32768.0); (* Soda Ash Dose Tank L DNPAI15.value := (ANY_TO_REAL (SL35A110AI8.value)/32768.0); (* Soda Ash Storage Tan	m *) 0-1.3m *) 0kPa *) 0-5m *) 0-1.3m *) 1 0-1.3 *) evel 0-1m *) k Level 0-1m *)

Example 3 Representation of variables

Name	Туре	Initial value	D Group	Attribute	Scope	Direction	Retain	Comment	
iConstant327	DINT	327	Irtegers	Read	Global	Internal	No	In:eger Constant Value 327	
iConstant60	DINT	60	Integers	Read	Global	Internal	No	In:eger Constant Value 60	
i60SecondCounter	DINT	0	Integers	Free	Global	Internal	No	Value of 60 Second Counter	
i60MinuteCounter	DINT	0	Intecers	Free	Global	Internal	No	Value of 60 Minute Counter	

- 10		

Name	Туре	Initial value	D	Group	Attribute	Scope	Direction	Retain	Comment
rBlowerPALSp	REAL	10.0		Reals	Free	Global	Internal	No	Blower Low Pressure Setpoint
rConstant327p68	REAL	327.68		Reals	Read	Global	Internal	No	Real Constant 327.68
rConstant3p0	REAL	3.0		Reals	Read	Global	Internal	No	Real Constant 3.0
rBWLowFlowSp	REAL	10.0		Reals	Free	Global	Internal	No	BW Flow Low Setpoint
rBWTank1BWLSp	REAL	0.5		Reals	Free	Global	Internal	No	BW Tank 1 BWL SP
rBWTank1LAH	REAL	1.9		Reals	Free	Global	Internal	No	BW tanks 1 Level Alarm High SP
rBWTank2BWLSp	REAL	0.5		Reals	Free	Global	Internal	No	BW tanks 2 Bottom Water Level SP
rBWTank2LAH	REAL	1.9		Reals	Free	Global	Internal	No	BW tanks 2 Level Alarm High SP
rConstant0p1	REAL	0.1		Reals	Read	Global	Internal	No	Real Constant 0.1
rConstant0p5	REAL	0.5		Reals	Free	Global	Internal	No	Real Constant 0.5

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PLC/RTU hardware and software

Timers								
Name	Туре	Initial value	D Group	Attribute	Scope	Direction	Retain	Comment
tOneHourTimeSp	TIME	t#60m	Time's	Read	Global	Internal	No	One Hour Time SP
tOneSecondTimeSp	TIME	t#1s	Times	Read	Global	Internal	No	One Second Time SP
tOneMinuteTimeSp	TIME	t#1m	Times	Read	Global	Internal	No	One Minute Time SP
tThirtySecondTimeSp	TIME	t#30s	Times	Read	Global	Internal	No	Thir:y Second Time SP
tTenSecondTimeSp	TIME	t#10s	Times	Read	Global	Internal	No	Ten Second Time SP
tTwentySecondTimeSo	TIME	t#20s	Times	Read	Global	Internal	No	Twenty Second Time SP
tTenSecElapsedTime	TIME	t#Os	Timers	Free	Global	Internal	No	Ten Second Elapsed Time Value
tFifteenSecondTimeSp	TIME	t#15s	Time's	Read	Global	Internal	No	Fifteen Second Time SP
tBWReclaimTimeSP	TIME	t#600s	Times	Free	Global	Internal	No	BW Reclaim Settling Period SCADA SP
tBWReclaimElapsedTime	TIME		Times	Free	Global	Internal	No	BW Reclaim Time Elapsed Time
tBWSeqBWPumpsElapsedTime	TIME		Time's	Free	Global	Internal	No	BW Seq BW Pumps Elapsed Time
tNinetySecTimeSp	TIME	t#90s	Times	Free	Global	Internal	No	Ninety Second Timer SP
tThreeMinuteTimeSp	TIME	t#3m	Times	Read	Global	Internal	No	Three Minute Timer SP
tBWSeqPumpsTimeSP	TIME		Time's	Free	Global	Internal	No	BW Sequ Pumps Duration SCADA SP
tFiveSecondTimeSP	TIME	t#5s	Time's	Free	Global	Internal	No	Five Second Time SP

Example 4 Function Block Language layout examples



PLC/RTU hardware and software



Example 5 Creating a pulse effect from the SCADA using Structured Text

```
(* Program to Create a Pulse effect on SCADA Outputs *)
(* Plant Manual Start Pulse *)
TON1 ( DNPB01.value , tFiveSecondTimeSp );
    IF (TON1.Q) THEN
        DNPB01.value:= FALSE ;
    END_IF;
(* Alum P1 Manual Start/Stop Pulses *)
TON11 ( DNPB011.value , tFiveSecondTimeSp );
    IF (TON11.Q) THEN
        DNPB011.value:= FALSE ;
    END_IF;
TON12 ( DNPB012.value , tFiveSecondTimeSp );
    IF (TON12.Q) THEN
        DNPB012.value := FALSE ;
    END_IF;
```

Example 6 Map SCADA status and alarm points from internal variables using Structured Text

PLC/RTU hardware and software

(* DNP Status and Alarm Points Mapped	from Internal ISaGRAF Points *)
DNPBI0.value:=bAFPlantStartStop; DNPBI1.value:=SL06DI5DI15.value; DNPBI2.value:=bAFPlantAlarm;	(* Actifloc Plant Running *) (* Actifloc Plant Emergency Stop Alarm *) (* Actifloc Plant Fault *)
DNPBI3.value:=NGT(SL04DI5DI1.value); DNPBI4.value:=SL11DI5DI2.value;	(* TW P1 Power *) (* TW P1 Remote Mode *)
DNPBI5.value:=SL11DI5DI1.value;	(* TW P1 Local Mode *)
DNPBI6.value:=AU:(SL04D15D12.value); DNPD17.value:=ATUP1P(;	(* TW P1 O/L Fault *) (* TW Purp 1 Cogurad Fault *)
DNPBI8 value:=bTWP1R5;	(* IW Fump I Sequence Fault *) (* TW P1 Stop Sequence Fault *)
DNPBI9.value:=bTWP1R7:	(* TW P1 Local Run Alarm *)
DNPBI10.value:=SL04DI5DI3.value;	(* TW P1 Status *)
DNPBI11.value:=bTWP1R4;	(* TW P1 Spare *)
DNPBI12.value:=NOT(SL04DI5DI6.value);	(* TW P2 Power *)
DNPBII3.value:=SLIIDI5DI4.value;	(* IW F2 Kemote Mode *) (* TH P2 Teast Mede *)
DNPBI14.value.=SLIDISDIS.value, DNPBI15.value:="OC(SI04DISDI7.value).	(* IW F2 LOCAI MODE *) (* TW P2 A/I Fault *)
DNPBI16.value:=bTWP2R6:	(* TW P2 Sequence Fault *)
DNPBI17.value:=bTWP2R5;	(* TW P2 Stop Sequence Fault *)
DNPBI18.value:=bTWP2R7;	(* TW P2 Local Run Alarm *)
DNPBI19.value:=SL04DI5DI8.value;	(* TW P2 Status *)
DNPBI20.value:=bTWP2R4;	(* TW P2 Spare *)
DNPB121.value:=::O:(SLU4D15D111.value); DNPB122.value:=:O:(SLU4D15D12.value);	(* Backwash Pl Power *) (* Deelwash Di Dewete Wede *)
DNPBI22.Value:=SL09DISDI2.Value;	(* Backwash Fi Kemote Mode *) (* Packwash Pi Tosal Mode *)
DNPBI23.value:=X000D15D11.value;	(* Backwash FI LOCAI Mode *) (* Backwash P1 O/I *)
DNPBI25.value:=SL08DI5DI13.value:	(* Backwash P1 VSD Fault *)
DNPBI26.value:=bBWP1R6;	(* Backwash P1 Sequence Fault *)
DNPBI27.value:=bBWP1R5;	(* Backwash P1 Stop Sequence Fault *)
DNPBI28.value:=bBWP1R7;	(* Backwash P1 Local Run Alarm *)
DNPBI29.value:=bBWP1R3;	(* Backwash P1 Status *)
DNPB130.value:=DBWP1R4; DNDD121.malue:=NO(2/CL00DIED112.malue).	(* Backwash Pl Spare *)
DNPBI31.Value:=CO:(SLU9DISDI12.Value); DNPBI22.walue:=ST09DISDI4.walue:	(* Backwash F2 Fower *) (* Backwash P2 Remote Mode *)
DNPBI33 value:=SI09DI5DI3 value:	(* Backwash 12 Kemote Hode *) (* Backwash P2 Iocal Mode *)
DNPBI34.value:=(CT(SL09DI5DI13.value))	(* Backwash P2 $0/L$ *)
DNPBI35.value:=SL08DI5DI15.value;	(* Backwash P2 VSD Fault *)
DNPBI36.value:=bBWP2R6;	(* Backwash P2 Sequence Fault *)
DNPBI37.value:=bBWP2R5;	(* Backwash P2 Stop Sequence Fault *)
DNPBI38.value:=bBWP2R7;	(* Backwash P2 Local Run Alarm *)

Example 7 Control quality Bits to SCADA Status and alarm points using Structured Text

(*	Set	Quality	Flags	to	1	*)	

(*	DNP	Boolean In	nputs *)
DNE	BIO	flags := 1	;
DNE	PBI1.	flags := 1	.;
DNE	PBI2.	flags := 1	.;
DNE	PBI3.	flags := 1	.;
DNE	PBI4.	flags := 1	.;
DNE	PBI5.	flags := 1	.;
DNE	PBI6.	flags := 1	.;
DNE	PBI7	flags := 1	.;
DNE	PBI8	flags := 1	.;
DNE	PBI9	flags := 1	
DNE	PBI10).flags :=	1;
DNE	PBI11	.flags :=	1;
DNE	PBI12	flags :=	1;
DNE	PBI13	flags :=	1;
DNE	PBI14	.flags :=	1;
DNE	PBI19	flags :=	1;
DNE	BILE	.tlags :=	1;
DNE	BII	(.tlags :=	1;
DNE	'BI18	(.flags :=	1;
DNE	BIL	.flags :=	1;
DNE	BIZU	ltlags :=	1;
DNF	B121	Ilags :=	1;
DNE	B122	(ilags :=	1;
DNE	B123	().flags :=	1;
DNF	B124	.ilaqs :=	I)

PLC/RTU hardware and software





SCADA

12 SCADA

12.1 General

12.1.1 Responsibilities

General

General: Provide SCADA systems as documented in the Electrical Scope of Works and references within.

Instrumentation

13 Instrumentation

13.1 General

13.1.1 Aims

Responsibilities

General: Provide instruments as follows, documented and install to manufacturer's requirements.

Provide transmitter with integral output displays for each instrument for localised reading and transmitter outputs for connection to input/output (I/O) modules and remote monitoring on SCADA systems.

Provide cabling and connection to local I/O modules with concealed cabling routes where practical.

Provide power and/or supplies to all items scheduled.

Provide calibration as further documented.

13.1.2 Standards

General To manufacturers requirements.

13.1.3 Cross references

Associated worksections

Conform to the following:

- General electrical requirements.
- Preferred equipment schedule.
- Low and extra low voltage power systems.
- Cable support and duct systems.

13.1.4 Interpretation

Abbreviations

General: For the purposes of this contract the abbreviations given below apply.

- I/O: Input Output

Definitions

General: For the purposes of this contract the definitions given below apply.

- I/O module means either a PLC or RTU or stand alone input output interface.
- Transmitter. Means signal converter from instrument and display unless otherwise noted.

13.1.5 Power supply units

Provide and connect each instrument to the electrical supply to manufacturers specifications.

Surge reduction filters shall be provided to protect all instrument power supplies.

Instrumentation

13.1.6 Surge protection devices

Refer to standard surge protection drawing TBA I/O WIRING DIAGRAM EXAMPLES.

Surge protection devices: As scheduled in the *Preferred equipment schedule* worksection.

Earth: Separate earth to AS3000:2007 Section 5.8.

13.1.7 Cabling

Refer to Low and extra low voltage power systems worksection.

13.1.8 I/O interfacing

Connect transmitter I/O, as listed in the Preferred Equipment Schedule, to the local RTU/PLC. As a minimum provide a 4-20mA process signal and fault signal. Outdoor instrument enclosures

All electrical components, terminals, linkages, surge protection, displays, transmitters, etc. of outdoor instruments shall be contained in an IP65 or greater 316 stainless steel enclosures unless otherwise noted in the schedule.

13.2 Execution

13.2.1 As installed submissions

General: Submit manufactures documentation, maintenance and calibration manuals.

13.2.2 Calibration

Calibrate all instruments on site during commissioning. Include local operators during calibration to assist with training.

Instrument Calibration Certificates shall be submitted to the Superintendent for all installed instrument devices establishing the overall accuracy of the devices from primary element to the output signal.

Calibration Certificates shall also be submitted for all test and measurement equipment used to calibrate the field instruments.

13.3 Selections

Refer to Preferred equipment schedule worksection.

Telecommunications cabling

14 Telecommunications cabling

14.1 General

14.1.1 Responsibilities

General

General: Provide a passive telecommunications cabling network system as follows and as documented.

14.1.2 System description

Network connection

General: Provide network connection as documented.

Building distributor

General: Provide building distributor as documented.

Backbone cabling

General: Provide backbone cabling as documented.

Telecommunications outlets

General: Provide telecommunications outlets as documented.

Patching

General: Provide patching of telecommunications outlets and equipment as documented.

Surge protection devices (SPD)

General: Provide inline SPD to protect final equipment in racks and cabinets. Refer to *Preferred equipment schedule* worksection for selections.

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.

System performance

All structured cabling components shall be from the one manufacturer, i.e. a single vendor solution and covered under one Certification.

Application class to AS/NZS 3080 clause 6.3: E.

Balanced system to AS/NZS 3080 clause 7 (data): Category 6.

Balanced system to AS/NZS 3080 clause 7 (voice): Category 6.

Fibre system class: To AS/NZS 3080 clause 8.

System warranty: 15 years minimum.

14.1.3 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.

Telecommunications cabling

- Preferred equipment schedule.
- General electrical requirements.
- Cable support and duct systems.
- Low and extra voltage power systems.

14.1.4 Standards

General

Authorities: To the requirements of the Australian Communications and Media Authority (ACMA).

Cabling products: To AS/ACIF S008 and AS/NZS 3080.

Installation of cabling: To AS/ACIF S009, AS/NZS 3080, AS/NZS 3084, SAA HB 29 and SAA HB 243.

Installation of small office/home office cabling: To AS/ACIF S009, AS/NZS ISO/IEC 15018 and SAA HB 29.

Cable management and documentation: To AS/NZS 3085.1.

EMC: To the recommendations of AS/NZS 3080.

14.1.5 Interpretation

Abbreviations

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

- ACR: Attenuation to cross-talk ratio
- CES: Communication earth systems.
- CET: Communications earth terminal
- ELFEXT: Equal level far end cross talk
- EMC: Electromagnetic compatibility.
- EMI: Electromagnetic interference.
- EMR: Electromagnetic radiation.
- FEXT: Far end cross talk
- MDF/BD: Main Distribution Frame / Building Distributor
- MM(OF): Multi-mode (optical fibre)
- NEXT: Near end cross talk
- OM1: MMOF 62.5µm (usually) or 50µm in size 100Mb/s to 2000m, 1Gb/s to 275m and 10Gbit/s to 33m
- OM2: MMOF 62.5µm or 50µm (usually) in size 100Mb/s to 2000m, 1Gb/s to 550m and 10Gb/s to 82m
- OM3: MMOF 50µm in size -1Gb/s to 1000m, 10Gbits/s to 300m and 100Gbits/s to 100m
- OM4: MMOF 50µm in size 1Gb/s to 1000m, 10Gb/s to 550m and 100Gbits/s to 150m
- OS1: SMOF 9µm in size e.g. 10Gb/s to 10km
- OTDR: Optical time domain reflectometer
- PoE: Power over Ethernet
- RU: Rack unit.
- SM(OF): Single-mode (optical fibre)
- STP: Shielded twisted pair
- TRC: Telecommunications reference conductor.
- UTP: Unshielded twisted pair
- WAP: Wireless access point

Telecommunications cabling

14.1.6 Submissions

Technical data

General: Submit technical data including the following:

- System design parameters: Performance.
- Voice and/or data transfer rate.
- Cable type and characteristics.
- Segregation requirements for EMI/EMR.
- Maximum length of cables.
- Cross-connect type and characteristics.
- Cross-connect block.
- Patch cords.
- Fibre optic terminations.
- Patch panel module.
- Cable management for racks.
- Rack.
- Fly leads.

Shop drawings

General: Submit showing the following for approval:

- Layouts of equipment racks.
- Cross-connect layout.
- Cabling diagram for complete system.
- Cable management system.

Certification

General: Submit product and installation certification for the installation.

14.2 Products

14.2.1 Network termination

Network termination device

General: Provide network termination device as documented.

14.2.2 Distributors

Equipment racks

General: Provide equipment racks as scheduled in the Electrical scope of works worksection.

Cross connect patch panels

General: Provide cross connect patch panels as documented.

Density: Modular 24 port angled 1RU patch panels for 19" racks

Terminations: Terminate directly to the modular connector.

Fixed terminations:

Telecommunications cabling

- Front terminals: RJ45 modular connector.

Patch cords: Terminate cord ends with appropriate registered jacks.

Optical fibre termination panels

Break out trays: Provide fibre optic cable break out trays at each group of fibre optic cable terminations.

Loom cables: Neatly loom cables and lay stripped cables into the break out tray.

Secure cables: Make sure that cables are secured by the sheath and that there is no stress on the fibre optic cores.

Fibre Ports: All unpatched fibre ports shall have a dust covers fitted.

Warning labelling: All fibre termination enclosures shall be labelled with laser radiation warning labels.

Cable management

Record book: Provide a record book at each cross-connect.

Location: Secure log books in each distribution frame records holder.

Identification, labelling, and record documentation: To AS/NZS 3085.1.

14.2.3 Cables

Copper Standard: To AS/ACIF S008.

Balanced system cables: UTP.

Fibre Standard: To IEC 60793-2-10.

Default type: Refer to equipment schedule

Up to 300m in length - OM3 or OM4

>300m in length – OS1

Length: Provide \geq 3m spare at each end. 1.5m spare at each pit (subject to minimum bend radius requirements)

Component type: LC for Multimode and SC for Single Mode

Safe practices: To AS/NZS 2967.

External Standard: Water penetration resistance to IEC 60794-1-2.

14.2.4 Telecommunications outlets

General

Outlets: Provide RJ45 8 way modular jacks except where documented otherwise.

Shuttered Outlets: In high dust environments, shuttered outlets shall be provided.

Standard: To AS/ACIF S008.

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Telecommunications cabling

Pinouts: T568A to AS/NZS 3080

14.2.5 Fly leads

General Type: Stranded.

Length: 1200 mm.

Quantity: Provide fly leads to 50% of outlets installed.

14.2.6 Patch cords

General Type: Stranded.

Length: 500 mm minimum.

Quantity: 100% of outlets installed.

Fibre: All unused patch cords shall be fitted with dust caps.

Termination: Registered jacks.

Colour

UTP Cable Type	Colour
Standard Data Patch Cable	Blue
Telephony Patch Cable	White
SCADA Patch Cable	Yellow
Equipment Cross-over Data Patch Cable	Red
VLAN Trunk, Server, Wireless Access Point Patch Cable	Green

Fibre Type	Cable	Connector
Multi-Mode 50µm (OM3/4)	Aqua	LC
Single Mode 9µm (OS1)	Yellow	SC

50 μm MMFO patch cables shall not be connected to 62.5 μm and vice versa

Telecommunications cabling

14.3 Execution

14.3.1 General

General

Standard: To AS/NZS 3084, AS/NZS 3080 and AS/ACIF S009.

Procedure: The space requirements as documented take precedence over the specific space requirements of AS/NZS 3084.

Terminate: All cable cores.

Equipment Racks: Unless otherwise specified all active equipment, patch panels and fibre optic termination enclosures shall be housed within 19" racks enclosed within a cabinet as per the preferred equipment schedule.

14.3.2 Cables

Installation

General: To manufacturers recommendations.

Crossover: Install cables neatly and without crossovers between cables.

Loom size: Loom cables into groups not exceeding 50 cables, and hold looms in place using Velcro cable straps at least 20 mm wide. Do not exert compressive force on the cables when installing cable straps.

Cable Management

Horizontal cable management shall be installed.

Vertical cable management is to be used in open racks and cabinets.

Overhead cable management is required to connect all Racks in a multiple installations. The overhead cable management shall be sized to accommodate sufficient 4 pair cables to completely populate a fully loaded rack.

Cable separation

For safety: To AS/ACIF S009, and by at least 150 mm.

Electromagnetic interference (EMI): To SAA HB 29.

Fluorescent luminaires: Maintain a clearance of \geq 300 mm.

External cables

External cables: To ACIF C524.

All external cables to be reticulated underground in conduit unless specified otherwise.

14.3.3 Telecommunications outlets

General

Each outlet location (or Wireless Access Point) shall have a minimum of 2 outlets installed, terminated and tested.

Installation

Mounting: Flush mount. Each outlet shall be installed with the key at the bottom of the jack and the conductors at the top to prevent dust contaminating the conductors.

Telecommunications cabling

Termination: All outlets shall be installed and terminated to the T568A wiring scheme.

Strain Relief: Cable entry strain relief point to the outlets shall be at the rear of each jack.

Style, material and colour of plates: To match adjacent power and switch plates.

14.3.4 Earthing system

General

Standard: to AS/ACIF S009 and SAA HB 29.

Communication earth system

Communication earth system (CES): Provide a communications earth terminal (CET) adjacent to each electrical switchboard. Connect the CET to the local protective earth (PE) system at the switchboard.

Distributor: Provide an earth bar within each distributor and connect to the local CET in accordance with SAA HB 29.

Interconnections: Verify that there are no interconnections between the lightning protective earthing system and the telecommunications earthing system.

Telecommunications reference conductor (TRC)

Provide TRC system and connect to each telecommunications distributor. If a TRC is required to reduce signal noise, specify which distributors are to be connected and the method to be used by reference to AS/ACIF S009.

14.3.5 Labels

Labelling Site Code: Asset ID

Rack Numbers: Each rack/cabinet on site will be assigned a sequential rack number prefixed by the Asset ID.

Example: CD101-R01

Telecommunications cables: Label cross-connects and outlets in accordance with the requirements of AS/NZS 3080 and SAA HB 29 Figures 5 – 18.

Labels on CATx cables will be a 24mm wide wrap around label made of flexible nylon tape. An approved example is the RHINO Flexible Nylon Tape P/N1734524.

(http://global.dymo.com/enAU/LabelsOverview/Flexible_Labels.html). An alternative can be used after a sample is submitted to TasWater and approved.

Label to indicate the origin and destination of the cable and at every pit.

Example:

CATx Cable: Each data cabling run will be labelled sequentially (starting from one). Regardless of what the use of the cable is data, phone or other, the label will be prefixed with the Rack number. Example of running a new data outlet back to the existing comms rack in the Ops Building at Forth, the last outlet is 234.

Rack No. + Cable No.

Rack: R01

Telecommunications cabling

Outlet label: R01-234

Cable label: R01-234

Fibre Optic Cable Labels: Labels on fibre optic cable will be a 9 x 70mm Sleeved Cable Marker. An approved example is Part Number PMT-CT9X70, with black text on a yellow background from Industrial Labelling (http://www.industriallabelling.com.au). An alternative can be used after a sample is submitted to TasWater and approved.

Optic fibre cables that link sites will be given an identification number and recorded in the spatial geo database. The cable shall be labelled at each termination point, at each entry/exit point of racks, where cables run in cable trays the cable will be labelled at each entry/exit point and each pit that the cable passes through.

Example running a new 24 core single mode OS1 cable between Charles Street and Ti-Tree sites, next available fibre cable number in the Rack Log book is 5.

Site Code + Originating Rack ID + Fibre Type +No. Cores+ Cable No. + Destination Site ID + Destination Rack ID

Site Code: CHARL

Originating Rack ID: R01

Fibre Type: Single Mode = OS1 or Multimode = OM3 or OM4

No. Cores: 24

Cable No: 005

Destination Rack ID: R02

Fibre Termination label: CHARL-R01-OS1-24-005-TITREE-R02

Optic fibre cables that link racks on sites will be given an identification number and recorded on a site plan of the cabling pathway. The cable shall be labelled at each termination point, at each entry/exit point of racks, where cables run in cable trays the cable will be labelled at each entry/exit point and each pit that the cable passes through.

Example running a new 24 core Multi Mode (MM) OM4 cable back to the existing comms rack in the Ops Building at Charles Street, next available fibre cable number in the Rack Log book is 6.

Site Code + Originating Rack ID + Fibre Type +No. Cores+ Cable No. + Destination Rack ID

Site Code: CHARL

Originating Rack ID: R01

Fibre Type: Single Mode = OS1 or Multimode = OM3 or OM4

No. Cores: 24

Cable No: 006

Destination Rack ID: R02

Fibre Termination label: CHARL-R01-OM4-24-006-R02

Telecommunications cabling

Outlets: Label to show the origin of the cross-connect, the workstation or outlet number and the port designation.

Patch Leads: All UTP patch leads will be labelled sequentially and a label attached to each end of the patch lead (as per example illustrated).

All fibre patch leads will be labelled sequentially.

Optical Device Hazard Warning: A warning notice detailing the hazards associated with optical devices shall be affixed to each termination enclosure in a prominent position.

Label type table

Component	Label scheme	Туре
Cables	Origin and destination (150mm from cable ends)	Self adhesive – wrap on
Cross-connects	Port Number	Proprietary
Outlets	SAA HB 29 Fig 5-18	Engraved plate
Wall boxes	SAA HB 29 Fig 5-18	Engraved adhesive label
Patch cords	Type of service	Colour code

14.3.6 Testing

Standards

Testing of balanced cabling systems: To AS/NZS IEC 61935.1 and AS/NZS 3080:LR for permanent link.

Testing of patch cords: To AS/NZS IEC 61935.2.

Fibre Optic Cable Testing: To follow AS/NZS 14763-3 OLTS and OTDR

General

General: Carry out 100% channel tests. All required test equipment must be supplied and copies of current calibration certificates provided.

All fibre cores shall be terminated and tested at installation.

Tests: To AS/NZS 3080 in conformance with SAA HB 29 Include the following:

- Basic Link and Channel transmission tests including the following:
 - Wire map.
 - Length.
 - Characteristic Impedance
 - Attenuation / Insertion Loss.
 - DC Loop resistance
 - NEXT (both directions).
 - FEXT (both directions).
 - ACR.
 - Propagation delay (both directions).

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- Delay skew.
- Power sum NEXT (both directions).
- Power sum FEXT (both directions).
- Power sum ACR.
- ELFEXT.
- Power sum ELFEXT (both directions).
- Return loss (both directions).
- Optical fibre cable: Carry out Basic Link transmission tests including the following:
 - Length.
 - Attenuation.
 - All Multimode fibre links shall be tested with a Optical Loss Test (e.g. FLUKE DSP-4XXX or DTX series Digital Cable Analyser) at both 850nm and 1300nm in both directions.
 - All Single mode fibre links shall be tested with an OTDR (e.g. FLUKE DSP-4XXX or DTX series Digital Cable Analyser) at both 1310nm and 1550nm in both directions.
 - Tests shall include OTDR testing in both directions.
 - Results shall reflect loss, length, fibre identification and the number and type of connectors and splices used in the fibre link.
 - Expected loss budget Calculation results shall be included as a direct comparison to the actual test results.

14.3.7 Completion

Cable management

General: Before practical completion submit log books for each distribution frame with details of cable terminations and provisions for recording cable, line and jumper information.

Identification and labelling, and record documentation: To AS/NZS 3085.1.

Record Documentation to include;

- Communications cable routes accurately marked on site drawings
- A1 size floor plans on AutoCAD format showing equipment and outlet locations
- Cabinet layout diagrams
- Structured Cabling System frame layouts
- Certification and Application Guarantee
- ACMA Certificate of Compliance TCA-1
- Test reports for copper cable
- Test reports for optical fibre cable

One bound and one soft copy of all documentation shall be provided.

14.4 Selections

14.4.1 System description and selections

Refer to *Electrical scope of works* worksection.

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15.1 General

15.1.1 Responsibilities

General

General: Provide proprietary packaged stand-by generating set(s) as documented, incorporating the following on a single skid base:

- Engine cooling system.
- Combustion air system.
- Exhaust system.
- Liquid fuel system.
- Acoustic enclosure.
- Control system.
- Connection to low voltage power system.

15.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works
- Preferred equipment schedule
- General electrical requirements.
- Liquid fuels.
- Low and extra low voltage power systems.
- Switchboards proprietary.
- Switchboards custom-built.
- Custom built control and marshalling panels.
- Switchboard components.

15.1.3 Standard

General

General: For the purpose of this worksection, conformance to the following standards relating to stand-alone systems is also applicable to those systems which are to be connected to the network supply:

- Stand-alone power systems: To AS/NZS 4509.1 and AS/NZS 4509.2.
- Standards: To AS/NZS 3010

15.1.4 Interpretations

Definitions

Net continuous rated output (or prime rating): Net continuous electrical output available at alternator terminals, not including the electrical power consumed by the generating set's dependent and essential auxiliaries.
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Net short-time rated output (or stand-by rating): Net electrical output available from the generating set for 1 hour in every 12 hours at net continuous rated output, not including electrical power consumed by the generating set's dependent and essential auxiliaries.

Start response time: Total elapsed time from receipt of start signal to final connection to load.

15.1.5 Submissions

Technical data

General: Submit technical data including the following:

- Technical description and specifications of each generating set, including output curves for base load and stand-by conditions, alternator and engine data, automatic voltage regulator, synchronising and load sharing modules and auxiliaries.
- Type test reports as follows:
 - Generating sets.
 - Alternators: To AS 60034.1, AS 60034.5 and AS 60034.7.
- Net continuous rated output.
- Net short-time rated output.
- Transient and subtransient reactance of the alternators.
- Voltage regulation grade.
- Generating set efficiency at 50%, 75% and 100% load.
- Calculations for performance of acoustic enclosures and silencers.
- Evidence that the engine type has previously passed cold starting tests at the minimum ambient site temperature.

Shop drawings

General: Submit shop drawings indicating the following:

- General arrangement of equipment, generating sets, fuel tanks, exhaust silencers, control panels, batteries, cable tray runs.
- Single line schematic showing the interconnection with the building electrical system.
- Operating sequence in test and emergency modes as well as restoration of normal supply.
- Location and size of fuel tanks.
- Physical size of exhaust silencers including clearances from other system, building and structural elements.
- Physical size of generating set base and clearances for maintenance.
- Location and estimated size of control and distribution boards.
- Location of cable entry/connections
- Location of emergency stop(s)
- Location of control and starting batteries.
- Acoustic performance criteria (engine, exhaust, air flow), to determine the level of sound proofing required.
- Maximum mass and overall dimensions of each separable assembly.
- Access clearances for operational maintenance and dismantling.
- Electrical single line diagram, and general arrangement for the complete system.
- Control diagrams.
- Alarms and shutdown annunciator text engraving schedule.
- Details of foundations and anti-vibration mountings.

Power generation - engine driven

15.2 Products

15.2.1 General

Multiple generating sets

General: For multiple generating sets operating in parallel, provide generating sets of the same make and type.

Mounting

General: Mount the engine and alternator units on a common structural steel frame to support the generating set assembly and the engine local control board.

Vibration suppression

Where specified in the Scope of Works provide vertical and horizontal restraint: Support the mounting frame on vibration isolating mountings complete with captive type vibration isolation mounts.

Coupling

General: Directly couple the engine and generator shafts with a self-aligning type coupling, capable of transmitting the engine maximum output torque under operating conditions, including starting and overload.

15.2.2 Alternators

General

Standards: To AS 60034.1, AS 60034.5, AS 60034.7, AS 60034.8, AS 60034.9 and AS 60034.11.

Voltage waveform: Sinusoidal, with total wave form deviation not exceeding 10%.

Excitation: Provide self-regulated brushless type exciters or directly driven exciter. Where specified in the Scope of Works provide permanent magnet excitation.

Overspeed: Withstand a speed of 1.2 times unit rated speed for both alternator and engine.

Alternator underspeed withstand: Normal operation at net continuous rated output at a speed of 0.95 times unit rated speed, without overheating.

Sustained short-circuit withstand: At least 2.5 times full load steady state short-circuit current, for at least 5 s.

Number of poles: 4.

Enclosure classification: IP21, with screened ventilation openings.

Cooling method classification: Class IC 01, to AS 1359.106.

Insulation classification: Thermal class 180 (H), to IEC 60085.

Anti-condensation heaters

General: Provide at least 2 anti-condensation heaters within the winding enclosure.

Rating: Rate heaters to maintain the windings and insulation at least 6°C above ambient temperature when the alternator is at rest and one heater is in service.

Location: Locate a heater at each end of alternator windings in a position which allows heat transfer to the winding insulation by convection, without exceeding maximum allowable insulation temperature. Do not fix heaters to windings.

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Terminations: Connect heaters to separate identified terminals within a separate accessories terminal box which is connected to a permanent supply.

Connection diagram: Provide a connection diagram for the heaters. Locate within the terminal box.

Winding thermistors

General: Provide thermistors to alternator stator windings.

Standard: To AS 60947.8 and AS 60034.11.

Thermistor type: Positive temperature coefficient.

Thermistor temperatures:

- Engine shutdown: 160°C.
- Winding temperature high pre-alarm: 140°C.

Terminal boxes

Construction: Provide metal terminal boxes. Size to allow the current transformers, power and control cables and cable lugs to be neatly installed and terminated with necessary clearances between live parts and the box, and without placing undue strain on termination points.

Supply cable terminal box: Provide removable lid and side covers.

Terminals: Provide star connected windings. Bring both ends of each winding out to separate terminals. Establish a neutral terminal. Do not provide an MEN connection at the alternator.

Sealing: Provide neoprene or bonded cork gaskets between terminal boxes and their frames and covers.

Marking: To AS 60034.8.

15.2.3 Engines

General

Sizing: Take into account the nature of loads including auxiliaries, harmonics and transient operation.

Bearings: Provide front and rear main bearings, so that crankshaft alignment is not affected by dismantling of the alternator.

Governing

General: Provide electronic controlled governors which enable engines to operate continuously at 1500 r/min from no-load to the maximum rated electrical load connected to the alternator. Provide filters which ensure that harmonics or switching spikes generated by the load do not interfere with the operation of the governor, overspeed or underspeed cut out devices.

Governing accuracy: Class M3, to AS 4594.

Governor adjustments: Provide adjustment settings for the following:

- Speed droop.
- Stability.
- Maximum speed.
- Acceleration rate.
- Load gain.

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15.2.4 Diesel fuel storage

General

General: Conform to the Liquid fuels worksections.

15.2.5 Controls

General

General: Provide automatic and manual modes to start and shut down generating sets in the selected sequence and, if operating in parallel, share the load to optimise their rated kW and kVAR capacities.

Manual sequence control

General: Provide controls to manually, start, synchronise and shut-down each generating set. Include emergency stop, synchroscope, meters, selector switches, check synchroniser and status indicating lights.

Automatic start control

General: Provide for the following:

- When a 'start' signal is received, generating sets start automatically, come on-line and, if appropriate synchronise before connecting to the load.
- Connection of alternators for sequential control of load sharing/shedding.
- Shutdown of alternate machines.

Automatic engine shutdown

General: Provide for generating sets to run to suit the load demand until receipt of the mains 'restored' signal is received. At this point the automatic sequenced engine shutdown signal must be activated after an adjustable time delay of 0 - 30 min.

Engine shutdown

General: Provide a shutdown control system which disconnects the alternators, and shuts down engines upon the occurrence of fault conditions, such that:

- Engines cannot be restarted before safety devices have been manually reset and system alarm sensors have returned to the normal state.
- The overspeed shutdown acts directly to disconnect the fuel supply independent of the governor.
- The shutdown control system may be reset by the operation of one reset switch, after safety devices have been manually reset.

Emergency and fault shutdown

General: Provide for the following conditions to register as audible and visible alarms and each generating set to immediately shutdown:

- Emergency stop push-button: Pressed.
- Generating set: Over voltage.
- Generating set protection: Activated.
- Generating set: Over current.
- Engine: Overspeed.
- Engine oil pressure: Low.
- Jacket water temperature: High.

Emergency stop push-buttons

Provide one push-button per generating set.

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Type: 40 mm diameter red, palm operated type mounted in a metal wall box fixed to a free standing U channel pedestal. Wire to disconnect the generator and immediately shut down the engine when the controls are in the automatic or manual mode.

15.2.6 Control panels

General

General: Provide control panels, switchgear and controlgear assemblies to the Custom control and marshalling panels, *Switchboard components, Preferred equipment schedule* worksections and as documented.

Equipment: Accommodate equipment operating in parallel and stabilise load sharing between each generating set at all load steps. Include reverse power interlock.

Modbus output

Provide Modbus output (TCP preferred) enabling the interrogation of all generator system alarms and outputs.

Engine local control board

General: For each generating set, provide the following:

- Generator running indicator. Green if separate indicator lamp.
- Fault indicator. Red if separate indicator lamp.
- Key operated local engine start/stop control.
- Controls for auto/off/manual/load test.
- Emergency manual shutdown.
- Speed indicator, kW meter, frequency meter, ammeter, kVAR meter, power factor meter, and hours run meter.
- Indicator showing generating set under local control.
- Oil pressure indicator.
- Coolant temperature indicator.
- Undervoltage protection: Adjustable down to 90% rated voltage with time delay 0 to 10 s.
- Under frequency protection with two stages:
 - First stage: Adjustable 47 50 Hz with time delay 0 to 10 s.
 - Second stage: Adjustable down to 40 Hz and with instantaneous trip.
- Automatic voltage regulator consisting of the following:
 - Switch to select manual or automatic voltage control.
 - Solid-state type automatic voltage regulator.
- Under and overvoltage sensing.
- Power transducers.
- Over and underspeed sensors.

Alternator output control: For overload and fault protection provide the following:

- Type: Circuit breaker. Manual changeover.
- Rating: To protect the alternator.

Alternator voltage control:

- Manual control adjustment.
- Automatic voltage regulator:
- Voltage adjustment.
- Set point adjustment.

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15.2.7 Batteries and chargers

General

General: Provide batteries and charger systems for the following:

- Engine start.
- Control and alarm functions.

Standards

Batteries: To AS 4029.1, AS/NZS 4029.2 or AS 4029.3.

Battery chargers: To AS 4044.

Batteries

Location: Locate in proprietary battery holders attached to the generating set constructed of corrosion resistant material. Isolate batteries from vibration.

Covers: Provide insulation for battery terminals.

Capacity: Sufficient to crank the engine for 3 successive attempted starts, repeated at 5 min intervals.

Isolator: Provide a lockable isolator to prevent accidental starting.

Batteries chargers

General: Select the charger to suit the batteries supplied.

Mains power: Connect chargers to the mains power to ensure that power is maintained to the charger under all supply conditions.

Alarm outputs: Provide the following local audible and visual alarms together with facilities for extending them via a common alarm output to a remote location:

- Battery charger fault Can be provided under common Generator Fault.
- Battery voltage or low battery voltage alarm.

15.2.8 Starting

Electric starting

General: Provide starter motors, batteries and chargers, and associated control equipment to automatically start each engine.

Wiring: Wire starter motors so that starter motor solenoid contacts are on the active side and field windings are at earth potential when the motor is de-energised. Provide an interlock, connected directly to the engine, to prevent the starter motor operating when the engine is running.

Starting interlock: Provide a starting lock out system which prevents further starting attempts after set number of unsuccessful attempts. Default setting of 3.

15.2.9 Acoustic enclosures

General

General: Provide weatherproof acoustic enclosures to surround generating sets, including inlet and outlet sound attenuators.

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Sound pressure level limit

General: 85 dB (A) at 12 locations 1 m from the enclosure exterior surface, at 1.5 m above floor or roof levels, measured with the generating set operating at constant maximum rated full load output, with doors closed and service penetrations sealed.

Doors

General: Provide doors of same material as the enclosure. Provide door stays to each door.

Ventilation

General: Provide ventilation to the enclosure so that:

- The generator can run at full rated load under the specified ambient conditions.
- Hazardous concentrations of toxic or explosive fumes and gases are prevented.

15.2.10 Marking

Rating plates

Include:

- Full rated load of generator.
- Fuel capacity.
- Maximum wet weight.

Auxiliary wiring

Ferrules: Provide to wiring ends identifying each conductor.

Engine direction of rotation

General: If driving shafts or associated rotating parts are accessible, clearly and permanently mark the direction of rotation on an adjacent fixed surface.

Rotation identification: Provide a label within the supply cable terminal box identifying the phase rotation on terminals.

15.3 Execution

15.3.1 General

Plinths

General: Provide reinforced concrete plinths for floor mounted equipment, sized to suit equipment footprints.

Drip trays

General: Provide removable drip trays under those parts of the assembly where fuel or lubricant leakage may occur. Provide overflow outlet pipes taken to a point where a receptacle can be fitted under the pipe outlet.

Capacity: At least 1.5 times the oil capacity of the engine sump.

Material: 1.6 mm galvanized steel with brazed joints and rolled edges.

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15.3.2 Permanent test load

General

General: When nominated in the *Electrical scope of works* worksection provide a permanent, fan cooled, resistive test load connected to the generating set control panel.

Automatic Operation: The load test is to operate automatically applying load to the generator when running below 50% capacity. Load is to be applied in steps. Load is to be removed from the system when the generator is running above 50% capacity or not running.

Arrangement: Enclose test load resistors and fan and associated switchgear and controls in 2 segregated enclosures within a common ventilated sheet metal enclosure.

Degree of protection:

- Indoor locations: IP41.
- Outdoor locations: IP55.

Rating: At least 50% rated output of combined generating sets.

Resistor bank: 415 V, 3 phase, delta connected, stainless steel finned, sheathed element type. Interconnect resistors with nickel plated copper links supported on stand-off insulators. Arrange resistor banks to suit switched load steps.

Resistor bank switching: Switched in at least 3 equal load steps.

Internal wiring:

- Connection to elements: 150°C silicon rubber insulation.
- General internal wiring: V-90HT insulation.

Circuit breakers: Provide a main circuit breaker to connect the alternator supply and individual circuit breakers for each resistor group.

Protection: Provide a thermal overload relay for fan motor protection. Provide safety interlocks to disconnect the load if ventilation air flow is restricted or resistor temperature limits are exceeded.

Fan run-on: 5 min after load disconnection.

Local monitoring: Provide local annunciation for the following:

- Load step indication.
- Fan run-on.
- Common alarm for fan motor overload, air flow restriction, and safety interlock operation.

15.3.3 Engine cooling

General

General: Provide a cooling system consisting of radiators, fans and pumps.

15.3.4 Engine air intake

General

Filters: Provide dry type air intake filters of sufficient capacity to permit continuous engine operation for 200 hours before filter servicing becomes necessary. Provide filter manometers.

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Ductwork: To AS 4254.

Fans: Provide a fan selected for the installed system air pressure drop. Include power absorbed by the fan under site operating conditions when calculating generator output.

15.3.5 Exhaust system

General

General: Provide exhaust piping from the engine complete with silencers, piping, ductwork, supports and expansion devices.

Exhaust piping

Material: Grade 316 Stainless steel.

Diameter: Match engine exhaust manifold connection.

Connections: Provide flanged connections to silencers and pipe interconnections.

Vibration isolation: Provide a stainless steel flexible connection to the engine.

Weatherproofing

General: Provide weatherproof flashing, sleeves and acoustic seals where the exhaust system penetrates the roof or external walls.

Exhaust drainage

General: Grade the exhaust line away from the engine to drainage pockets, or connect to a suitable drainage outlet.

Exhaust pipe insulation

General: Insulate the full length of exhausts within buildings.

Insulation Material: Suitable for temperatures up to 550°C.

Maximum thermal conductivity: 0.036 W/m.K at 20°C.

Minimum thickness: 50 mm.

Application: Wrap insulation around exhaust pipes. Hold in place with 12 mm x 0.55 mm zinc-coated steel straps at 600 mm maximum centres.

Sheathing: Sheath insulation as follows:

- Sheathing not exposed to weather: 0.55 mm metallic-coated steel sheet.
- Sheathing exposed to weather: 0.55 mm metallic-coated steel sheet or 0.8 mm (minimum) aluminium sheet.
- Joints: Lap joints in sheathing at least 30 mm and rivet or screw at 150 mm maximum centres.
- Edges: Neatly cut around nozzles and cone down to flanges.
- Terminations: At terminations, return edges of sheathing to protect edges of insulation.

15.3.6 Diesel fuel system

General

General: Comply with the *Liquid fuels* worksection.

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Fuel connections

Fuel piping and associated auxiliary equipment: To AS 1940.

Stop valves

General: Provide stop valves on the inlet to, and outlets from, the daily service tank.

15.3.7 Completion

Completion tests

General: For each generating set carry out the following:

- Check tightness of connections and securing devices.
- Verify correctness of operation of protection devices and systems including sensor settings. Simulate actual conditions as far as possible, in order to test responses to faults imposed.
- Verify contact operation for interface to RTU/PLC .
- Before connecting the generator to mains supply or project loads, verify that the correct electricity supply phase sequence is provided at switchboards and control panels, and that circuit protective devices are correctly sized and adjusted.
- Functional checks to AS 4594.1 Table 7, List C, items C1 to C5 inclusive.
- Cold start with the engine having been at rest for the previous 24 hours, timed from receipt of mains failure signal to acceptance of full rated load in 3 load steps to within the limits of output voltage and frequency.
- Three actual or simulated power failure start-ups with continuous running of at least one hour after each startup.
- Noise tests in accordance with AS 1217.7. Noise measurements shall be taken at the generator set and at the property boundary at the specified times when the generator set is running at full rated load.
- Continuous operational trial consisting of:
 - 1 hour at 100% rated power.
 - 1 hour at 110% rated power.
 - 30 min at 75% rated power.
 - 30 min at 50% rated power.
- Continuous operational trial: During the trial, measure the following at the beginning and end of the test:
 - Generator kW and kVAR output.
 - Generator output voltage.
 - Generator output current.
 - Generator output frequency.
 - Power factor.
 - Oil pressure and water temperature.
 - Each battery charger current and voltage readings.

Synchronisation and load sharing tests: For generating sets running in parallel perform tests to verify automatic synchronisation and load sharing including the following:

- Sequence start and shutdown of each generating set.
- Parallel operation of generating sets.
- Synchronising of generating sets.
- Equal load sharing of kW and kVAR over 5 equal load steps.
- Operation of controls, switchgear and auxiliaries.

Fuel for the site acceptance tests shall be supplied by the Contractor.

Power generation - engine driven

The total run-in time for the generator set shall be 24 hours of running accumulated during the site acceptance test period and Run-in period and shall include at least one continuous running period of at least 8 hours. The generator set shall be run for at least one hour every week during the Run-in period.

Service at the completion of the Run-in period shall include replacement of air, fuel and oil filters, valve tappet adjustment, sump oil change and alternator bearing lubrication. A labelled sample of the drained sump oil shall be supplied to TasWater's Representative, who at his discretion may have it tested for evidence of premature wear.

Temporary test loads

General: Provide test loads including power and control wiring, ancillary equipment and test instruments to achieve the kW, kVAR and necessary load steps

The plant loads and load bank (where provided under the Contract) may be used for site tests. Any additional test load or equipment required shall be the responsibility of the Contractor.

Reports

General: Submit reports from manufacturers or suppliers verifying the performance of safety and control functions of each system.

Maintenance

Call out: Respond to call outs for breakdowns or other faults requiring corrective maintenance during defects liability period. Attend on site within 24 hours of notification. Rectify faults and replace faulty materials and equipment.

15.3.8 Operation and maintenance manuals and training

General

As per General electrical requirements worksection.

15.4 Selections

Refer to Preferred equipment schedules worksection.

15.4.1 Performance

Performance schedule

Refer to *Electrical scope of works* worksection.

15.4.2 Diesel fuel storage tanks

Refer to *Electrical scope of works* worksection.

15.4.3 System control panel

Refer to *Electrical scope of works* worksection.

Liquid fuels

16 Liquid fuels

16.1 General

16.1.1 Responsibilities

General

General: Provide liquid fuel installations.

Selections: As documented.

16.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works.
- Preferred equipment schedule.
- General electrical requirements.

16.1.3 Standards

General Standard: To AS 1940.

Steel and stainless steel tanks Standard: To AS 1692.

16.1.4 Pre-completion tests

Site tests

Discharge and suction piping: Air pressure test to 350 kPa. During tests keep tanks freely vented so that they are not subjected to the test pressure.

Fill, dip and vent lines: Air pressure test to 35 kPa. Fit a safety device to ensure that this pressure is not exceeded, and remove the device after the test is completed.

On completion of testing: Remove water and other contaminants from tanks, valves and pipe fittings. If necessary lubricate valve seats and poppets and seal inspection plugs with black pipe jointing.

16.2 Products

16.2.1 Storage tanks

Design

General: Design tanks to accommodate the static heads equal to the height of the vent pipe above the tank.

Fittings

General: Provide the following:

- Personnel access.

Liquid fuels

- Specify if larger access opening is required than specified by the standard. See AS 1692 clause 2.6.
- Fill connection with internal pipe connection.
- Dipstick indicating system.
- Suction connection, complete with internal pipe, check valve and anti-vortex device.
- Return connection and internal pipe.
- Remote contents gauge connections.
- Delete if not required. If remote indication is provided a dipstick will also be required. See AS 1692 clause 2.3.1.
- Drain connection for above ground tanks.

Tank supports

General: Locate supports close to the ends of the tank. Provide doubling plates (120 coverage) fixed to the underside of the tank, of the same material and thickness as the tank. Form box type stools from 6 mm mild steel plate, and weld to the doubling plates. Make provision for tank expansion.

16.2.2 Service tanks

Construction

Open: Welded construction, reinforced around the top edge. Provide a lid fabricated from metallic-coated steel 0.8 mm thick with rolled edge.

Closed: Welded construction. Provide a bolted inspection cover.

Tank stands

General: Provide a welded frame stand at least 900 mm high, fabricated from mild steel angle.

Collection trays

General: Provide a collection tray fabricated from metallic-coated steel sheet 0.8 mm thick, with a 50 mm upturn and rolled edge.

Tank connections

Drain connection: DN 25 boss and screwed plug.

Flow connection: \geq DN 20.

Supply connection: \geq DN 25.

Overflow return connection: Sufficient to allow 125% of pump capacity to be returned to the main tank without overspill.

Vent connection for closed tanks: \geq DN 40.

Controls

General: Provide liquid level switches set to start the liquid transfer pump at low liquid level (half full), and cut the pump out at high level (full).

Auxiliary contacts

General: Provide voltage-free contacts set to close on a fall in the liquid level to one-third full.

Liquid fuels

16.2.3 Tank finishes

External

General: Blast clean steel tanks and associated steelwork, including hold-down bolts and straps, to grade Sa 2½ of AS 1627.9, and apply coating systems within 4 hours of blast cleaning.

Tank finishes table

Tank type	Coating system
Underground tank	Tar free high build polyamide cured epoxy.
	Minimum coating thickness: 200 µm
Above ground tank	Inorganic zinc silicate to AS/NZS 3750.15, followed by
	polyurethane to AS/NZS 3750.6.
Tank enclosed in chamber	Inorganic zinc silicate to AS/NZS 3750.15.
Service tank	Inorganic zinc silicate to AS/NZS 3750.15.

Internal

General: Remove debris and clean.

16.3 Execution

16.3.1 Underground tank installation

Excavation and backfilling

General: Keep excavations free of surface water. After placing the tank, backfill with sand.

Sand backfilling

Type: Chemically inert sand, free from foreign matter such as salt, organic matter and clay lumps, and graded.

Placing: Place sand backfilling in layers not more than 200 mm thick.

Ballasting

General: If ballasting is necessary to prevent flotation, fill the tank with water before backfilling. Provide a concrete ballast collar at least equal to the weight of the full tank.

16.3.2 Trench covers

General General: Provide covers for fuel pipe trenches in concrete floors.

Cover material

General: 6 mm thick mild steel chequer plate, cut to fit floor trench rebates, galvanized after fabrication.

16.3.3 Cathodic protection

Standard Standard: Comply with the recommendations of AS 2832.2.

Liquid fuels

System

General: Provide a cathodic protection system for underground tanks, by either:

- A sacrificial anode.
- An impressed current system, designed and installed by a suitably qualified organisation.

Characteristics: Provide the following:

- Monolithic insulating couplings in the suction, vent return and fill lines immediately next to the tank.
- Power supply, anodes and interconnecting wiring, incorporating a facility for periodic testing.
- Insulation to the return connection.

Power supply: Provide solid state regulated d.c. power supply with balanced outputs and ammeter.

16.3.4 Contents indicators

Dipsticks

General: Form from brass section or anodised aluminium extrusion, with the bottom 100 mm coated with nylon or equivalent non-conducting coating. Stamp or engrave calibrations at intervals of not more than 5% of nominal tank capacity.

Contents gauges

Dipsticks may be adequate in many situations. Contents gauges are more expensive but more convenient. Delete if not required.

General: Provide a remote-reading contents gauge and connect to a magnetic base balance chamber in the fuel tank, via a fuel-resistant plastic or neoprene pipe. If the vent pipe is not visible to the filling operator, locate the gauge next to the filling point.

16.3.5 Piping and accessories

Pipes inside tank Heavy steel pipe: To AS 1074.

Filling and service piping General: Medium steel pipe to AS 1074.

Filling: \geq DN 75.

Service: ≥ DN 25.

Joints for steel piping General: Screwed to AS ISO 7.1.

Joint sealing: Seal threads of permanent joints with litharge and glycerine. Make demountable joints with 'soft jointing' compound.

Cleaning

General: Flush out piping with fuel, only when the system is complete.

Underground piping

General: Temporarily support the piping in the trench before backfilling. Provide at least 150 mm of backfilling all around piping.

Trenching: Conform to the **Service trenching** section.

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Liquid fuels

Gradients

General: Lay piping to permit self-draining and avoid airlocking, and to the following minimum gradients:

- Fill pipe: 1:50 down in the direction of flow.
- Gravity return pipe: 1:100 down in the direction of flow.

Corrosion protection

General: Wrap non-galvanized steel pipe and screwed or welded joints with anti-corrosive grease impregnated tape or other purpose-made vapour barrier adhesive plastic tape. Extend the tape 150 mm from the extremity of any thread or weld.

Lock boxes

General: Provide 300 mm diameter cast iron boxes with lockable cast iron cover flaps, to each filling and dip point and buried valves.

Installation: Set boxes with the top 25 mm above the adjacent finished pavement or ground surface. Surround and support the box with concrete, at least 150 mm thick. Provide gravel underlay to drain the box.

16.3.6 Fuel oil pumps

Туре

General: Self priming positive displacement internal gear type pumps with mechanical seal and direct driven by totally enclosed motor.

Bypass

General: Provide an automatic built-in overpressure bypass with adjustable spring relief.

Mounting

General: Mount the motor and pump on a common base plate.

Material

Casing and rotor: Cast iron or cast steel.

Shaft: Hardened steel.

Drip tray

General: Provide a 50 mm deep drip tray under each pump.

Material: 1.6 mm thick copper with brazed joints with rolled edges.

16.3.7 Marking

Labels

General: Provide identification labels to fill and dip boxes, at least 150 x 50 mm overall, with lettering at least 25 mm high stating the intended function.

16.3.8 Charging

General

General: Fill tanks with fuel, and top up immediately before the date for practical completion.

Electronic security and access control Electronic security and access control

17.1 General

17.1.1 Responsibilities

General

General: Provide electronic security and access control systems as follows and as documented:

- Connection to existing remote monitoring system.

Annunciation to be via:

- External strobe and siren.
- Internal sirens.
- Remote monitoring via hard wired telephone connection.

The following events to be reported individually to the existing monitoring company:

- Intruder alarm.
- Tamper alarms.
- Low battery voltage.
- AC supply failure.
- Fire Alarm.
- Door NOT latched.

Security classification: As documented.

System communications: As documented.

System provider

Electronic security system provider: A licensed security organisation only.

Surge protection devices (SPD)

Inline surge protection: As per Preferred equipment schedule. Rating to suit supplying circuit.

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

17.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works
- Preferred equipment schedules
- General electrical requirements.
- Cable support and duct systems.
- Low and extra low voltage power systems.
- Telecommunications cabling.

Electronic security and access control

17.1.3 Standards

Intruder alarm systems General: To AS/NZS 2201.1.

Alarm transmission system: To AS/NZS 2201.5.

Internal detection devices: To AS 2201.3.

17.1.4 Submissions

Records

General: Submit records to AS/NZS 2201.1.

Licence: Submit copy.

Shop drawings

General: Before commencing work submit shop drawings showing the following:

- Schematic diagram of all systems.

17.2 Products

17.2.1 General

Alarm system panels or processors

As scheduled.

Capacity: Provide separate sectors for each nominated internal zone, and for normally-closed and normally-open perimeter zones.

Sector time delay: Provide adjustable time delay entry/exit for each sector, with adjustment range 0 to 30 s.

Batteries and chargers:

- Sealed battery: Provide a sealed battery and charger system contained within each control panel with capacity as scheduled for the complete system in normal operation.

Activation

Activation devices: Via external smart card readers as scheduled.

External: IP66 and vandal proof.

Default mounting height: 1100 mm from floor level.

External audible and visual alarms

General: Corrosion-resistant weatherproof metal enclosures containing sirens and blue strobe lights. Fix in locations not readily accessible without a ladder.

Anti-tamper devices

Anti tamper devices: Provide anti-tamper devices to control panels, external equipment, control and activating devices, and access control devices.

Function: To register an instantaneous alarm if covers are removed or vital wiring is disconnected.

Electronic security and access control

Alarm circuit supervision

Alarm circuit supervision: At each detection device, provide alarm circuit supervision by means of an end-of-line device connected via a separate circuit within the cable.

Function: To register an instantaneous alarm if cable characteristics change, such as when cut or short circuited.

Event logging

Printer: Provide for event logging from the alarm and access control panel at the existing security monitoring system.

Function: To generate a report showing, as a minimum, the date, time and category of alarm initiations and access control entries.

Remote monitoring

External monitoring to be provided under an existing contract, refer to schedules.

Monitoring system: Provide a monitoring system in the alarm panel or processor for transmission of alarms and monitoring of the system by parties responsible for attending to alarms.

17.2.2 Access control

Access control processors or panels

Provide with scheduled card readers, electric strikes and relay outputs to control strikes from panel.

Door control devices

General: Provide electric strikes as scheduled to suit door construction and hardware.

Monitoring: Provide lock status and door position monitoring of door control devices.

Fail-safe: Connect door control devices in a fail-safe mode to permit egress in the event of power failure.

Authorised products: Provide equipment listed in the ActivFire Register of Fire Protection Equipment.

Glass doors: Provide tumbler, drop bolts or magnetic holders.

Double leaf doors (solid frame): Provide an electric strike on the fixed leaf, connected to the door frame by concealed flexible wiring.

17.2.3 Intruder alarm

Volumetric detection devices

General: Provide volumetric detectors as documented.

Selection: To provide detection within the space occupied by the detector. Provide additional detectors to achieve coverage in all rooms.

PIR detectors: Mirror optic type with \geq 7 curtains.

Installation: To AS/NZS 2201.1.

Electronic security and access control

17.3 Execution

17.3.1 General

Mains supplies

Permanent power supply: Provide permanent power supply on dedicated circuit(s) to the following:

- Intruder alarm panels and access control panels including sub panels.
- Electric door strikes and card readers.

Marking: Label the switchboard circuit breaker from which power for the security systems is obtained as follows:

SECURITY SYSTEM - Do not switch off.

Interconnection to other services

General: Provide functions and equipment to allow the interconnection to other systems. Provide and connect wiring to the designated services.

Completion tests

General: Carry out tests, including out-of-hours tests, to demonstrate the security system's performance. Include the following:

- Test components for correct function and operation.
- Demonstrate that devices perform on site, to at least the level stated in the manufacturer's performance specification for that device.
- Test the operation of alarm sectors and panel functions, including open and short circuit tests.
- Demonstrate that the system functions under mains fail condition.
- Demonstrate operation of the battery and charger including a full discharge/recharge over the designated time.

Maintenance:

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: \leq 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, sitting or aiming of devices.
- Environmental conditions evident at the time of installation.

Fault reports during the defect liability period are available from the existing monitoring company, refer to schedules.

Electronic security and access control

Manuals

Include the following in as-installed manuals:

- Details of all installed hardware.
- Schematic diagram of all systems including locations and cable routes.

17.3.2 Programming and zoning

Intruder detection: Program the intruder detection system and access control.

User base programming: To be completed under an existing contract as scheduled.

17.3.3 Interface to Fire Indicator Panel (FIP)

When requested in the *Electrical scope of works* worksection a voltage free contact will be provided at the Fire Indicator Panel (FIP). Provide a connection between the voltage free contact at the FIP and the security data gathering panel and program to annunciate at the remote monitoring station as a separate alarm.

17.3.4 Interface to indoor lighting control

When requested in the *Electrical scope of works* worksection a voltage free contact shall be provided at the security data gathering panel to control power to indoor lighting circuits. Provide a connection between the voltage free contact at the security data gathering panel and auxiliary contacts on contractors controlling power to lighting circuits at each distribution switchboard.

Control shall be provided by switching contactors on all indoor lighting circuits. When the security system is disarmed close the contact to signal power available to luminaires. When the security system is armed open the contact, after preset time delay, to signal power to luminaires to be switched Off. Provide a voltage free contact that works in a failsafe manor so the contact is closed when power to the security system and battery backup is disconnected.

17.4 Selections

17.4.1 System description

System description schedule

Security classification	Minimum Class 4
System communications	Hard wired.

17.4.2 Security monitoring systems

Security monitoring systems schedule

Monitoring	Existing contract. Contact Big Alarm Security Services (BASS), Devonport Tasmania. Contact Jamie Kaye 0458 554 480.
Communication method	Hard wired: Provide direct connection to Building Distributor/MDF. Wireless: Via GSM device.

Electronic security and access control	
External audible and visual alarms	External strobe and siren as documented.
User base programming	To be completed by Monitoring company contractor.

17.4.3 Intruder detection and access control system

Intruder detection and access control system schedule

Security risk classification to AS/NZS 2201.1	Minimum Class 4
Activation method	Single card swipe
De-activation method	Three card swipes
Number of activation devices to be provided including programming	One device at each external door.
Spare capacity	25% of alarm zones
Annunciation	As documented.
Power Supply and Battery backup	To suit applied load with 24 hour battery backup of all components.
Indoor audible alarms	Surface mounted sounders in plant room areas. Recessed sounders in office space areas.

Fire detection, VESDA, gas suppression and alarms Fire detection, VESDA, gas suppression and alarms

18.1 General

18.1.1 Responsibilities

General

General: Provide fire detection, VESDA, gas suppression and alarm systems as follows and as documented.

Existing installations: Update A4 walkabouts and drawings.

New installation: Provide A4 walkabouts and drawings.

Provide drawing at FIP showing location of MSB.

VESDA and gas suppression

Provide a VESDA system and gas suppression to all switchboards and control panels scheduled in the *Electrical scope of works* worksection.

Provide visual and audio warning devices for VESDA system.

Gas: FM200. Quantity to suit switchboard sizes.

Connect the VESDA system to the Fire Indicator Panel (FIP). Each switchboard and control panel scheduled as a separate zone.

18.1.2 System description

General System type: Addressable.

Interface: Emergency warning and intercommunications system.

Surge protection devices (SPD)

General: Provide inline surge protection to protect final equipment.

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

18.1.3 Cross references

General

Requirement: Conform to the following:

- General electrical requirements.
- Preferred equipment schedule.
- Cable support and duct systems.
- Low voltage and extra low voltage power systems.
- Occupant warning system.

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Fire detection, VESDA, gas suppression and alarms

18.1.4 Standard

General

Standard: To AS 1670.1 and AS 7240.13.

18.1.5 Submissions

Technical data

Product data: Submit for the following:

- Fire indicating panel.
- Detectors.
- Manual call points.
- Alarm bells.
- Magnetic door holders.

Shop drawings

General: Submit showing the following:

- Fire detector layout.
- Dimensions and details of control and indicating equipment.
- Location.
- Circuit identification.
- Labelling details.

18.2 **Products**

18.2.1 Authorised products

General

Equipment: Provide equipment listed in the ActivFire Register of Fire Protection Equipment.

18.2.2 Control and indicating equipment

Standards

General: To AS 7240.2.

Air-handling fire mode control panels: To AS 4428.7.

Alarm investigation facility (AIF): To AS 4428.10.

Alarm signalling equipment: To AS 4428.6.

Power supply units: To AS 4428.5.

Fire brigade panel: To AS 4428.3.

Routing equipment: To AS 7240.21.

Wire-free alarm zone circuits: To AS 4428.9.

Fire detection, VESDA, gas suppression and alarms

Fire indicator panels

General: Provide metal cubicle-type enclosures.

Isolation

Isolating facilities: Provide on fire indicator panels to enable testing without the transmission of alarm signals to the fire brigade.

Capacity

Spare zones: 50% minimum.

18.2.3 Detectors

Standards

Carbon monoxide (CO) fire detectors: To AS 7240.6.

Duct sampling units (DSUs): To AS 1603.13.

Heat detectors: To AS 7240.5.

Point type smoke detectors: To AS 7240.7.

Integral heat detector/alarm units: To AS 1603.3.

Integral smoke detector/alarm units: To AS 3786.

Multi-sensor fire detectors: To AS 7240.15.

Multi-point aspirated smoke detectors: To AS 1603.8.

Optical beam smoke detectors: To AS 1603.7.

Point type smoke detectors: To AS 1603.2.

Remote indicators: To AS 1603.15.

Visual warning devices: To AS 1603.11.

Self-indicating detectors

General: Provide a light emitting diode mounted in a clearly visible position, which illuminates whenever detector operation causes an alarm condition to register on the fire indicator panel. Provide self-indicating devices which, if faulty, will not render the detector inoperative under fire conditions.

Mounting positions of light emitting diodes: Conform to the following:

- Visible detectors: On the outside of the detector or its base.
- Detectors concealed above ceilings: On the underside of the ceiling immediately below the detector.
- Detectors in other concealed spaces: On a visible panel close to the entry to the concealed space housing the detector.
- Remote indicators: To AS 1603.15.

Fire detection, VESDA, gas suppression and alarms

18.2.4 Manual call points

General

Standard: To AS 1603.5 and AS 7240.11.

18.2.5 External alarm indication

Standards Bell circuits: To AS 4428.1.

Strobe lights: To AS 1603.11.

Power supply

To the strobe light and ≤ 2 others: From the fire indicator panel battery power supply.

To additional strobe lights: From the mains supply. Provide appropriate interface relays, operated by the fire indicator panel.

18.2.6 Magnetic door holders

General Standard: To AS 4178.

Control facilities

Standard: To AS/NZS 1668.1.

Signals: Provide ancillary control device circuits and connections for automatically controlling and releasing magnetic door holders to operate the relevant doors under fire alarm conditions.

18.2.7 Warning system

General Occupant warning system: To AS 1670.1 Section 3.22.

18.2.8 Power supply

General

Surge protection: Ensure that normal operation is maintained and that voltage surges in the power source do not damage the control and indicating equipment.

Sealed batteries: Cycle the batteries before practical completion so that \geq 100% of nominal capacity is available at practical completion.

18.2.9 Remote annunciation unit

General

General: ROMTECK ASE Next G device in Fire Indicator Panel to provide remote annunciation of alarms to Tas Fire Service. Units available from Tas Fire Service.

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Fire detection, VESDA, gas suppression and alarms

18.3 Execution

18.3.1 Fire alarm monitoring

General Standard: To AS 7240.21.

Connection: Via ROMTECK ASE Next G device. Communication with Tas Fire is via the units integrated Next G mobile telephone, not via hard wiring. Program and connect to FIP to enable annunciation to Tas Fire Service. Pay all fees associated with providing the unit. Test to ensure operation in the area. Principal to pay ongoing mobile phone service fees.

18.3.2 Detectors

Installation

General: Install detectors so they can be easily inspected and tested in situ, and readily withdrawn from service.

Integral smoke detector/alarm units: To AS 1670.6.

18.3.3 Installation wiring

General To AS 1670.1 Section 3.24.

18.3.4 Air handling systems

Fire fan control and indication panels (FFCP) Standard: To AS/NZS 1668.1.

Signals: Provide fire detection and alarm signals for the fire fan control and indication panel (FFCP).

18.3.5 Testing

General

Tests: Carry out tests, including out-of-hours tests, to demonstrate the automatic fire detection and alarm system's performance to AS 1670.1 Section 7 and the compliance Sections of the relevant parts of the AS 1603 series. Include the following:

- Test components for correct function and operation.
- Demonstrate detection and alarm performance on site, to at least the level stated in the manufacturer's performance specification for that device.
- Test alarm zone identification.
- Demonstrate air sampling system operation for 14 days with data logger to verify stability of detectors and devices.
- Demonstrate addressable device operation for 14 days with data logger to verify stability of detectors and devices.
- Test interface to interconnected systems.
- Demonstrate correct shutdown sequences during fire mode.
- In situ testers: To AS 1603.16.

Fire detection, VESDA, gas suppression and alarms

18.3.6 Operation and maintenance

Maintenance

Maintenance and records: To AS 1851.

18.4 Selections

18.4.1 System description

Interconnection to other systems schedule Refer to *Electrical scope of works* worksection.

Occupant warning system

19 Occupant warning system

19.1 General

19.1.1 Aims

Responsibilities

General: Provide building occupant warning system as documented and to AS 1670.1. Section 3.22(b).

19.1.2 Cross references

General

General: Conform to the Electrical general requirements worksection.

Associated worksections

Associated worksections: Conform to the following:

- General electrical requirements
- Cable support and duct systems.
- Fire detection and alarms.

19.1.3 Standards

General Occupant warning: To AS 1670.1. Section 3.22(b)

19.1.4 Submissions

Technical data General: Submit product data for all components.

Samples

General: Submit samples of the following:

- Electronic sounders.

Shop drawings

General: Submit shop drawings showing the following:

- Panel layouts and enclosures including associated building works.
- Cabling diagrams.
- Equipment layout.
- Sounders.

Test reports

General: Submit test reports as follows:

- Sound levels.
- Sealed batteries test report.
- Commissioning test report.

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Occupant warning system

- System installer's statement.
- System test certificates.

19.2 Products

19.2.1 General

Authorised products

General: Provide equipment listed in the ActivFire Register of Fire Protection Equipment.

19.2.2 Electronic sounders

Selection: Select and provide to meet performance requirements and as documented.

19.3 Execution

19.3.1 General

Field wiring

General: To Electrical general requirements, Low voltage and extra low voltage power systems and Cable support and duct systems.

19.3.2 Electronic sounders

Mounting: Securely fix to building elements.

Office areas: Flush or recess mounted.

Plant rooms: Surface mounted, flush or recess mounted.

19.3.3 Operation and maintenance

Maintenance Standard: To AS 1851.

General: Perform Level 2 maintenance routines.

Emergency evacuation lighting

20 Emergency evacuation lighting

20.1 General

20.1.1 Responsibilities

General

General: Provide single point emergency lighting and exit signs as follows and as documented.

20.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical general requirements.
- Low and extra low voltage power systems.

20.1.3 Standards

General System design, installation and operation: AS 2293.1.

Inspection and maintenance: To AS/NZS 2293.2.

20.1.4 Submissions

Samples General: Submit samples of all luminaires and exit signs.

Technical data

General: 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.
- Central battery and charger performance test reports, including discharge and charging characteristics.

Type test data

General: Submit type test data.

20.2 Products

20.2.1 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.

Emergency evacuation lighting

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. After testing, this switch must automatically revert to normal operating mode.

Batteries

Type: Provide a lead-acid or nickel-cadmium batteries capable of operating each lamp at its rated output continuously at least 2 hours during completion tests and 1.5 hours during subsequent tests.

Battery life: At least 3 years when operating under normal conditions at an ambient temperature of 25°C and subjected to charging and discharging at 6 monthly intervals.

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

20.3 Execution

20.3.1 Single point system

Power supply

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

Test switch

General: Provide a timed test switch at each distribution board supplying emergency and exit luminaires.

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

20.3.2 Marking and labelling

Labelling

General: Label each luminaire with a unique identifying number and record the number and luminaire location in a schedule included in the emergency evacuation lighting operation and maintenance manual. The label must be permanently fixed, indelible and readable at a distance of 1 m.

20.3.3 Tests

General

General: 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 performance specification for that device.

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Emergency evacuation lighting

- 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.

Mains supply

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

20.3.4 Maintenance

General

Emergency evacuation lighting: To AS/NZS 2293.2.

Interval: Carry out the 6-monthly procedures before practical completion and again before the end of the maintenance period.

Lighting

21 Lighting

21.1 General

21.1.1 Responsibilities

General

General: Provide lighting as documented.

21.1.2 Project requirements

Proprietary equipment

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

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

Self ballasted lamps: To AS/NZS 4847.2.

21.1.3 Cross references

General Requirement: Conform to the following:

- Electrical scope of works.
- Preferred equipment schedule.
- General electrical requirements.
- Low voltage power systems.

21.1.4 Standards

Standards

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

Portable general purpose luminaires: To AS/NZS 60598.2.4.

Lighting

Recessed luminaires: To AS/NZS 60598.2.2.

Road lighting luminaires: To AS/NZS 1158.6.

Radio interference limits: To AS/NZS CISPR 15.

21.1.5 Interpretations

Abbreviations

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

- CCT: Correlated colour temperature.
- CRI: Colour rendering index.
- DALI: Digital addressable lighting interface.
- EEI: Energy efficiency index.
- ELV: Extra low voltage.
- EMC: Electromagnetic compatibility.
- ILCOS: International lamp coding system.
- PLC: Programmable logic controllers.
- SBC: Small bayonet cap.
- SES: Small Edison screw.

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Proprietary luminaires: Luminaires available as a catalogue item.
- Custom-built luminaires: Luminaires manufactured to order.

21.1.6 Submissions

Technical data

General: Submit technical data of the following:

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

21.2 Products

21.2.1 Proprietary luminaires

General

General: Provide proprietary luminaires complete with lamps, luminaire control equipment, lighting control equipment, and accessories as documented.

21.2.2 Lamps

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

Lighting

High pressure sodium vapour: To IEC 60662.

High pressure mercury vapour: To IEC 60188.

Low pressure sodium vapour: To IEC 60192.

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

Single capped fluorescent lamps: To AS/NZS 60901.

Tungsten halogen: To IEC 60357.

Fluorescent lamps Colour corrected temperature: 4000 K.

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

Lamp life: \geq 20,000 hrs.

Tungsten halogen lamps

Tungsten halogen lamps not enclosed behind glass: low pressure, low UV emission type.

Low voltage dichroic lamps: Provide dichroic lamps with integral reflectors.

Lamp life: \geq 5000 hrs.

Glass safety lens: Required.

21.2.3 Ballasts

General

General: Provide ballasts for lighting systems selected to be compatible with the lamp and control method.

Standard: To AS/NZS 61558.1.

Operation: Silent, low loss, matched to lamps and starters.

Electronic fluorescent lamp ballasts Standards: To AS/NZS 61347.2.3 and AS/NZS 60929.

Current total harmonic distortion: < 15%.

Number of ballasts: Provide separate ballasts for each lamp.

Reactive fluorescent lamp ballasts Standard: To AS/NZS 60921 and AS/NZS 61347.2.8.

Connections: Provide quick-connect terminals or wiring, suitable for the operating temperature close to the ballast.

Number of ballasts: Provide separate ballasts for each lamp.

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

Discharge lamp ballasts

High-pressure mercury vapour, low-pressure sodium vapour, high-pressure sodium vapour and metal halid type: To AS/NZS 61347 and AS/NZS 60923.

Metal halide type:

- \leq 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: Provide igniters which cut out when lamp ignites and after pre-determined time period if lamp fails to ignite.

21.2.4 Power factor correction

General

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 high intensity discharge (HID) lamp ballasts.

21.2.5 Gear tray cover

General Fixing: Screw fixed.

21.2.6 Wiring

Flexible cords

General: Provide recessed luminaires with an external \geq 1.5 m length of 0.75 mm² 3-core V75 (minimum) PVC/PVC flexible cord, connected to a 10 A 3-pin moulded plug to AS/NZS 3112.

Other fittings flexible cord cross sectional area: $\geq 1 \text{ mm}^2$.

21.2.7 Lighting control

Manual controls

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

21.2.8 Accessories

Lighting outlets

Pin arrangement: Standard: 3 flat pin with looping terminal.

Lighting switches

General: Provide light switches as documented and to suit connected load.

Standard: To AS/NZS 3133.

Minimum: 10 A, 230 V a.c.

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Key switches

Lighting

General: Proved key switches as documented.

Run-on timer switches

General: Proved run-on timer switches as documented.

Delay: Adjustable to 20 minutes.

Dimmer switches

General: Provide integral dimmer/switch units as documented. Rated for the characteristics of the controlled load and compatible with the electronic transformers.

Proximity switches

General: Provide proximity switches as documented.

Standard: To AS 60947.5.2.

Daylight switches

General: Provide integral photo electric switch units as documented.

Performance: Adjustable between 50 and 1000 lux.

Time delay: > 2 minutes.

Illumination differential: > 50 lux.

Motion detector switches

General: Provide movement detectors which cover designated areas as documented.

Timer: Incorporate 'on' timber adjustable between 1 and 5 minutes minimum and 30 minutes and 2 hours maximum.

Standard: To AS 2201.3.

Type: Passive infra-red.

Manual time delay switches

General: Proved manual time delay relay switches as documented.

Type: Pneumatic.

Duration: Adjustable between 5 minutes and 15 minutes.

Indicator light: Required. Activated when artificial illumination is 'off'.

Fire resistant enclosures

General: Provide fire resistant downlight enclosures to recessed luminaires to AS3000.

Standard: Approved to the requirement of AS 3000:2007 clause 4.5.2.3. (b).

Ragbolt assemblies

General: Lighting poles shall be installed with ragbolt assemblies cast into reinforced concrete bases. Bases to be designed to take into account the local soil conditions. All poles to be supplied with crossarms, end caps & light mounting fixtures required for the documented fitting.

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Lighting

Supports and mounting

General: Provide standard and custom supports and mounting accessories for all luminaires of a suitable structural integrity. All mounting accessories are to be provided to suit the fittings specified and ceiling details on architectural drawings.

Mounting slabs

General: Provide concrete mounting slabs for all ground level floodlights. Provide compacted base material and finish slab flush with surrounding surfaces. Where installed on a sloping surface the front edge shall be level and the sides to follow the average ground contour. Bases to be properly formed with trowelled finish.

Slab thickness: \geq 150mm.

Compact base thickness: \geq 300mm.

21.3 Execution

General

Luminaires shall be installed in accordance with the manufacturer's written instructions. The completed installation shall have a neat and aesthetic appearance.

All lighting circuits are required to be earth leakage protected.

21.3.1 Re-use of luminaires

Modifications and refurbishing

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

Component replacement: Starter and lamp.

Diffuser: Clean.

21.3.2 Other services

Liaise with other trades and coordinate lighting layout with ceiling set-out and other services. Obtain approval of alterations required.

21.3.3 Supports

General

General: 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 one space.

Lighting

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: Provide 2 fixings at each end of fluorescent luminaires. A single fixing at each end in conjunction with 1.6 mm backing plates may be used for narrow luminaires.

Recessed luminaries

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

Standard: To AS 2946.

21.3.4 Wiring connection

Recessed luminaires

General: Connect recessed luminaires to a plug socket outlet.

Lighting tracks

General: Locate associated low voltage transformers within 600 mm of the track.

21.3.5 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.

21.3.6 Fire Resistant Enclosures

General

General: Provide approved fire resistant enclosures around recessed luminaires where required by AS3000:2007. Noting areas where default minimum clearances are not achieved or extraneous combustible material may collect around the luminaire.

21.3.7 Lamp and ballast burn in

General

General: All lamps and ballasts are to be commissioned according to the manufacturers recommendations. This includes full burn in times, noting some lamps require 100 hours of burn in.

After completion of the installation, fluorescent fittings shall be left on continuously for a period of 24 hours and then a check shall be made for any excessively noisy fittings. Any fittings which are considered excessively noisy by TasWater's Representative shall either be repaired or replaced by the Contractor to the satisfaction of TasWater's Representative.

21.3.8 Security system lighting control

When scheduled in *Electrical scope of works*: All indoor lighting circuits shall be controlled via a voltage free contact in the electronic security system. Power to those lighting circuits to be provided when security system is disarmed, power to those lighting circuits to be Off when security system is Armed, with timing delay provided by

Lighting security system. Normal switching to also be provided. Refer to *Electronic security and access control* worksection for more details.

Uninterruptible power supply

22 Uninterruptible power supply

22.1 General

22.1.1 Responsibilities

General

General: Provide uninterruptible power supplies as follows and as documented.

22.1.2 Cross references

General

Requirement: Conform to the following:

- Electrical scope of works
- Preferred equipment schedule
- General electrical requirements.
- Switchboards proprietary.
- Switchboards custom-built.
- Switchboard components.

22.1.3 Standard

General

UPS: The AS 62040 series has been introduced as a central standard.

Electronic compatibility (EMC) requirements: To AS 62040.2.

Classification of uninterruptible power supply (UPS): 'Unrestricted sales distribution' (Class A-UPS).

General: To AS 62040.2 and AS 62040.3.

Converters: To AS 60146.2.

Inverters: To AS/NZS 5603.

Batteries: To AS/NZS 4029.2 or AS 4029.3.

Batteries installation: To AS 2676 series and AS 3011 series.

Authorities

EMC: Comply with the requirements of the Australian Communications and Media Authority.

22.1.4 Interpretations

Abbreviations

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

- EMC: Electromagnetic compatibility.

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Uninterruptible power supply

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Uninterruptible power supply (UPS): Battery operated static inverter system with automatic controls to provide electrical power in the event of an interruption to the primary power supply.

22.1.5 Completion tests

General

Standard: To AS 62040.3.

Test loads

General: Supply reactive test loads including power, control wiring and ancillary equipment.

Function: To achieve the kW, kV.Ar and load steps necessary to demonstrate and verify the designated steady state and transient frequency and voltage responses and waveform deviation tests.

Functional unit tests

Rectifier: Factory tests to AS 62040.3 and AS 60146.1.1.

Inverter: Factory tests to AS 62040.3 and AS 60146.2.

Switch: Factory tests to AS 62040.3 and AS 60146.1.1.

Monitoring and control: Factory tests to AS 62040.3.

Battery: Factory tests to AS 62040.3 clause 6.6.15, 6.6.16, and 6.6.17.

Battery: Capacity test to AS/NZS 4029.

Complete UPS

On-site tests: Provide 'routine; and 'optional' tests to AS 62040.3 Table 4 in conformance with the **On-site tests** schedule.

EMC: To AS 62040.2.

Power line condition: Test input power factor and harmonic content on completed installation.

22.1.6 Submissions

Design – documentation Standard: Submit technical data to AS 62040.3.

Calculations: Submit calculated input power factor and harmonic content.

Shop drawings

General: Include the following:

- The UPS system general arrangement and layout with details of connections, circuit breakers, cable sizes, overall dimensions, weight, location of access doors, cable terminating locations, and necessary clearances.
- Functional block diagram.

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Uninterruptible power supply

- The general arrangement of the remote manual by-pass switch/cabinet and indication/alarm panel with details of installation requirements.
- Type and rating of equipment items.
- Battery layout and associated details.

22.2 Products

22.2.1 System

Performance

Environment: Provide systems suitable for operation under the documented special service conditions.

Module type: Single module.

Mode: Single.

Redundancy: n+1.

Operation: On-line double conversion.

Transfer switch: Electronic automatic.

By-pass supply: Prime.

Automatic bypass: Provide an automatic, no break, integral static by-pass switch with automatic reset to transfer the load automatically to the by-pass supply when the UPS output characteristics are outside the designated limits.

Maintenance by-pass: Provide a manual by-pass switch to transfer the load to the by-pass supply, by-passing the UPS and static by-pass switch.

Interrupters: Individual.

Isolation switches: Required.

Battery charger: Integral.

Protection

Discrimination: Provide main circuit breakers, both input and output within the UPS to fully discriminate with upstream and downstream protection.

Components: Provide component protection to minimise damage and downtime in the event of component failure.

Output: Provide protection against output overload and short circuit to ensure output short circuits will not damage the UPS.

Safety interlocks: Provide interlocks to prevent accidental damage to the UPS during maintenance and normal operation.

Uninterruptible power supply

22.2.2 Rectifier

General Performance: To meet system requirements.

22.2.3 Battery charger

General Performance: To meet system requirements.

22.2.4 Battery

Performance General: As documented.

Type: Sealed lead acid, recombination type.

Service life: \geq 10 years.

22.2.5 Inverter

General

Performance: To meet system requirements.

Testing: To AS/NZS 5603.

Classification: Class 'A' to AS/NZS 5603.

Submissions: To AS/NZS 5603 Appendix B.

22.2.6 Monitoring and control

General: Provide local functions to the Local functions table.

Local functions

Local control facilities	Incoming mains isolation If batteries are not contained within the UPS enclosure: Battery supply isolation Manual bypass, to isolate the UPS and maintain power to connected equipment
Local monitoring facilities	Incoming mains: On, off, trip Battery supply: On, off, trip Overtemperature shut down: Activated System automatic bypass: Activated
Local audible and visual alarms	Overload shutdown High temperature warning Overtemperature shutdown Battery contactor open Low battery d.c. overvoltage Input power failed Output overvoltage Output undervoltage Static switch on manual Load on bypass

Uninterruptible power supply

UPS free running

Remote functions

General: As documented.

22.3 Execution

22.3.1 Completion

Spares

General: Supply spare parts necessary to maintain the mean time to repair.

Storage: Package and label spare parts for long-term storage within the UPS room.

Completion tests

General: Test run the UPS system continuously connected to the test load, for at least 48 hours. Record line and load voltage, current frequency and temperature measurements.

On-site tests

General: As documented.

22.3.2 Maintenance

General: 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.

22.4 Selections

Refer to *Electrical scope of works* worksection.