ELECTRICAL STANDARDS

REVISION 2J March 2011

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REVISION HISTORY

DATE	VERSION No	NOTES	UPDATED BY
15/08/2008	REV G	Purchase Specification – Switchboard and Electrical Connections for Sewage Pump Station – Submersible, wet well type	Phil McKone
12/02/91	Rev D	Electrical Standard Cable Types Drawing 97397	SunWater
N/A	Rev 1(01/03)	Electrical Standard Field Cabling and Termination ES301-(10/95)	SunWater
N/A	Rev 1 (1/03)	Electrical Standard SCA wiring and termination ES320	SunWater
N/A	Rev 1 (1/97)	Electrical Standard indoor SCA Enclosures ES401-(10/95)	SunWater
October 2008		South Waist Water Treatment plant Specification	GHD
October 2008	Draft	FRW Electrical Standards Combining Previous Standards into one standard.	David Cox
November 08	2 – Special Release	Release for the Tender of Ibis Ave Pump station Electrical.	David Cox
January 2010	Revision 2	Minor updates	David Cox
March 2010	Revision 2A	Section 3.2 Colouring of wiring – Amended	David Cox
March 2010	Revision 2B	Minor Changes, allow spring terminals, Added Security Camera Details.	David Cox
April 2010	Revision 2C	Minor Changes, Soft starters, communications Device Net or Modbus, Preferred Equipment Register Updated, Paint colours, and updated Sewage Pump Station specific Specification. Added Reference to AS3008 Appendix B.	David Cox
April 2010	Revision 2D	Naming Conventions for Pump Stations, Commissioning of Pump Stations, Painting and finishes, Correction of Clause Numbers.	David Cox
May 2010	Revision 2E	Minor Changes requested by D.Quirk	David Cox
August 2010	Revision 2H	Updated Preferred Equipment Register.	David Cox
November 2010	Revision 2I	PLC PID, Permanently Connected Generators.	David Cox
April 2011	Revision 2J	Rename to RRC Electrical Standards	David Cox

1 ELECTRICAL STANDARD CABLE TYPES

Table: Electrical Standard Cable Types

TYPE	APPLICATION	DESCIPTION	SPEC
1.1	**HIGH VOLTAGE**		
1A	MAINS/SUB MAINS UP TO & INC 3.3/6.6 kV	MULTI CORE COPPER CONDUCTOR WITH SCREEN, PAPER INSULATED (MIND), BELTED, LEAD ALLOY SHEATH, GALV STEEL WIRE ARMOURED, PVC SHEATH (NYLON 11/12 JACKET WHERE BURIED DIRECT).	AS1026
1B	MAINS/SUB MAINS 6.35/11Kv to 19/33kV	MULTI CORE COPPER CONDUCTOR WITH SCREEN, PAPER INSULATED (MIND), BELTED, LEAD ALLOY SHEATH, GALV STEEL WIRE ARMOURED, PVC SHEATH (NYLON 11/12 JACKET WHERE BURIED DIRECT).	AS1026
1C	MAINS/SUB MAINS/HV EQUIPMENT UP TO 19/33kV	SINGLE OR MULTI CORE, EPR INSULATED INDIVIDUALLY SCREENED, V90 PVC SHEATHED	AS1429
1D	MAINS/SUB-MAINS/HV EQUIPMENT UP TO 19/33kV	SINGLE OR MULTI CORE, XLPE INSULATED INDIVIDUALLY SCREENED. V-90 PVC SHEATHED.	AS1429
1.2	**POWER UP TO 415V**		
2A	MAINS/SUB MAIS/EQUIPMENT	MULTI CORE, PV INSULATED & Sheathed (V75-4V75) steel armoured ug grade 0.6Kv/1kV	AS5000
2B	MAINS/SUB MAIS/EQUIPMENT	SINGLE OR MULTI CORE PVC INSULATED & SHEATHED (V75-4V75) CIRCULAR CABLE 0.6kV/1kV	AS5000
2C	BUILDING WIRE	PVC INSULATED (V75) SINGLE CORE 0.6kV/1kV	AS5000
2D	FLEXIBLE CONNECTION	SINGLE OR MULTI CORE COPPER CONDUCTOR PVC INSULATED & SHEATHED (V75) FLEXIBLE ORDS 0.6kV/1kV	AS3191
2E	SUBMERSIBLE PUMP MOTOR CABLE	MULTI CORE COPPER CONDUCTOR EPR INSULATED CSP SHEATHED, FILLED INTERSTECES, FLEXIBLE CABLE 0.6kV/1kV (EPR/CR OR EPR/EPR MAY BE OFFERED)	AS5000
1.3	**COMMUNICATION**		
3A	TELECOM (INDOORS)	MULTI PAIR 1/0.4mm PVC INSULATED & SHEATHED	AS1049
3B	TELECOM	MULTI PAIR 1/0.4mm POLYTHENE	AS1049

	(OUTDOORS)	INSULATED & SHEATHED (+ NYLON 11/12 JACKET WHERE BURIED DIRECT)	
3C	UHF RADIO LOW LOSS COAXIAL	TINNED ANNEALED COPPER CONDUCTOR, CELLULAR POLYTHENE INSULATED SOLID COPPER SHIELD UV STABILISED POLYTHENE SHEATH 50 OHM NOMINAL IMPEDANCE MAX 5db/100m ATTENUATION AT 450MHz MAX 7db/100m ATTENUATION AT 900MHz	HELIAX ½"

1.4 SPECIAL PURPOSE

4A	CRANES/HOISTS FLEXIBLE SYSTEMS	RUBBER INSULATED & SHEATHED, FLAT.	AS1979
4B	CRANES/HOISTS CONTROL PENDANT	RUBBER INSULATED & SHEATHED, CIRCULAR, WITH TENSION FELIEF CORD	AS1979
4C	SECURE WIRING SYSTEMS	MIMS (PVC SHEATH IF SPECIFIED)	AS3187
4D	CATHODIC PROTECTION (IMPRESSED CURRENT POSITIVE)	COPPER CONDUCTORS POLYETHYLENE INSULATED POLYETHYLENE SHEATHED (XLPE OR HMW PE MAY BE OFFERED)	AS5000

1.5 CONTROL & INSTRUMENTATION

5A	CONTROL TO 415V	MULTI CORE, 1.5mm2 STRANDED COPPER, PVC INSULATED & S (V75)	
5B	INSTRUMENTATION	MULTI TWISTED PAIR 0.5mm STRANDED COPPER, PVC INSULATED & SHEATED OVERALL SCREEN WITH DRAIN WIRE	DEKORON IEC
5C	INSTRUMENTATION	AS FOR 5B, PLUS INDIVIDUAL PAIRS SCREENED	DEKORON IED
5D	INSTRUMENTATION	AS FOR 5C PLUS GALV STEEL WIRE ARMOURED & PVC SHEATH. (;LUS NYLON JACKET WHERE BURIED DIRECT)	DEKORON IEG
5E	THERMO-COUPLE EXTENSION CABLE	MULTI TWISTED PAIR TO MATCH THERMOCOUPLE ELEMENT. PVC INSULATED, INDIVIDUAL PAIRS SCREENED OVERALL SCREEN WITH DRIAN WIRE COMMUNICATIONS CORE, PVC SHEATHED.	DEKORON IEK
5F	CONTROL CUBICLE ELV INSTRUMENTATION	SINGLE PAIR 7/0.30 (0.5mm2) PVC INSULATED, SHEATHED.	DEKORON IEB
5G	CONTROL CUBICLE WIRING	SINGLE CORE 1.5mm2 STRANDED COPPER PVC INSULATED	AS5000

2 GENERAL REQUIREMENTS

2.1 Cross References

All materials and workmanship shall be of the best standard and shall comply with the relevant Australian Standards, or if such do not exist, with the relevant IEC or International (ISO) Standards.

Irrespective of any requirements shown in these documents the installation as a whole shall comply with:

» AS/NZS 3000 – Wiring Rules;
» AS/NZS1100 – Technical Drawings
» AS/NZS1102 – Graphical symbols for electro technical documentation;
» AS/NZS 3013 – Classification of the fire and mechanical performance of wiring systems;
» AS/NZS 5000.1 – Electric cables – Polymeric insulated;
» AS/NZS 3008 – Electrical installations – Selection of cables;
» AS/NZS 3702 – Item designation in electro technology;
» AS/NZS 2293 – Emergency escape lighting and exit signs for buildings
» National Electricity Rules http://www.aemc.gov.au/rules.php.;
» Health and Safety Act 1997;
» Electricity Act 1994;
» Electricity Safety Act 2002;
» Electricity— National Scheme (Queensland) Act 1997; and
» Ergon Energy Electrical Connection and Metering Manual
http://www.ergon.com.au/network_info/electrical_contractors/service_providers/technical_docs/asp/tech_documents.asp
» Degrees of protection (IP code): To AS/NZS 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;
» All other applicable standards and codes.

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

2.2 Service Conditions

All equipment shall be capable of correct operation under the service conditions that are encountered at the location in which the equipment is installed when conditions at the site are as specified above. This shall include suitable derating as a result of elevated temperature The design temperature for equipment shall be the Site Maximum Ambient Temperature plus any temperature rise caused by installation in environmental factors, such as exposed locations or the operation of adjacent equipment, together with losses from the equipment contained within the enclosure. The temperature rise calculations shall reflect the actual situation in which the equipment is installed. However, as a minimum, the following temperature rises due to environmental factors shall be adopted in these calculations:

- Within well ventilated buildings: + 0oC
- Within external enclosure not exposed to the sun: + 0oC
- Within external enclosure exposed to direct sun: + 15oC

If requested the Contractor shall supply calculations, to the satisfaction of the Principal, of expected temperature rise at equipment locations as a result of equipment losses, exposure to the sun and other factors.

2.3 Electrical Supply

Power distribution voltages at the site are 400 V. The LV switchgear, equipment and cabling shall operate within the 400V distribution systems that have the following Characteristics as a minimum:

Table: LV Power Supply Characteristics

Parameter	Value
System Voltages	230/400 volt (+10%, 6%)
System Earthing	MEN – Neutral solidly earthed
System Fault Level	15 kA for 1 second – confirm with supply authority
Connection	3 Phase (4 wire) and earth – MEN at LV switchboard

System fault levels will vary throughout the site and equipment shall be designed to suit the fault level at the installed location.

Maintain the same phase sequence as provided by the supply authority to sub mains, switchboards and multiphase loads throughout the installation.

Use the following designations:
> A phase – Red.
> B phase – White.
> C phase – Blue.

2.4 Coordination with Authorities

Coordinate with and pay all fees required by any authority having jurisdiction over the installation and furnish the Principal with certified copies of all certificates required by those authorities.

The contractor will be provided with the application reference and shall arrange for the coordination and connection of electrical supply to suit the works. All fees and charges other than the mentioned capital contribution are the responsibility of the contractor.

The contractor will be held responsible for any loss or damage resulting from a failure to comply with the above requirements.

2.5 Departures from the Documents

Should any part of the tender depart from the requirements of these documents, or any alternative proposal be submitted, it shall be identified in a Schedule of Non-Conformance.

This schedule shall list:
> The specified requirement;
> How the tender departs from the specified requirement; and
> The cost associated with removing the non-conformance.

Unless non-conformances are identified in a Schedule of Non-Conformance the Tender shall be deemed to be entirely in accordance with this specification and the drawings.

Non-conformances identified in the schedule shall be specifically approved by the Superintendent; otherwise the requirements of this specification shall apply.

2.6 Statutory Requirements

The Contractor shall ensure that all equipment supplied, including valves, complies with all statutory requirements in force in the Queensland.

All certificates of compliance and registration are to be obtained by the Contractor in the Principal's name, at no cost to the Principal.

2.7 Design

The contract documents indicate the extent of the work; however a certain amount of detailed design work is required of the Contractor, including the preparation of shop drawings and other submissions. The scope of works under this contract includes this detailed design work.
Where the Contractor selects equipment or methods that differ from those in the documents, they are responsible for any associated redesign work. This includes any consequential redesign of other systems, such as cable and protection changes when motors ratings are altered for example.
The quality, longevity, operability and maintainability of the redesigned sections of the work shall be at least equal to that original design.

All equipment shall be designed to operate continuously at full load for 24 hours per day, 365 days per year at the extremes of temperature and humidity specified for the installation location, in the specified environment with a design life of 25 years.
The Installation shall be designed to ensure satisfactory operation in which continuity of service is the first consideration, and to facilitate inspection, cleaning and repairs. All materials and equipment supplied shall also be designed to ensure satisfactory operation under the Site and Service Conditions specified for the site and under such variations of load as may be

met with under working conditions on the system including those due to faulty synchronising and short circuit.

The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the existing equipment and equipment supplied under other Contracts.

All equipment shall function without undue vibration and with the least practicable amount of noise. Any vibration or noise under normal load operation conditions, which is considered by the Superintendent to be excessive, shall be corrected.

All electrical connections and contacts shall be of ample section and surface for carrying continuously the specified currents without undue heating. Fixed connections shall be secured by bolts or set screws of ample size, adequately locked.

Kiosks, cubicles and similar enclosed compartments shall be adequately ventilated to minimise condensation. All contactor or relay coils and other parts not located in air-conditioned spaces shall be suitably protected against corrosion and fully tropicalised.

All apparatus, connections and cabling shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire.

All items of equipment shall inherently be designed for safety of operation and the plant layout shall be designed such that the plant may be operated in a safe manner.

Guards shall be provided for protecting personnel against exposed moving parts and hot surfaces and shall comply with the requirements of the Division of Workplace Health and Safety. Guards shall be removable for maintenance access.

The equipment layout shall provide adequate access for operation with all controls placed for ready access and with all indicators and instrumentation in easy to read locations.
In the design of the equipment layout adequate access for the installation and erection of the equipment shall be provided.

Major equipment items shall not be located in such a manner that would prevent the safe removal and replacement of any major item of the installation.

The manufacturer's rating plate showing type, serial number and rating details shall be attached to each equipment item in a position where it will be readily observable after installation of the equipment. Copies of the manufacturers rating plate shall be installed on the associated switchboard door.

All items of equipment and all wiring terminations and terminals shall be clearly identified by means of engraved labels. Adhesive labels will not be considered satisfactory. The identification shall be in accordance with the circuit and wiring diagrams.

Particular attention shall be paid to fire safety and the potential spread of fire shall be inhibited by sealing off all openings at the completion of the erection phase.

All locks supplied under this section of the Specification shall be master keyed to the requirements of the Superintendent.
All equipment of similar nature and type shall be keyed alike.

All items of equipment having equal or similar functions will be of the one manufacture and of similar appearance, finish, mounting arrangement and the like.

Where alternatives of equipment are permitted under this Specification and more than one item is to be supplied, all equipment shall be of the same manufacture and type. All equipment of the same type, supplied under different sections of the contract or not, shall be of the same manufacturer and from a contiguous range.

Corresponding parts shall be made to gauge and shall be interchangeable wherever possible. Where required by the Superintendent, the Contractor shall prove this quality by actually interchanging the various parts.

All equipment and fixings shall be selected so that it is suitable for the corrosive effect of the environment in which it is installed. The equipment shall give a service life of at least 25 years without excessive maintenance.

Stainless steel components shall not be used in low oxygen environments that will prevent the formation of the protective chromate layer.

Fixings shall be suitable for use with the base material of the component that is fixed, and shall consist of either:

» Stainless steel; or
» Plated steel, with a platting thickness to suit the aggressiveness of the environment.

Where dissimilar metals are installed in moist or aggressive environments care shall be exercised to avoid the effects of galvanic corrosion. In this case the components shall be either inherently sealed from the environment, eg stainless steel electrically isolated from each other by separating them with either:

» A minimum 3mm air gap; or
» A minimum 2mm of UV resistant, non-hygroscopic material such as rubber, PVC or polythene.

Welding of corrosion protected surfaces shall not be permitted unless specifically directed in the documents.

Stainless steel components shall be thoroughly passivated after welding or being subject to any process that creates an oxide layer.

2.8 Drawings and Technical Submissions

The Contractor shall prepare detailed working drawings covering of the whole of the works to be carried out in this Contract. In particular, if there is insufficient detail on the drawings to permit evaluation solely on the information provided then the drawings shall be accompanied by further technical submissions consisting of manufacturer's data.

The Contractor shall submit copies of all working drawings to the Superintendent for review before any work shown on the working drawings is carried out.
Format of Submission, shall be:
Paper Prints: Three (3) sets of A3 sized paper prints,
Electronic files: Adobe Acrobat .PDF files suitable printing at A3. And bound, purged AutoCAD 2007 files with all necessary supporting files eg. Fonts and pen sets.

At practical completion ownership of all drawings shall be transferred to Rockhampton Regional Council. Rockhampton Regional Council reserves the right to edit, modify and use the drawing for other projects.
Technical submissions, covering major or critical items, e.g. PLC systems, switchgear, cable terminations, etc, shall be provided:

> Where the submission of technical and other manufacturers data is specified;
> If requested by the Superintendent;
> Where the make and model is not indicated in the documents; and/or
> Where the make and model differ from those indicated in the documents.

Provide technical submissions to the Superintendent for review before any work utilising the equipment is carried out.

Technical submission shall consist of manufacturers data describing the item, including, ratings, dimensions and technical features. The submission shall be concise and not simply be the bulk submission of manufacturer's installation manuals. If the information is only available within a larger manual the relevant information shall be extracted from the manual for the submission, with the manual Table of Contents also forming part of the submission.

2.8.1 General

The drawings shall be clearly legible when printed on A3 size sheets.

All drawings shall be to a professional standard and drawn in accordance with the relevant Australian, IEC or International (ISO) Standards.

Where appropriate, the drawing scale must be shown. The drawing shall also include a graphic scale to facilitate scaling when a sheet is reproduced at a different size to the original.

Plant room layout drawings are to be prepared to a scale of 1:50 or larger. Equipment detail drawings shall be drawn at a scale of 1:20 or larger.

Drawings shall be prepared to an acceptable standard and shall be fully detailed.

All drawings shall include the Manufacturers' detail or serial number of all plant/equipment so that sufficient information is available for the ordering of replacement parts.

Drawing schedules shall be supplied and shall list all working drawings by number and title.

2.8.2 Non-standard Symbols

Where the use of non-standard symbols is unavoidable, prior approval shall be obtained from the Superintendent and reference to the symbol(s) shall be made in the form of a legend on the drawing, accompanied by explanation and description.

2.8.3 Assembly Drawings

Drawings of assemblies of mechanical and electrical plant and machines shall include, where appropriate:

- Overall dimensions and mass (including the mass of the heaviest lift for maintenance;
- Finished sizes and tolerances of all wearing parts;
- Terminal point details;
- Expansion limits;
- Lubrication points;
- Minimum clearances;
- Welding preparation and procedures;
- Where plant or plant items subject to pressure and temperatures higher than ambient;
  - Design pressures and temperatures;
  - Working pressures and temperatures;
  - Test pressures and temperatures;
- Test pressures and temperatures;
- Insets, where necessary, to ensure every item of the assembly is clearly shown;
- All points of support;
- All points of attachment of the plant to piping, conduits or other items supplied by others; and
- Location of holding down bolts or other points of support or anchorage.

2.8.4 Electrical Drawings

Electrical schematics for the installation shall be drafted in accordance with AS 1102 and shall include the following:

> Ammeter scales and current transformer ratios;
> Circuit breaker and fuse current ratings;
> Ratings of capacitors, resistors and any other electrical devices;
> A short name description of each relay, timer or control device to describe its operation;
> A cross-reference system that indicates where each contact for a relay or timer is located. The system may include sheet and line numbers;
> Switchboard drawings including layouts and construction details and panel wiring diagrams;
> Single line diagrams;
> Items shall be designated as per AS 3702;
> All field wiring diagrams;
> Overall system diagrams of communication systems, showing terminal strip allocation;
> Cable types and system components; and
> Block cabling diagrams with detail frame allocation and terminals.

Electrical wiring diagrams for the installation shall be produced showing all cable terminations including cable numbers, wire numbers and terminal numbers.

A wiring schedule shall be submitted showing all cable sizes and number of cores.

The Contractor shall remain entirely responsible for the control logic, correct operation, performance and design.

2.8.5 As Constructed Drawings

The Contractor shall keep one (1) set of plans on the site with all the latest amendments and variations shown thereon. As the job progresses the Contractor shall show thereon all deviations and changes from the contract drawings, keeping an accurate record of the work as it progresses.

Included in these records shall be the actual location of all built-in work.

These amended drawings shall form the basis of the As Constructed set of drawings for inclusion in the Operations and Maintenance Manual.

Once works are completed on site, copies of the working drawings as amended during construction shall remain on site.

2.9 Installation, Operating and Maintenance Manuals

The Principal attaches considerable importance to the provision of proper installation, operating and maintenance instructions, and due regard shall therefore be paid to the detail and completeness of such documents. These manuals should be clear, concise and precise and be suitable for use by tradesmen who are not familiar with this particular installation.

Provide new manuals covering the new installation.

The Contractor shall supply for approval as early as possible, but at the latest two weeks before the Equipment is due to be delivered two draft hard copies of the Operations and Maintenance Instruction Manuals. No later than two weeks after approval by the Superintendent, four copies of the final manuals shall be supplied to the Superintendent. The Contractor shall issue such amendments to the manuals as from time to time may prove necessary due to service experience or technical developments. The Manuals shall be fully detailed covering all items in the installation. The text of the Operating and Maintenance Manuals, together with all drawings, illustrations and diagrams shall refer specifically to the Equipment being supplied under this Contract, and shall be specially prepared where necessary. General instructions referring to a range of typical equipment will not be acceptable.

Draft manuals must be substantially complete prior to requesting approval from the Superintendent.

The difference between the draft and final manual is the standard of presentation (that is the quality of reproduction, binding, layout, neatness, printing etc.) with the written content of the draft and final manual being the same. Final submission will also include a Adobe PDF version of the full manual with the document provided with sections and electronic selectable contents page for ease of navigation.

The Operating and Maintenance Instruction Manuals shall be assembled and bound in a four ring black A4 binder of the heavy duty, swing hinge, split prong type, of stiff binder board construction designed for rough usage. The binder shall have the title of the project, equipment description and the Contractor’s name, imprinted on the spine and front cover.

Binders shall not exceed 75 mm in thickness. If required by the quantity of instruction manual material, multiple volumes shall be supplied, each clearly marked with the volume number.

Each volume shall contain a full index for the entire manual and also a detailed index for it’s own content. A sufficient number of volumes shall be provided so that the material contained in each volume (including drawings, if any) does not use more than 80 percent of the binder capacity.

The Instructions shall be fully detailed covering all Equipment supplied under the Contract and the text, illustrations, and diagrams shall refer specifically to the Equipment being supplied under the Contract. In addition the manuals shall incorporate the existing equipment to be retained and the existing

manual information can be used for this purpose if suitable. The manuals shall include the following:

> Table of contents and index tabs;
> Specifications, test data (including all works and site tests), performance and equipment characteristic curves;
> As built installation drawings detailed location of all equipment, cable and containment routes, etc;
> Copies of all test results and certification;
> List of recommended spare parts;
> Copies of all manufacturers guarantees or warranties;
> Description of the equipment and components. This should include an overview with block diagrams and detail descriptions;
> Short form operating procedures;
> Complete and detailed step by step operating instructions, including setting up, start-up, shutdown, emergency, and abnormal operation, as well as steady state operation. A section shall be devoted to isolation and restoration procedures to be followed when maintenance is required on the various major items of plant.
> A full description of all construction and operational testing recommended ensuring proper preparation prior to operation of the equipment;
> Comprehensive preventative maintenance schedules outlining each operation and the recommended period at which each item of maintenance should be carried out;
> Complete installation and maintenance instructions including details on preventative, breakdown and troubleshooting diagnostics for known potential problems. These instructions shall be accompanied by illustrated equipment diagrams (assembly drawings) for use by maintenance personnel for parts selection and assembly instruction. i.e. Services Manuals, Workshop Manuals and Trouble Shooting Manuals. Instructions recommending the return of the equipment to the supplier for repair are not acceptable;
> Recommendations to prevent deterioration during prolonged shutdown periods;
> Assembly drawings showing relationship of equipment components (such as sectional views and exploded views of the equipment);
> Settings of adjustable parameters, including set points of protective devices, such as TOL devices and protection relays;
> Parts list (cross-referenced to assembly drawings). i.e. Parts Manuals;
> Where the Equipment manufacturer offers several options for a certain part i.e. the actual part installed shall be stated in the instructions;
> Nameplate information, Contact number and Manufacturer's contact address for each item of equipment and component part thereof;
> List of all special maintenance tools required and supplied by the Contractor;
> List details of any computer, PLC or other program used in the Contract; and
> The information shall be arranged in such a manner as to permit insertion of amendments and additional material. The instructions shall be cross-referenced for ease of use in maintenance and such reference number shall cross-reference to all drawing numbers, item numbers, part numbers

and catalogue references necessary to ensuring identification and understanding of systems.

The format of the manuals shall be generally as follows:
> The page size shall be A4;
> All pages shall have reinforced binding margins;
> Preferred drawing size is A4. A3 drawing size may be used where clarity of drawing will be lost with reductions. Existing larger drawings to be bound in clear plastic packets;
> Pages are to be numbered by section rather than consecutively so that additional pages can be readily inserted without affecting the existing page numbering; and
> New sections are to commence on new pages separated by tabulator dividers.

There should be provision for noting revisions on each page with amendment list in front of each manual.

2.10 Asbestos and Polychlorinated Biphenyls

All Equipment supplied under this Contract shall be entirely free of asbestos and polychlorinated biphenyls.

If asbestos or polychlorinated biphenyls are encountered during construction the
Superintendent shall be immediately notified.

2.11 Provision for Handling Equipment

All heavy parts of the plant supplied under the Contract shall have provision for lifting, slinging and handling during erection and overhaul or maintenance. All parts normally lifted during periods of maintenance and weighing one tonne or over shall be marked with their weight.

Eyebolts shall be provided where necessary to facilitate handling and overhaul of the various parts of the plant.

2.12 Tools and spare parts

The Contractor shall supply any special tools that may be necessary to enable the erection and dismantling of the equipment and shall draw to the Superintendent's attention all parts requiring periodic maintenance or replacement.

All tools shall be in new and unused condition.

Any tools which are required of a special nature for any equipment etc., installed by the Contractor shall be supplied to the Superintendent in a purpose designed box or receptacle.

At least 8 weeks before the date for practical completion, submit a schedule of portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

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

Provide spare parts listed in the appropriate work sections.

Replace spare parts consumed during the maintenance period.

2.13 Packing and Transport

All Equipment shall be carefully packed and secured for transport in such a manner that it is protected from all dust and climatic conditions during loading, transport, unloading and subsequent storage in the open. Equipment shall be suitably packed and protected against vibration, movement and shock that may occur during loading and transport. Particular care in packing shall be taken when the Equipment is transported by road. Heavy and bulky equipment shall be provided with adequate lifting fixtures to facilitate ready handling during transit and on arrival at site.

Instruments, relays and fragile items shall be packed separately. All items that include delicate equipment shall be sealed in polythene sheeting and silica gel desiccant or vapour corrosion preventive shall be inserted within the polythene packing.

Contractors shall submit their proposals to the Superintendent for protection of equipment during transit; however, the responsibility for safe delivery remains with the Contractor.

All equipment supplied under this Contract shall be clearly identified on the outside of any case with the type and number of items contained therein and the gross weight. Large crates are to be marked on three sides, and smaller crates which can be easily manhandled are to be marked on at least two sides.

The names of haulage firms, shipping companies, shipping agents, customs authorities and any special handling firms shall be advised to the Superintendent before the equipment is despatched. One copy of each applicable shipping specification, packing list, mass note, packing note and the relevant control numbers of consignment notes, waybills, bills of loading, customs clearance certificates, tranship notes and the like shall be forwarded

to the Superintendent as each paper required is raised, together with expected dates of departures and arrivals en route.

Adequate precautions shall be taken in the packaging of all machines that have ball and/or roller bearings so as to minimise the risk of damage to the bearings. Any bearing found with “brinelling” marks shall be replaced at no cost to the Principal.

Special precautions shall be taken to protect journals where they rest on supports during transport. At such points, anticorrosion fluid impregnated wrappings shall be used to protect the journals during transport.

2.14 Testing and Commissioning

In addition to testing requirements specified elsewhere in this specification, the requirements of this clause shall also apply.

The Contractor is completely responsible for the satisfactory installation testing and commissioning according to the relevant Australian, IEC or other appropriate standard and to the requirements of the Superintendent.

The Superintendent reserves the right to inspect at any time, the shop drawings, equipment, materials and installation called for in this Specification and on the drawings during manufacture, installation and commissioning.

Performance tests shall be undertaken and recorded at the site to validate undertakings given in written warranties and performances levels specified in this Specification.

Sample test and commissioning records of the type to be used for testing and commissioning the works described in this Contract shall be submitted to the Superintendent within two weeks of award of contract. After review of the records by the Superintendent, additional records and/or requirements may be forwarded to the Contractor for use in testing and commissioning these works.

At the minimum, the following records shall be provided:
> For insulation and continuity testing for all cabling;
> For distribution board and switchboard insulation test;
> For TOL and other equipment settings;
> For earthing resistance tests;
> For instrument configuration and calibration;
> For functional tests; and
> Other records and procedures to be followed during testing and commissioning as appropriate for the equipment and/or system.

The Contractor shall keep testing and commissioning records. Copies of these records shall be to the Superintendent immediately on request. Copies of the records shall be incorporated in the Operations and Maintenance Manual.

Commissioning shall comprise a minimum of two stages:

> Testing and pre-commissioning by the Contractor on site of individual equipment and of integral system operation;
> Final commissioning by the Contractor as directed by the Superintendent of equipment and integral system operation to the satisfaction of the Superintendent;
> Final Commissioning shall only be commenced pursuant to the following conditions being to the satisfaction of the Superintendent;
> Satisfactory rectification of identified defects and omissions;
> Equipment and system performs satisfactorily as confirmed by the testing and pre-commissioning records; and
> Operations and maintenance manuals satisfactorily complete.

A prerequisite to Practical Completion shall be completion of Final Commissioning to the satisfaction of the Superintendent.

Factory Testing hold point – Once the switchboards and PLC equipment is constructed full function and operational factory testing will be carried out and witnessed by the Principle or Principles Reprehensive. A test plan will be provided to the Principle 2 weeks before testing is due to take place.

Tests shall include as a minimum proving all digital/analogue inputs/outputs and communication busses and any other items deemed necessary by the Principal.

2.15 Training

Provide training with all the necessary equipment, manuals, videos and notes using trained and experienced staff.

2.15.1 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.

Prior to final inspection and after all commissioning tests have been completed, the operation of each of the systems is to be demonstrated to not less than five (5) persons nominated by the Principal.

These demonstrations shall cover all aspects of use, programming and operation of the plant and equipment and of maintenance procedures. They are to relate closely to the Operational and maintenance manuals.

2.15.2 Certification

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

2.15.3 General

> Use only qualified manufacturer's representatives who are knowledgeable about the installations.

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

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

2.16 Interruptions to Electrical Supply

The Contractor shall maintain electrical supply to all installations throughout the duration of the works.

Should it be necessary to interrupt electrical supply then written application shall be made to Superintendent at least two weeks beforehand. This notification shall include a description of the works to be executed, the installation affected and the projected duration and timing of the interruption. Interruptions to electrical supply are strictly at the discretion of the Principal, and should the requested interruption not be possible, the Contractor shall reschedule the works to a time at which an interruption can be tolerated, at no additional cost.

Shutdowns should be kept to a minimum the contractor will provide the principle with a plan prior to works demonstrating the change over while keeping the plant operational for consideration.

2.17 Plant and equipment access

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;
> Failure of plant and equipment (including leaks) does not create a hazard for the building occupants;
> Failure of plant and equipment (including leaks) cause a minimum or no damage to the building, its finishes and contents;
> Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes; and
> 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.

2.18 Painting and finishes

2.18.1 General

If exposed to view (including in plant rooms) paint new services and equipment.

2.18.2 Surfaces painted or finished offsite

Conform to *Metals and pre-finishes*.

Comment [CAPSPLAN1]: C an't find reference within this document

2.18.3 Exceptions

Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied offsite need not be repainted onsite provided the corrosion resistance of the finish is not less than that of the respective finish in this clause.

2.18.4 General

Conform to the recommendations of AS/NZS 2311 Sections 3, 6 and 7 or AS/NZS 2312 Sections 5, 8 and 10, as applicable.

Provide the following low odour/low environmental impact paint types with the following VOC (volatile organic compounds) limits:

» Primers and undercoats: < 5 g/litre;
» Low gloss white or light coloured latex paints for broad wall areas: < 5 g/litre;
» Coloured low gloss latex paints: < 85 g/litre; and
» Gloss latex paints: < 90 g/litre.

New unpainted interior surfaces: To AS/NZS 2311 Table 5.1.
New unpainted exterior surfaces: To AS/NZS 2311 Table 5.2.

2.18.5 Coats

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

2.18.6 Combinations

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

2.18.7 Protection

Remove fixtures before starting to paint and refix in position undamaged on completion.

2.18.8 Paint Colours

Table: Paint Colours – (All Paint Colours Specified to AS2700)

Potable Water Non Potable Water	Pipes and Fittings Pipes and Fittings *For External Potable and Non Potable Water where the water is likely to stand for any length of time, the Pipes and Fittings are to be painted Silver and have Pipe Markers attached which comply with AS1345-1995.*	B15 Mid Blue G21 Jade
Backwash/Sludge	Pipes and Fittings	B41 Bluebell
Air	Pipes and Fittings Operated Valves	B25 Aqua G12 Holly
Gas	Pipes and Fittings	Y44 Sand
Sewer	Pipes and Fittings	X31 Raffia
Oil-mineral, vegetable or animal Flammable or combustible liquids	Pipes and Fittings	X53 Golden-Tan
Acids and Alkalis	Pipes and Fittings	P23 Lilac
Other fluids, including drainages	Pipes and Fittings	N61 Black
GWTP Filter Gallery	Steel Work Walls	T14 Malachite T33 Smoke Blue
GWTP Chemical Store	Steel Work Walls Doors	T14 Malachite T33 Smoke Blue Colourbond - Rivergum
Pump Stations	Pump Motors Pumps Interior Walls Exterior Walls Doors & Windows Hydraulic Cylinders Pump Bases	N53 Blue Grey B15 Mid Blue N11 Pearl Grey G55 Lichen G52 Eucalyptus X53 Golden Tan N55 Lead Grey
Chlorine Buildings	Interior Walls Exterior Walls Doors Roof Line	N11 Pearl Grey G55 Lichen G52 Eucalyptus G52 Eucalyptus
Reservoirs	Tanks Roof Line Roof Colourbond Walls – Trim Colourbond Walls	G55 Lichen G52 Eucalyptus Colourbond Mist Green (Pale Eucalypt) Colourbond Mist Green (Pale Eucalypt) Colourbond Caulfield Green
Buildings	Doors, Trim Exterior	G63 Rivergum (Wilderness) G54 Mist Green (Pale Eucalyptus)
Barrage	Exterior	N35 Light Grey
Safety	Hand Rails	Y14 Golden Yellow
Switch Boards	Outside of Indoor Assemblies Removable Panels/Escutcheons Control Panels Outside of Outdoor Assemblies	X15 Orange N14 White N11 Pearl Grey G34 Avocado

Communications	Towers – When Specified	R11 International Orange N14 White As per Clause 8.10.2.6, Visual Aids Provided by Aerodrome markings, Markers, Signals and Signs. Version 1.2 September 2004, Civil Aviation Safety Authority.
	8.10.2.6 Masts, poles and towers must be marked in contrasting bands with the darker colour at the top. The bands must be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less.	

2.19 Marking and Labelling

2.19.1 General

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

> Locations exposed to weather: Provide durable materials;
> Pipes, conduits and ducts: Identify and label to AS 1345; and
> Cables: Label at each end to indicate the origin and destination of the cable.

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

Operating and maintenance manuals: Provide marking and labelling text identical to the text and terminology used in operating and maintenance manuals.

Label isolating switches and outlets to identify circuit origin.

2.19.1.1 General:

Select from the following materials:

> For indoor applications only, engraved two colour laminated plastic;
> Stainless steel or brass ≥ 1 mm thick with black filled engraved lettering.

2.19.1.2 Emergency Functions: To AS 1319.

2.19.1.3 Colours:

Generally in conformance with AS 1345 as appropriate, otherwise black lettering on white background except as follows.

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

2.19.1.4 Edges:

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

2.19.1.5 Fixing:

Fix labels securely using screws, rivets. Self tapping screws, proprietary self adhesive labels or double sided adhesive tape will not be accepted by the Superintendent.

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

2.19.1.6 Label locations:

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

2.19.1.7 Label text:

To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.

2.19.1.8 Lettering heights:

> Danger, warning and caution notices: ≥ 10 mm for main heading, ≥ 5 mm for remainder;
> Equipment labels within cabinets: ≥ 3.5 mm;
> Identifying labels on outside of cabinets: ≥ 5 mm; and
> Other locations: ≥ 3 mm.

2.19.1.9 Operable devices:

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

> Controls;
> Indicators, gauges, meters and the like;
> Isolating switches; and
> Outlets.

2.20 Record drawings

General: 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.

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.

2.21 Cleaning

Practical completion: At practical completion, clean the following:

> Insides of switchgear and control gear assemblies; and
> Switchgear and contactors, and other electrical contacts. Adjust as necessary.

3 ELECTRICAL INSTALLATION

3.1 Wiring Systems

Wiring systems shall comply with the following standards:
- AS/NZS 3000 Electrical Installations.
- AS/NZS 3008 Electrical Installations – Selection of cables.
- AS/NZS 3013 Electrical Installations – Classification of the fire and mechanical performance of wiring systems.

WS (wiring system) classifications are described in AS/NZS 3013. Appendix G of this standard contains a guide as to suitable wiring systems to achieve certain classifications. AS 3000:2007 Appendix H, WS Classification of wiring systems (Informative).

All components of the wiring system shall be suitable for the WS classification assigned to the wiring system, either in this specification or the applicable standard. Should a standard require or recommend a higher WS classification than that required in this specification then the requirements or recommendations of the standard shall apply.

WS classifications for particular spaces shall be:
Plant and switch rooms Below 2000 AFFL WSX2
Plant and switch rooms Above 2000 AFFL WSX1
Other Locations WSX1

3.1 Cables

Cables shall comply with the following standards:
AS/NZS 5000.1 Electric cables Polymeric insulated – For working voltages up to and including 0.6/1 kV
Except where specifically detailed otherwise, all cables shall be new.
Unless otherwise indicated all cables shall have stranded copper conductors.

All cabling and wiring shall be supplied and installed in accordance with the applicable standards, in particular AS 3000 and AS 3008.

Unless approved by the Superintendent all Single-Core cables in parallel shall be installed as per Appendix B of AS/NZS 3008.

Cabling shall be of the size required to meet the current rating and voltage drop requirements of AS3008 plus 10 percent. Cables shall be rated according to AS3008 taking due regard to derating appropriate to the installation.

Flexible, submersible cable, to Australian Standard AS 3116 shall be employed for connections to submersible motors or where continued immersion is expected.

Cables for all low level instrument signals shall use twisted pair conductors and shall be screened

AS 3000 and AS 3008 for the actual circuit loading and method of installation, or as specified.

Minimum size shall be:

Lighting sub circuits	2.5 mm2
Control sub circuits	1.5 mm2 tinned copper flex
Power sub circuits	2.5 mm2
Power sub mains	6 mm2
Lighting final circuits	1.5 mm2
Control final circuits	1.5mm2 tinned copper flex
Power final circuits	2.5 mm2
ELV PLC wiring	0.5mm2 tinned copper flex
Instrument loop Wiring	0.5mm2 screened, twisted pair
Current Transformers	2.5mm2 double insulated
Bus wiring for closing and tripping supply	2.5mm2 tinned copper flex

All wiring shall conform to the following unless otherwise agreed by the Principle.
All control multi-core cables installed shall have for cable with up to 8 cores/pairs 1 spare cone /pairs, for cables with greater than 8 cores/pairs 10% of cores available for future expansion.

Table: Cable Colours

Colouring of wiring shall comply with AS3000.

Function	**Colour**
AC Power	
3 – phase	Red, White, Blue
1 – phase	Red
Neutral	Black
Earth	Green/Yellow
DC Power and Control	
Positive	Orange
Negative	Grey
Earth	Green/Yellow
Control	
Extra Low Voltage AC/DC	
Active and Neutral	White
Analog Twisted pair	Black and White
Thermocouple	ANSI-M961
Earth	Green/Yellow

Each cable shall be provided with a unique cable identifier Metal identification tags, of stainless steel or other approved material. Tags shall be stamped indelibly with the appropriate cable number; the letters and figures shall not be

less than 6mm high. Identification tags shall be fixed at each end of each cable.

These shall be cross referenced to the cable schedule which will include: Cable type, Cable/core size, number of cores, Starting Point, End Point, Route, and Length.

TPI and TPS cables shall be 0.6/1 kV grade as applicable in accordance with AS/NZS 5000.1.

Insulation shall be PVC V90 grade unless otherwise indicated.
All cables shall be circular and have multi-stranded copper conductors. Flat cables shall not be utilised.

Wire and cables shall be brought to the site in their original packages with their labels intact otherwise they shall be liable for rejection. All wiring in which kinks or abrasions occur shall be condemned and shall be replaced by the Contractor at his own expense.

Cabling shall be Instrolex (formally Decron) – Overall screened instrumentation wiring with separate cables for analogue and digital/outputs.

Proprietary instrument cables shall be as supplied by or as recommended by the relevant instrument manufacturers.

Screened and steel wire armoured cabling shall be provide as required to meet EMC or hazardous area requirements.

3.2 Cable Installation

Upon delivery of the cable drums, they shall be visually inspected for damage incurred during transport or storage. The seal on the inner and outer cable end shall be examined and the condition of armouring, serving or sheath inspected for damage, corrosion or leakage of impregnating oil. Any damage discovered shall be reported to the Superintendent.

During installation cables shall be handled with due care. When pulling cables, any winch used shall have automatic tension limiters and the tension shall not exceed that specified by the manufacturers for the particular cable and conditions of installation. Winching ropes shall be attached to the cable armour with steel mesh sleeves and care shall be taken that cable sheaths are not damaged in any way.

When laying or snaking the cable, no twists or kinks shall be allowed to occur. Throughout the installation, twisted, kinked, knotted or crossed cables shall not be permitted in any enclosure. Runs shall be neat and workmanlike in appearance.

When drawing cable into conduits only chalk type or other approved lubricants not injurious to PVC sheathing may be used. Petroleum based substances such as grease or oil are not permitted.

When rollers are used during installation, sufficient units shall be emplaced to keep the cable clear of ground and other obstructions. Vertical rollers shall be used at all changes of direction.

Cables shall not be bent to a radius less than that recommended by the manufacturer. Should any damage occur to any part of a cable (including serving) during handling or installation, the Superintendent shall be informed and work shall only proceed after his inspection and authorisation to continue has been given.

All cables and wiring shall be identified at each end where they are connected to apparatus or terminal strips using ferrules similar to hellerman, hellagrip or hellaclip. The identification used shall correspond to that shown on the drawings.

When installing cable supports and cables the contractor shall comply with the following general requirements:

- Cables shall be continuous from the conductor termination points. Joints in cable runs will not be accepted.
- Bending radii for cables shall not be less than that recommended in the relevant Australian or Standard or Code or by the cable manufacturer.
- Cables shall be provided with supports located as close as is practicable to the point of termination of the cable.
- All cables shall be provided with effective clamps. Single ore power cables forming part of a 3-phase circuit shall be rigidly held in trefoil arrangement.
- Where cables or conduits are required to emerge from the floor or support platforms other than at equipment location they shall emerge at walls only.
- Where cables or conduits emerge from the flor or support platform to the equipment, they shall be fully protected in sheet steel ducts.
- Where cables or ducts pass through a fire proof barrier, the opening shall be sealed y fire stops. Such fire stops shall be arranged for easy renewal for addition and removal of cables.
- Where cables or cableways pass through a wall, the entry shall be sealed by removable sealing plates or other means.
- All conduit entry to buildings or cubicles shall be sealed to prevent entry of water and vermin. Floor conduit ends shall be plugged until installation begins. Conduit accommodating consumer's mains shall be completely weatherproofed at the point of entry of the cables. A downward pointing bell mouth shall be fitted to the top of the conduit.
- All Cables shall be protected from direct sun light exposure.

Metal identification tags, of stainless steel or other approved material shall be attached to each cable. Tags shall be stamped indelibly with the appropriate

cable number. The letters and figures shall not be less than 6mm high. Identification tags shall be fixed at each end of each cable.

All naming of wiring and Cables shall be (Equipment No – Wire No.) eg. Primary Sludge Pump 1: PRISL/1 – 12345

Wire to and connect all outlets and equipment shown on the drawings and indicated within this specification.

Carry out all wiring on the loop-in system and note that jointing of cables and use of connectors will only be permitted at outlets or suitably positioned junction boxes.

Wiring shall not be run through fittings.

Wiring shall enter and leave at the one point.

Wiring shall consist of TPS cables surface mounted or concealed in continuous rigid conduit or attached to cable ladder

Wiring shall not be installed between roof sheeting and insulating material when insulation is directly beneath roof sheeting.

Cables shall be adequately supported along their entire length to the approval of the superintendent. Supports shall be installed at maximum intervals of 1000 mm and at lesser intervals where required to prevent undue sagging. Cables in sloping or vertical runs shall be supported every 600 mm.

Where not installed on cable rack or tray, cables shall be saddled to concrete masonry or steelwork or clipped by cable clamps to Unistrut channels. Channels shall be of sufficient width to accommodate all cables in the run plus a 20% spare capacity.

Structural steelwork shall not be drilled, welded or cut to facilitate cable installation without the Superintendent's written permission. Cladding on transfer towers and canopies is not to be used for cable support or penetrated in any way unless authorised.

Cables emerging from the ground shall be protected by 6 mm galvanised mild steel channel from 2000 mm above ground to 150 mm below ground rigidly fixed to the structure and directly connected to the earthing system.

When planning cable routes the Contractor shall comply with the following requirements.

> All cables and supports shall be kept clear of walkways, operating spaces and maintenance spaces.
> Marshalling boxes shall be in positions not exposed to risk of mechanical damage or damage by fire or water.

The use of Ramset nails for support of cables or cable supports is not acceptable.

The following groups of cables shall be segregated from each other by continuous barriers or required free space separation when installed in common tray/ladder systems or by using separate ducts or conduits:

1. 230/400V power supplies
2. 200V control supplies and systems
3. ELV control supplies, and signal and communications systems, including Thermistor wiring.

Each core shall be left sufficiently long and neatly looped to allow a fresh termination to be made. After all cores of the control cable have been terminated the unsheathed portion of the cable shall be laced neatly with an approved non-flammable cable strapping.

During installation, all cables shall be cut from drums in such a manner that cut-offs are a minimum and any surplus cable remaining is in a single length.

Cables shall be installed in continuous lengths.

Cables shall be sealed after cutting in a suitable and approved manner.

Single core cables forming part of a three phase system shall be clamped together in trefoil over their entire route to avoid derating.

The configuration of parallel trefoil circuits shall comply with the recommendations of AS 3008 Appendix B. This configuration requires that the phase arrangement in one cable group shall be a lateral mirror image of the phase arrangement of the adjacent group.
The clamping of single core cables in trefoil shall be of sufficient mechanical strength to withstand the forces generated by fault currents.
Single core cables shall be installed so as to avoid hysteresis and eddy currents in surrounding metal work or cleating.

All cables shall be installed and terminated using fittings appropriate to the situation.

Tinned compression cable lugs manufactured from solid drawn high conductivity copper shall be employed for all power cables and shall be applied by means of the manufacturers approved compression tool fitted with the appropriate size die.

The unsheathed part of multi-core cables shall be neatly laced with cable ties or other means approved by the Superintendent.

Where screened signal wires are specified, screening shall be continuous from the signal source to the receiver. Earthing of the screen shall be at the substation end only and shall be achieved by connection to the instrument earth busbar.

Final connections to instruments and similar equipment which is with draw able from its mounting shall be made with flex entries in PVC double insulated

flex not less than 32/0.2 mm. Sufficient flex, neatly strapped, shall be provided to permit easy withdrawal of equipment.

Control cable cores shall be terminated in crimp pins and have wire number ferrules. Where numbering of ferrules on similar circuits is the same the numbers shall be prefixed with the main circuit reference.

Plug and socket connections between fixing wiring and equipment shall have threaded collars or latches with prevent the accidental removal of plugs. Plug and socket connections shall be capable of making and breaking the direct-on-line starting currents of motors.

Cables terminating in an air bell or similar pressurised device shall have cores terminated in a potted junction box to prevent air migration through the cable.

Cable glands shall be of an approved weatherproof type of a type that is consistent with the IP rating of the enclosure and the hazardous area classification.

As a minimum, glands in general areas shall be constructed from:
> Cables up to 25mm overall diameter: Nylon or PVC; and
> Cables larger than 25mm overall diameter: Nickel plated brass.

Nickel plated brass glands shall not be used in conjunction with aluminium alloy boxes or Aluminium gland plates. Use stainless steel glands in this case. PVC weatherproof shrouds shall be provided and fitted for glands mounted outdoors or in readable visible areas. The shrouds shall be ALCO “SG” type or approved equivalent.

All gland plates shall be drilled to the sizes required by the cable gland. The gland sizes shall conform to the manufacturer’s recommendations.

Where it is required that PVC cables be connected to equipment that is too small to accommodate the gland, or if permanent wiring is provided with equipment (e.g. Solenoid valves), then cables shall be terminated in a conveniently located two-way junction box. The connection to the equipment from the junction box shall be made using flexible conduit and approved fittings. The enclosure rating of the junction box and fittings shall be appropriate for the area of installation.

All cable terminations shall be made using pre-insulated crimp lugs or bootlace ferrules.
Crimp lugs shall be crimped with an approved crimp tool. Where hand operated crimping tools are used, the tools shall be of the type which will not release until full compression is applied.

Hexagonal crimping dies shall be used on all cables of 70 mm2 cross-section and above.

Lugs shall be approved by the Superintendent and shall be tinned copper.

Suitable full sized bolts shall be used for the connection of lugs onto equipment terminals. Where lugholes are not big enough for the size of bolt being used, copper flags shall be provided and fitted.

Wire stripping shall be performed using an approved wire stripper. The wire shall be stripped to an extent that prevents the covering entering the terminal connection or crimping lug but does not allow the protrusion of bare wire from the terminal block or lug.

No more than one wire shall be connected to one side of any terminal unless approved by the superintendent.

The correct size and type of screwdriver shall be used for making terminal block connections.

Terminal strips shall be provided within enclosures and equipment for control cable terminations.

Terminal strips shall be provided with the number of terminals required on the drawings plus 10% spare rail capacity.

The terminal blocks shall be coloured as follows:

General	Grey
Intrinsically safe	Blue
Earth	Green/yellow

Where control cables and power cables (above 50 V D.C.) are connected to terminal strips in the same enclosure approved protective covers and warning labels shall be installed over power connections.

Each terminal shall be identified with a number in accordance with the drawings using permanent clip-on non-flammable terminal markers with black characters on a white background.

The cores of all cables shall be continuity checked, and numbered with white engraved ferrules with black numbers to correspond to the relevant termination diagrams and equipment drawings. Wrap around adhesive markers are not acceptable. The Contractor shall ensure that the component numbers of the identifier are aligned and that the identifier is clearly visible.

Ferrules shall be of a sleeve type which will not slip off the ends of the cables and/or as may be specified in the Principal's Preferred Equipment List.

The overall cable shall also be labelled with approved tags and identifying references.

Ducts used in switchboards 40 x 40 or larger shall use wiring retainers (NHP Cat No CL40-40 or equivalent) in sufficient quantity's to facilitate the retention wiring when duct covers are removed.

Ducts shall be sized to allow at a minimum of 25% free capacity.

Any damage to civil works or steel, including paintwork caused by electrical installation work shall be made good by the Contractor.
After erection all holes in floors and walls and in cable pipes through which pass cables, conduits or earth bars shall be sealed. All penetrations shall be sealed with a fire resistant two part expanding silicon rubber similar to Selleys Fire stop. The contractor shall ensure that all penetrations are fire, weather and rodent proof.

3.3 Power outlets

All power sub-circuits shall be protected by residual current devices. Residual current devices shall be integral to the circuit breakers installed within distribution switchboards i.e. take up one pole space on the distribution board.

Isolation switches shall be provided to all direct connected equipment and appliances. Isolators shall be capable of being locked in either the open or closed positions. Allow for single or three phase isolators as required.

Unless otherwise specified switched socket outlets shall be Clipsal 56 series or equivalent.

3.3.1 Minimum rating

15 A, 240 V A.C.

3.3.2 Mechanism

General: Construct the face plate and mechanism so that the mechanism cannot be displaced during normal operation by means of retaining screws.

3.3.3 Indicators

Provide red indicators above switch toggles, to be visible with switches “on”.

3.3.4 Pin arrangement

Mount outlets with the earth pins at the 6 o’clock position.

3.3.5 Minimum rating

20 A, 500 V A.C.

3.3.6 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.

3.3.7 Plug

Provide a matching plug top for each outlet.

3.3.8 Construction

Surface mounted type of high impact resistant plastic, with flap lid on the outlet.

3.3.9 General

Provide surface mounted accessories in plant rooms, roller doors and mechanical equipment.

3.3.10 Surface mounting

Type: Proprietary mounting blocks.

3.3.11 Restricted location

Do not install wall boxes across junctions of wall finishes.

3.3.12 Marking

Label isolating switches and outlets to identify circuit origin.

3.4 Underground Installation

Underground Installation shall not be used unless approval in writing is given by the Superintendent or superintendent's representative.

Prior to trenching the route shall approved by the superintendent.
Unless otherwise indicated underground cables shall be installed in conduit.

Underground conduits shall consist of:

- Power and control: Orange Heavy duty uPVC conduit to AS 2053.
- Communications: White uPVC conduit, similar to Class 9 pressure pipe.
- Corrugated conduit similar to Corflo shall ***not*** be utilised.
- All conduit changes in direction shall be made by large radius set bends.

Prior to trench excavation the contractor shall clear the area along the line within 2 m of the trench. All bushes, trees and vegetation shall be cleared and removed from the site. All stumps and roots with 600 mm of the sides of the trench shall be grubbed to a depth of 300 mm.

The contractor shall be responsible for dial before you dig and any associated costs for locating cables.

All trenches, unless otherwise directed by the Superintendent, shall be excavated in ground as found along the line and to the depths and widths shown on the drawings. Provide in the as constructed manuals photos of trenches showing depth, location, and cable prior to back filling. The line of the trench must be kept perfectly straight and parallel to the planned alignment. The bottom must be kept level across the trench and the sides as near the vertical as is practicable.

Any cavities in the bottom of the trench must be filled with selected stone free material, properly compacted to the proper grade.

The contractor shall take care to erect shoring as necessary to effectively prevent the sides of the trench from running or falling into the excavation and to keep trenches free from water during all cable/conduit laying operations.

Spoil from the trench excavation not required for backfill in the trench shall be mounded above the backfilled trench.

Traffic flow along roadways shall be maintained at all times. Where traffic must cross open trenches, suitable bridging shall be provided by the Contractor.
Where trenches are to be excavated across roads, the Contractor shall ensure that the road pavement material is kept separate from other excavated material to allow for same being easily replaced after backfilling. If this is not done, the Contractor shall provide the same consolidated depth of pavement material of the same quality as previously existed, compacted to the same density as surrounding material.

The Contractor shall take every precaution that is necessary for the protection from injury of all existing drain pipes, electric and telephone conduits and other existing works and services wherever met with, or which are adjacent to the work, and to avoid damaging such drains, conduits or service connections or any fittings attached thereto.

The Contractor shall be held responsible for the keeping clean and the maintenance of the trenches in good order and condition between the time of excavation and laying and shall obtain the Superintendent's approval before commencing to lay cables.

The Contractor at his own expense shall carry out all measures to divert any water interfering with the progress of the works, keep the trenches and excavations free from water while the works are in progress, and prevent any injury to the works by water due to floods or other causes.

The Contractor shall have proper and approved pumping equipment for keeping the trenches and excavations free from water while the works are in progress.

Provide sealing with pliable non-setting waterproof compound, of buried entries to conduits using waterproof seals. Seal all conduits immediately after

installation. Where cables are not installed straight away the conduits shall be sealed using end caps.

After the excavation has been completed and approved the trench shall be cleared of all sharp objects and a foundation layer of stone free bedding material shall be placed. The depth of bedding material shall be such that after the cable or duct is laid, the minimum depth of bedding between the underside of the cable or duct and the trench floor is 50 mm.

All bedding shall be compacted to a minimum of 90% standard compaction density (AS 1289 Test E1.1).

Cable drums shall be arranged so that the cable is always pulled from the top of the drum using suitable shotters, hooks or come-alongs and a swivel to prevent damage to the cable. The cable shall be pulled just fast enough to keep the drum rotating smoothly and sudden stopping shall be avoided. When pulling cables into trenches, rollers shall be spaced to prevent the cable dragging on the ground. At bends an assembly of rollers and skids or rollers and angle rollers shall be used and the cable shall not be bent to less than 15 times OD.

All changes in direction or grade shall be in easy stages.

Before backfilling, draw cords shall be installed in all ducts and the ends sealed with a Non-setting mastic compound. Any caps or draw wires in spare ducts, which may have been disturbed, shall be reinstated.

Draw cords shall be 6mm polypropylene cord.

Backfilling of the trench shall only be commenced after the Superintendent has witnessed the conduit/cable installation and authorised the backfilling.

Bedding material, Cable Protection and Marker Tape shall comply with the requirements of AS3000.

Underground cable route concrete markers shall be installed above all underground cable joints, at every change of direction of underground cable and on straight runs at least every 30 metres.

Markers shall consist of a concrete block 400 mm square 100 mm deep with an engraved brass label attached. The marker shall identify the cable and indicate its direction of lay as indicated on the drawings. Labels shall be fixed to the concrete block with screw fixings (not raw plugs) and epoxy adhesive.

Markers in unpaved areas shall be installed with 20 mm projecting above the surface. Markers in paved areas shall be flush with the surface.

On each side of the top of the drainage channel, and immediately adjacent to the cables, provide a marker post. The post shall consist of 90 x 90mm SHS with a welded cap. The complete assembly shall be hot dip galvanised after fabrication then powder coated Light Orange X15 to AS 2700. The post shall

be embedded in a 250 x 250 x 500 deep concrete footing and be 900 high. On each of the two faces in line with the lay of the cable provide a brass label screwed to the side of the post with the wording, 'DANGER Electric Cable Crossing'.

Where cables cross open, unlined drainage channels the cables shall be covered with a 75mm thick continuously poured concrete slab which overlaps the sides of the cables by a minimum of 150mm on both sides. The concrete slab shall be located 200mm below finished ground level.

An additional layer of marker tape shall be provided directly on top of the concrete.

3.5 Wiring Enclosures and Support

Cables shall be installed within wiring enclosures consisting of conduits, ducts, cable trays or cable ladders.

Wiring enclosures shall provide the degree of mechanical protection required to achieve the WS classification of the wiring system to AS 3013.

Building Drains, Down Pipes etc shall be diverted away from wiring Enclosures, Conduits, ducts, cable trays and or cable ladders.

Frames supporting equipment shall be finished with due regard to the operating conditions.

Frames exposed to the weather or other corrosive environments shall be closed section, sealed welded and hot dip galvanised.

Fastenings (bolts, nuts, screws, clips, washers, rivets, etc) used shall have a corrosive resistance equivalent to the metal or alloy so that they are not preferentially corroded. Brass, monel metal and stainless steel will generally be accepted. Hot dip galvanised may be accepted where the surface coating would not be damaged. Carbon steel spring clips and self tapping screws shall not be used or approved.

The Contractor shall repair all defective or damaged coatings as soon as possible to avoid deterioration of the base metal. The surface shall be restored to be in accordance with the treatment originally specified.

Conduits shall generally be run as directly as practical, with a minimum of bends.
Run conduits so as to enable cables to be drawn in after erection. Provide sufficient accessible junction boxes for this purpose.

Where junction boxes are exposed to weather, the lids shall be sealed with an approved gasket.

Junction boxes shall be of ample size to enable the cables to be neatly diverted from one conduit to another without undue cramping.

Inspection fittings shall not acceptable as draw in points, except where they are used in accessible surface runs of conduit to allow the conduit to pass around beams and other exposed structural members.

Conduit fittings shall be sized so that cable is not bent to less than its minimum bending radius.

During installation, the ends of conduits shall be temporarily plugged to prevent the ingress of dirt.

As a minimum conduit type shall be:

Wiring System Classification to AS/NZS 3013	Conduit Type
WSX1	Light Duty uPVC
WSX2	Heavy Duty uPVC
WSX3	Screwed galvanised steel conduit

Conduits shall be neatly run and securely fastened by means of approved saddles. Saddles shall be provided within 150 mm of all fittings or terminations.

The direction of conduit run shall be parallel to the walls, floors and ceilings wherever practicable.

Conduit shall be installed so as to avoid all mechanical duct systems and other pipe systems and services and shall in all cases be at least 75 mm from heating pipes and at least 500 mm from boilers or furnaces.

The Contractor shall be responsible for the true horizontal or vertical installation of all boxes and fittings.

Surface conduits shall be run so as to be as inconspicuous as possible by running in corners and the like.

The route of all surface conduits must be discussed with the Superintendent before installation is commenced.

Where conduits are cast in-situ into concrete they shall be installed in strict accordance with the requirements of the Superintendent.

Where slabs and walls have a layer of reinforcement adjacent to each surface, the conduit shall be installed in the neutral plane between the two layers of reinforcement in such a manner that the reinforcement is not displaced in any way. Deep or extension conduit boxes shall be used as necessary.

Conduit run between the reinforcement and the surface of the slab will not be permitted.

Where slabs or walls have only one layer of reinforcement placed centrally in the slab, the conduit shall be placed as nearly as possible to the centre of the slab without displacing the reinforcement.

The Contractor shall notify the Superintendent on completion of each section of conduit and prior to pouring of the concrete so that the work may be inspected.

The Contractor shall obtain the approval of the Superintendent prior to installing conduits that cross other runs. Such crossings shall be avoided if an alternative route exists.

Rigid uPVC conduit and corrugated conduit and fittings shall be in accordance with AS 2053.

The use of corrugated conduit shall be limited to short sections, not exceeding 500mm in length, where a conduit run needs to deviate around an obstruction.

All joints shall be cemented with approved cement after cleaning with recommended solvent.

Screwed fittings shall not be used.

Conduit fittings shall be manufactured from rigid uPVC.

Conduits and fittings damaged during installation or delivery will be condemned and shall be removed from site.

uPVC conduit shall be securely fastened with proprietary Stainless saddles at a maximum spacing of 0.5 m. Where necessary to eliminate sagging in the conduit additional saddles shall be provided. Where uPVC conduit is installed across rafters or joists in roof spaces it shall be fastened to the side of a timber batten to approval.

Provide saddles within 150 mm of all fittings and terminations.

Where any straight section of rigid uPVC conduit exceeds 4 m in length an approved expansion joint shall be provided for each 4 m or part thereof along the entire length of the straight section.

All sets and bends in rigid uPVC conduit shall be made using internal springs of correct size to prevent wall collapse. Conduits in which any collapse of walls is evident will be condemned.

Precautions shall be taken during construction to protect the conduits from damage or
movement from position by equipment being used by the builder and other trades.

uPVC conduits shall not be installed without further protection when exposed to weather.

Unless otherwise indicated the flexible conduit shall be Non Metallic Anaconda or equivalent.

Unless otherwise indicated flexible conduit shall be used to make final connection to individual items of plant, eg. Motors, particularly plant subject to mechanical vibration or requiring to be moved during plant adjustment. The length of flexible conduit shall be kept to the minimum necessary to make the connection and accommodate plant movement.

Flexible Conduit type shall be suitable for the WS rating of the wiring system, hazardous area classification and the ambient conditions, such as sunlight, temperature, chemicals etc.

Corrugated uPVC conduit shall not be utilised as flexible conduit.

Flexible conduits shall be terminated utilising proprietary fittings.

Cable Ladder is the preferred method of running cables. All cable ladder installed external to buildings shall be fitted with a lid to minimise cable exposure.

Unless otherwise approved by the Superintendent all cable ladder, shall be vertically mounted to reduce build up of dust and material.

Cable ladder shall be aluminium type to suit the installed environment.

Cable ladder shall comply with AS 3000. Cables shall, where possible, be run on cable ladder racks or trays of ample width to accommodate the cables specified with a 30% allowance for future cabling.

Provide wall mounted cable ladder or tray in switchboard cable trenches sized to accommodate 30% spare cable space.

The use of open cable trays or ladders near pipe runs where frequent work is required shall be avoided. Where cables may be subject to mechanical damage ladder racks and trays shall be fitted with approved covers.

All cables shall be tied at suitable intervals.

Power cables laid in racks or trays loaded less than 50% of their maximum current rating may be grouped together with not more than 6 other such cables. Power cables loaded above 50% of their maximum current rating shall be installed with sufficient spacing to prevent derating.

All cable ladder, tray and associated fish plates, bends, tee pieces etc shall be hot dip galvanised after fabrication and shall be free of burrs or projects to prevent cable damage.

All tray bends, both horizontal and vertical shall have a minimum radius of 450 mm for power and control cables unless otherwise stated.

All nuts and bolts required for the installation of ladder and tray sections shall be stainless steel grade 316.

Cable ladder racks shall have a maximum rung spacing of 300 mm and be supported on galvanised fabricated mild steel brackets welded or bolted to building structures. They shall be supported at intervals such that when fully loaded with a load of 150 kg/m2 of cable ladder rack surface area plus a mid span point load of 100 kg, then the deflection shall not exceed 1/200 of the span length. Cables shall be fixed to sloping and vertical runs of cable ladder rack by saddles, clamps, or nylon cable ties or similar style and quality of “Panduit” PLT series.

Rack sections shall be bolted together and bolts shall not protrude into the rack section which may damage cables during installation.

Because of the range of temperatures and length of runs required for some sections of cable supports, it is required that provision be made for expansion and contraction of the tray or ladder, to prevent buckling and distortion. Sliding joints shall be so constructed that abrasion of the mating surfaces does not cause removal of the anticorrosion coating and suitable facilities for preserving earth continuity shall be made at each sliding joint or gap. Care should be taken to ensure that cables are not fastened to the tray or ladder in such a way that the cable is stressed during movement of the steel work.

Where it is necessary to cut or weld cable ladder racks, the exposed metal shall be treated with anticorrosion coating approved by the Superintendent.

Cable ladder rack routes shall be bonded to the earth grid via 16 mm2 green/yellow PVC covered cable at each end of the run, at the nearest available substation earth.

Cables shall be spaced on racks to avoid build-up of material during normal operation.

Easily accessible peaked covers shall be fitted to ladder, tray and duct, subject to direct sunlight or prone to build up of dust or materials.

Where covers are fitted they shall be clamped to the ladder, tray and duct by means approved by the Superintendent.

Cable ladder racks shall be mounted to maintain 300 mm clearance between racks vertically and at least 150 mm under structural sections.

Cable racks shall be installed to maintain a minimum head clearance of 2100 mm.
Subsidiary cable trays additional to cable ladder racks shall be installed where required to give adequate support to cables. Minimum thickness of cable trays shall be as approved by the Superintendent.

Brackets and supports shall be of hot dipped galvanised steel entirely suitable for the application. Hot dipped galvanised P1000 Unistrut will be acceptable where suitable. Samples of each type of bracket shall be submitted to the Superintendent for approval. All brackets and fixing shall be jig drilled and designed to allow the rapid interchange of identical equipment.

Approved insulating separators shall be installed between the aluminium ladder, tray or duct and steel supports or any other dissimilar metals interface and shall have a minimum thickness of 3 mm.

Aerial cable supports shall be designed to suit the installed cable loads including those caused by environmental conditions applicable to the installation and shall be suitable for the installed location.

4 SWITCHBOARDS AND CABLING

4.1 Switchboard Works

Terminal strips shall be provided for completing connections between each item of equipment and external wiring.

Terminal strips shall not be less than 300mm above floor level and not greater than 1700mm above floor level.

Terminal strips shall be provided with labels identifying each terminal.

When Specified by the Superintendent Provision will be provided for connecting of a portable emergency generator to the site main switchboard via an elevated external generator link box with suitable bolt on connection bars for generator connection.

For Sewage Pump stations please refer to Section 11 – Sewage Specific Specifications – Wet Well.

When Required Energy Retailers metering will be by meters contained within an external metering enclosure as per the Ergon metering and revenue manual.

The main switchboard will be provided with private energy metering with connection to the SCADA.
Comply with the requirements for Site and Service Conditions contained in the General Requirements section of this specification.

Switchboards shall also comply with the following additional requirements:

ATTRIBUTE	REQUIREMENT
Voltage	400 VAC
Voltage Tolerance	+10% 6%
Frequency	50 Hz ± 1Hz
Number of Phases	Number of Phases 3 phase 4 Wire
Type test	Partial Busbars only
Short circuit	Coordination Type 2 to AS 3947
Mounting Type	Mounting Type Floor Mounted on Galvanised steel plinth
Cable Entry	Bottom or top non magnetic Gland Plate
Finish	Refer finish section of specification
Connection	Front only
Form of construction	Form 3b for main switchboard, Form 1 for other enclosures to AS3439.
Material of construction	Marine grade aluminium for external enclosures, Stainless steel 316 or marine grade aluminium for enclosures in non air conditioned rooms; Galvanised and painted sheet steel in main

	switch room.
Spare pole and current carrying capacity	Minimum 25% on completion of installation

4.2 Reference

Switchboards shall be to AS 3439.1 and shall comply with AS 3000, and other applicable standards and Ergon requirements.

All equipment shall have front connection and removable cover plates shall be provided to permit ready access for this purpose.

Switchboard shall be constructed to withstand a prospective unfused fault current of not less than that indicated. The switchboard shall be type tested in accordance with AS 3439.1 to the extent shown in the table above. Internal separation shall be to AS 3439 to the Form indicated.

Each unit shall be constructed suitable for mounting in accordance with the table above, and to the approval of the Superintendent.

4.3 Documentation and Testing

In addition to the requirements specified in the General Electrical Requirements section of this specification, the requirements of this clause shall apply.

Provide shop showing the following details, for each switchboard, for review by the
Superintendent:

» General arrangement showing dimensions, layout of equipment, busbars and connections;
» Sheet metal and sealing details;
» Type and ratings of equipment, and.
» Schematics, wiring diagrams and terminations.

Prior to dispatch to site switchboards shall be subject to the tests in the applicable standards and a functional test.
The Contractor shall give the Superintendent at least 5 working days notice of the tests so that the Superintendent can witness the tests. The equipment will only be accepted after the satisfactory completion of the tests noted above and function tests.
Should the test be unsuccessful the equipment shall be repaired or replaced as appropriate and subject to retest until successful.

4.4 Construction

Switchboards shall generally be of fully metal enclosed, dead front construction such that it is not possible to gain access to live busbars, wiring or terminals without the use of tools.
All equipment shall be front connected and removable cover plates shall be provided to permit ready access for this purpose.

Unless otherwise indicated the minimum degree of protection provided by the switchboard against contact with live parts and ingress of foreign bodies and liquid as required by AS 3439.1 and as defined in AS 60529 shall be:

- Switchboard cupboards or switch rooms: IP52
- Plant rooms: IP54
- External locations: IP56

All equipment shall be readily accessible.
The height from the floor to the bottom of any item of equipment shall not be less than 300 mm.

The height from the floor to the top of any item of equipment shall not exceed 1700 mm.

Unless otherwise indicated the equipment and switchboard shall be naturally cooled. Forced ventilation shall not be used unless specifically approved.

Where forced ventilation is used the requirement shall be met using a single cooling fan for each compartment.

All sheet metal used in the manufacture of switchboards shall be cold rolled mechanical sheet mild steel, marine grade aluminium or 316 grade stainless steel which shall be supplied flat, free from dents, rust, scale and other blemishes.

The minimum thickness of mild steel or stainless steel sheet shall be:
a) Cabinets of maximum width 600 mm without frame 1.5mm.
b) Cabinets of maximum width 900 mm without frame 2.0mm.
c) Cabinets of maximum width greater than 900 mm without frame 2.5mm.
d) Where frame of angle iron or rolled steel is used 1.5mm.

Notwithstanding the above, where cabinets are of less than 150 mm in depth, the minimum thickness of sheet shall be:
For (a), (b) and (d) above 1.5mm
For I above 2.0mm

Further where the front opening of a cabinet is divided and/or reinforced by a rigid cross member, the dimension used for assessing metal thickness shall be the maximum dimension of the largest opening so divided by the cross member.

The minimum thickness of aluminium sheet shall be 3 mm regardless of cubicle dimensions.

The switchboard, if more than 1200 mm in length, shall be constructed as a number of separate rigid cubicles bolted together to form a neat, totally rigid and continuous switchboard and so arranged that any cubicle can be withdrawn from the switchboard once bolts have been removed and interconnecting cables and busbars disconnected. Busbar length need not be limited to cubicle width.

Blind rivets or self tapping screws shall not be used in any part of the switchboard unless specifically noted.
The section framework of switchboards shall be constructed by one of the following methods:

> Folded metal section, welded;
> Modular Sheet Metal Panels, bolted or welded; and
> Welded angle or rolled sections.

For aluminium cubicles, cabinets shall be of rolled sheet construction, ie. Aluminium angle frame shall not be used.

The minimum size of angle used for framework shall be 38 mm x 38 mm x 6 mm. An angle bracket shall be provided for termination of cable boxes where applicable.

For framed switchboards the outside covering shall be aluminium neatly fixed by continuous welding and the outer surfaces shall be smoothly finished by grinding and/or machining.

Corner joints shall be neatly mitred and welded. Cabinets and cubicles designed for wall mounting shall be fitted with mounting bars to approval. Cubicles housing heavy equipment, e.g. Circuit breakers, shall be suitably reinforced to approval.

Separate framework shall be provided for fixing of mounting supports for heavy equipment independent of any partition reinforcing.

Tapped bolts holes in sheet metal shall not be used for structural purposes. Use bolts and nuts with suitable washers.

Unless otherwise specified, all switchboards shall be fitted with doors on the front of the cabinet.

Where a sub circuit distribution board is incorporated in a cubicle type switchboard, that section of the front of the cubicle shall be fitted with a door. The circuit breaker operating toggles shall be accessible through an escutcheon. The door to the distribution compartment shall be provided with a handle suitable for access without the use of a tool.

Doors shall be constructed of material of the same type and thickness as that used in the manufacture of the switchboard cabinet, pressed or rolled to give a neat rounded finish. Door shall be lipped all round with a minimum lip of 12 mm and corners shall be neatly mitred and welded.

Doors shall be stiffened where necessary.

All doors, panels and removable covers shall be provided with resilient (neoprene or approved) sealing gaskets. Foam plastic is not acceptable.

Hinges shall be of the fully concealed type or shall be of the plain barrel and pin type with chrome plated barrel to approval. In either case, hinges shall be arranged so as to permit the door to be lifted off.

Where switchboards are wall or pole mounted, the doors are to be provided with the facility for doors to open a minimum of 100 degrees and held open by door stays.

Door handles shall be chrome plated or of non-rusting material fitted with a barrel type lock and shall be of robust construction of approved type. For surface mounted or freestanding cubicles, the door handles may be of the projecting type. Doors larger than 900 mm high shall be fitted with a latch operated rod fastening both top and bottom of door.

Door handles for Ergon metering cubicles shall be as above but with facility for padlocking to suit Ergon approved locks.

A metal card holder, minimum dimension 150 mm x 250 mm, shall be provided on the inside of all doors.

Door mounted equipment shall have suitable insulated barriers fitted to prevent contact of personnel against live equipment with the doors in the open position. The barriers shall also prevent mechanical damage to door mounted equipment.

All doors shall be earthed to the main switchboard chassis through the use of a copper equipotent bonding wire bolted to both the door and the chassis.

All locks shall have a common key which shall be master keyed as required by the Principal.

Three keys shall be provided, all of which shall be given to the Superintendent.

Ergon Metering Cubicles shall be provided with Ergon approved padlocks to Ergon's keying system.

All welds shall be full penetration fillet welds ground and machined smooth and all weld spatter shall be removed.

Welds shall be treated and dressed to conform in appearance and finish to the component material. The dimensions of the weld shall be as such as to provide adequate penetration and strength to the component concerned to enable it to fulfil its normal service function.

All joints, particularly lap joints and joints to the framework shall be completely and continuously welded throughout the entire periphery of the section to avoid differential oxygen concentration between the outside and inside of the joint.
Application of all coating systems shall be carried out using suitable spray equipment, brushes and applicators and coatings shall not be applied to surfaces affected by moisture, dust, dirt or grease or contaminated in any way.

The coatings shall be applied to clean dry surfaces when the relative humidity and ambient temperature are within the ranges recommended by the manufacturer.
Minimum and maximum drying and curing times recommended by the manufacturer shall be strictly observed before application of the next coating.

The finishing coat shall be continuous over the surface to be coated and shall be free from defects which would adversely affect the protective properties of the coatings or the aesthetic appearance.

Each coat shall be of a different shade or colour from the preceding coat to facilitate identification. Where necessary, this shall be achieved by the addition of an approved tinter to the first coat.

Care shall be taken in the application of the finishing coats to ensure that no air is entrapped between the zinc primer coat and the finishing coats.
All coating work including the application of finishing coats shall be carried out prior to delivery of steelwork or equipment to site. Adequate protection to the coating system shall be provided to ensure minimum damage during transport.

Unless otherwise specified in this specification, the following coating system shall be used.

4.5 Indoor Applications

Primer Coat Zinc Chromate Primer (AS K211 Type 2) to a minimum dry film thickness of 40 micrometres.
Finishing Coats Two coats of premium quality Alkyd (AS K126) in the required colour to a minimum dry film thickness of 35 micrometres for each coat.

4.6 Outdoor Applications

Primer Coat As above except dry film thickness of 75 micrometres.
Finishing Coats As above except dry film thickness of 45 micrometres for each coat.

4.7 Colour Scheme

as per *section 2.18 Painting and Finishes*.

Standard To AS 2700

- Outside of Indoor Assemblies: Light Orange X15;
- Outside of Outdoor Assemblies: Avocado G34 or if wall mounted, to match wall colour;
- Control panels: Pearl Grey N11; and
- Removable Panels/Escutcheons: White N14.

Escutcheon plates shall be neatly cut to fit around equipment so as to conceal wiring ducts, cables, busbars and the like.

Escutcheon plates shall be hinged on one side and be arranged so that the escutcheon can be lifted off.

Escutcheon plates shall be not less than 1.5 mm zinc anneal or stainless steel, 3 mm marine grade aluminium as specified to match board construction. Escutcheon plate fixing screws shall be of the mushroom head type.

Escutcheon plates shall be provided with handles to facilitate ease and safety in removal from the switchboard. The handles shall consist of at least two 100 mm long “D” type metal handles lock nutted to the escutcheon plate.

Busbars shall be rounded edge hard drawn high conductivity (HDHC) copper and shall comply with AS 3439.1 where applicable.

The main busbars shall have a minimum continuous rating equal to the incoming circuit breaker or isolator.

All droppers or tee off busbars to circuit breakers or controlling devices shall have the same rating and that rating shall be equal to the maximum possible load on any one set of droppers.

All joints, take off points and other connections on the busbars shall be adequately prepared to avoid high contact resistance for the life of the board. This preparation shall include as a minimum requirement, abrading with fine grade emery paper or draw filing then coating with a non corrosive rust inhabitant compound or preferably silver plated.

Busbar clamps, for clamping two sections of busbar or droppers from busbars, shall have a minimum of two bolts complete with locking devices. These bolts shall not be used to support the busbar.

Busbar supports shall be non-hygroscopic, have adequate mechanical strength and be spaced for the full fault capacity of the board.

The main busbars shall be coated with extruded PVC or heat shrink insulation in the following colours:

A Phase	Red
B Phase	White
C Phase	Blue
Neutral	Black

The main busbars in the Main Switchboard shall be completely enclosed and except for power takeoffs, shall be segregated from all other equipment and wiring. Provide inspection covers in each busbar enclosure.

The earth bar shall be rated to suit the prospective fault level. It shall be identified with a 50 mm long coating, of green or green/yellow extruded PVC or heat shrink insulation at each section of the switchboard.

The earth bar shall be tapped at regular spacing's to provide at least four tapped holes per motor starter. Aluminium to copper interfaces shall be treated to prevent corrosion without increasing electrical resistance at such joints.

The Neutral bar shall be completely insulated from earth.

Provide an easily removable MEN link to connect the earth and neutral bars. The link shall be readily accessible from the front of the board and the termination points for connection to the main earthing system shall also be located in this position.

Install the MEN link if the switchboard earthing is indicated as being MEN. If the earthing requirements are not specified confirm with the Superintendent the requirements for installation of the MEN link before proceeding.

Removable gland plates shall be provided at all cable entry points.
Gland plates shall be manufactured from 4mm thick brass or 6mm thick aluminium. Fix gland plates by means of bolts and captive nuts and provide a suitable gasket between the gland plate and the cabinet.

All cables passing through a gland plate shall be fitted with approved cable glands to prevent ingress of moisture or corrosive fumes. (Requirements for cable glands are included elsewhere in this specification)

Gland plates shall be of sufficient size to accommodate at least 20% additional cables above the present requirement, including any allowance for any future equipment shown on the drawings or specified herein.
All external cabling shall terminate on terminal strips inside the switchboard or panel.
Exceptions to this are the motor power cables 10 sq mm and larger and mains cabling which may terminate directly onto their respective devices.

Cable serving or inner sheath shall be left on the cable wherever possible i.e. from the gland to approximately the first termination.

The terminal blocks shall be mounted on a horizontal steel rail and shall be placed so that connections can be easily, safely and reliably made and viewed.

Terminals should be logically grouped and terminals of different voltages shall be separated by means of an approved barrier. There shall be sufficient room and clearance in the termination areas to permit the future disconnection and

reconnection of cabling without creating a hazard or requiring a shutdown of other circuits.

All power circuitry and terminations shall be segregated from control and other circuits, and shall be shrouded and provided with a cautionary label in the vicinity to prevent unintentional contact with potentially lethal voltages.

Where access can be gained to uncovered energised conductors, a cautionary label shall be located to provide effective warning. The label shall bear the words “Alive Isolate Elsewhere”.

Circuit groups having operating voltages in excess of 100 volts shall be protected by means of an approved insulating cover bearing the legend “Warning ..... Volts”.

Terminals shall be sized and arranged so that one wire only is terminated in either side of each terminal block. Extra terminals with bridging connector links shall be provided where multi-terminations occur. Minimum size of terminals shall be of Sprecher and Schuh type VR225.

Each terminal strip shall have at least 10% spare terminal capacity over and above the present requirement, including any allowance for any future equipment shown on the drawings or specified herein.

All terminals shall be numbered sequentially and labelled accordingly. Incoming cable cores shall be terminated sequentially (by core number) along the terminal strip with no cross over of cores.

Each wire shall be terminated with the correctly sized and approved insulated crimp lug fitted in accordance with the manufacturer’s recommendations. The lug shall be of the type and size most suited to the device terminal eg. Ring tongue for stud terminals and lip blade for tunnel type terminals.
Each cable core shall be marked at each termination with neat fitting sleeve type ferrules. The marking shall comprise of the cross-reference number from the relevant schematics and prefixed by the drive reference number. Neutrals shall be identified with the motor reference number.

Wiring shall be adequately tied, run neatly and enclosed in a cable duct. Duct shall have perforated sides for cable access to individual terminals and shall be fitted with a lid. Ducts shall have a minimum spare capacity of 25% over and above the allowance for future equipment shown on the drawings or specified herein.

Internal wiring shall be insulated (0.6/1kV grade) with V90 PVC insulation.

The control and instrumentation wiring shall be of adequate size, a minimum of 1.0 mm2 (32/.0.20) rating, multi-stranded flexible copper conductors, PVC V90 Grade. The minimum size for power cables shall be 2.5 mm2. Each control wire shall be tinned and terminated with a boot lace ferrel. Wires shall be colour coded as referenced in the Electrical Installation section of this document. Wiring on (or to) all equipment, doors or hinged panels shall be

arranged in a manner that prevents any strain or chaffing of the wiring over the full travel of the door or panel.

Flexible wiring shall be used across such hinged or removable sections.

Wiring shall not rest on busbars or metal edges.

All cable cores shall be of sufficient length at each termination to allow a fresh connection to be made.

4.8 Equipment

All equipment shall be suitable for industrial use and supplied and installed on the switchboard panels to the approval of the Superintendent.

All equipment shall be firmly mounted to the switchboard by fixing independent of terminal studs or other electrical connections.

The equipment shall be fixed to the switchboard panels by means of brass set screws, bolts or metal thread screws of minimum length, fitted with relevant washers and securely lock nutted.

Excessive lengths of exposed thread will not be tolerated.

An insulating plastic duct with a removable insulating plastic cover shall be provided adjacent to each row of equipment for outgoing circuit wiring and shall extend over the full width or height of the cabinet. The duct cover shall be fixed such that it cannot be installed on a different duct.

The plastic duct shall have entries punched or drilled to match the equipment mounted on the panel. The cross section area of the plastic duct shall be sufficient to accommodate all outgoing circuit cables in accordance with wiring regulations.

Plastic Duct shall be mounted far enough from top to bottom of control gear to allow easy removal for service to remove and install associated wiring.

It shall be possible to operate and see the status of all power bulk power switching devices, such as main switches and distribution or final sub-circuit circuit breakers, from the front of switchboard without the use of tools. This shall occur in such a manner that the operator cannot come into contact with live components. In general this shall be achieved by:

» Projecting the operating handle of the switch or circuit breaker through an escutcheon, which in turn is behind a protective door. The outer protective door shall open without the use of tools, eg have a rotary handle for access;
» The use of an extension operating handle on the compartment door; and
» Other means, such as motor operators with Open and Close pushbuttons on the front door.

The circuit breakers for any control final sub circuits in motor control centres shall be installed within the relevant motor starter compartment. Unless otherwise indicated these circuit breakers shall only be accessible by opening the motor starter compartment door.

4.9 Switchgear

The switches shall be suitable for fault making/load breaking duties to AS 1775. Suitable main switches are auto circuit breakers; fused FCU's of fault make/load break switches. Non-auto circuit breakers or FCU's with solid links are not acceptable unless they have been tested for fault make/load break duties to AS 1775.

Unless noted otherwise, the following duties shall apply:

Type of switching	"Independent Manual Operation"
Rated Duty	"Uninterrupted Type" for non-vented enclosure.
Fault Capacity	"Rated Short Time Withstand Current"
Utilisation Category	AC21 Minimum AC23 for Motor Loads

The contractor shall ensure that all circuit breakers are correctly sized to protect the downstream equipment against overload and fault conditions. Circuit breakers should be suitable for the voltage and frequency that they control. The Contractor shall size the circuit breakers and submit such sizes for approval by the Superintendent.

Where the Principal has identified an application preferred circuit breaker which is underrated for the specified fault level, the Contractor shall use a suitably rated circuit breaker otherwise identified by the Principal. In the absence of an alternative circuit breaker having been identified by the Principal, a suitably rated circuit breaker shall be submitted by the Contractor for approval by the Superintendent.

Notwithstanding the above all circuit breakers shall have an interrupting capacity according to the specified fault levels.
In the case of sub-circuit circuit breakers, the main circuit breaker may be used as a current limiting device. The cascaded circuit breakers shall fulfil the following conditions:

> The peak value of current interrupted by the backup breaker shall not be more than the level which the breaker on the load side can withstand mechanically;
> The I2t during the short circuit current interruption shall not be more than that which the breaker on the load side can withstand thermally;
> The rated breaking current of the breaker on the load side shall be higher than the current value at the crossing of its break-time characteristic with the opening time characteristics of the backup breaker; and
> Circuit breakers shall be selected in accordance with the manufacturers recommended cascade coordination chart, Category II only.

The circuit breaker trip ratings shall be labelled or inscribed on the circuit breaker body in an approved way. This inscription shall be clearly visible with covers in place.

Horizontally mounted circuit breakers shall have been fully tested as being capable of successfully operating under full load and short circuit conditions in the horizontal position.

Circuit breakers shall incorporate the following features:
> Arc interrupting device;
> Toggle action quick break;
> Inverse time limit characteristics;
> Trip-free handle;
> Contacts to be non-welding;
> Mechanism to be non-tamper able;
> Common tripping device for multiphase units;
> Uniformity of style and construction;
> Pad lockable in the “off” position; and
> Handles shall have an intermediate trip position.

Double pole circuit breakers shall be used on 24 V dc circuits.

Provide one (1) set of locking devices for circuit breakers.

Fuses shall be HRC type and shall comply with AS 60269 and shall be suitable for the fault level of the installation. All fuse cartridges (excluding those mounted in fuse combination units and fault current limiters) shall be held in a fully enclosed moulded fuse holder with shrouded contacts.

Fault current limiter cartridges shall be held in approved holders and shall be readily accessible.

Where fuse extraction handles are required, they shall be clipped inside the cubicle adjacent to the fuses. Where the fuses are located behind more than one cover, one handle shall be provided behind each cover.

At least one 3 phase set of fuses for every size included in the switchboard shall be mounted in fuse clips with individual fuse size labels in a spare fuse rack inside a dedicated cabinet for spare fuses.

Earth fault protection incorporated into the main incomer.

4.9.1 Integral type

General: Incorporate earth leakage in circuit breaker protection operation, provide to all light
and power outlet circuits as well as those shown.

4.9.2 Tripping

Residual current classification: **Type II**

Maximum tripping current: 30mA

Rating:	Transfer switches shall be rated for full load break and load make to the level shown
Poles:	Transfer switches shall have the required number of poles for all phases as well as neutral. Poles shall be sizes to suit the connecting conductors.
Auxiliaries:	Provide two of C/O contacts for each transfer switch cabled two the PLC interface terminal strip within the switchboard.

4.10 Control Gear

AC Contactors shall comply with AS 3947.
Unless otherwise indicated, the following details shall apply.

> Block style, electromagnetic, air break type;
> Rated duty shall be “uninterrupted type” for non ventilated enclosure;
> AC utilisation category shall be “AC2” minimum (“AC3” or “AC4” for motor loads);
> DC utilisation category shall be “DC2” minimum (“DC3” to “DC5” for motor loads;
> Quiet in operation; and
> Series or parallel contacts shall not be used to achieve the required ratings.

4.10.1 DC Coils

Blocking diodes shall be fitted across DC coils to prevent voltage spikes during switching operations.
All relays shall be plug in type equal to Finder 56 series as a minimum. Each relay shall have 4 C/O 12A contacts (rated at AC1 250Vac; DC1 30Vdc), a position indicator and be completely enclosed within clear, plastic dustproof covers. Rated coil voltage shall be clearly marked on the relay.
The applied voltage and current (A.C. or D.C.) to relay coils, contacts and insulation shall be within the manufacturer’s recommendations.
Where a relay’s contacts are to be used for mixed voltages, the contacts shall be separately isolated from each other by means of a clear plastic cover (or similar to Superintendent’s approval) so as to prevent accidental short-circuiting.
Minimum mechanical life shall be 10 million operations on A.C. supply.
As a minimum, relay bases shall be DIN rail mounted, have spade relay connections, finger proof screw type cable terminals and be supplied with relay retaining clip. The bases shall be those recommended by the relay manufacturer if compliant with the above requirements.
Contactors shall be used for switching current in excess of 12A and shall comply with the requirements of this clause.

4.10.1.1 DC Coils

Blocking diodes shall be fitted across DC coils to prevent voltage spikes during switching operations.

Motor protection relays shall be electronic type with hardwired and Modbus connection for control and monitoring Schneider TeSys T relay with ground fault protection and electronic shear pin protection as required. Relays shall be provided with all necessary inputs, outputs and options to meet the control and protection requirements.
Relays shall be provided with either a Megellis or an LTM CU operator interface on each cubical door to provide access to all relay functions and provide default screen showing hours run under normal operation. Where not possible separate electromechanically hours run indication shall be provided.

4.10.1.2 Standards

AS/NZS 61000.3.6:2001 – Electromagnetic compatibility (EMC) Limits Assessment of emission limits for distorting loads in MV and HV power systems (IEC 100036:1996) HB 2642003 – Power quality Recommendations for the application of AS/NZS 61000.3.6 and AS/NZS 61000.3.7 AS 3947.4.2 Low voltage switchgear and control gear Part 4.2: Contactors and motor starters A.C. semiconductor motor controllers and starters.

4.10.1.3 General

Each starter and associated equipment shall be housed in the MCC. The operator interface panel shall be positioned in the cubical door as for motor protection relays.
The starters shall be specifically designed to operate a standard 400 VAC squirrel cage motor with input supply as indicated in site conditions.

The starter installed rating shall be on the basis of the motor nameplate full load current with a suitable derating for ambient temperature, enclosure, ventilation, with due regard to the characteristics of the driven equipment.

The starter shall have a sinusoidal PWM output, using IGBT technology in the power output module. The basic switching frequency shall be adjustable, and shall be set to the minimum value necessary to achieve the desired performance parameters.

The control module shall feature digital technology, programmable from a keypad, with a digital display showing the drive parameters in clear English, and values in engineering units and with password protection to minimise unauthorised changes to drive parameters. The keypad and digital display shall be accessible from the front operating face of the switchboard. The work includes the programming and setting of all parameters.

Starter shall be suitable to start and supply all equipment connected suitable for operating continuously and with up to 12 starts per hour at any loading.

4.10.1.4 Performance

OPERATION: The starter design is to incorporate an integral main contactor to start and stop the drive power circuits and a bypass contactor to bypass the soft starter once the drive is running up to speed. When the drive is started it should uniformly ramp the motor speed to the rated speed. The rate of acceleration, starting torque and current limit shall be adjustable parameters.

4.10.1.5 Control

Inputs

Provide the following minimum discrete inputs:

> Digital input for run.
> Digital input for auto/manual.
> Digital inputs, programmable for user defined functions.

Outputs

Provide the following minimum discrete outputs:

> Bypass contactor operation – where not internal.
> Fault relay.
> Analogue motor current, 4–20 mA.
> Auxiliary relays, programmable for user defined functions.

The status of the starter and all elements shall also be available from the communications port.

4.10.1.6 Indication

The following motor parameters shall be available at the digital display, without the use of passwords.

> Motor current
> Status, run, stop, fault.
> Cause of a trip, over current, overvoltage, over temperature, etc.
> Pre trip parameters recalled from the fault memory log.

The status of the starter shall also be available from the communications port.

4.10.1.7 Protection

Provide the following minimum integral protection:

> Overvoltage
> Under voltage
> Over temperature
> Short circuit.
> Earth fault.
> Starter overload.

The integral motor protection shall provide a two body thermal model with user adjustable heating and cooling time constants, with indication and trip for:

> Thermal overload

> Thermistor / RTD
> Timed Over current
> Timed Under current
> Stall
> Earth fault
> Phase imbalance

The unit shall prevent a hot restart if the start would result in a trip before the end of the acceleration time.

The controller is to be of such a design that it is automatically ready for operation following a power failure.

For under-voltage conditions the controller shall require operator reset.

The unit shall maintain an accessible history log of starts and start times. The unit shall provide adjustable pre-trip warnings for:

> Thermal overload
> Phase asymmetry / Fail
> Over current
> Earth fault
> Under current pickup.

4.10.1.8 Harmonics

When installed on site and operating at any load the starter shall comply with the minimum standard requirements. The Contractor shall provide the anticipated harmonic voltages and currents and a conformance statement before construction, and confirm the predicted values by test during commissioning.

The configuration of the starter shall be such that the limits specified are not exceeded.

Electromagnetic Disturbance

The starter shall be provided with filters as required to ensure that the installation as a whole complies with listed standards. The installation and earthing of the converter components, enclosures, motor cabling, and the motor shall be done to ensure compliance.

The Contractor shall submit type test compliance documentation for the offered equipment. The design and installation shall incorporate all of the features present in the successful type test.

4.10.1.9 Features

The starter shall feature:

> Automatic restart after momentary power failure.
> Adjustable acceleration and deceleration times with settings up to 60 seconds.
> Automatic reset of selected fault conditions.

> All parameters to be stored in non-volatile memory.
> Parameters to be uploaded and downloaded via integral USB port. Provide software and cable.
> Comprehensive diagnostics and multilevel faultfinding.
> The control card shall be capable of being included in a plant wide communication and control system such as Modbus.
> Control panel and display suitable for remote mounting.

4.10.1.10 Cooling System

The cooling system shall comprise dual redundant fans and filters as needed to prevent overheating. The fans shall be forced supply fans pressurising the starter cubicle. The fans shall be a dual arrangement, with both fans operating under normal conditions.

Filters shall be washable dry panel filters with an efficiency of at least 90% on No.2 dust. The panels shall be filter media in plastic frames and be easily removable without the use of tools.

All ventilation openings shall be protected with vermin proof mesh. The design shall prevent rainwater from entering the switchboard.

The overall noise level external to the enclosure, measured 3 meters in front of the ventilation outlet shall be less than 45 dBA. If required to achieve this level, provide an induct silencer to reduce noise breakout.

4.10.1.11 Communications

Provide with Device Net communications to allow full control and monitoring of the starter.

4.10.1.12 Spare Parts

Provide the following spare parts, packed for long-term storage.
> One set of semiconductor fuses (where fitted).
> One set of control circuit fuses.
> One control card for each starter type.
> One set of filter panels.

4.10.2 Controls

REQUIREMENT: Provide control equipment and indications to allow for automatic and manual control of the controllers.

CONTROL VOLTAGE: 24VDC is to be used for the control voltage and separate from the power circuit supply.

4.10.2.1 Testing

REQUIREMENT: Perform onsite testing once all controllers are installed and operating to verify compliance with harmonic distortion and radio frequency interference requirements specified.

As commissioned starter parameters shall be provided in hardcopy and on CD on successful commissioning of the plant.

Surge Protective Devices shall comply with the requirements of AS3000:2007 Appendix F, AS1768, and AS4070

Surge arresters shall consist of metal oxide varistors (MOV) shunt arresters specifically designed for multi-pulse lightning events on powerlines installed in the accordance with the requirements of AS 4070. The surge arrestors shall be installed between each phase and the neutral bar by the shortest most direct route using straight copper bar or cable of minimum cross sectional area 35 mm2.

The arresters shall be rated at 275 V RMS, 80 kA on a single shot 8/20 usec impulse with an energy absorption capability exceeding 2800 Joules. Each device shall comprise five, separately HRC fused, MOV segments whose status is continuously monitored and displayed on a five segment LED bar panel or digital display. The device shall be encapsulated in shock absorbent material, and be fitted with integral 250 VAC 2A changeover isolated alarm contacts.

Reduction in surge handling capacity to below 80% shall activate the contacts. Peak let through voltage as defined in AS 17681991 Cat C 20 kA pulse conditions shall not exceed 900V. The device shall have a design capability of withstanding and diverting at least 1000 20kA Cat C pulses.

The arresters shall be segregated from other switchboard components by solid metal barriers.

They shall be mounted so that the LED indicators are clearly visible at all times without the need to open doors.

Surge filters shall be provided is indicated in the drawings. They shall be mounted so that the LED status indicator is clearly visible with the distribution section door open.

Pushbutton switches shall be IP66 rated, 22mm diameter, modular units with clip-on contact blocks that can be extended in the field and a metallic ring surrounding the button.

The button on switches that start motors, close CB’s or otherwise put equipment into operation shall be flush with the front of the surrounding ring.

The button on switches which stop motors, open CB's or otherwise isolate equipment shall extend forward of the surrounding ring.

Rotary switches shall be IP66 Rated, 22mm diameter, cam-operated, modular units with clip on contact blocks that can be extended in the field and a metallic ring surrounding the operator.

Unless otherwise indicated, switch positions shall be arranged with a displacement of 60`. If "OFF" position required, it shall be in a vertical plane.

The escutcheon plate shall be square and shall be reverse engraved to clearly indicate switch functions.

Colours of switches shall comply with the recommendations of AS/NZS 3947.5.1:2000.

Indicating lights shall be IP66 rated, 22mm diameter, signalling units with plastic freznel lenses. Opal lenses are not acceptable.

Lamps shall be 24V type with an integral transformer as required. The secondary supply of the transformer shall be suitable for operation of a 24V lamp.

Indicating lights shall be complete with an extra-low voltage multi-chip LED type lamp with sufficient brightness so that the lamp can be readily seen in full sunlight.

Colours of indicating lights shall comply with the recommendations of AS/NZS 3947.5.1:2000 Low-voltage switchgear and Control gear, Control circuit devices and switching elements – Electromechanical control circuit devices.

Terminals shall be designed for the connected cables and also be suitable for cables at least two sizes larger. All terminals suitable for up to 70 mm2 cable shall be of the same manufacture and type and shall be suitable for mounting on standard 32 rail DIN 46277, and manufactured from polyamide.

For cables up to and include 6 mm2, two screw tunnel terminals, with M4 (minimum) brass or plated steel screws, shall be provided. Screw diameter shall not be less than 70% of tunnel diameter.

Spring washers shall not be used for bolted electrical connections.

For cables greater than 6 mm2, any one of the following links is acceptable.

- M8 (minimum) brass or plated steel screws sweated into a 6 mm thick (minimum) brass or copper bar. A full nut and flat washer shall be fitted to each screw;
- M8 (minimum) hexagon head, plated steel or brass set screw tapped into a 6 mm thick (minimum) brass bar. A flat washer shall be provided for each set screw;

- Tunnel terminals with one Allen head grub screw per terminal. Screw diameter shall not be less than 90% of tunnel diameter; and
- Approved nut tightened, line-tap clamp that prevents the cable strands spreading and securely clamps the conductors.

For aluminium cables, only types (a) and (b) are accepted.

Terminals for cables above 70 mm2 shall be stud connecting and screw mounted to the switchboard. (They shall not be rail mounted).

Terminal blocks shall be mounted horizontally, not more than 200mm from the top of the switchboard. Rail lengths shall be such as to provide capacity for future terminals. Each rail shall have a minimum spare capacity of 20% or 3 terminals, whichever is the greater.

Terminals of Thermistor circuits shall have an engraved label so that access to the terminals is prevented without removing the label. The label shall read "Thermistor terminals do not test above 2.5 V".

4.11 Measurement Devices

Current transformers shall be resin encapsulated window type and shall comply with AS 1675.

Unless otherwise indicated, the following details shall apply:
a) Rated primary current shall have a current rating equal to the maximum current rating of the frame size of the controlling device.
b) Secondary windings of measurement current transformers shall be rated at 5 A. The burden shall be 0.4 ohms (10 VA) minimum and the accuracy shall be class 2 minimum; and
c) Secondary windings of protection current transformers shall be rated at 5 A and shall be suitable for the burden.
d) CT's shall be rated to 1.0 accuracy class.

All CT's shall be provided with proprietary CT shorting and test blocks to allow safe maintenance an installation.

Hours run meters shall be provided to all motors and shall be the cyclo type non re-settable type with minimum 5 digit display (0.0 – 9999.9 hrs).

Meters shall be solid state power meters with integral RS485 communications Merlin Gerin 710 or approved equal. Communications protocol shall be Modbus.

The meter shall be front panel mounted and have a LCD type display that displays the selected readings from all three phases simultaneously.

The meter shall allow the user to define CT and VT ratios so that the display is in real units.

The meter shall be capable of measuring the following parameters:
> Instantaneous Voltage at cable termination (3, min/max);
> Instantaneous Current at cable termination (3, min/max);
> Demand Current at cable termination (3 + N, min/max);
> Power factor (3, av);
> kVA, kVAR, kW, kWh, kVA demand, kW demand (total); and
> Frequency at cable termination (av, min/max).

4.12 Ancillary Equipment

4.12.1 Standards

Batteries shall comply with the following standards:
AS 3011.2 Electrical installations secondary batteries installed in buildings Sealed Cells
AS 4029.2 Stationary batteries Lead acid Valve regulated sealed type.

4.12.2 General

Provide battery for the purpose of powering the protection, indication and controls for minimum 16 hours operation at normal system operation load.

4.12.3 Batteries

Batteries banks shall consist of strings of individual cells connected in series to achieve the required capacity. Parallel strings of batteries shall not be utilised.

Batteries shall be valve regulated sealed lead acid with a minimum guaranteed life of 10 years at the specified location and with the charger provided.

The batteries shall have a C10 capacity to suit connected loads with 25% allowance for growth.

Capacity shall be selected to ensure 16 hour operation.

4.12.4 Standards

Battery charges shall comply with the following standards:
AS 4044 Battery chargers for stationary batteries Type 2

4.12.5 General

Provide constant voltage, three phase, current limiting type battery charger systems for the purpose of charging battery systems as indicated.

4.12.6 Isolation

Battery chargers shall have sufficient isolation from the mains, or other protective measures, so that they are suitable as the source of supply for SELV or PELV systems.

4.12.7 Noise Level

When the charger is delivering maximum load current the maximum noise level at a distance of 900mm in any direction shall not exceed 50 dB.

4.12.8 Ripple

The charger output shall incorporate a filter network which achieves ripple of less than 2% rms at no load and not inferior to a three phase bridge rectifier at full load.

4.12.9 Cabinet Mounted Battery Chargers

Provide cabinet mounted battery chargers in enclosures with a minimum degree of protection of IP42.

Chargers shall be linear or switch mode chargers that are fully automatic in operation.

Provide an input circuit breaker on the front panel of the charger and DC output protection, consisting of double pole circuit breakers, on both the charger and the load output.

Provide meters to display the following analogue values:
> Battery Voltage;
> Charger Current; and
> Load Current.

Provide the following alarms:
> Loss of AC Supply;
> Low Battery Voltage; and
> Earth Fault on DC.

Alarms shall consist of separate voltage free contacts for each alarm.

4.12.10 Capacity

The capacity of the charger shall be sufficient to charge the battery from fully discharged to within 75% of fully charged in 6 hours, and at the same time support the plant standing and operational loads:

4.12.11 Signage

Provide cautionary, regulatory and emergency safety signs the charger enclosure and
Switch room in accordance with AS 2676.1.

4.13 Labelling

All fuses and circuit breakers shall be numbered and described using engraved laminated plastic labels which are clearly visible after the installation of all equipment and wiring. Where double or triple pole circuit breakers are used, numbering shall allow for all poles and neutral terminals to be provided on the neutral bar so as to allow for future replacement with single pole breakers. All zones shall be clearly marked and labelled.

All switches, circuit breakers, contactors, relays and the like shall be labelled with the circuit function as detailed in the Specification or the drawings.
All labels shall be black lettering on white background. Engraving on labels shall be of minimum height 6 mm unless otherwise approved.

All labels shall be mechanically fixed with round head metal thread screws, nutted or tapped. Do not fix labels to removable duct covers.

A typed card index identifying labels and numbers with connected circuit functions printed or typed shall be inserted in the card holder on the inside of the door. The card index shall also indicate cable size(s) for associated mains and/or sub mains to and from the panel.

Where switchboards are specified to comply with AS 3439.1, provide and install on the switchboard one or more nameplates with essential marking as required by Clause 5.1 of AS 3439.1.

Provide additional engraved labelling detailing the following to escutcheon of each switchboard

Description	**Example**	**Lettering Size**
Switchboard designation	Main Switchboard	25mm
Source of supply	Fed From: Ergon Pillar	6mm
Supply cable size and type	Mains Size: 8 x 120mm² Cu/XLPE/PVC/NJ	6mm
Earth cable size and type	Main Earth: 1 x 120mm² Cu/PVC	6mm
Earth location	Earth location: SW corner of building	6mm
Design fault level	Fault current: 35kA	6mm
Manufacturer details	Manufactured By: Bob's Switchboards	6mm
Date of manufacture	Date: December 2020	6mm

Provide details of switchboard labelling for approval by the Superintendent prior to fabrication.

4.13.3 Schematic

Provide laminated switchboard schematic securely fixed to inside of switchboard showing as installed configuration and equipment / cable sizes.

4.13.4 Wire Labelling

All control wiring shall be identified by the fitting of wire numbering ferrules at each end of the wire. The wire numbering system is to incorporate slip on sleeves with inserted wire number tags with black lettering on a white background. The system is to allow for modification of the wire number without having to re-lug the wire.

4.14 Spares

The contractor shall supply minimum 1 spare of each item of electrical equipment supplied. A list shall be provided to and agreed by principle prior to spares being purchased.

5 AREA LIGHTING AND GENERAL POWER

5.1 Standard Requirements

AS/NZS 1680.0:1998 Interior lighting – Safe movement provides general recommendation on suitable lighting level for safe movement and orientation of 40lux where no other specific recommendation is available.
AS 1680.2.1—1993 Part 2.1 Interior lighting: Circulation spaces and other general areas provides more specific recommendation for external catwalks and stairs of 20lux.
Recommendations for outdoor area lighting are contained within AS1158 Lighting for roads and public spaces Part 3.1: Pedestrian area (Category P) lighting—Performance and design requirements. These are orientated towards public spaces and roads and car parks. The recommendations of this standard with reference to the plant are generally applicable to the vehicle movement areas.

5.2 Internal Lighting

Sufficient lighting shall be installed to satisfy the requirements of AS1680 using polycarbonate diffuser IP65 weather proof impact resistant fittings.
Internal Light fittings are to be Pierlite PWP polycarbonate diffuser IP65 weather proof impact resistant luminaries. Product Code PWP236QS or equivalent.
Emergency lighting shall be centrally located in the switch room. Where Generators are installed a maintained emergency fitting shall be installed to allow sufficient light for re-fuelling. Emergency lights shall be polycarbonate diffused IP65 weather proof impact resistant fittings. Emergency light fittings shall be fitted on the main switch board a test switch to enable testing of the emergency light fittings.
Internal Emergency Light fittings are to be Pierlite PWP polycarbonate diffuser IP65 weather proof impact resistant luminaries. Product Code PWP236M or equivalent.

The requirement for removable light fittings has been identified for some switch rooms and pump stations where there is limited electrical support. Internal light fittings in these buildings shall be connected by plug and socket to enable any faulty fittings to be removed by the operations or maintenance staff and sent to the electrical workshop for repairs. Removable Light fittings shall be internal lighting only.

When specified light fittings shall be installed using a special purpose outlet and socket. The plugs and sockets shall be 4 wire and have both a switched active and maintained active to enable the repositioning of both standard light fittings and emergency fittings. The socket (Clipsal part No 410) shall be installed on a junction box (Clipsal Part No 240/20/2) using nylon cables glands to gland the cables in and out of the junction box.

The requirement for movement detectors to turn on external lighting may be required at the superintendent's discretion. Where the need has been identified the Motion Detectors shall be a Infrascan 250V 10 3 wire outdoor (IP66) CLIPSAL PART No 750WPR or equivalent. The lights controlled using

the motion detector shall also be fitted with a bypass switch to bypass the motion detector.

Exit light where required shall be installed to AS2293 and be hard wired. Exit lights shall be run on an independent circuit and fitted with a test switch on the main switch board to enable testing of the battery pack. The Exit lights shall be LED Pierlite part No LEDXM2P or equivalent.

6 AUTOMATIC FIRE DETECTION

6.1 General

The intent of this is to provide early warning for protection of equipment in the main switch room of the plant.

6.2 Scope

Design and provide AS1670 compliant smoke detection and warning system to the new MCC building consisting of:
» Addressable FIP located within the MCC building
» Multi Point Aspirated Smoke detection system (VESDA or approved equal) with two level alarm points, the first to provide warning to the SCADA and the second higher concentration level to provide trip to the incoming power supply.
» Building occupant warning system for the MCC with weatherproof sounder and flasher located inside the MCC.
» Provide any power or PLC connections as required.

6.3 Submissions

» Provide proposed layouts and schematics for approval including Form 15 certification of designs prior to order of equipment or materials.

7 PLC AND SCADA

7.1 Scope

The PLC shall be supplied with all required processors, backplanes, IO, communications and power supplies to allow existing and new equipment to be connected and controlled by this new PLC.

An IO schedule shall be provided to the principle for approval prior to installation.

The system shall be provided with 25% installed spare IO on completion of the installation.

All unused programmable logic controller inputs and outputs shall be wired to terminals and marked as spare.

The SCADA shall not be assumed to have sufficient tags for the proposed works existing screens, reporting, events alarms and trending are to be retained and extended to new equipment and IO similar to the existing.

Unless specified differently the PLC shall be one of the following.

7.1.1 For Small Sites – Sewage Pump Stations, Monitoring Sites.

These sites shall use a MIRI AD 2006 Telemetry Module Part No AD2006TR-M5212-LA-24. This PLC is powered by 24VDC and has the optional TCP/IP port.

All analog data being passed to and received from SCADA shall be scaled to 0 – 4095.

MIRI controllers shall be supplied 24VDC via a 2 pole DC Circuit Breaker.

Expansion Module where required shall be AD2000 I/O and configured using the Default Miri Protocol. Expansion Modules are also required to be installed in a fail safe manner.

Where Expansion Modules are required they shall be the following type.

AD2000 IO	16 point low voltage digital input module	Part Number M16-LN
AD2000 IO	16 point relay output module	Part Number M16-TR
AD2000 IO	8 channel analog input module	Part Number M8-AD
AD2000 IO	4 channel analog output module	Part Number M4-DA

7.1.2 For Medium sized sites – Pump Stations, Small Treatment Plants.

These sites shall use the Allen Bradley CompactLogix range. The processor shall have available one Ethernet Port and one Serial port. Where Radio Communications are required the processor serial port shall be used. Configuration for the Serial port setup shall be supplied by the principle.

Unless authorised by the superintendent the CompactLogix shall be configured using the following preferred modules.

Ethernet Processor, 750 k Memory	Cat. No. 1769-L32E
Ethernet Processor, 1.5 M Memory	Cat. No. 1969-L35E
Right End Cap Terminator	Cat. No. 1769-ECR
8 Channel Analog Input Module	Cat. No. 1769-IF8
4 Channel Analog Output Module	Cat. No. 1769-OF4
32 Point 24VDC Digital Input Module	Cat. No. 1769-IQ32
32 Point 24VDC Digital Output Module	Cat. No. 1769-OB32
Compact I/O 24VDC Power Supply 2 Amp	Cat. No. 1769-PB2
Compact I/O 24VDC Power Supply 4 Amp	Cat. No. 1769-PB4
Compact I/O to DSI/Modbus Module	Cat. No. 1769-SM2

All analog modules shall be set for 4-20 mA with the Data Format set to Engineering Units unless authorised by the superintendent. All analog data being passed to and received from SCADA shall be scaled to 0 – 32767.
Structured text shall **not** be used in any part of the PLC program.
PID's shall be configured with **Dependant** Gain.

For Large sized sites – Large Treatment Plants and Pump Stations.
The superintendent shall provide the specification for the PLC to be used on Large Treatment Plants and Pump Stations.

7.2 PLC and Programming Considerations

Software shall be generated and documented in accordance with the IEE Guidelines for the documentation of computer software for real time and interactive systems, 2nd Ed 1990 (ISBN 0 86341 2335), or Australian equivalent. PLC Software and SCADA shall be fully tested during the Site Acceptance Test (SAT). Factory testing shall be carried out prior to Site Acceptance Testing for Proof of Concept. A Risk Assessment shall be carried out on the Edited Programs prior to implementation. The contractor shall provide a schedule of tests to be performed at each stage of commissioning to verify correct operation. Schedules shall be submitted minimum 2 weeks prior to testing for comment to the Superintendent. The Superintendent may witness any or all of the commissioning tests.

The contractor will be responsible for the build points and displays in Experion; this will need to be done with consultation with Honeywell and FRW Process Systems Specialist.

Because the PID instruction uses a time base in its calculation, you need to synchronize execution of this instruction with sampling of the process variable (PV).

The easiest way to execute the PID instruction is to put the PID instruction in a periodic task. Set the loop update time (.UPD) equal to the periodic task rate and make sure that the PID instruction is executed every scan of the periodic task.

When using a periodic task, make sure that the analog input used for the process variable is updated to the processor at a rate that is significantly faster than the rate of the periodic task. Ideally, the process variable should be sent to the processor at least fie to ten times faster than the periodic task rate. This minimizes the time difference between actual samples of the process variable and execution of the PID loop. For example, if the PID loop is in a 250 millisecond periodic task, use a loop update time of 250 milliseconds (.UPD = .25), and configure the analog input module to produce data at least about every 25 to 50 milliseconds.

For more information refer to Rockwell Automation Publication 1756-RM003K-EN-P

All PID shall be configured with dependent Gain, have the ability to drive output manually from SCADA, and shall incorporate bump less transfer changing from manual to Automatic control.

7.3 Enclosure and connections

The PLC shall be housed within a separate ground mounted enclosure within the control building and all field connections shall be via a separate adjacent Field Termination Assembly (FTA). Proprietary PLC IO cabling shall be used between the PLC IO and the terminations within the FTA. All field cabling shall terminate on separate terminal blocks with interconnections to PLC IO as required. PLC inputs shall be protected to recommendations of the manufacturer and to suit the installed location.

All **ANALOG inputs and outputs** leaving the PLC enclosure **shall** be protected via a Critec UTB30 or equivalent Transient barrier. Where analog devices are installed in a remote location from the PLC enclosure (i.e. in the field or within another building) the analog devices shall also be protected via a Critec UTB30 or equivalent Transient barrier.

7.4 Power Supply

Provide dual redundant power supplies to all PLC equipment sourced from the 24VDC control supply.

8 TELEMETRY

8.1 General

Where Telemetry is required the following shall be adhered to.

8.2 Radios

> For Small Installations using the Miri Controller the internal Trio Radio shall be used for communications.

> For Allen Bradley Installations where Radio Communications is specified, a Trio E series Radio Model Number ER450-51A01-EH0 shall be used.

8.3 Microwave Links

Where Microwave links are specified they shall be licensed links and shall be following type.

Microwave Equipment – EM Solutions Ethermux.

8.4 Honeywell Experion Station.

When specified the Honeywell Experion Station computer shall comply with the following.

Computer	Dell Optiplex 760 or Equivalent
Operating System	Windows XP Professional Minimum Service Pack 2
Monitor	22” LCD display
Memory	Minimum 2GB System RAM
HDD	Minimum 500GB Hard Disk Drive
Optical Drive	Dual Layer DVD Burner and Software
Printer	Hewlett-Packard A4 Colour Laser Printer Including 1 Set of Spare Toner Cartridges.

8.5 Touch Screen Panels.

When specified

8.6 Security Cameras.

When specified the cameras shall be IP based and connected to the switch room using industrial, Shielded, CAT6 Ethernet Cables. Locations for the Camera’s shall be approved by the Superintendent prior to installation.

Axis 221 day/night camera’s installed in all weather enclosures shall be used for fixed cameras.

Axis PTZ 213 camera's complete with weather dome shall be used else where.

9 CONTROL FUNCTIONAL SPECIFICATION

9.1 Plant control and sequencing

Where a PLC is to be replaced with a new PLC, it shall be configured to provide the same sequencing and process interlock as the existing process controller adapted to suit the new electrical distribution and any new instrumentation. Existing controller program is to be obtained from FRW.

9.2 Modes and Control

All equipment shall be generally provided with 4 control modes being:
» Isolated/tripped/disabled
» Local Manual (via PLC)
» Local Automatic
» Remote Automatic (SCADA via PLC)

When isolated/disabled/tripped mode is selected then this will be brought up as an alarm or event to the SCADA.

9.3 Normal Operation

9.3.1 Continuous Operation

The plant is configured for continuous operation.

9.3.2 Start up and Close Down

Selecting automatic operation will start individual plant items as necessary. Once started plant components will shut down automatically in the event of a serious malfunction On returns of mains supply or generator supply after failure the plant shall restart automatically after a preset period.

Individual equipment items shall be stagger started to reduce the inrush loads on the plant.

9.4 PLC Outline Operation

9.4.1 Motor Control

All drives, pumps and actuated valves shall have 3 modes of control:
> Automatic: i.e. normal PLC control.
> Remote Automatic: i.e. from SCADA manual control (PLC interlocks are to be operational in this mode, to protect mechanical and electrical equipment, together with the process).
> Local: i.e. from the switchboard ‘Auto – Manual’ switches (PLC interlocks are to be

operational in this mode, to protect mechanical and electrical equipment, together with the process).

> The PLC shall provide an adjustable delay (5 seconds initially) between successive motor starts to avoid excessive surges in the mains supply. The delay in the PLC shall be adjustable via SCADA.
> If a motor fails to return a running signal (confirmed by contactor closure and current measurement feedback) within a preset time limit, default set at 60 seconds, then a 'Drive Failed' alarm is generated by the PLC for the SCADA.
> A device is not called to run and is inhibited from starting if its motor fault relay has been set. The motor is cleared to start only after the alarm has cleared and the motor has been manually reset at the switchboard or reset via SCADA.

9.5 Pump Duty

Pump duties where configured as duty/standby shall be rotated by the PLC on an hours run basis, or to be manually set from the SCADA HMI (the initial changeover period is to be set at 7 days). Provide capability to enter individual run times via the SCADA HMI for each pump so that wear can be biased.

9.6 Valve Control

Control of actuated isolation (on/off) valves shall be via digital control outputs from the PLC as either:
» Valve open; or
» Valve closed
With feedback as:
» Valve position (420mA or MODBUS);
» Valve open limit;
» Valve closed limit; and
» Valve fault.

Valves are provided with mode select switches as Local / Off / Remote select switches.

If any non-modulating valve fails to reach its appropriate limit switch within a predetermined time period of an Open or Close command then a 'Valve Failed to [open / close as applicable]' alarm shall be generated by the PLC and valve shall attempt to close. Alarms shall be cleared via SCADA or manual reset.

Total time open as well as total number of openings and motor run time shall be logged, displayed and made available for inclusion in reports.

Selection of Off or Manual shall generate an alarm in the SCADA.

All alarms, events and acknowledgements shall be logged to the alarm or event log on the SCADA.

9.7 DOL Motor Starter Control

Control of direct on line starters for fixed speed loads less than 5.5kW shall by via hardwired outputs and shall include:

» Fault indication (lamp on MCC cubicle) Emergency stop (lamp illuminated flashing) / Other (lamp illuminated solid)
» Start / Run
» Fault reset

Removal of the start run command shall cause the drive to stop (provide stop command as necessary to suit relay). Commands shall be repeated as necessary.

Starter feedback shall be over communications bus and include:
> Motor Current
> Motor Tripped – Under load (water void based on current)
> Motor Tripped – Overload (TOL)
> Motor Tripped – Over torque (shear pin based on current)

Hardwired inputs include:
> » Fault
> » Local Mode Select
> » Local Start
> » Local Stop
> » Local Fault Reset
> » LCS Emergency stop
> » LCS local isolator open
> » CB Tripped / isolated

Total run hours as well as total number of starts shall be logged, displayed and made available for inclusion in reports.

A local hours run meter shall indicate the hours run of the motor on the MCC cubicle.
All alarms, events and acknowledgements shall be logged to the alarm or event log on the SCADA.

9.8 Soft Start Motor Starter Control

Control of soft starters for fixed speed loads greater than or equal to 5.5kW shall by via hardwired outputs and shall include:
> » Fault indication (lamp on MCC cubicle) Emergency stop (lamp illuminated flashing) / Other (lamp illuminated solid)
> » Start / Run
> » Fault reset

Removal of the start run command shall cause the drive to stop (provide stop command as necessary to suit relay). Commands shall be repeated as necessary.

Starter feedback shall be over communications bus and include:
> » Motor Current
> » Motor Tripped – Under load (water void)
> » Motor Tripped – Overload (TOL)
> » Motor Tripped – Over torque (shear pin)

Hardwired inputs include:
> » Fault
> » Local Mode Select
> » Local Start
> » Local Stop
> » Local Fault Reset
> » LCS Emergency stop
> » LCS local isolator open
> » CB Tripped / isolated

Total run hours as well as total number of starts shall be logged, displayed and made available for inclusion in reports.

All alarms, events and acknowledgements shall be logged to the alarm or event log on the SCADA.

10 PERMANENTLY CONNECTED STANDBY GENERATORS.

When specified by the principle that a permanently connected standby generator is to be supplied the following shall be adhered to unless an instruction is given in writing by the superintendent or superintendent's representative.

The tenderer shall undertake the design, manufacture, testing and delivery of diesel powered generator that shall provide back up electric power in times of emergency and or outages from the normal supply.

The Generator shall be designed to run a minimum of 120% of the full load of the installation. It is the tenderer responsibility to ensure the required loads are correct prior to design.

The supplier shall be responsible for the supply and installation of power and communications cables connecting between the Generator and the point of supply of the installation.

The General specifications of the document shall prevail unless specifically addressed

Automatic Changeover

Where automatic Changeover is included as part of the specification

On power failure the changeover switch shall initiate the starting of the Generator and transfer load from mains to the Generator supply.

Upon the stable return of mains supply there shall be a signal to shut down loads then transfer the load back to mains supply and restart motors.

Maintenance – The tenderer shall maintain and service the generator for a minimum of 12 months from the date of practical completion.

The following shall be monitored by the PLC and SCADA.

1. Line Currents x3 Phase
2. Line Voltages x3 Active – Neutral
3. Phase Voltages x3 Phase - Phase
4. kilo Watts, kW
5. kilovolt-amperes reactive, kVar
6. kilovolt-amperes, kVa
7. Power Factor
8. Frequency, Hz
9. Engine Revolutions per minute, RPM
10. Battery Volts

11. Oil Pressure
12. Engine Temp
13. Fuel Level
14. Hours Run

10.1 Australian Standards

All equipment and services are to be in compliance with all relevant Australian Standards or ISO Standards in the absence of relevant Australian Standards.
Design and Performance Requirements

The unit shall be capable of providing emergency power supply and shall be enclosed in a sound proofed container type structure.
Design Responsibility.

The Contractor shall be responsible for the detailed design of a generator to be manufactured and delivered under the Contract, including all mechanical and electrical components. Design shall be in accordance with the intent described in the specifications and be suitable for the purposes expressly stated or which can be reasonably inferred from this specification.

The Principal is relying on the Contractor's knowledge, skill and expertise in carrying out design responsibilities to ensure that the generator manufactured and supplied under the Contract, including all mechanical and electrical components, function as intended.

10.2 Performance Requirements

The generator shall be rated to meet the standby load specified in the Job Specification with a power factor of 0.8 at 415 volts, 3 phase.
The diesel engine shall be capable of driving the generator with all accessories in place and operating at the generator set kW rating after de-rating for the range of temperatures expected in service and the altitude of the installation.

Voltage regulation shall be plus or minus mains power 0.5 percent of the rated voltage for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
Frequency regulation shall be isochronous from steady state no load to steady state rated load.
The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

10.3 Design

The Contractor shall, at the time of tender, submit performance guarantee's, comprising fuel consumption and power output at 10%,25%, 50%, 75% and 100% of full load capacity.
The Contractor shall also, prior to the manufacture and or purchase of any electrical generator sets, submit to the Superintendent detailed design calculations showing all electrical calculations in respect to the sizing of the electrical generator sets.

10.4 Drawings

The Contractor shall be entirely responsible for the design and production of drawings for all mechanical and electrical equipment to be manufactured, tested and supplied. The Contractor shall also be responsible for the modification and update of all Contractor's drawings to Work as Executed status.

10.5 HOLD POINT 1

The Tenderer is to submit; All drawings in AutoCAD electronically and PDF format.
Drawings and specifications shall include full details of the internal arrangement and performance of the proposed electrical generator sets.

10.6 Operation and Maintenance Manuals

All plant and equipment supplied, installed and commissioned under the Contract Works shall be incorporated and included within three (3) copies of Operation and Maintenance Manuals. The Manuals shall be specific to the equipment supplied and irrelevant information shall be deleted or crossed out.

The Manuals shall cover all aspects of the Contract Works and contain sufficient information for the installation, operation and maintenance of all plant and equipment supplied under the Contract. Each copy of the Manual shall be bound or contained in a three ring, hard cover binder, with the equipment and plant identification permanently marked on the outside cover.

The page format shall be A4, and printed in a clear typeface with a 35mm margin for binding. Punched holes in the pages shall be strongly reinforced so that they do not tear out of the binder due to continual use.
In addition, the Contractor shall submit an electronic copy on disk containing all information relevant to the O&M Manuals.

The Operations and Maintenance Manual shall include and incorporate the following minimum contents:

10.6.1 Title Sheet - containing:

(a) Name of the Pumping Station;

(b) Contract Details

(c) Full details of the Contractor, subcontractors and supplier names, addresses and telephone numbers.

(d) Emergency contact names and telephone numbers.

10.6.2 Table of Contents - Listed as follows:

a) Chapter 1

Equipment Description - a full description of the equipment with a tabulation of dimensions and performance ratings is to be supplied.

b) Chapter 2

Detailed Operating Instructions - a step by step procedure organised in sections entitled:

i) Checks before Starting;

ii) Starting;

iii) Continuous Operation;

iv) Stopping;

v) Emergency Stopping;

vi) Abnormal Operation as applicable;

vii) Trouble Shooting

c) Chapter 3

Installation and Commissioning Instructions - details of standards and procedures for transporting and installing the equipment including a step by step procedure for mounting or erecting, wiring and lubricating the equipment. Alignment tolerances and check requirements shall be stated.

d) Chapter 4

Maintenance - step by step procedure for fault correction and preventive maintenance including replacement of consumables. A list of any necessary special tools shall be included.

e) Chapter 5

Repair, Overhauling and Dismantling - step by step procedures to extract, fully dismantle, re- assemble and re-install the equipment.

f) Chapter 6

Test Data and Trouble Shooting - instructions to qualified tradesmen for assessing the operational performance of the equipment.

g) Chapter 7

Spare Parts and Tools List - The recommended spare parts stock,

including lubricants, part numbers, serial numbers and recommended sources of supply.

The Operation and Maintenance Manuals including works as executed drawings shall be prepared by the Contractor and submitted to the Superintendent prior to the delivery of generator sets.
These manuals are to be submitted in electronic copy (PDF format)
Upon receipt of these documents the ownership shall revert to Council who shall have exclusive right to their use.

10.7 Warranties

Where the Contractor; subcontracts the manufacture of electrical generator sets, the Contractor shall obtain, and shall ensure that the Principal will have the benefit of, warranties or guarantees as specified in the contract or offered by the suppliers, including warranties and guarantees that are obtained by, or offered to the subcontractors of the Contractor. This is deemed to include the following:

The generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of acceptance following commissioning against defects in materials and workmanship.

The warranty shall be comprehensive. No deductible shall be allowed for travel time, service hours, repair parts cost, etc.

The Contractor shall prior to any electrical generator sets being delivered to site, submit to the Superintendent, an unconditional written warranty from the Manufacturer of the electrical generator sets accepting liability for any defects in materials or workmanship which become apparent in the Manufacturers electrical generator sets at any time during and throughout the Contracts Defects Liability Period.

10.8 The Manufacturers written warranty shall be submitted in the following form:

"This company, (insert name of manufacturer), as Manufacturers of the following equipment, (list equipment) hereby give an unconditional warranty over its product, manufactured at (insert location of plant), in accordance with the requirements specified under this Contract number

Any item of equipment manufactured and delivered prior to the Contractor submitting to the Superintendent the Manufacturers warranty shall be liable for rejection.

The provisions of this Clause shall not relieve the Contractor of his responsibilities to correct or replace defective or non-conforming work, which becomes apparent during the Defects Liability Period.

10.9 Defects Liability Period

The Defects Liability Period for the works shall be fifty two (52) weeks and shall commence from the date of following manufacture, delivery, installation, testing and acceptance.
If any defects or non-conformance become apparent under normal use of the works and the defect or non-conformance are due to any cause, including design, workmanship or materials, for which the Contractor is responsible, the Superintendent may direct the Contractor to correct, including remove or replace the defect or non-conforming part of the Works and specify a reasonable time within which the Contractor is to comply with such direction.
If the Contractor fails to comply with such a direction within the time specified to correct the defect or non-conforming part of the Works, the Superintendent may remedy such defect or non-conformance at the Contractor's expense and the Principal may recover from the Contractor damages for breach of Contract.

The Contractor shall not be responsible for the effects of fair wear and tear during the Defects Liability Period.
Nothing in this clause shall release the Contractor from liability for any breach of Contract or for any loss or damage arising out of defects or non-conformance in design, workmanship or materials for which the Contractor is responsible.

10.10 Generator Engine

The generator engine manufactured and supplied shall be a four cycle heavy duty diesel or approved equivalent and unless otherwise approved by the Superintendent be of a direct injected nature, water-cooled, diesel design. The engine shall be new and a current model.
The engine shall have an electronic governor system to provide automatic isochronous frequency regulation.
The radiator and cooling system shall be rated for full load operation at a 45º C ambient as measured at the generator air inlet.
Spring / pad type vibration isolators shall be provided as recommended by the generator set manufacturer.
The engine starting battery shall be equipped with a trickle charger fed from the mains supply to ensure the battery remains in an active state.
The Contractor shall supply to the Superintendent the Manufacturer’s Performance Data on the charger for approval prior to the purchase of the charger.
The engine shall be fitted with a residential type exhaust silencer which complies with relevant Australian Standards and be housed inside a weatherproof acoustic canopy to protect it against the elements allowing the generator set package to meet sound level requirements.
The silencer and exhaust shall be routed to discharge exhaust gasses external to the generator housing and shall be provided with a rain cap and rain shield.

10.11 Engine Status Monitoring

The following information shall be available from the ComAp InteliLite NT AMF 25 Compact Controller. These shall also be made available in the Station PLC as well as on the Experion SCADA system.
Engine oil pressure (kPa)
Engine coolant temperature (degrees C)
Engine oil temperature (degrees C)
Engine speed (rpm)
Number of hours of operation (hours)
Number of start attempts
Battery voltage (DC volts)
The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

10.12 Engine Control Functions

The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain; damping and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

10.13 GENERATOR ALTERNATOR

The alternator to be supplied under the Contract Works shall be of a brushless configuration and shall be a current model. The alternator shall be fitted with anti-condensation heaters that shall be energised during non running periods
The Contractor shall supply to the Superintendent the manufacturer's performance curves of the alternator with regards to the proposed pump / plant starting and running currents for approval prior to manufacture and or purchase of the alternator.
Refer to Clause 3 Design and Performance Requirements.

10.13.1 Performance

Voltage regulation shall be plus or minus 5.0 percent for any constant load between no load and rated load for both parallel and non-parallel applications.

The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable de-rating factors, with the engine-generator set at operating temperature.

The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified KVA load at near zero power factor applied to the generator set.

The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

10.13.2 Configuration

The generator engine and alternator shall be close coupled together and resiliently fixed and mounted to a heavy-duty skid type fuel tank base assembly enclosed in a fully sound attenuated container. Anti-vibration rubber mounting systems shall be incorporated between the engine/alternator and the mounting base.
The fuel tank shall not be welded into the base and shall be readily removable an shall have a minimum capacity of 12 hours full load operation and shall include appropriate dipsticks or other approved measuring devices. The fuel tank shall be mounted in a bunded area sufficient area to contain any fuel spill that may occur.
The base shall incorporate a battery tray with hold-down clamps within the rails and shall be configured to ensure that any fluid, lubricant and or / coolant leakage or spillage is contained within the unit and will not be capable of discharge from the unit. The configuration of the containment will ensure that the total volume that can be contained as per Australian Standards.
The base mounting frame shall be equipped with bolting down lugs.
The fuel tank base assembly shall be of double skin construction or approved equivalent and incorporate a sloping base plate to form a water sump. A drain cock shall be placed in the side of the skid base to disperse any water, which may build up within the diesel fuel. This drain cock shall be secured by pad lock for security purposes.
The entire generator unit, including base assembly shall be designed to permit ready SWL lifting by a mobile crane from lifting lugs, positioned such as to be ready accessible and safe.

10.13.3 Acoustic Enclosure

The generator engine/alternator set shall be housed in a weatherproof acoustic enclosure.
Internal acoustic materials used shall be oil and water-resistant.
The acoustic enclosure shall have access doors on all sides to permit ready access for inspection and maintenance. No windows are required in the doors.
Doors shall be fitted with keyed locks complying with Council's requirements.

The Contractor shall ensure that the acoustic enclosure is designed and manufactured to maintain a maximum sound pressure level of 70 dB(A) as measured at 7 meters from the acoustic enclosure. The Contractor shall supply independent test results of noise measurements at the time of testing and prior to delivery of the generator set.

10.13.4 Alternator Control Panel

The alternator shall be equipped with a control panel mounted in a shockproof manner to the alternator main frame. The control panel shall allow for the operation and control of the alternator in a stand-alone mode with the acoustic canopy removed.
Terminals shall be provided within the control panel of the alternator to allow for remote monitoring and automatic control of the unit in a remote mode.

10.13.5 Generator Set Control

The generator set shall be provided with a microprocessor based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
The generator set must have integrated control through MODBUS (RS485) communications capability.
The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
The generator set mounted control shall include the following features and functions:

10.13.6 Control Switches

The Emergency Stop Switch shall be Red "mushroom-head" push button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
The Reset switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

10.13.7 Generator Set AC Output Metering.

The generator set shall be provided with a metering set including the following features and functions:
Digital voltmeter, ammeter, frequency meter and kilowatt (KW) meter.
Voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be colour coded in the following fashion:
Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current output KW, KW-hours, and power factor.
Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltage (line to neutral or line to line) simultaneously.

10.13.8 Generator Set Alarm and Status Display

The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:
The alternator control panel or integral controller unit shall house the following minimum instrumentation:

a) System normal
b) Engine over speed - shutdown
c) Engine under speed - shutdown
d) Low alternator voltage - shutdown
e) Current “A” “B” and “C” phases
f) Voltage phase to phase
g) Voltage phase to neutral
h) Frequency
i) Overload circuit breaker
j) Water temperature gauge
k) Engine oil pressure gauge
l) DC Metering
m) Constant potential battery charger keeping the alternator starter battery fully charged in the standby mode.
n) Control switch, manual / off / auto
o) Fuel Level Indicator
p) System normal
q) Engine over speed - shutdown
r) Engine under speed - shutdown
s) Low alternator voltage - shutdown
t) Current “A” “B” and “C” phases
u) Voltage phase to phase
v) Voltage phase to neutral
w) Frequency
x) Overload circuit breaker
y) Water temperature gauge
z) Engine oil pressure gauge
aa) DC Metering
bb) Constant potential battery charger keeping the alternator starter battery fully charged in the standby mode.
cc) Control switch, manual / off / auto
dd) Fuel Level Indicator

All switches, lamps and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed.
There shall be no exposed points in the control (with the door open) that operate in excess of 32 volts.

a) Low oil pressure (alarm)
b) Low oil pressure (shutdown)
c) Oil pressure sender failure (alarm)
d) Low coolant temperature (alarm)

e) High coolant temperature (alarm)
f) High coolant temperature (shutdown)
g) Engine temperature sender failure (alarm)
h) Low coolant level (alarm or shutdown - selectable)
i) Fail to crank (shutdown)
j) Fail to start/over crank (shutdown)
k) Over speed (shutdown)
l) Low DC voltage (alarm)
m) High DC voltage (alarm)
n) Weak battery (alarm)
o) Low fuel-day tank (alarm)\
p) Fuel level indicator (Analog 4-20 mA or Modbus)
q) Low fuel – reserve tank (alarm)
r) Fuel level indicator (Analog 4-20 mA or Modbus)
s) High AC voltage (shutdown)
t) Low AC voltage (shutdown)
u) Under frequency (shutdown)
v) Over current (warning)
w) Over current (shutdown)
x) Short circuit (shutdown)
y) Ground fault (alarm) (optional - when required by code or specified)
z) Over load (alarm)
aa) Emergency stop (shutdown)
bb) Bund area high level (alarm)

10.13.9 Completion and Return of Check List

Tenders/ Suppliers are to complete the check list detailed at Clause 19 of this specification and are to return it with the tender submission. Failure to complete and return the check list at that time may lead to the tender not being considered any further.

Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labelling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

10.14 WORKS TESTING

The prime purpose of Works Testing is to demonstrate compliance or otherwise that the electrical generator units designed and manufactured by the Contractor meet the Contract requirements and Performance Guarantees submitted by the Contractor at the date of tender.

The Contractor shall provide the Superintendent with 10 days written notice of his intention to commence Works Testing. The written notice shall include full

details of the time and location and the testing methodology proposed by the Contractor.

Unless otherwise approved by the Superintendent, Works Testing shall be carried out following satisfactory manufacture of the generator unit.

The Contractor shall ensure that experienced and qualified personnel are present during Works Testing, for the purpose of supervision, adjustment and remedial work as required.

Works Testing shall consist of two or more tests per generator unit as required herein to demonstrate compliance with the Contract Performance Guarantees and shall be carried out by the Contractor in the presence of the Superintendent or his representative. Test results are to be recorded on the approved recording sheets and copies of the completed sheets furnished to the Superintendent.

10.14.1 HOLD POINT 2

This test shall be carried to demonstrate that the generator units meet the general requirements of the specification and in particular gauges, electrical controls, instrumentation, vibration, noise attenuation and all other functional requirements.
This test shall be carried out over a period of at least four (4) consecutive hours to demonstrate that the power output and fuel consumption over the test period meets the Performance Guarantees submitted by the Contractor at the date of tender.

It shall be the Contractor's responsibility to demonstrate to the satisfaction of the Superintendent that the generator unit has achieved the Contract Performance Guarantees.

The Contractor shall measure by approved gauges/instruments and submit test reports of the power output and actual hourly fuel consumption rate of each generator unit at loadings of 10%,25%, 50%, 75% and 100% respectively.

The Superintendent may reduce the duration of the second test to less than the required four (4) consecutive hours if he is convinced that the generator unit under test satisfies the Contractor’s tendered power output and fuel consumption.

During the second test, the Contractor will be permitted to carry out such modifications as deemed necessary to improve the performance of the generator equipment and systems. Details of any modifications must be submitted to and approved by the Superintendent prior to the commencement of such modifications.
The individual generator unit shall be deemed to have passed the Works Test if:

a) The fuel consumption at10%, 25%, 50%, 75% and 100% power output measured at the time of test does not exceed the respective

hourly fuel consumption Performance Guarantees by more than 5% and;

b) The maximum kW power output at full load is not less than the kW power output stated in the Performance Guarantees.

If any of the above requirements are not met, the generator unit is considered to have failed the Works Test and will be liable for rejection.
The Contractor shall provide training for the facility maintenance personnel covering operation and maintenance of the equipment provided. The training programs shall be not more than 4 hours in duration and the class size shall be limited to 5 persons.

Session One: shall be confined to Mechanical operation and maintenance

Session Two: shall be confined to Electrical operation and maintenance

Training shall be undertaken on site at North Rockhampton Sewage Treatment Plant and shall be co-coordinated with the Superintendent or his representative.
The manufacturer of the generator set shall maintain service parts inventory at a central location, which is accessible to the service location 24 hours per day, 365 days per year.

a. The Generator shall be fitted with LED lighting with in the cubicle and powered from the generator batteries. The LED lighting shall be IDEC LF1A (IP67F) unless otherwise agreed by the superintendent in writing.

11 SEWAGE SPECIFIC SPECIFICATIONS – WET WELL

The General specifications of the document shall prevail unless specifically addressed in this section.

11.1 References

1. General reference may be made to Sewage Pumping Station Code of Australia WSA-04.

11.2 Council supplied information

Council where required will advise the following at the time of the purchase:

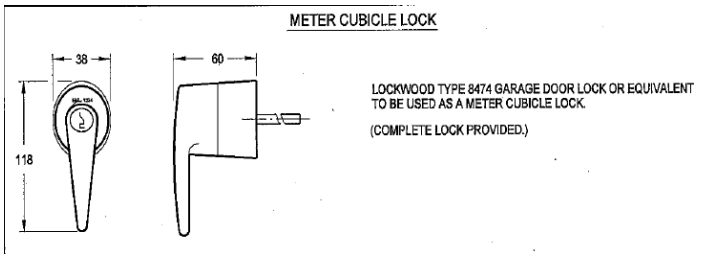
- Pump station name
- Pump Station Location
- Electrical sizes of the submersible sewage pumps
- Primary and secondary electrical power sources
- Radio telemetry RTU frequencies
- Radio telemetry antenna size
- Antenna orientation and alignment direction

11.3 Power Supply

11.3.1 Metering

1. All metering shall comply with the requirements of AS3000 and the Ergon Energy Electrical Connection and Metering Manual.
Ergon technical documentation available from:
"http://www.ergon.com.au/network_info/electrical_contractors/service_providers/technical_docs/asp/tech_documents.asp"

15. A metering cubicle allowance shall be provided for the meters with a separate door.
16. The electricity supply authority meter compartment door shall have no viewing window.
17. The electricity supply authority meter compartment door shall be locked using the Ergon energy Meter Cubicle Lock (drawing A4 887907-01) Lockwood Type 8474 Garage door lock or Equivalent. Locks Available from Queensland Locksmith's phone 1800 233 333 or http://www.queenslandlocksmiths.com.au/. The council shall be provided with 3 keys to fit the meter cubicle lock.



Low voltage current transformer metering as per the Ergon Energy Electricity Connection and Metering Manual. The current transformers and meter voltage fuses are required to be mounted in a dedicated metering cubicle. This cubicle is to enclose only the Ergon Energy equipment. All access panels shall have provision for sealing.

11.3.2 Primary Power Supply

1. The primary electrical supply to the switchboard shall be underground. The primary electrical supply cable conduit shall be above ground as short a distance as possible and designed to afford maximum mechanical protection to the cable
2. The Primary electrical supply to the switchboard shall enter through the base of the switchboard via minimum 100mm diameter conduit with long radius bends.
3. When the pump station requires its own transformer substation, ground level substations are required. Council shall not approve pole mounted substations.

11.3.3 Secondary Power Supply

1. Either a duplicate electrical power supply from the electricity authority separate grid or an on-side electrical generator or facility for a plug-in mobile generator may be specified at the time of purchase.
2. If a plug-in generator is specified, than a socket and switchgear is required to be installed which is compatible with Council's mobile generator plug-in cabling as follows.
    - For two pump motors each 0 – 5.5kW, (Pump Station Size A), then the one inclined socket will be: externally mounted, appliance inlet, 3 phase + neutral and earth, 5 pin Marechal DS6 disconnector or type, for 8 mm padlock.
    - For two pumps motors each 7.5 – 18.5kW, (Pump Station Size B), then the one inclined socket will be: externally mounted, appliance inlet, 3 phase + neutral and earth, 5 pin Marechal DS9 disconnector type, for 8mm padlock.
    - For two pumps motors each 22 – 45kW, (Pump Station Size C), then the one inclined socket will be: externally mounted, appliance inlet, 3 phase + neutral and earth, 5 pin Marechal DS2 disconnector type, for 8mm padlocks.

- The sockets detailed above are general Marechal brand series part numbers. Contractors are to ensure the correct detailed Marechal part number for the required configuration. Alternative brand equipment is not acceptable for safety reasons for padlocking, fitting clearances and securing clips.
- For pump motors over 45kW, a lockable generator link box shall be provided.

11.4 Switchboards

1. Switchboards shall be oriented so that doors do not open in the direction of any pits or the pump well.
2. Switchboards shall be a 'Duplex' or double-sided type configuration with front and rear compartments and overall dimensions at least 900mm wide, 900mm deep and 2000mm high.
3. Front side to be in two separate compartments being, bottom part (unless otherwise specified) for pump cable plug and sockets (minimum 350mm high), and top part (unless otherwise specified) for main pump controls. A separate door is required for each compartment.
4. Rear side to be in three separate compartments being, bottom part for the plug in mobile generator switchgear, middle part for the telemetry equipment and top part for the electricity supply authority meters, switches and equipment. A separate door is required for each compartment.
5. The pump cable plug and socket compartment to be gas sealed from the remainder of the cabinet compartments and the wet well conduits. The sealing and gland/grommet arrangement to be capable of being resealed after a pump and cable removal event.
6. Cabinet to be installed on a concrete slab cantilevered off the side of the pump station. Concrete shall extend a minimum of 1000mm in front of Door openings. Stainless steel fixings and appropriate dissimilar metals insulation required.
7. Cabinet to have at least 1500mm clearance in front of doors, to any obstructions.
8. Cabinet to be suitable for the connection of the primary and secondary electricity power sources. The primary and secondary electricity power sources will be specified at the time of purchase.
9. Switchgear to isolate the primary electrical power supply to enable the secondary electrical power supply is to be located in the rear side bottom compartment

10. A three phase plug and socket combination switched connection arrangement shall be provided for each submersible pump in the pump cable Plug and socket compartment of the switchboard.
11. The pins shall be connected as follows:

    Pin 1 – Phase A
    Pin 2 – Phase B
    Pin 3 – Phase C
    Pin 4 – Spare

Pin 5 – Earth
Pilot Pin 1 – Thermistor
Pilot Pin 2 – Thermistor

12. The plug and socket combination switched arrangement shall be as follows:
    - For motors 0 – 5.5kW (Pump Station Size A), than each pump will have a socket and plug combination to be 7 pin 'Marechal 32A DS1 type'.
    - For motors 7.5 – 18.5kW (Pump Station Size A), than each pump will have a socket and plug combination to be 7 pin 'Marechal 50A DS3 type'.
    - For motors 22 – 45kW (Pump Station Size A), than each pump will have a socket and plug combination to be 7 pin 'Marechal 90A DS6 type'.
    - The sockets detailed above are general Marechal brand series part numbers. Contractors are to ensure the correct detailed Marechal part number for the required configuration. Alternative brand equipment is not acceptable for safety reasons for padlocking, fitting clearances and securing clips.
    - For Pumps Larger than 45kW, each pump will be hard wired to the switchboard.
13. Each pump cable shall have a separate conduit between the wet well and the switchboard. For pump motors up to 18.5kW, each conduit shall be 100mm in diameter and have long radius bends. For pump motors greater than 18.5kW, each conduit shall be 150mm diameter and have long radius bends.
14. Each pump cable conduit shall be completely sealed to prevent pump well gasses entering the switchboard cubicle. The sealing arrangement shall be capable of being resealed after pump removal.

1. Electrical equipment in the pump main control compartment shall include:
    - Current Limiting Main Switch 415VAC
    - Primary power lightning protection, Critec TDF Series – Transient Discriminating filer or Equivalent. With OPTO-Isolated output wired back to the PLC input for device status indication.
    - Secondary power connection plug and switches,
    - Circuit breakers and Combination circuit breaker RCD's
    - Relays and timers
    - Voltmeter with phase selector switch (active – active and active to neutral)
    - Incoming Ammeter with phase selector switch
    - Touch Screen Terminal – RED LION G3 Series – Operator Interface for indoor or outdoor applications, glossy finish with UV rated overlay – Part No G306MS00
    - Touch Screen Trending – RED LION G3 – Compact Flash Card – G3CF512M
    - Hour meter with 5 digits for each pump

- Ultrasonic Level Transmitter - Endress + Hauser Prosonic S, FMU90 Controller.
- High Level Float
- 15A Switched Socket Outlet on front Panel
- RFI & EMI protection
- 20% additional spare space.

2. Electrical Protection equipment shall include:
    1. Water Void (under current)
    2. Flow switch on each reflux valve
    3. Thermal overload
    4. Phase failure/Asymmetry relay (time delay, auto reset)
3. All switches and operation controls to be labelled with work name plates. Name plates shall be mounted by drilling and tapping or by use of a clinch nut or other captive treaded insert system. The use of self tapping screws to mount name plates is prohibited.
4. Allowable starting current shall comply with the Ergon Metering and Revenue Manual.
5. Soft starters shall be 'heavy duty rated' type.
6. Variable speed drives to be 'standard duty rated' type.
7. Isolators shall be of a type to facilitate the use of lockout locks and tags.
8. Ammeters to suit full normal full load current at approx 60% of full scale.
9. Automatic operation of the pumps will be from signals from the primary water level measurement using Endress + Hauser Prosonic S, FMU90 Controller. However operations inhibit of the pumps via telemetry signals is required to prevent the pumps from operating under downstream sewerage system emergencies.
10. ***Capricorn Coast Only*** – There is an interconnection between the Miri and Radtel Telemetry Networks located at Mount Barmoya Repeater Site. FRW Electrical staff will make the following points available at the Mount Barmoya Miri Master. The contractor is responsible for engaging Radtel to extract the data from the Miri Master and display on the Radtel Screens.
    1. Pump Start/Stop
    2. Pump 1 running
    3. Pump 1 fault
    4. Pump 2 running
    5. Pump 2 fault
    6. Phase Failure
    7. High well water level
    8. Overflow water level
    9. Pump 1 reset
    10. Pump 2 reset
11. Red flashing light on front panel to operate when water level is at high well water level or greater. Light to operate until water level drops to the 'all pump stop level'. There is to be no Red Flashing light to be installed externally from the main switch board.

12. Internal fluorescent lighting shall be provided in the switchboard compartment and the telemetry compartment. Automatic switching when each cabinet door is opened and closed.
13. All wiring and equipment is required to prevent Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI).

1. The pump station shall be fitted with primary and secondary water level measurement. Primary water level measurement shall use 24VDC Endress + Hauser Prosonic S, FMU90 Controller. Secondary water level measurement shall use voltage free independent float switches.
2. The secondary water level measurement using voltage free independent float switches is the alarm signal source direct to the telemetry system, and requires the following measurement levels: high well, overflow.
3. The 4-20 mA analog output for primary water level measurement using the '24VDC Endress + Hauser Prosonic S, FMU90 Controller' is to be wired to the Miri Analog input.

1. Telemetry Module - AD2006 Miri Radio/PLC 24VDC with Ethernet option Part No. AD2006TR-M5212-LA-24, complete with antenna.
2. All Pump stations shall use a MIRI telemetry controller. The Miri controller shall be used as a Programmable Controller to control the pump station operation. The Miri controller shall also be used for communications.
    a. For Rockhampton the Miri shall communicate to the Miri repeater located at Mount archer.
    b. For Capricorn Cost installations the Miri shall communicate with the Master Miri located at Mount Barmoya. The Miri Master transmits and receives on 473.000. The remote Miri radios shall be set to transmit at 1 watt unless otherwise advised.
    c. Where line of site is not possible the superintendent may provide direction to use an Existing Miri site as a store and forward repeater to relay the information to the Repeater Site.
3. The telemetry equipment includes the MIRI telemetry controller, antenna, Surge Arrestors (Antenna and Analog), cabling and connections.
4. 24 Volt DC Power supply with battery backup to run the Telemetry Module, Touch Screen, and Ultrasonic Level Transducer. Consisting of:
    a. Innovative Energies SR Series Battery Charger, 24VDC no break, Temperature Compensation, Fan Cooled, Phoenix combicon (plug in screw terminal block). Model Number SR250C24TFXL-C.
    b. Sonnenschein Dry fit A 400 Valve Regulated Lead Acid (VRLA) Batteries.

Type:	A412/20 G5
Part No:	NGA4120020HS0BA
Nominal Voltage:	12 VDC
Nominal Capacity:	20 Ah
Length:	167mm

Width:	176 mm
Height:	126 mm

5. The antenna shall be a stainless steel Yagi type for the Capricorn coast and aluminium for other areas. The size of the antenna (number of elements) orientation (vertical or horizontal) and alignment direction (magnetic compass) will be specified at the time of purchase.
6. The antenna and cabling shall be installed on either a stand alone pole not attached to the switchboard cabinet or the pump station vent pole. The antenna shall be a minimum of 2 meters above the top of the cabinet. The Antenna pole shall be earthed and if required be fitted with Lightning Arrestors.

11.5 Naming Convention for Pump Stations

- The Pump Stations shall be named by the Adjacent Road. (Development Names shall **NOT** be used) E.g. a pump station located on Ibis Avenue shall be called Ibis Avenue Pump Station.
- When more than one pump station exists on any road the road name shall be used with a number following. E.g. The first pump station on Ibis Avenue would be referred as Ibis Avenue Pump Station No1, the second would be referred as Ibis Avenue Pump Station No2, etc.

11.6 Commissioning of Pump Stations

- Prior to any commissioning the contractor shall give the Superintendent a minimum of 7 days notice. As part of this notice the contractor **shall** supply copies of the following documents.
    - Electrical Connection Report, (Electrical Safety Regulation 2002 S159) showing;
        - > Name and address of the person for whom the work was performed
        - > The electrical installation tested
        - > The day the electrical installation was tested
        - > The number of the electrical contractor licence under which the electrical installation was tested.
        - > The certificate must certify that the electrical installation, to the extent it is affected by the electrical work, has been tested to ensure it is electrically safe and is in accordance with the requirements of the wiring rules and any other standard applying under the Electrical Safety Regulation 2002.
        - > Copies of all test results from the test carried out.
    - A copy of the “Form A” submitted to Ergon Energy for electrical connection.

****** Equipment listed in the Equipment list below shall be used unless otherwise agreed in writing by the superintendant.******

Table: Equipment List

EQUIPMENT / ITEM	PREFERED OPTION
Ammeters (throughout Plant)	Crompton Instruments Analog
Ammeters (Main Incomer)	Crompton Instruments Digital
Voltmeters	Crompton Instruments Analog
Analog Display – Loop Powered	Red Lion – Model CUB4LP
Battery Charger/Power supply (For small installations and pump stations)	Innovative Energies SR Series Battery Charger, 24VDC no break, Temperature Compensation, Fan Cooled, Phoenix combicon (plug in screw terminal block). Model Number SR250C24TFXL-C
Batteries (for above Battery Charger)	Sonnenschein Dry fit A 400 Valve Regulated Lead Acid (VRLA) Batteries. Type: A412/20 G5 Part No: NGA4120020HS0BA Nominal Voltage: 12 VDC Nominal Capacity: 20 Ah
Cable trays and ladder	Ramset-Fastrak
	Burndy
	Uni strut
Chlorinator	Wallace & Tiernan – Model V500EPS
Chlorine Analyser	Wallace and Tiernan Deplox 3+ Amp (Membrane Wet Cell with ph probe, flow switch and pressure less)
Chlorine Gas Sensor	Wallace & Tiernan – Acutec 35
Chlorine Injection Lines	Upvc – UV stabilised
Circuit Breakers	Terasaki
	HPM
	Merlin Gerin
	Schneider – NS Series Circuit Breakers
	ABB
Control Relays – AC	G.E RL4 RA
	Telemecanique
Control Relays – DC	G.E RL4 RA
	Telemecanique
Current Transformers	Nilsen
	Crompton Instruments
Dissolved Oxygen Sensor	Danfoss – OXY 4100 System 3
Emergency Stop Pushbuttons	NHP FT1-DESL
	Telemecanique
	Cutler Hammer ESM9/P
Ethernet Switch – Unmanaged	Moxa – Model EDS-308-M-SC
Ethernet Switch/Router – Managed	24Port Managed Switch Cisco Catalyst 3560 Series PoE – Rack Mount
Fire – Pannel	Notifier Analogue Addressable Panel – AFP-2800
Fire – Suppression	Chubb – Argonite Wormald – Intogen
Fire – Smoke Detection	Xtralis VESDA VLP Notifier Ionisation Smoke Sensor – FSI-851
Flow Transmitters	Siemens F M (electromagnetic) MAG 6000 panel mount controller with Modbus RTU/RS485 Communications.
Float Switch – Reservoirs	BESTA AG, TriMod – Besta, Type AA 01 140 IP65
GPO's	Clipsal 56 Series, IP56 15A

HMI SCADA	Honeywell Experion
Hours run meters	Siemans
	Wattmaster
Indicating Lamp Fittings	Sprecher & Schuh
	G.E.
	Telemecanique
Indicating Lamps	Light Emitting Diode type (high intensity)
Integration SCADA Services	Honeywell
Isolators	Clipsal
	Kraus & Naimer
	Bremas
	Merlin Gerin
Level Measurement – Ultrasonic	Endress + Hauser Prosonic S FMU90 Controller – with Field housing. Ultrasonic sensor 93 – Sensor to be chosen to suit application and approved by the Superintendent.
Lighting – Internal & External	Pierlite PWP polycarbonate diffuser IP65 weather proof impact resistant luminaire. Product Code PWP236QS
Lighting – Internal Emergency	Pierlite PWP polycarbonate diffuser IP65 weather proof impact resistant luminaire. Product Code PWP236m
Lighting - LED	IDEC LF1A (IP67f) Series LED Illumination Units (Water-, Dust- nad Oil-proof) www.idec.com
Lighting – Maintained Exit Lights	Exit lights above all exit doors (Exit Lights to be LED type)
Lighting – External SPS	Pierlite Chalmit TH Product Code 813-500TH (Stainless Steel for use as well lighting at Sewage Pump Stations)
Modbus – Ethernet Gateway	Telemecanique ConneXium Ethernet Gateway TSXETG100
Motor Contactors	Sprecher & Schuh
	G.E.
	Telemecanique
Motor Protection – DOL	Sprecher & Schuh
	Telemecanique – TeSys T Motor Protection Relay, Model LTM R Modbus, complete with TeSys T LTM CU Control Operator Unit. For drives requiring Shear Pin Protection expansion module LTM E.
Motor – Soft Starters	Telemecanique Altistart 48(ATS48)
Motors Motors – Drive	VEM K21B 250 M4 WEG (all motors to mining spec) SEW Eurodrive (Direct Coupled)
Moulded Circuit Breakers	Terasaki
	Merlin Gerin
	ABB
Ph Sensors	Endress + Hauser
Poles – Antenna	Polo Pty Ltd
Power Meter	Merlin Gerin – Series 700 – PM710 with RS 485 / Modbus protocol
Power Supply – 240VAC-24VDC	1606XLP50E Allen Bradley 50W 2.1A 110/240V ac – 24-28V dc.
	1606XLP100E Allen Bradley 100W 4.2A 110/240V ac – 24-28V dc.
Power Supply – 240VAC-12VDC	1606XLP50B Allen Bradley 50W 4.2A 110/240V ac – 12-15V dc.
Power Supply – 24 to 12 Converter	Innovative Energies – www.innovative.co.nz IEXT/MV-12 21-60V 13.8V 70W
Pressure Boosting System	Grundfos Hydro MPC
Pressure Transmitters	Honeywell – St3000 Part number STD924-E1H-00000-

	AN,S2,MB,CA+XXXX (For Reservoirs) Endress & Hauser – CERABAR M PMC/PMP
PLC Interposing Relays	Finder 60/13 series. 10A. Round pin press to test flag indication. 24 V DC
Programmable Logic Controller	Allen Bradley Compact Logix (refer to PLC section of this manual) Honeywell 620 PLC
Programmable Logic Controller/Radio	AD 2006 Miri Radio/PLC 24VDC with Ethernet option and analog outputs. Part No. AD2006TR-M5212-LA-24
Pumps – Re-use	Grundfoss
Pumps – Submersible	Flygt
Rack	B&R ARLB6842RU RACK – including 2 cable management trays.
Radio	Datacom Trio E Series – ER450
Selector Switches	Kraus & Naimer
	Telemecanique
Scales – Drum	RINSTRUM – Ranger 5100
Slip Rings	Conductix – RAR-D07X01DA08-SPEC
Surge Filters	Critec TDF Series – Transient Discriminating Filer or Equivalent shall be used. With OPTO-Isolated output wired back to the PLC input for device status indication
Surge Arresters	Incoming power supply shall be protected via the use of a Critec 1 Mode MOVTEC, 220-277V, 100kA surge suppressor Part No. TDS MT 277. Alarm contacts shall be wired back to a plc input for alarm indication
	All analog inputs and outputs leaving the enclosure shall be protected via a Critec UTB30 or equivalent Transient barrier
	Coaxial antenna RF feeders shall be protected via Critec CSP SERIES Coaxial surge protector or equivalent using N Type connector Male to Female
	All Serial communications cables (RS-232, RS423, RS-422, and RS-485) entering or exiting the switchboard shall be protected be a Critec DEP Series – Data Equipment Protector or equivalent.
	Where a 10BaseT or 100BaseT Ethernet network is installed all devices on the network shall be protected using Critec LAN RJ45 – Local area network protector or equivalent.
Temperature Sensors	RTD PT100 3 wire
Terminal Strips	Sprecher & Schuh
	Telemecanique
Thermal Overloads	Sprecher & Schuh
	Telemecanique
Timing Relays	Anly
	Omron
	Telemecanique
Touch Screen Terminal – 6”	RED LION G3 Series – Operator Interface for indoor or outdoor applications, glossy finish with UV rated overlay - Part No G306MS00
Touch Screen Terminal - Trends	RED LION G3 - Compact Flash Card – G3CF512M
Touch Screen – Colour	RED LION G3 Series
Level Measurement - Ultrasonic	Endress + Hauser Prosonic S, FMU90 Controller
UPS	APC Smart Series – Rack Mount 1400VA including 4 x Rack Mount Battery Expansion Modules, SNMP Card.
Variable Voltage Variable	Danfoss VLT AQUA FC200

Frequency Drives	
Voltage Relays	Rhomberg Braisler
	Crompton