Temo Consulting

Technical Specification

For

Consultancy for Engineering and Project Management

ELECTRICAL SERVICES

MFMR AUKI – MALAITA PROVINCE
SOLOMON ISLANDS



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P.A.T Consulting Ltd
Level 2
Lot 76, Gordon St
P.O. Box 16567
Suva, Kiribati
Email ptemo@temoconsulting.com
Telephone + 67 9 3316 478
+ 67 9 3317 733
Facsimile + 67 9 3303 234

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1 Specification Revision and QA status

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2 INTRODUCTION

2.1 OVERVIEW

This specification details the requirements for **ELECTRICAL SERVICES for MFMR Auki – Malaita Province, Solomon Islands**

All work covered by this specification shall be subject to all provisions of the Conditions of Contract and the Preliminary and General Sections of the Architectural Specification.

The work in this Trade Section shall be carried out by a qualified and registered Electrical Services Subcontractor who shall be a Subcontractor to the Main Contractor and shall be subject to the same General and Special Conditions of Contract applying to the main contractor.

All clauses of the complete specification shall apply to the Electrical Services Subcontractor and all his specialist sub-Subcontractors.

2.2 SUMMARY DESCRIPTION OF THE ELECTICAL SYSTEMS

The Electrical Services covers lighting systems, power systems, connection to Main Switchboard (MSB), generator power supplies and all other works necessary to implement this specification.

This section of the work shall be carried out only by Electrical Services Subcontractor who can show they have had recent and successful experience on works of similar nature and magnitude, and evidence of these experiences shall be submitted if requested.

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3 GENERAL INSTUCTION

3.1 COMMUNICATION

All communication shall be in writing and shall be with the Consulting Engineer or any person appointed by him.

3.2 CONDITIONS OF CONTRACT

Refer to the Main Building Contract for details on the “Form of Contract” for the works specified.

The said document specifies commercial, legal and tendering conditions for these works.

Any queries regarding Conditions of Contract and its interpretations for these works shall be directed to the consulting engineer before tender closing date.

3.3 DEFINITIONS AND ABBREVIATIONS

The term **“Contract”** used herein refers to the work included in this Specification, as does the term **“Subcontract”.**

The term **“Electrical Services Subcontractor”** or **“Subcontractor”** used herein refers to the Electrical Services Subcontractor, regardless of actual contractual relationships, e.g. Electrical Services, Subcontractor, Nominated Subcontractor, engaged to complete all works described in this Contract.

“Approved” shall mean subject to the inspection and entire approval of the Engineer before being worked or fitted into the Contract works.

“Provide” and **“Install”** used separately shall be interpreted to mean **“Provide and Install”** and shall include all design installation and testing, setting to work and maintenance.

“Indicated” means as indicated on the Contract drawings, specification and by notes, figures, sketches or writing; thereon or by any combination thereof.

The terms **“Employer”, “Client”, “Principal”** and **“Owner”** refers to **FMC Pacific**.

The terms **“Architect”** refers to **Kearney Architecture**

The term **“Consultant”, “Engineer”** and **“Engineers”** used herein refers to **Temo Consulting.**

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3.4 REVIEW THE SPECIFICATION

The Subcontractor shall read, review, study and familiarise themselves with this specification and bring anything that they do not understand or do not agree with, under the attention of the consulting engineer before or at tender closing stage in their tender letter.

Tenderers are to make use of the tender period to clarify any aspects or inconsistencies of these documents that may influence the pricing or the execution of the contract. Any such inconsistencies found subsequent to the letting of the Contract shall have the interpretation placed upon them by the Engineer. The Subcontractor shall abide by this interpretation.

Requests for alternatives or changes to the specification after tender closing shall not necessarily be accepted.

3.5COMPLIANCE

A price for a tender complying with this specification in all respects shall be compulsory.

The intent of this specification is to provide for the work herein set out and as shown on the accompanying drawings to be fully completed in every detail for the purpose designed. The Subcontractor shall allow to supply, construct and install everything reasonably necessary for such construction to comply with the intent of the specification and drawings not withstanding any omissions in the drawings and/or specifications.

The Contract includes all work incidentals to the work shown and specified and as necessitated by the conditions of the site or of the works or of the materials as apparent or as discovered during the progress of the Works.

The Electrical Services system installation shall be carried out by an approved specialist sub-Subcontractor under the control of this Subcontractor and form part of this contract.

The intent is that all systems supplied under this contract are complete in every respect, and all items and work necessary to this shall be deemed to be included whether specifically indicated or not.

3.6 DESIGN RESPONSIBILITY

The design responsibility for the installation shall be with the engineer.

3.7 SUBCONTRACTOR'S RESPONSIBILITY

The Subcontractor shall be responsible for the installation to perform as designed.

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The Subcontractor shall be responsible for all the specified equipment to perform as designed and shall verify the performance compliance with the suppliers before an order is placed.

The Electrical Services Subcontractor shall be deemed to have carefully examined the Contract Documents, the Specification and Drawings. If the Electrical Subcontractor has any doubt as to the meaning of any portion of these documents he shall inform the engineer in writing before tendering on the project. The engineer shall provide clarifications to the query in a notice to tenderers.

The Electrical Services Subcontractor must carefully consider local conditions, visit the site of the proposed work, and make any field survey necessary for proper planning and execution of the work. Failure to do so shall in no way relieve the Electrical Services Subcontractor of responsibility for changes or unanticipated costs due to field conditions.

After a tender has been accepted the responsibility for any misunderstanding or error shall rest with the Electrical Services Subcontractor. The Electrical Services Subcontractor shall examine carefully the Architectural, Structural and other trade's drawings and satisfy himself that the work under his contract can be satisfactorily carried out without changes to the building as shown on drawings. Before commencement of his work he shall examine the progress of other trades and report at once any defect or interference affecting his own work or the warranty of same. No extras will be allowed subsequently for his omission to make adequate inspection or take adequate precaution.

The Electrical Services Subcontractor shall arrange his own work in co-operation with other trades so that all work is installed to the best advantage. Where equipment is installed by the Electrical Services Subcontractor without due regard to other trades, relocation of such equipment shall be performed by the Electrical Services Subcontractor at his own expense.

3.8 GENERAL RESPONSIBILITY

The Subcontractor shall comply with all proper instructions issued by the Engineer or the Main Contractor in relation to this Contract.

The Subcontractor shall be responsible for the adequacy, stability, and safety of all its site operations and method of construction.

The Subcontractor shall respect the rights of the adjoining areas occupants and shall advise the main contractor when access to areas out of construction areas is requires for the purposes of carrying out the Contract Works.

The Subcontractor warrants that at all times shall be suitably qualified and experienced, and shall exercise due skill, care and diligence in the carrying out and completion of Works under Subcontract (WUS)

The Subcontractor shall carry out and complete WUS in accordance with the design documents so that the Subcontract Works, when completed, shall:

a. be fit for their stated purpose; and

b. comply with all the requirements of the Subcontract

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3.9 ERRORS, AMBIGUITIES AND OMISSIONS

Errors, ambiguities and omissions in drawings or specifications shall be reported to the Engineer for correction before any part of the work involved is started. Unless otherwise expressly stipulated, no additional allowance shall be made because of errors, ambiguities or omissions which should reasonably have been discovered during the preparation of the tender or which may become evident later and which should have been directed to the attention of the Engineer in timely manner. The written decision of the Engineer shall be final.

3.10 CONTRACTOR PRICE

A lump sum fixed price excluding taxes is required. The price shall not be subject to variation for the duration of the contract period.

The Contract includes all work shown and specified and as necessitated by the conditions of the site or of the works or of the materials as apparent or as discovered during the progress of the Works.

By submission of a tender the Tenderer warrants that he is expert in understanding the systems, capable of both design and construction, and that all work will be suitable for its intended function where located, and will comply with all requirements of statutory and other authorities having jurisdiction.

3.11 PRE-START MEETING

The Subcontractor shall prior to commencing the Subcontract Works on site, attend a pre-start meeting to be held at the address and time mutually agreed with the Main Contractor.

The meeting may address the following matters:

a. construction and site specific issues;
b. lines of communication and authority levels;
c. possession of the site;
d. frequency and venue of site meetings;
e. progress payments;
f. working hours;
g. safety requirements;
h. insurance;
i. scope of works;
j. programs; and
k. resources.

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3.12 SITE MEETINGS

A senior and responsible representative of the Electrical Services Subcontractor's staff with powers of making binding decisions on behalf of the Electrical Services Subcontractor shall attend all site meetings called by the Construction Manager or Project Manager.

3.13 CONTRACTOR'S REPRESENTATIVE

The Subcontractor shall provide all necessary supervision during the Contract. It shall have on site at all working times a competent representative whose name shall be notified to the Main Contractor and Engineer in writing and who shall be authorised to receive on behalf of the Subcontractor any instructions from the Main Contractor, Engineer or Engineer's Representative.

3.14 APPROVAL OF DRAWINGS AND SAMPLES

Within ample time to prevent construction delay, the Sub-Contractor shall submit to the Engineer samples of all major plant and equipment for approval. The electrical Subcontractor shall also submit 2 sets of final shop drawings detailing all aspects of proposed work for approval.

The electrical Subcontractor shall not enter into any commitment or commence any work without the approval of the shop drawings and materials samples by the Engineer.

Consent shall not relieve the Subcontractor from his obligation to comply with this specification. Supply without delay, any samples, information or drawings requested by the Engineer.

3.15 ALTERNATIVES

The Subcontractor is encouraged to forward alternatives for both the design and specified equipment and the installation, provided that full details of these alternatives and prices are forwarded with their tender under cover of their tender letter.

Nomination of particular manufacturer, reference, or source of supply shall be taken, unless specifically noted otherwise, to indicate type and quality required.

Any alternative equipment shall meet or exceed the specified equipment and installation in all respects as follows but not limited to the following:-

- Performance and duty.
- Maintenance and spare parts.
- Durability.
- Energy efficiency.

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- Life cycle costs analysis.

All costs associated to prove the above shall be borne out by the Subcontractor.

3.16 APPROVALS

All approvals of documents and site work shall be performed by the consulting engineer or any person appointed by them.

3.17 SHOP DRAWINGS

The Sub contractor shall prepare installation drawings for shop fabrication and working drawings for installation on site. All dimensions and locations shall be verified on site. Installation drawings shall be submitted for review by the Engineer before manufacture. The review of any drawings by the Engineer in no way affects the Sub-Contractor's responsibility for the satisfactory completion of the work.

The Electrical Services Subcontractor shall review all relevant drawings, including architectural, structural, other services and co-ordinate and co-operate with the main contractor and the relevant subcontractors to avoid conflict with the building structure and other building services. Any changes required due to this co-ordination shall be provided at no extra cost.

The installation drawings shall include all details necessary for the proper accommodation of the plant as a whole. This includes all foundation, and fixing bolts details, access details etc. Accurate shop drawings are to be provided for the penetration and cast in requirements for the pre-cast concrete panels for both walls and floor panels.

Should any alterations be necessary due to errors in, or late availability of information from the Sub contractor, all charges incurred in the correction or alteration shall be to the Electrical Services Subcontractor’s expense.

3.18 AS INSTALLED DRAWINGS

The Electrical Services Subcontractor shall provide installation and record drawings to be kept on site throughout the construction phase. All deviations to the shop drawings shall be marked clearly in red ink. The marked up set of shop drawings shall form the basis of the production of the as installed drawings.

3.19 PROGRAMME

The Tenderer shall submit a programme of works with their tender in Gantt Chart Form, specifying Tasks, Duration, Resources and dependencies between scheduled tasks. The critical path activities and milestones shall be identified. This programme shall be kept updated at all times for the entire duration of the project.

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3.20 ACTS, CODES, REGULATIONS AND STANDARDS

The Contract Works shall comply with all relevant statutory regulations and any special requirements and Kiribati Electricity Authority Standards including:

- All requirements and recommendations of the SAA Wiring Rules (AS3000).
- The requirements of the Solomon Islands Electricity Supply Authority.
- The National Building Code of Solomon Islands
- The requirements of the Local Authorities.
- The requirements of Local Telecom Authority
- The requirements of the Occupational Health and Safety Department.
- The requirements of the Dangerous Goods Regulations.
- The requirements of NZS 4219:(1983) - Specification for Seismic Resistance of Engineering Systems in Buildings
- NZS 4203 - Code of Practice or General Structure Design and Design Loadings for Buildings.
- NZS 4232 - Performance Criteria for Fire Resisting Enclosures.
- Should there be any conflict between this Specification and the above Regulations and By-Laws; the matter shall be referred to the Engineer for clarification.

Where a New Zealand or Australian standard is not available, the relevant British standard shall be used and the standards shall take precedence in the above stated order. Where standards are not available, acceptable engineering standards shall be forwarded for approval.

Equipment suppliers and manufacturers' recommendations shall be closely followed with respect to both the installation and commissioning.

The latest issue/revision of all the above documents at the time of tender shall apply in each instance.

3.21 PERMITS AND FEES

The Electrical Services Subcontractor shall give all necessary notices, obtain all necessary permits and pay all fees in order that the work may be carried out, and shall furnish all certificates as evidence that the works installed comply with laws and regulations. Bring to the attention of and clarify any unusual aspects of the installation with the relevant Authority during the permit application period.

Pay all fees and costs relating to patent rights, trademarks, or other protected rights and fully indemnify the Owner against any claims arising there from.

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3.22 SITE WORK

Site work shall be performed in a workman like manner and the site shall be kept neat and tidy.

3.23 WORKING HOURS

For the duration of the contract works, the official working hours shall be coordinated with the main builder and agreed upon prior to commencement of work.

3.24 SITE PERSONNEL

The work shall be performed by people with the necessary experience, qualifications and registration to perform the work.

Documentation to this effect shall be submitted to the client's representative before any workmen will be allowed on to the site.

3.25 SITE FACILITIES

All site facilities shall be supplied by the Subcontractor inclusive of communication, storage, office and ablutions.

3.26 OCCUPATIONAL HEALTH & SAFETY

The Contractor shall z in matters relating to work safety. The Contractor shall ensure that their personnel are fully equipped with safety equipment and that a strict regime of safety is followed on site that complies with local OHS (Labour Department) Authority requirements.

3.27 COORDINATION

The Subcontractor shall allow for full co-ordination between all the trades both in the preparation of shop drawings as well as on site.

All routes of piping, ducting and cables and location of all equipment shall be agreed in advance, shown on shop drawings and not varied during the installation.

3.28 HOT AND DANGEROUS WORK

All minor and major hot work and work that could cause bodily harm or work that is a fire hazard for example grinding, sawing, cutting, welding, soldering and brazing shall not proceed without the consulting engineer's permission.

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3.29 PROGRESS PAYMENTS

Progress payments for sectional completion shall be based on work completed and commissioned less retention moneys.

3.30 VARIATION ORDERS

Variation orders shall be based on the price schedules that shall be completed by the Subcontractor.

3.31 DOCUMENTATION PRECEDENCE

This specification shall take precedence over other documents except in the case where it contravenes a Kiribati law or local authority regulation.

In case of document discrepancy or ambiguity, the matter shall be referred to the consulting engineer for a ruling which shall be final and binding to all parties.

3.32 QUALITY ASSURANCE

The Subcontractor shall submit with his tender a draft quality assurance plan indicating his quality control plan with hold points to be signed off by his personnel as well as the consulting engineer to ensure the quality of the installation.

The consulting engineer may add additional hold points or procedures if required.

3.33 MATERIALS FOR CONSTRUCTION AND FINISHES

The materials used in the construction of the equipment are to be of the highest quality of their respective kinds.

All parts liable to rust, including screws, bolts and nuts shall be cadmium plated or hot dipped galvanised. All metalwork in this Contract including switchboards, distribution boards, cable tray, trunking, cable ladder, support brackets etc. shall be protected against corrosion, to the satisfaction of the Engineer.

3.34 PROTECTION OF PEOPLE AND PROPERTY

Insofar as compliance with the Subcontract permits, the Subcontractor shall:

a. Take measures necessary to protect people and property;

b. Avoid unnecessary interference with the passage of people and vehicles; and

c. Prevent nuisance and unreasonable noise and disturbance.

If the Subcontractor damages property, the Subcontractor shall promptly rectify the damage and pay any compensation which the law requires the Subcontractor to pay.

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3.35 PROTECTION OF EQUIPMENT

All equipment delivered to the site for the Contract works shall be adequately protected during transport and adequately protected during storage on site and elsewhere. Damaged equipment shall be totally replaced with new items.

3.36 PROTECTION OF WORKS

3.36.1 General

The Subcontractor shall be responsible for taking all reasonable steps to avoid other trades or environmental conditions from damaging or disfiguring equipment or materials of this Contract by protecting the works adequately at appropriate stages of the Contract programme. The Subcontractor shall liaise with the Main Contractor and other trades in this regard.

The Subcontractor shall adequately protect equipment and incomplete works in areas exposed to the weather.

The Subcontractor shall arrange site access with the Construction Manager. The Subcontractor shall comply with all site security provisions set by the Construction Manager.

3.37 WORKMANSHIP

3.37.1 General

Carry out all work in a neat and serviceable manner. Follow best trade practices and comply with any manufacturer's recommendations.

Confirm positioning of all fixtures with the Engineer before installation. Confirm mounting height and location of all fittings before installation.

3.37.2 Finish& cleaning

The completely erected installation shall be handed over in a perfectly clean condition with all rust and dirt removed paintwork in good clean condition with erection scratches and other damage marks made good and bright parts properly cleaned and polished.

Keep the work areas clean and tidy at all times. Remove all rubbish as it accumulates. On completion, remove all debris and waste caused directly or indirectly by the work and leave the installation and surrounding areas completely clean.

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3.38 GUARANTEE

The Electrical Contractor shall provide a written guarantee in respect of all materials supplied under the Contract against defects which may occur or be found in workmanship, materials and design for a period of twelve (12) calendar months in service after the date of Practical Completion Certificate as detailed below.

All defects, fair wear and tear excepted, shall be made good free of all costs to the Owner, whether or not the workmanship and materials have been previously inspected and accepted.

3.39 WARRANTY

The complete installation shall be guaranteed free of defects and faulty workmanship for a period of 12 calendar months after the date of issue of Practical Completion Certificate.

Any defects during this 12 months shall be repaired/replaced free of charge inclusive of parts and labour.

Any equipment attended to during this period shall have an extended guarantee period of another 12 months from date of repair.

Where equipment supplier's offer extended warrantees in excess of 12 months, they shall be passed unto the client for their benefit.

3.40 AS BUILT DRAWINGS

A draft of the As Built documents shall be provided to the Engineer four weeks prior to Practical Completion for approval. Provision and acceptance of final as-built, commissioning, and maintenance documentation shall be a prerequisite for Practical Completion.

"As Built" drawings, to the approval of the Engineer shall be provided for the Contract Work. These shall be in similar detail to the installation drawings, but shall also include any amendments and any additional detail necessary to show the functioning or installation, or particular items of plant.

The approval of any drawings by the Engineer in no way affects the Electrical Services Subcontractor's responsibility for the satisfactory completion of the Contract.

3.41 DEMONSTRATION & INSTRUCTION TO CLIENT AND STAFF

The Electrical sub-contractor shall provide all instructions to members of the Client's organisation as necessary for them to recognise defective conditions in the Contract plant. Formal instruction shall be coordinated with the Client via the Main Contractor

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and shall take place following provision and acceptance of final as-built, commissioning, and maintenance documentation, and prior to Practical Completion.

The Subcontractor shall also provide such informal instruction as may be required prior to the formal instruction. The hydraulic sub-contractor shall assign a person thoroughly familiar with the Contract plant for the purpose of such instruction for a period of 2 complete days during which period his time shall be completely given over to instruction. Instruction shall be given as follows:

- Explain the function and operation of all equipment, and indicate where these items are dealt with in the Operating and Maintenance instructions.
- Demonstrate all indicating instruments, gauges and settings of equipment and indicate the current readings of such items.
- Indicate where and how any item of Contract equipment can be disconnected or isolated.

3.42 COMMISSIONING, INSPECTION AND TESTING

Four weeks prior to carrying out any inspections, testing and commissioning, submit details of the test procedures proposed, together with Test/Report Sheet formats for the Engineer's review. These procedures and formats, once acceptable to the Engineer, shall be used as the basis of all Inspections, Testing and Commissioning.

Prior to inspection/commissioning of the Works by the Engineer for the purposes of certifying Practical Completion, provide the Engineer with completed, signed Electrical Certificate of Compliance, Test/Inspection/Commissioning Reports on the equipment, services, etc., indicating that the Works are now ready for inspection. The contents and results of these Reports must be acceptable to the Engineer, and are an essential prerequisite to the Engineer proceeding with inspection/commissioning of the work for the purposes of the issue of the Certificate of Practical Completion.

The Certificate of Practical Completion does not become due until site testing and commissioning is complete to the satisfaction of the Engineer, and the completed Certificate of Compliance issued to the Engineer.

Arrange for Subcontractors to be in attendance where inspection testing and/or commissioning of the installation involves their equipment and where specifically requested herein.

Repair or replace as instructed by the Engineer, at no charge, any item or features not complying with these Documents.

Allow the Engineer and any relevant local bodies the opportunity of attending and witnessing the tests and commissioning. Include the following in the test procedures as a minimum:

- Check complete installation visually for compliance with the Specification.

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- Check all control panels for operation of switches, circuit protection, contactors, controls etc.
- Continuity and insulation resistance checks on all wiring and cabling. Ensure sensitive equipment is disconnected. Check and test all RCD equipment for correct operation.
- Check all labelling.
- Check fixings of all equipment and systems installation to ensure stability under possible seismic conditions.
- Provide approved written test result from the Kiribati Electricity Supply Authority.
- Test and commission all components, items, circuits and systems both independently and in association with the complete installation.
- Allow to employ the manufacturers of any specialist equipment installed to test and commission that equipment.
- After commissioning give at least two weeks' notice in writing to the Engineer that the installation is ready for final demonstration.
- Demonstrate the satisfactory operation of the installation and all component parts to the satisfaction of the Engineer.
- Provide all equipment and apparatus necessary for this demonstration.
- Carry out any tests the Engineer may require to demonstrate that the installation functions as specified or intended.
- Inspect and test the complete system in accordance with Kiribati Building Code and AS3000, and obtain Certificate of Compliance from the Kiribati Electricity Authority.

3.43 OPERATION AND MAINTENANCE MANUALS

Provide 3 sets of Maintenance Manuals bound and indexed in Black A4 ring binders labelled with the project name and purpose on the front cover and spine. The manuals shall include the following information:

- Brief outline description of systems and principal design details.
- System schematics.
- Operating instructions for the equipment installed.
- Schedule of all equipment showing location, maker's name and details of local agent.
- Provide spare parts lists, manufacturers' technical information, with detailed wiring diagrams for all composite equipment.
- A description of recommended maintenance procedures and the desirable frequency thereof, recommended lubricants, and recommendations for locating faults and isolating equipment.

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- Commissioning results, copies of works test certificates.
- A set of As-built drawings in A3 shall be provided for inclusion in each copy of the Manual.

3.44 MAINTENANCE AND DEFECTS LIABILITY

The Maintenance and Defects Liability Period shall extend for a period of twelve (12) calendar months from the date of Practical Completion. During the maintenance and defects liability period the Contract Plant shall be under the control of the Owner but the Subcontractor shall be in attendance and shall carry out all maintenance work as maybe required at no cost to the Owner.

Repair any defect which does not compromise the effectiveness of any system, excluding fair wear and tear within 7 days during the maintenance period specified.

Defects which do comprise the effectiveness of the system shall be repaired within 24 hours. Failure to do so will result in the work being done by others at the Electrical Subcontractors expense.

3.45 PRACTICAL COMPLETION, HANDOVER AND MAINTENANCE

Practical completion and hand over shall be after approval of the commissioning results and issuing of as built documentation.

3.46 FINAL COMPLETION

Final completion shall be considered achieved when the Maintenance and Defects Liability Period has been satisfactorily completed and all specified requirements have been met to the Engineers satisfaction.

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4 TECHNICAL CLAUSES

4.1 DRAWINGS

Drawing No.	Details
E0000	Drawing Schedule, Legends & Symbols & Abbreviations
E0001	Site Plan - Electrical Infrastructure Layout
E0002	Site Plan - Lighting Layout
E0003	Site Plan - Enlarge Electrical Layout
E0010	MSB Single Line Diagram
E0100	Ground Floor Plan - Lighting Layout
E0110	Ground Floor Plan - Power Layout
E0120	DB-GF & DB-U1 Schematic Diagram
E0200	First Floor Plan - Lighting Layout
E0210	First Floor Plan - Power Layout
E0220	DB-FF & DB-U2 Schematic Diagram
E0400	Grounding System Detail
E0401	Switchboard Accessories Detail
E0402	Trenching & Cable Installation Detail

The drawings listed in the schedules shall form part of and shall be read in conjunction with this Specification.

One set of all drawings shall be kept on site by the Electrical Services Subcontractor.

The attached drawings show the system layouts, general arrangements and requirements. The Electrical Sub-Contractor shall carry out the detailed design and show all levels, sets, deviations, supports, etc. on the shop drawings.

4.2 GENERAL SCOPE OF WORKS

- Obtain all regulatory approvals, apply for and obtain building consent and pay all local authority fees.
- Issue shop drawings for approval.
- Submit Materials and Equipment Submittals for Approval
- Perform co-ordination between trades.
- All tools, etc., necessary to perform the work.
- Follow the approved Quality Assurance plan.
- Allow for weekly site meetings.
- Provide as-built drawings.
- Provide for a 12 month warranty period and maintenance of all installed equipment after project turn-over.

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4.3 DETAILED DESCRIPTION OF WORK TO BE PERFORMED

The scope of the subcontractor's work shall include, but is not limited to the provision of all supply, co-ordination, installation, commissioning and maintenance of work summarised below and shown in the contract drawings.

All work necessary to provide a complete and fully functional system shown or implied in the documents and shall include:

1. Liaison with Local Electricity Authority and client before commencing work for Utility metering and connection to the Main switchboards as indicated on the drawings.
2. Supply & installation of mains cabling from the Existing Infrastructure connection point to the development as indicated on the drawings
3. Supply and installation of New MSB with metering, Bus Bars, MCCB's, MCB's, TVSS, Contactor, phase failure relay, 3 Phase Fuse & indicators, PFC as indicated in the Single Line diagram and all related drawings. Main MCCB's and shall be provided with shunt trip release for remote emergency controlling and monitoring. Sufficient dry auxiliary contacts shall be provided for these functions. No generic substitute is permitted.
4. Supply and installation of Power Factor Correction (PFC). This shall have filter, setting stages and automatic discharged switch for safe handling during maintenance.
5. Supply & Installation of new canopy type standby diesel generator, 415/240V, 3Ph, 4W, 50Hz with self bunding fuel day-tank with all accessories, warning alarm functions & remote monitoring functions. The generator control panel shall have a inputs/ outputs necessary for interfacing with BMS for remote monitoring. All necessary hardware and soft ware shall be supplied together with the generator to enable interface with the BMS system. The generator shall also have battery charger and starting batteries for this new generator
6. Supply & installation of submains cabling from the Genset to MSB/ATS as indicated in the drawings
7. Supply of fuel, for site testing purposes for the generator and commissioning (full tank of the genset)
8. Supply & Installation of 2062L self-bunded fire rated genset backup diesel fuel storage tank complete with external visual guage, automatic refueling pump & remote monitoring system with accessories and refueling pipe work from fuel tank to refueling point. The refueling piping shall be installed in trench with appropriate protection and caustion slabs as per AS/NZ Standard.
9. Supply & installation of UPS, UPS Battery Bank, UPS Static Switch, Service By-pass Panel, Isolator Panel and others as indicated on the drawings.
10. Supply and installation of all Distribution boards complete with outgoing branches MCCB's, ELCB'S and MCB's as indicated on the drawings. All Distribution boards shall have a 25% spare pole capacity.
11. Supply & Installation of Submains Cabling from the MSB to each distribution boards as Indicated on the Drawings.
12. Supply & Installation of all Isolators, Switches and GPO's as indicated in the drawing. These shall be only as per consultant approved specifications.
13. Supply and installation of all sub-circuit cabling.
14. Supply & Installation of all cable trunking / trays / conduits, cable pits, etc. for all electrical services equipment

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15. Supply and installation of MV/ LV grounding system as indicated in the drawings.

16. Application of Fire sealant on penetration made on fire wall pertaining to Electrical service.

17. Making good any surfaces affected during the electrical construction works.
18. Warranty information of the various plants/ equipment/ fixtures (DB's, GPO's Lighting Fixtures, mains and submains etc.)
19. Testing and commissioning of the completed installation.
    - Local Regulator Compliance Certificate
    - Local Utility Compliance Certificate
    - Mains & Submains Meggar Insulation Test Results
    - QA and Operational Test Results; room by room analysis (lighting, power outlets, switches, MSB, DB)
    - Genset, MSB, Distribution Board, Equipment Commissioning Test Result
    - Equipment FAT results (Generator, MSB etc.)
    - Thermographic Scan Test Results for all DB's, MSB, connections etc.
    - MSB Earth Test Result
    - Provide Test results for the Lightening Protection System.
    - Letter of Practical Completion
    - Client Training Certificate
    - Warranty Letter for all materials installed, workmanship
20. Instruction/training to Principal's representatives on the Operation and Maintenance of all systems. Provision of client Training Certificates
21. Provision of Shop Drawings. These shall be approved first by the consultant before commencing any fabrication and installation works.
22. Submittal of As-Built & Operations & Maintenance Manuals. The O&M shall include the below information as a minimum.
    - Warranty information of the various plants/ equipment/ fixtures (MSB's, Gensets, GPO's Lighting Fixtures, mains and submains etc.)
    - Maintenance Schedules and Procedures of the various plants/ equipment/ fixtures (MSB's, Gensets, GPO's Lighting Fixtures, mains and submains etc.)
    - Specification/ technical datasheet of all materials and equipment installed.
    - Equipment Schedule with Supplier contact details
    - MSB/Genset Changeover Process
    - Provision of Technical Specifications of the various plants/ equipment/ fixtures (MSB's, Gensets, GPO's Lighting Fixtures, mains and submains etc.)
23. Provide Poly logger reading for 48 hours after all installation has been complete. (allow for load balancing as maybe required)
24. Contractor to allow for Thermo scanning of the new MSB at the 6th and 12th month from the date of practical completion and commissioning
25. Contractor to allow for 12months of defects & liability period works.
26. Approval from Utility prior to commencing work and after the installation is completed is required and shall be submitted to the consultant.

27. Any other items required, please specify details.

Tender Issue

The above shall include all required liaison between the electrical subcontractor and all associated specialist services subcontractors i.e. fire subcontractor, hydraulics sub-contractor, Medical sub-contractor and mechanical services subcontractor etc.

4.4 ADDITIONAL WORKS FORMING PART OF THE ELECTRICAL SERVICES CONTRACT

The following works associated with the Electrical Services are also to be carried out/included by the Electrical Contractor:

Concrete	Chasing, coring, cutting, and making good, placing and casting in of pipe sleeves and conduits, bases and plinths for equipment, excluding galvanised steel edge surrounds which are to be provided as a part of the electrical sub contract
Masonry	Chasing coring, cutting and making good, plant enclosures and service risers
Roofing	Openings and flashings and counter-flashings.

4.5 MATERIALS IN GENERAL

The installation shall consist of new and unused materials, be of current manufacture and of the highest quality. Where brand names are specified in this document, they are specified to set a standard which must be met.

Contractor is welcomed to offer alternative equipment satisfying the same standard to those scheduled, subject to approval by the client's/or representative.

Materials and work not specifically mentioned shall be supplied as required by normal trade practice to enable completion of the work even if not specifically mentioned in these documents. The electrical installation shall be provided complete and fully operational.

4.6 SERVICE AND REPAIR ACCESSIBILITY

Equipment shall be installed to provide easy accessibility for maintenance/service and it shall be possible to replace all the equipment without major structural building modifications.

Where equipment is installed in concealed locations the location shall be identified at the point of access to the approval of the Main Contractor and the location noted in the As Built documentation.

4.7 VOLTAGE

HV Reticulation

Nominal System Voltage: 11 KV

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Highest System Voltage: 12 KV

Frequency 50 Hz

Number of Phases 3

Number of Wires 3

LV Reticulation

Line to Line Voltage 415 Volt

Phase to Neutral Voltage 230/240 Volt

Frequency 50 Hz

Number of Phases 3

Number of Wires 4

4.8 FAULT LEVELS

Check any stated ratings with the Supply Authority and where a discrepancy is confirmed, advice in writing during construction.

The design and construction of switchboards, associated components and connections shall give satisfactory performance under all variations of load conditions including fault currents, over current and short circuits circuit current as may be experienced.

Provide equipment that will provide protection of semi-conductor components against potential damage caused by switching and other external transients.

4.9 POWER CABLES

4.9.1 LV Reticulation

For all low voltage reticulation (415/ 240V), generally use multi-stranded copper cable. Do not use aluminium conductors for low voltage reticulation (415/ 240 V) unless approved in writing by the project engineer.

The minimum sizes of the cables shall be in accordance with design drawings. Where a discrepancy is noted on the cables sizes, the contractor shall advise and seek clarification in writing during pricing and construction.

Where specified PVC cables (insulated and sheathed): Use 0.6/1 kV and V75 rating unless otherwise shown. For environments exceeding 70 ^{o}C, use V105 rating.
For XLPE cables, use 0.6/1 kV and 90 ^{o}C rating. EPR cables where specified as flexible cable use 0.6/1 kV and 90 ^{o}C rating.

The installation method of main cables in the cable trenches or cable trays shall be provided to the Engineer for approval.

Joints in cable runs shall not be allowed unless specified or authorised in writing.

Tender Issue

Cables must be adequately supported at intervals during the laying operation. Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables. All ducts shall be indicated on the as-built drawings to be supplied under this contract.

4.10 EARTHING

4.10.1 Main Earth &Earthing

Supply, install and connect up a main earth to the requirements of the New Zealand Electricity Regulations 1997, AS/NZS 1768-1991 Standard and the Kiribati Public Utilities Board (KPUB) Requirements. Carry out all tests as required by the New Zealand Codes of Practice.

Supply, install and connect up an earth bar of sufficient length and rating of the transformer, switch room and generator.

Provide, install and connect up all earthing and bonding as required by the N.Z. Electricity Regulations 1997 and Amendments together with any requirements of the relevant Codes of Practice and Kiribati Electricity regulations.

Earth continuity conductors shall be provided in all sub mains and sub circuits including those for lighting. Where the earth continuity conductor does not form an integral part of the sub main it shall be run adjacent to its respective sub main over its entire length.

Bond to earth all Mechanical Services pipe work; hot and cold water; plumbing and mechanical ductwork. Provide earth bonds for all sinks, shower trays, cable ladder, cable tray, trunking, metallic conduit. All earthing and bonding conductors shall be copper, green PVC insulated. Where conductors are looped between bonded equipment, they shall be secured into a common lug to ensure continuity of the whole system should an individual piece of equipment be disconnected. Star washers shall be used to provide effective earth connections to pre-painted surfaces such as trunking, panels, boxes, etc. Earthing and bonding to be provided by the Subcontractor, inside plant rooms.

4.10.1.1 The Conduit System

The wall tray shall be provided with an approved copper bonding strip, fastened to the wall tray. All conduit terminations at the wall tray shall be bonded to the bonding strip by means of locknuts and bushes and the bonding strip shall be bonded to the Earth Point Terminal Busbar by means of an insulated 4 mm2 PVC conductor.

The metal switch and socket outlet cover plates shall be bonded by means of the mounting screw connections to the device mounting yokes.

Tender Issue

4.11 SWITCHBOARDS

4.11.1 Low Voltage (415 V) Switchboards

4.11.1.1 Detailed Scope of Works

Detailed Scope of Works for Main Switchboard and Supply point shall include but not limited to the following:

a) Provision of new Main Switchboard together with all associated Main Distribution Boards (MSB's) and sub distribution breakers as indicated on the drawing.
b) Quality branded switchgear (NHP, ABB, Schneider, Siemans) shall be provided and no generic substitutions is permitted. The major switchgear components shall be draw-out type.
c) Switchboard shall be provided with intelligent managed interfaces for remote monitoring and control such as a Multi-Function Meter that shall be capable of monitoring the following but not limited to:
    - Voltage
    - Current
    - Frequency
    - THD
    - Power Factor
    - Active Power, Apparent Power, Reactive Power, Active Energy
    - Phase Angle
d) Multi-Function Meter shall have the following but not limited to:
    - Very high sample rate to capture harmonics and sub-transients
    - High accuracy monitoring and measurement
    - Easy to read and configure
    - Option for remote communication including Ethernet/IP
    - User settable alarm configuration

The Subcontractor shall note that breaker sizes are provisional based on assumed loads and are subject to verification based on final equipment selection, at which stage any cost shall be to the client's account.

The Subcontractor shall provide all cascading tables for breaker selection.

The incoming supply to the main distribution board shall be connected from the new pad mounted transformer and a 100% backup generator as indicated on the drawings.

4.11.1.2 General

Layout and manufacturing drawings of all switchboards shall be reviewed before manufacture commences to ensure that the physical size of the switchboard components are such that placement in final position on site is possible. The Subcontractor shall confirm the design of the main switchboard will meet prospective fault level of 36 KA RMS, 1 sec

Tender Issue

Manufacturing and functional test result including type test certificate are to be supplied with the switchboard. Particular care is to be taken to ensure that adequate cable termination space is provided. The complete switchboard where applicable shall comply with AS 3439.1 and all current amendments.

Every switchboard shall be provided with effective means of isolation by single rotary type switch isolators with a handle on the main breaker. No main isolators shall be of the “micro gap” type.

All DB cabinets shall have both latching and key lock handles unless otherwise specified.
All distribution switchboards shall be adequately rated for a short circuit current rating as specified in the drawings. All distribution boards shall be provided with 25% spare pole capacity and 25% spare space for additional switchgear. All DB’s shall be labelled to ensure ease of maintainability.

4.11.1.3 Construction

Ensure fault ratings are specified.

Provide sheet metal, enclosed type, fitted with side hinged doors, and quick acting latches. They shall be folded 1.6 mm quality baked enamel finish internally and externally. Internal colour is to be white, and the external colour is to be selected by the Architect. Earthing contact points to be polished for better grounding.

For externally located switchboards, they must be IP66 rated marine grade. The externally located switchboard shall have a minimum IP54 protection when the main door is opened or the screw fixed panel is removed or equivalent. All switchboards located inside a room/building shall be IP56 rated minimum. Bus bars and connected circuits shall be capable of carrying continuously a total load equal to the rated capacity of the incoming isolator. The temperature rise of all components shall be in accordance with AS3439.1 clause 7.3.

Ensure that adequate terminal space is provided on neutral and earth bars. Adequate wiring space shall be provided between Distribution Boards and ceiling and floor spaces to enable the addition of 25% of the circuits initially installed. No control components shall be located within the MCBs cubicle.
Earth continuity shall not depend upon metal to metal joints. For cubical earthing use starred washers between screw and panel. All hinged doors shall be earthed, use flexible copper across the door hinges with crimp lug to braided stud.

Switchboards shall be semi-recessed mounted unless concealed in wall cupboards, or approved otherwise by the Electrical Engineer.

The earth and neutral bar shall be located well clear of incoming cables and other connections.

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The metalwork on the complete switchboard shall be thoroughly cleaned of all rusting, degreased and primed with zinc chromate. All mechanisms likely to rust are to be rust proofed.

The switchboards shall be manufactured by an approved manufacturer. The name of the proposed switchboard manufacturer shall be submitted at time of tender for consultant further evaluation.

4.11.1.4 Bus bars and Connections

Bus bars and connections thereto shall be fully insulated and are to be identified in accordance with AS3439.1 clause 7.6.5. Live parts shall be completely covered with insulation which can only be removed by destruction and must comply with AS 3439.1 Clause 7.4.2.1. All branch circuit breakers inside the MSB shall be connected to the main bus using copper bus bars unless otherwise specified. All connections thereto shall be fully insulated and are to comply with AS3439.1 clause 7.8.

Bus bars shall be properly supported to withstand the specified short circuit current capacity of the bus bars during fault.

Bus bars are to be sized in accordance with AS3439.1 clause 7.3. They shall be capable of carrying the continuous rated current in accordance with AS3439.1 clause 7.3. Bus bars shall be rated at the full current rating of the main switch and braced to withstand fault levels before safely clearing any sections or a whole of the affected area by the circuit breakers and relays.

4.11.1.5 Neutral and Earth Bars

These shall comply with NZS 1998. These shall be constructed of copper bus bar of size equal to phase bus bars. Neutral and earth bars shall be provided with purpose made tunnel type termination's sufficient for all connections with a cable size of 10mm2 or less. All cables greater than 10mm2 shall be terminated with crimp lugs and bolted on to the Neutral or Earth Bar. A minimum of 25% spare capacity shall be provided on Neutral and Earth Bars.

In addition, terminations are to be provided for incoming neutral and earth cables of sizes on the drawings together with a removable Copper Busbar link connecting the neutral and earth bars.

4.11.1.6 Cable Access

Where cables pass into switchboards adequate protection shall be provided from Electrical damage. This shall be in the form of plastic bushes or a rubber strip permanently attached to the metalwork. Adequate wiring access shall be provided to enable the addition of 25% of the circuits initially installed.

Tender Issue

Spare or future cable access shall be sealed with blanked plates to prevent the ingress of moisture or dust. This shall be provided to maintained the IP rating of the switchboard or distribution boards.

Care shall be taken to ensure moisture cannot enter the switchboard by running down or along cables.

4.11.1.7 DB Shop Drawings

Shop drawings must be submitted to and approval must be obtained from the Electrical Engineer prior to manufacture. Shop drawings must show the following:

- Dimensions (drawn plan view and elevation 'in situ')
- Colour
- IP Rating
- Labels (to be an indication of what will installed)
- Switchgear - rating and make
- Cable entry
- All components, make and type
- Detailed internal wiring and cable tagging.
- Detailed grounding system for Main earthing and isolated grounding.

4.11.1.8 Essential Features

The switchboard shall be designed to ensure satisfactory operation in which continuity of service is the paramount consideration, and to facilitate convenient operation. It shall be designed to eliminate the risk of accidental short circuits and to exclude vermin and insects.

Every reasonable precaution shall be incorporated for the safety of personnel in operating and maintaining the switchboard. Live contacts on overload units and ammeters shall be shielded.

Adequate ventilation shall be provided on enclosed cubicles to prevent condensation and for the removal of heat.

4.11.2 Distribution Components

4.11.2.1 General

All switchgear shall comply with AS 3947 or IEC 60947

4.11.2.2 Miniature Circuit Breakers

Tender Issue

MCBs can be used for currents no more than 63A unless specified otherwise. General power circuits shall be protected by a minimum 16A MCB and lighting circuits by a minimum 10A MCB. All general power outlets in the vicinity of the damp zones are to be protected by a combined 30mA RCD/MCB.

MCBs shall be of the trip-free type with instantaneous release under heavy fault conditions. MCBs shall be mounted to be removable without removing adjacent circuit breakers. They shall comply fully with NZS 2205, Part 1 and current amendments.
Circuit breakers shall have a fault rating of not less than the fault level of the distribution system at the point of connection in the switchboard as shown in the drawings or stated in the schedule but not less than 6 kA.

Provide 25% spare ways on all MCB chassis. MCB bus bar terminals are to be provided and insulated to all these ways. MCB shall be mounted in a chassis 250A 3phase. Fault rating on chassis to be 10kA.

4.11.2.3 Residual Current Devices (RCDs)

All RCDs shall be a combined MCB & 'RCD' i.e. they shall incorporate MCB characteristics in addition to RCD functions. For the purpose of this specification these combined units shall be referred to as RCDs. RCDs shall have a fault rating of not less than the fault level of the distribution system at the point of connection in the switchboard but not less than 6 kA.

All RCDs shall be of the trip-free type with instantaneous release under heavy fault conditions. They shall comply fully with NZS 2205, Part 1 and with AS 3190 for Type 2 Current Operated (Core Balance) Earth Leakage Devices. All RCDs shall afford personal protection and having a residual operation current not exceeding 30mA. RCDs shall be installed and tested in accordance with NZECP11.

Every RCD shall have a reset and test facility (push buttons) for checking correct functioning of the RCD. Both the phase and neutral conductors shall be switched and rated as stated on the DB Schedules. The RCDs shall be manufacturer tested before delivery. RCD operation shall be internal. RCDs shall not operate remote.

4.11.2.4 Contactors

Contactors shall comply with BS 5424 Part 1, 1977 Category AC-3 with making and breaking capacities given for AC3 in Table 2 thereof and Class 1 intermittent duty. No contactor having a rating of less than 15 amps shall be used. Contactors shall have easily removable coils and contacts. All contactors shall have continuous rating equal to the motor rating plus 25%, but shall have a minimum rating of 15 amps.

All contactors shall operate without discernible noise and shall be fitted with 230 volt coils except where noted on the drawings. Ensure correct co-ordination of contactor short circuit ratings with protection fitted. Be fitted with auxiliary contacts for remote indication and circuit control. Contactors shall be Telemechanique or equal.

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4.11.2.5 Relays

All relays are to be of best quality with contacts rated for a continuous duty of minimum 10 amps. They shall be encased in hermetically sealed enclosures and shall be free from discernible noise when energised. Auxiliary contacts are to be self-cleaning. Timing relays shall be provided with adjustable delay periods as shown on the drawings.

Relays shall be OMRON plug in make or equal.

4.11.2.6 Selector Switches

Selector switches shall comply with the requirements of IEC 337-1 for AC 11 duty.
Selector switches shall be Santon, Austenlite, Tellux or Kraus Naimer manufacture or equal.

4.11.2.7 Labels

General - Engraved Traffolyte, black lettering on white, fixed by chrome plated screws and adhesive backing.

Application	-	Manufacturer's name
	-	Fault rating
	-	Supply sub main origin, size and type
	-	Distribution switchboard designation
	-	Outgoing sub main designation, size and type

Warning - Engraved Traffolyte, white lettering on red, fixed by chrome plated screws and adhesive backing.

Application	-	Safety and statutory
	-	Special isolation requirements

4.11.2.8 Terminals

Incoming and outgoing cabling for control systems shall be terminated into 'tunnel' type pressure terminals without the use of lugs. All terminals and each wire of every termination shall be identified with a wire number and shown on the drawings. Wire markers shall be Critchley or similar full circle type.

4.12 SUB MAINS & SUB CIRCUIT CABLING

4.12.1 Scope of Works

Scope of Works for cabling shall include the following:

Tender Issue

a) The electrical service Subcontractor shall carry out detailed site inspection to familiarise himself of incoming supply location and route.

b) Provision of 415/240 V LV cabling in accordance with the design drawings.

4.12.2 General

Cables used shall comply with the following:

- PVC & TPS Insulated : NZS 6401
- UG PVC : NZS 6401 with heavy sheath for underground use
- PVC NS PVC : NZS 6401
- PVC SWA PVC : BS 6346
- XLPE : BS 5467, AS 3198
- MIMS : AS 3187, BS 6207

Cables shall be minimum 600/1000 volt rating for 400-volt line voltage use. Red sheathed cables shall only be used for power supply to fire services.

The minimum size of wiring for light circuits shall be 1.5 mm2 and for socket outlets 2.5 mm2 with other circuits sized as shown on the drawings. All cables 1.5 mm2 and above shall be stranded.

The radius of cable bends shall not be less than the values specified in NZ ECP28: 1993. All cables shall be sized and selected in accordance with AS/NZS 3008 and shall not exceed the maximum volt drop as defined in the Electricity Regulations of 1997 and AS3000.

4.12.3 Sub circuit Cabling

Co-ordinate with all other trades. Ensure that pipe work and ductwork have precedence in allocation of space over cables.

Obtain the approval of cable routes from the Engineer before installing cables. Conceal all cables in ceiling or under floor spaces and in wall cavities. Cables are to be run in PVC duct or conduit when fixed to masonry or concrete walls. All such runs are to be either truly horizontal or vertical as appropriate. Agree all exposed cable routes with Engineer prior to commencing work

Sub circuit cables are to be a minimum 2.5mm2 for general power and 1.5mm2 for lighting. Larger sized cables than minimum shall be used where the loading, voltage drop or rating factor of the AS3000 necessitates larger cables.

Tender Issue

The precise location of equipment items in occupied areas subject to co-ordination with architectural Ftures shall be agreed with the Architect and Engineer prior to cabling. Run all concealed cables in walls vertically only, between access cavities and outlet unless enclosed in conduit or trunking.

Arrange for holes to be cast through beams and columns to avoid running cables over beam and column surfaces. All holes through structural members shall be approved by the Structural Engineer before drilling commences.

No more than four TPS cables shall be run bunched on any cable tray. The space between adjacent bunches shall not be less than 30 mm. Note that all cable runs are to be arranged in a tidy manner. Unnecessary crossing over or twisting in cables shall be corrected at the Sub-Contractor's expense if considered necessary by the Engineer.

Where cables penetrate outside walls, provide water-tight seal at penetration points. Where they penetrate fire rated partitions, provide fire retarding packing. Ensure that all cables are supported to avoid undue strain on cables or on terminations. All cabling shall be neatly dressed, run in single layers and identified as to function at terminating points.

All cabling shall be installed in a manner which permits its convenient withdrawal and replacement. No cable shall be cast directly into concrete. In such areas install cables in conduit or ducting. Draw wires shall be installed in conduits or pipes where necessary for later cable installation.

After installation but before connection, all cables shall be tested for insulation resistance using a 500 V tester for 230 V circuits and a 1000 V Megger for 400 V circuits. Sharp edges to steel or sheet metal shall be removed and such work shall be arranged to avoid accidental injury to personnel, or damage to insulation.

Provide insulated bushes at all points where cables enter metal enclosures. On no account shall plastic sheathed cables be run in any situation where timbers have been treated or likely to be treated with tar-oil, creosote or allied products.

Wiring will generally be run via cable trays within the ceiling space and drop to switches/outlets within wall framing. No horizontal cable runs within walls is allowed unless approved by the Engineer.

Wiring which supplies equipment liable to overheat and cause rapid deterioration of the wiring shall have the tails made off with heat resisting sleeves to protect the permanent wiring in a conduit box fitted with terminals and mounted adjacent to the fitting or equipment then run heat resistant cabling from the box.
Cabling shall be cleated at centres not exceeding:

- For TPS and PVC insulated : NZECP28: 1993
- For Conduit : 600 mm horizontally
  : 900 mm vertically

Tender Issue

No ordinary grade PVC insulated cables shall be run in any location where the temperature is likely to exceed 45oC. No high temperature grade PVC shall be run in locations where the temperature is likely to exceed 75oC.

4.12.4 Tough Plastic Sheathed Cables

No cables shall be set solidly in concrete or plaster. Where TPS cables pass through walls and floors, or in plaster, concrete or where they otherwise may be subject to damage or abuse, they shall be adequately protected.

Where cables enter metal-clad apparatus such as switchboards etc., the holes shall be properly bushed. No through joints will be permitted on straight runs. Where cables are required to run concealed in timber framed construction they shall be run so that there is no danger of damage to the cables from subsequent nailing of linings, etc. Horizontal runs in walls are not permitted unless there is no alternative.

Extra low voltage wiring shall be run segregated from other wiring where visible. Extra low voltage wiring shall be suitably identified every metre to approval.

4.12.5 Terminations

On lighting and power circuits terminate conductors using normal good practice. Where connection is made to bolted terminals use pressure crimp lugs. Terminations to light fittings, heaters, etc. in which temperatures in excess of 40oC will be experienced are to be made using heat resistant insulation of an approved type.

4.12.6 Termination/Junction Boxes

Junction boxes shall be of the waterproof polycarbonate type to IP56 protection. Terminals shall be of Klippon (polyamide) type, mounted on the base of the junction box. Boxes shall be sized so that 60mm clear space is provided between the box wall and the terminals.
All cable entries shall be bushed to provide a water and insect proof seal. All terminals and wires shall be number ferruled in accordance with the wire numbers given on the drawings.
All junction boxes shall be identified by code numbers which shall be reproduced on the as built drawing layout.

4.12.7 Cable Protection within Metal Trunking, Panels, etc.

All cabling that runs within metal framed walls, metal trunking, metal panels, etc. shall be protected from any sharp metal edges, metal sides and metal corners to the satisfaction of the Electrical Engineer. Where cable run within holes, proprietary or otherwise in the metal framing, trunking, panels, etc., ensure that suitable proprietary plastic/rubber grommets around there holes are provided to protect all cables against sharp edges.

Tender Issue

4.13 CABLE SUPPORT SYSTEMS

4.13.1 Detailed Scope of Works

Detailed Scope of Works for the Cable Support Systems shall include the following:

- Detailed design of cable support systems for new power cables as required.

4.13.2 General

The Subcontractor shall supply and install all items necessary to form a complete network of cable supports for the exclusive support of all electrical services cabling. The shared use of cable supports shall only be permitted with written permission from the Engineer. This shall include the following:

- Cable access ducts.
- Cable ladder / tray along all main cable routes.
- Conduit where no ceiling or wall linings exist.
- Multi-compartment cable trunking.
- Conduit buried in floor to all free standing furniture/fixture.

Prior to installation of cabling and cable support structures in all areas, co-ordinate with all other trades to confirm compatibility of proposed routes. Cable support structures shall be installed truly vertical or horizontal and parallel with the major axis of the building or walkways.

Cable support systems installed for the use of electrical 230V power cabling shall be installed a minimum of 300mm from cable support systems installed for the use of communications/fire/security cables unless installed within multi-compartment trunking.

Where cable support systems pass through fire rated partitions all holes shall be back filled with appropriate fire rated filler after the installation of all cables to reinstate the fire rating integrity of the partition.

Where cable support systems pass through external partitions all holes shall be back filled with appropriate water proofing compounds after the installation of all cables to provide a permanent watertight seal.

4.13.3 Cable Ladder

Provide and install cable ladder as required to support mains and sub main cables within the service tunnel with due regard to configuration and spacing of cables. Cable ladder and accessories shall be of the medium duty aluminium alloy, 6065 T5 of bolted or welded construction. Support system shall be galvanised with rust resistant fixings. All standard accessories including the support system shall be purpose made by the

Tender Issue

Manufacturer. Cable ladder shall be bonded to earth over its entire length and be installed to the Manufacturer's requirements and recommendations.

4.13.4 Cable Trays

Provide and install cable tray to support cables and major runs of sub circuit cabling (6 or more sub circuits) over their entire length.
All cable ladders and trays shall be provided with a capacity for 50% additional load, segregation between power and communications if installed on same tray to ensure spare capacity. Final sub circuits in plant rooms shall be surface mounted.

Provide and install cable trays above surface-mounted distribution boards and control panels to the ceiling space for all cabling by this Sub-contractor and associated specialist sub-contractors. All cable trays shall be hot dip galvanised finish or zinc/aluminium alloy coating finish throughout. All standard accessories, i.e. bends, joiners, covers, brackets, etc. shall be purpose made by the Manufacturer. Cable tray support systems, fixings and accessories shall be electro-galvanised.

Cable tray shall be supported to the Manufacturers recommendations and shall be bonded to earth over its entire length. All cabling and cable trays shall be fixed to the trays by proprietary nylon cable ties.

Provide a separate supply/install price list for the following cable tray and conduit sizes:

150, 300, 450 and 600 mm wide trays and 20 mm/25 mm PVC conduits c/w draw wires, boxes etc.

The required quantities will be determined by the nominated Structured Cabling Subcontractor.

Cable tray shall be colour coded as follows:

Electrical Services	:	Standard finish (Zincalume/Galvabond)
IT Services	:	Light green paint strips at 2m intervals

4.13.5 Conduit

4.13.5.1 General

All conduits shall be provided with a 50% additional capacity to ensure future load provision.

Cabling conduits shall be provided for the reticulation of cabling in all areas where cabling cannot be concealed within the building structure or as detailed on the drawings. Where more than three conduits follow the same route in all non-plant room type areas cable trunking shall be installed. Within plant room type areas cable tray shall be installed.

Tender Issue

All conduits shall be adequately sized (minimum 25mm diameter) so that any cable can be withdrawn and replaced at a later date. Provide draw-in boxes where necessary for this purpose at maximum 10m intervals. Conduits shall be made off into boxes, trunking, DB's etc. with locknuts, sockets and male brushes.

Where conduits are run near hot water pipes there must be at least a 150mm clearance from such pipes. In the case of cold water and other services at least 50mm clearance between the conduit and such pipes. Conduits shall be fixed to the building structure with the appropriate PVC or galvanised steel conduit saddles at intervals maximum 600mm. All fixing screws etc. shall be zinc plated.

Conduit runs shall be complete before any cables are pulled in. All elbows and tees shall be provided with inspection covers. Extra low voltage wiring shall not be run in the same conduit as other low voltage services. All exposed conduit shall be colour “Grey” unless detailed otherwise.

4.13.5.2 Rigid PVC Conduit

Plastic conduit shall be in accordance with the relevant standards and installed in accordance with the manufacturers recommendations. Use welded joints at all connections and use springs for making sets. Ensure that adequate provision is made for thermal expansion using the Manufacturers expansion joints. Threads on conduit shall not be exposed after screwing into fittings.

Rigid PVC conduit shall comply with the following:

- Be high impact
- Be heavy duty for underground or cast in installations
- Be light duty other than underground or cast in installations
- Be fixed with galvanised or PVC saddles at maximum 600mm spacing
- Comply with NZS 6207.

4.14 SWITCHES AND OUTLETS

4.14.1 Scope of Works

Detailed Scope of Works for switches and socket outlets shall include the supply and installation of new switches and socket outlets as shown on the drawings and as specified.

4.14.2 General

All 230V switches, outlets etc. and flush plates shall be of PDL 600 Series manufacture. Provide white vertical pattern unless stated otherwise.

Tender Issue

All surface mounted 230V and all 400V switches, outlets etc. shall be of the high impact polycarbonate type and where indicated shall be the waterproof - weather proof type to IP56. All shall be PDL 56 series manufacture.

Each general power circuit is to supply a maximum of 6 general purpose socket outlets. Allow for a maximum of 1.5 % voltage drop from the distribution board to any point on any sub circuit.

4.14.3 Light Switches

Light switches shall comply with NZS 2065 and shall be of 16amp inductive minimum rating. No switch shall have a current rating lower than the MCB or fuse rating of the circuit controlled.
Switches shall be securely mounted at a height of 1200 mm above floor level or as otherwise indicated on the drawings. In disabled toilets light switches shall be mounted at the same height as the door handles.

Switches shall be located on the locking side of doors or as otherwise indicated. Check door swing with the latest architectural drawings before mounting switches. Adjacent switches connected to different phases shall be housed in separate boxes or in partitioned boxes. Partitioned boxes shall have inner individual covers painted with the phase colour and overall flush plating covering all inner plates.

Drawings of multiple switch boxes shall be provided for approval before manufacture. Switches shall be ganged under a common flush plate where shown together on the drawings.

4.14.4 Switched Socket Outlets

Outlets shall be provided as detailed and generally be three flat pin types incorporating a switch of a minimum current rating of 10A and comply with NZS 1989. Outlets installed externally and in damp indoor and outdoor locations shall have a minimum degree of protection of IP56. Back to back installation shall be avoided.

Outlets shall generally be of the PDL 600 type, with white finish, high impact polycarbonate, and be installed horizontal, flush mounted as applicable, square and level. In rooms where intricate procedures are undertaken, the socket outlets shall be complete with neon indicators to indicate that power is ‘healthy’.

The Electrical Subcontractor shall allow in his tender to move power outlets and switches free of charge within a two metre radius from the specified position if requested by the Architect.

All socket outlets, light switches, push button stations and permanent connection units shall be sealed with Gibboard Acoustic sealant or equivalent.

- The switched socket outlet cover plates shall be white colour.

Provide and install IP65 protected switched socket outlet for external areas, and where specified.

Tender Issue

4.14.5 Fixed Equipment Outlets

Fixed Equipment and associated controls, unless detailed otherwise, will be supplied and fixed under other Trade sections.

Terminate fixed wiring as close as possible and convenient to each item in an outlet designed for permanent connection to the equipment.

Fit Isolator, for each item generally flush mounted in standard flush plate, mounted adjacent.

For general items installed above bench, connect from combination isolator / flexible cord outlet unit, with TPS circular flexible cord final connection.

For Equipment installed below bench, connect from isolator mounted above bench with cables concealed in wall or in conduit to an outlet box mounted below bench and thence to equipment with flexible cable.

Include neon indicator with isolator for any "Zip" water heater.

Connect to heated appliances, such as stove, washer etc. with high temperature grade flexible cables enclosed in flexible metal conduit from outlet junction box or surface mounted isolator adjacent to appliance terminals.

4.14.6 Flush Boxes

Flush boxes shall be provided for all light switches, socket outlets and isolators. Flush boxes shall be screw fixed to studs or noggins. Nail fixing is not acceptable.

Where boxes have to be cast into concrete they shall be double depth galvanised and shall be secured to the conduits with double lock nuts. Flush boxes shall be securely fixed to the reinforcing and to the boxing, boxes shall be truly vertical. Conduits shall be plugged and switch boxes completely sealed to prevent the ingress of concrete. Conduits shall be a minimum of 25mm diameter.

4.15 LIGHTING

4.15.1 Scope of Works

Detailed Scope of Works for Lighting shall include supply, installation and wiring of all lighting fittings as specified on the drawings.

4.15.2 General

The design of all lighting systems should consider the patterns of available natural light. Automatic daylight compensation and time clock switching should be considered for inclusion subject to cost constraints. General office lighting should be achieved using

Tender Issue

high efficiency LED fixtures. Lighting control within separate rooms (i.e. offices) will be controlled by localized switching in each room. External lighting will be controlled by PE cell, however, a manual override switching thru contactors shall be provided in the panel board where circuit is connected. Emergency and exit lighting shall be computer monitored and shall be linked to the existing monitoring system.

Install and connect all luminaires, using the proposed type listed lighting fixture schedule. All luminaires shall be re-confirm regarding its types, position and mounting height and be coordinated by the Architect before ordering any fixtures, fittings & accessories.

All fittings are to be supplied complete with lamps and if required with drivers before delivering it to the site. These shall be properly place inside cartons with protection means keeping it safe in storing before installation are to be done. Fittings with defective finishes shall be returned to the supplier and replaced with new one.

All enclosed fittings are to be insect and dust tight. Where fittings are to be installed recessed to its location, openings shall be correctly sized.
Fittings erected in rows shall be geometrically straight and at the same level except if otherwise different elevation is needed. Fittings specified to be chain mounted shall be supported at each end with special chrome fixing hooks at mounting level. Chain shall be brass or corrosion resistant type material, chrome plated.

Screws, nuts, etc. used for all luminaires shall be stainless steel. All ceiling mounted luminaires shall be fixed/mounted as per NZS 4219: 1983.

4.15.3 LED lighting fixtures and Fittings

All LED lighting fixtures shall be of high energy efficient type suitable for 240 volts, single phase, and 50 Hz supply. The housing shall be manufactured from best quality material. All control gear, wiring and accessories shall be housed completely inside the metal housing before delivery. The entire housing and accessories shall be a corrosion proof material.

Internal cable shall comply with BS 6231 450/750V heat resistant rubber insulated cable, suitable for conductors operating temperature not exceeding 105℃.

4.15.4 Lamps

All lamps shall be of Phillips brand or approved equal.
For types and specification please refer to the final selected lighting fixture schedules to be provided by the design electrical engineer.

4.15.5 Emergency / Exit Luminaires

Supply and install emergency and / or exit luminaires as shown on the drawings. All luminaires shall comply with AS/NZS 2293: 1995.

Tender Issue

All luminaires shall be supplied by Philips or other approved manufacturer. All luminaires shall be 'Self Contained', i.e. they shall incorporate a fully sealed rechargeable battery, low voltage battery cut-off circuit and a mains sensing circuit. The luminaire shall automatically and immediately switch to the emergency mode after mains failure. The luminaire shall fully illuminate within 1 second of mains failure.

The operating time of all luminaires after mains power failure shall be 2 hours minimum. All batteries shall be fully recharged after 16 hours and recharged to not less than 80% after 14 hours upon power restoration.

Each emergency/exit light shall be tested that when normal lightings is out these shall turn on automatically. A discharge test facility/switch shall be provided at the Distribution Board (Labelled as “Emergency Lighting Test Switch” and should clearly display a warning that” Interrupting the power supply will discharge emergency lighting batteries”). Installation of the discharge test facility shall comply with NZS/AS 2293.
All luminaires shall incorporate a test switch to simulate mains failure and a red LED indication to ensure that the battery charger is operating correctly. Emergency luminaires shall be wired via a test timer circuit.

Exit luminaires shall be 'Maintained' type, i.e. the emergency lamp shall be illuminated whether mains power is available or not. A master switch shall be provided for all exit luminaires to enable the luminaires to be switched off 'after hours'. All luminaires are to be labelled with screw fixed engraved red/white laminate labels designating circuit number and lamp voltage.

4.16 FIRE RATING

Approved fire and smoke stopping materials shall be used in compliance with and where required by the Kiribati Building Code and NZBC. Co-ordinate with the Engineer cables pass through fire cells.

Use approved fire stopping for all flush mounted outlets, such as flush mounted light switches and socket outlets, installed in hollow fire separation cavities.

Cabling and ladders / tray passing through fire resistance rated walls, floors and services shafts shall be fire stopped. Refer to the Fire Protection and Architectural Drawings as a guide to where fire cells, smoke stops and fire stopping shall generally be provided.

4.17 LABELLING AND PAINTING

Label all equipment listed below. The lettering shall be upper case, black, except for danger and warning labels, where it shall be red. The background of all labels shall be white. The labels shall be permanently fixed with no fewer than two rustproof, dust-tight fixings and positioned generally above the equipment which they identify. Preferred method is screw fixing.

Provide labels for switchboards, cables, distribution boards, circuit breakers, fuses, switchgear, isolation switches, relays, contactors, connection boxes, control equipment,

Tender Issue

lighting poles, etc. Provide circuit reference labels for all socket outlets, switches and emergency lights. Circuit reference labels shall be designated typically as follows:

For circuit R1 from DB A the label shall read "A-R1".

Labels fixed to mounting blocks or switch plates will not be accepted.

Unless specified otherwise, label lettering heights shall be as follows:

Letter Height	-	Equipment
10 mm	-	warning labels Switchboard/distribution board/power factor unit designation Fuse switch designations ACB designations
5 mm	-	all equipment contained within or mounted on each distribution board/power factor unit, i.e. contactors, relays, isolator, selector switches, fuses and MCB circuit numbers, lighting poles, etc.
3 mm	-	circuit references for all switches, outlets, etc. at each device.

The use of engraved purpose made Manufacturer's legend plates for isolators, selector switches, etc. may be submitted for approval by the Engineer.

Provide on the masking panel adjacent the respective system supply MCB, the following warning labels, "FIRE ALARM SYSTEM", "ESCAPE LIGHTING", "SECURITY SYSTEM" and "BATTERY CHARGER" etc. Letter height shall be 5 mm.

4.18 GENERATOR

4.18.1 General

The generator shall be standby rated, Marine Grade Weatherproof Container type, static regulated, brushless excited complying with IEC 34. This generator shall be provided with bulk fuel tank bunded type, rated for 8 hours of fuel supply at 100% load complete with all accessories and warning alarm functions. The generator specification shall include a maintenance contract for 5-years included as part of the tender package.
Only quality branded generator plant (FG Wilson, Cummins, Perkins or Caterpillar - 50 HZ out of UK, Australia or NZ) or approved equivalent shall be specified and no generic substitutions is permitted.

Generator shall have the following characteristics:

Tender Issue

1. Be suitable for a 3-phase, 4 wire, wye connected, solidly-earthed-neutral system.
2. The generator shall be adequately rated to start up and continuously run all connected loads at the main switchboard.
3. Output voltage:
   415V AC, phase-phase
   40V AC, phase-neutral
4. Rated speed 1500 rpm, frequency 50 Hz.
5. Be capable of engine overloads of 10% of rated standby (continuous) output for one (1) hour during any period of consecutive 12 hours running.
6. Sustain 3 x generator full load current for 3 seconds if a symmetrical short circuit occurs at the generator terminals.
7. The generator shall be capable of limiting its terminal voltage drop to less than 10% during a simultaneous load application.
8. All winding insulation shall be epoxy resin impregnated to a minimum of Class H Standard as defined in IEC 85.
9. Voltage regulation shall be automatic and shall be capable of maintaining the terminal voltage to within ± 2.0% of rated voltage for all loads from no-load to rated load at rated power factor and maintain a steady state voltage variation of not greater than ± 1% of rated voltage.

10. The generator enclosure shall be containerised type with sound attenuators and acoustic treatment of 70dBA in all directions measured at 7 meters from the external face of the genset at maximum loading. The generator should be assembled and type tested as a unit in manufacturers works in self-contained weatherproof marine grade acoustic enclosures.

11. All metallic surface and parts exposed to weather either with closed door or in an open position shall be given suitable paint finish appropriate for coastal environment. The generator set shall be further treated with marine grade paint suitable for coastal environment.

12. The output voltage shall be finely adjustable over the range from 95% to 105% of the nominal voltage. The adjustment shall be located on the generator control and instrumentation panel and shall be clearly labelled to show increase or decrease in voltage. The regulator shall, for a 100% load application, be capable of limiting the recovery time to less than 1.0 second. It shall also be capable of limiting the transient voltage rise to less than 15% when rated kVA at 0.8 pf is rejected.

13. The generator shaft shall be direct coupled to the crankshaft of the engine via a coupling, adequately rated to sustain all radial, axial and torsional thrusts transmitted between generator and engine during normal, overload and short circuit operating conditions.

Tender Issue

14. The generator power plant shall be supplied, installed and supported by a specialist generator supplier with appropriate electrical and mechanical trades persons in house to provide post installation and support.

4.18.2 CONTROL FUNCTIONS

The Contractor shall supply all control functions for the unit unless specifically noted herein that they are provided by others.

The generator changeover contactor control panel 3 Pole/ 4 Pole as per ASNZ 3000 which shall be installed as a free standing panel separate to the MSB, within a weather proof enclosure, and will provide the following functions:

4.18.2.1 Automatic Starting

A signal will be provided via the closing of clean contacts off a mains failure sensing relay within the Main Switchboard to initiate the automatic starting of the set. Once the set has run up to speed, and stabilised ("Ready to Load") it shall close a set of clean contacts to be used to automatically switch onto the load via the changeover contactor control panel. The changeover contactors will be suitably sized to cater for the full load as applied on the MSB. The changeover contactor shall be located adjacent to the remote control panel.

When the mains supply voltage suitably recovers, the clean contacts of the mains failure relay will open indicating the commencement of the automatic stopping sequence of the set as described below.

The automatic starting circuit shall be arranged to provide up to three consecutive attempts to start, each of approximately 10 seconds duration with a similar off period.

Should the set fail to start on the third attempt, the automatic starting circuit shall be locked out until restored manually at the control panel. A "Failed to Start" signal shall be provided for the building alarm system, sounding an alarm and indication signal on the control instrumentation panel mounted within the MSB room, via a set of clean contacts. This signal will be used to automatically revert back to the mains supply upon its restoration should the generator remain out of service.
If the generator cannot start the power within a period of 1-2 minutes; the simulator equipment will have to shut down and the sounder installed outside the simulator building shall activate automatically. Supply and installation of control wires for this function is part of the electrical subcontractor's contract.

4.18.2.2 Automatic Stopping

An adjustable timer shall, on restoration of mains supply, provide for a delay of up to maximum one (1) hour before closing a clean set of contacts to automatically switch back to the mains. However, timer can be set to a most desirable setting as needed where the normal supply attains its steady state and the power supply already stable.

Tender Issue

A separate adjustable timer shall be provided to stop specific loads 60 seconds prior to switching back to the mains. The signal shall reset automatically upon completion of the switch over.

A further minimum 10 minute "run on" cooling period shall be allowed after the load has been switched to the normal supply mains before the genset is automatically shut down.

Should a further loss of the 415V supply observed during the "run on" period; the set shall be capable of immediately switching-On to the load.

4.18.2.3 Restarting

After the set has been shut down and stopped, it shall be ready for immediate use at full load.

4.18.2.4 Control Switch

A manual rotary switch shall be supplied and fitted to the Generator control panel, to provide the following functions. It shall also be fitted with a complete set of auxiliary contacts wired out to the terminals in the control instrumentation panel, mounted within the MSB room, to permit the switch position to be continuously monitored.

OFF: When in the "OFF" position the generator shall be prevented from starting under all circumstances.

MANUAL: When switched to the "Manual" position the generator can be started manually and the load may be manually transferred to/from the generator via the automatic changeover panel.

AUTOMATIC: When switched to the "Automatic" position the controls synchronised via the automatic changeover contactors, in the changeover panel, shall be permitted to transfer the load from the mains to the generator upon receipt of the appropriate signal that the power supply has been disconnected.

TEST NO-CHANGEOVER: When switched to this position with a healthy mains supply maintained, the start-up sequence shall be automatically initiated but without the transfer of the load to the generator. However, should there be a mains failure whilst the switch is in this position the load shall be permitted to automatically changeover to the generator.

TEST WITH CHANGEOVER: With the switch in this position the generator start-up sequence shall be automatically initiated and the load shall switch from the mains to the generator.

Tender Issue

Confirm the automatic changeover PLC logic controls to be provided within the changeover control panel, and provide any additional controls as necessary to provide safe and reliable operation.

4.18.3 REMOTE CONTROL AND INSTRUMENTATION PANEL

The cubicles shall be front access and shall be mounted adjacent to the changeover contactor panel in the MSB room. All instrumentation and manual controls shall be clearly visible from the front of the panel.

The panel shall also have a remote monitoring facility via a modem connection.

The panel shall accommodate all equipment required to effect automatic, manual and test modes of control of the generator set along with all controls, indications and alarms including a single lamp test pushbutton.

Ammeters shall be combined maximum demand and instantaneous in all three phases, over scaled by 100% and be capable of withstanding overloads of 40% rated current for 1 second.

Equipment shall be suitable for intermittent use be of the highest quality to afford maximum reliability of operation and be adequately rated for their intended duty.

Equipment of similar functions shall be of the same Manufacturer throughout.

All spare contacts shall be wired back to terminals.

Instruments shall be 96 mm sq. and have their power and sensing supplies individually sub-fused. All fuses shall be of the high rupturing capacity (HRC) cartridge type in all three phases.

The following visual alarms and indications shall be provided on the front of the panel as a minimum. Additional alarms may be provided should the Vendor feel it is necessary for the safe and proper operation of their generator set.

- Ammeters (instantaneous and maximum demand)
- Voltmeter (phase-phase and phase to neutral)
- Frequency meter
- Hour run meter
- Jacket water temperature
- Ready to load
- Off load run on
- Failed to start
- Low oil pressure
- High engine temperature
- Engine over speed
- Battery charger fail
- Battery low volts

Tender Issue

- Generator available
- Alarm acknowledge and cancel pushbuttons
- Audible alarm common to all alarms.

A spare set of contacts (1 N.O. & 1 N.C.), shall be wired out to terminals for remote monitoring by the BMS system (as required) of each alarm and indication facilities list provided.

- Off load run on
- Failed to start
- Generator available
- Generator on load
- Fault (common fault alarm)

Any fault condition shall operate an audible alarm on the exterior of the MSB room.

Operation of an "acknowledge" pushbutton shall be used to mute the audible alarm only. Indication of the alarm condition may only be removed once the alarm condition has been corrected followed by the operation of a "cancel" pushbutton.

4.18.4 GENERATOR CONTROL PANEL

These panels shall be front access and shall house the generator supply circuit breaker, current transformers, and earth and neutral bars. Current transformers shall be readily removable by means of accessible bolted links and shall comply with BS 3938 Class 1 for indicating instruments.

Provide facilities to terminate the mains cabling specified on the drawings including studs or flags of copper bus sized to accommodate the appropriate crimped lugs.

4.18.5 GENERATOR SUPPLY CIRCUIT BREAKERS

4.18.5.1 General

The circuit breaker can be a fixed or auto type moulded case breaker 3-Pole suitable for generator protection, complying with IEC 947-2, utilisation category B, with a short circuit performance sequence of o-t-co-t-co.

The breaker shall be rated for short-time withstand current and short circuit making/breaking capacity to suit the respective generator. The continuous current rating shall not be less than maximum output of the generator.

Visual indication shall be provided for "OPEN", "CLOSED" and "TRIPPED" positions.

Provide facilities to terminate cables as shown on the drawings including studs or flags of bus bar sized to accommodate the appropriate crimped lugs.

4.18.5.2 Protection

Tender Issue

Discrimination shall be provided between this breaker the Main Switchboard circuit breakers, sub-distribution fuses and the changeover contactors. THIS IS IMPORTANT. Tenderers shall identify in their offers any circuits where clear discrimination is not achievable.

Protection, to be provided as an integral part of the circuit breaker, shall be solid state and include the following:

1. Adjustable long time.
2. Adjustable long time delay.
3. Adjustable short time.
4. Adjustable short time delay.
5. Adjustable instantaneous overcurrent.

Visual indication shall be provided for each of the above protection provisions to indicate a tripped condition. Provide any necessary auxiliary DC supplies to maintain this indication for a minimum duration of 12 hours.

Full technical details of proposed protection shall be included with the Tender.
Discrimination curves shall be supplied to the Engineer when the Generator drawings are submitted for review.

4.18.6 PANEL CONSTRUCTION

For externally located switchboards, they must be IP66 rated marine grade Stainless Steel, rust proof marine grade, of the sufficient thickness to prevent buckling and finished to the Manufacturer's Standards. The externally located switchboard shall have a minimum IP54 protection when the main door is opened or the screw fixed panel is removed or equivalent.

All switchboards located inside a room/building shall be IP56 rated minimum 16-gauge zinc anneal primer coated and electrostatically painted

All necessary ventilation shall be provided.

Panels shall be suitable for top entry and be adequately sized to permit gladding off and terminations of all cabling.

All terminations shall be capable of being made without disconnecting other items. A non-ferrous removable gland plate shall be provided.

All metalwork shall be bonded to an internal earth bar. Starred washers shall be used to provide continuity between adjacent surfaces.

Hinged metal doors with equipment mounted on them shall be separately bonded. Reliance on the door hinge for this purpose is not acceptable.

Panel doors shall be secured in the closed position with key lockable handle(s). Common keys and locks shall be used. Provide four spare keys.

Tender Issue

4.18.7 BATTERY AND CHARGER

A 24V battery/charger system shall be provided as an integral part of the skid mounted equipment. It shall be complete with all interconnecting cabling, for the purpose of diesel generator starting. It shall be of sufficient capacity to service the engine cranking system provided and be capable of at least the following:

- Three separate automatic starting attempts, each of not less than 10 seconds duration at intervals of not more than 10 seconds, plus,
- Further manual start attempts totalling 15 seconds.

The battery charger shall be located within the control and instrumentation panel, the fascia of which shall house the battery voltmeter, charge/discharge ammeter, and indication for charger fail, and battery low volts. Sealed lead acid storage batteries are preferred.

A battery separate from the starting battery shall be provided for control and instrumentation functions.

4.18.8 TERMINALS

These shall be manufactured from self-extinguishing materials, be rail mounted and of the self-locking screwed pressure plate type. Metal parts shall be not less than 85% copper and be nickel plated to prevent corrosion. They shall be adequately sized to take the conductor(s) which they connect and shall have a current rating of not less than 20A with the smallest terminals being capable of taking stranded conductors up to 2.5 mm2 CSA. The maximum number of cores to be terminated on each side of a terminal shall be one. If necessary, provide additional terminals to meet this requirement with looping between being done via proprietary internal jumper bars.

Earth terminals shall be green or green/yellow. Other terminals shall not be the same colour as earth terminals. Strip connectors shall not be used.

"Shorting" terminals are required for all current transformer wiring.

All terminals shall be of the same Manufacturer throughout and be labelled using the terminal Manufacturer's proprietary labelling system. Terminal numbers shall match those shown on the As-Built drawings.

4.18.9 SPARES AND TOOLS

Provide with the Tender a priced list of recommended tools and spares required for a one (1) year period. The Tender price shall EXCLUDE the supply of spares. Spares pricing shall be fixed for a period of two (2) years from Tender Closing Date.

Tender Issue

Tender Issue

5 DOCUMENTATION AND DRAWINGS

Documentation and drawings shall be provided for as follows: -

5.1 GENERAL

Drawings and documents for approval by the client's representative and the local authority, shall be provided for at the stages as indicated and work shall not proceed with the next stage until the drawings, documents and samples have been approved and the various actions have been taken as required.

5.2 TENDER STAGE

Submit at the time of tender the completed price, rate prices and deviations schedules, draft quality control plan as well as a tender letter with any deviations.

5.3 TENDER AWARD STAGE

Within three weeks of tender award, issue the following documents: -

Issue building consent documentation to the local authority.

Issue 5 sets of paper copies of the shop drawings detailing the extent of the installation.

The shop drawings shall be drawn with AutoCAD ver. 2006 minimum or later versions to a 1:100 scale in general and 1:50 scale for plant and equipment layouts.

The shop drawings shall contain all the technical information, all air flow rates and equipment model numbers shall be shown on the drawings. It is preferable that technical information is shown on drawings rather than in the owner's manuals.

5.4 CONSTRUCTION STAGE

The Q/A plan shall be updated and signed off as and when required.

5.5 HAND OVER STAGE

5.5.1 As-Built Drawings, Operations Maintenance Manuals

Provide 3 sets of Maintenance Manuals bound and indexed in Black A4 ring binders labelled with the project name and purpose on the front cover and spine.

Issue 3 sets of 1:100 paper copies and a CD with the electronic version of the as built drawings.

The as built drawings shall show the actual commissioned flow rates and equipment details and capacities.

Tender Issue

A draft of the As Built documents shall be provided to the Engineer four weeks prior to Practical Completion for approval. Provision and acceptance of final as-built, commissioning, and maintenance documentation shall be a prerequisite for Practical Completion.

`As Built' drawings, to the approval of the Engineer shall be provided for the Contract Work. These shall be in similar detail to the installation drawings, but shall also include any amendments and any additional detail necessary to show the functioning or installation, or particular items of plant.

The approval of any drawings by the Engineer in no way affects the Electrical Services Subcontractor's responsibility for the satisfactory completion of the Contract.

Acceptance of these drawings shall be required as a pre-requisite for Contract Completion.

All costs incurred for correction or alteration work due to failure of the Subcontractor to seek approval, or error in late submission of information supplied by the Subcontractor shall be to the Subcontractor's account.

5.6 MAINTENANCE (DEFECTS LIABILITY PERIOD)

5.6.1 GENERAL

Maintain the work for a period terminating 12 months from the date of Practical Completion of the whole of the Contract Works, replacing or repairing any faulty equipment or materials, or the results of incompetent workmanship, free of charge.

5.6.2 SCOPE OF WORKS

a) Routine maintenance and servicing is to be carried out on a monthly basis for a period of 12 months from the date of Practical Completion to the end of the Maintenance and Defects Liability Period without cost to the Owner.

b) Monthly maintenance and servicing in accordance with maintenance schedules recommended by equipment manufacturers.

c) Maintenance, testing and inspections in accordance with regulatory requirements and relevant New Zealand standards.

d) Rectification of defects at Providers cost.

e) Replacement of consumables at Providers cost.

f) Provision and filling out logbook which must on site detailing all visits.

g) Service personnel to be available for call out on a 24-hour per day, 7-day per week basis. Response time for emergency and corrective maintenance must not exceed 2 hours.

Tender Issue

5.7 SCHEDULE OF MAINTENANCE CONTRACT

The contractor shall provide a price to carry out preventative maintenance of all systems installed on the expiry of the Defects & Liability Period. A brief summary of the minimum maintenance scope follows;

5.7.1 GENERAL

a. The provision of skilled personnel fully conversant with the plant and equipment and competent to attend the same shall be included.

b. Attendance upon the plant and equipment for the purpose of routine cleaning and inspection at specified intervals shall be included.

c. All periodic maintenance services requiring system shutdown shall only be carried out after the normal operating hours and with authorization from the Employer's representative. The frequency of maintenance shall be as per Schedule of Maintenance Works of this Specification.

d. All replacement of parts and components shall be included in the comprehensive Maintenance Contract.

5.7.2 ELECTRICAL SYSTEM CHECKS AND TESTS

i) Check safe operation and tripping of all ELCB's

ii) Check safe operation of all exit and emergency light fitting upon failure of mains power supply

iii) Carry out thermo scanning of the main switch board and distribution boards together with the main cabling every 3 months and provide results to client and the consulting engineer.

iv) Check fuel and oil level in the standby generator

v) Test for automatic changeover of the standby generator in conjunction with the client.

vi) Test for safe operation and maintain the lighting control system in accordance with the lighting supplier's maintenance schedule.

vii) Test for safe operation and maintain the UPS system in accordance with the manufactures maintenance schedule.

Tender Issue

6 SCHEDULE OF RATES

The Tender shall include price breakdowns for each of the items listed in the Scope of Works above, plus additional items as necessary.

The Tender shall include a schedule of rates for common items such as cables, lighting fittings, fire distribution boards etc. The tender shall specify rates for labour. These rates shall be used to assess variation claims.

The tenderer shall complete the pages of the section and forward a completed copy to the client's representative together with their tender letter.

6.1 TENDER PRICE

…… (Tenderer's company name)

…… (Street address)

…….…….. (City)

……..…….. (Tel.)

…..……..…… (Fax.)

...……...…… (Email)

We, as per above, tender for the installation as per this specification inclusive of the provisional sums above for the total sum of

$……..….. (VIP)and in words

……Dollars

Responsible person's first and last names

……

Signature……

Tender Issue

7 RATE PRICES, MARGINS AND SUBCONTRACTORS

The rate prices below are for the purpose of calculating variation to the contract in addition to the work in this specification: The prices shown and the percentages shall include all the margins, P & G's as a selling price to the client and shall also be applicable to all Subcontractors.

Hourly charges:-

Installation technician weekdays	…… $/hour excl VAT normal time from 7h00 to 17h00
Commissioning weekdays	…… $/hour excl VAT normal time from 7h00 to 17h00
Electrician weekdays	…… $/hour excl VAT normal time from 7h00 to 17h00
Engineer weekdays	…… $/hour excl VAT normal time from 7h00 to 17h00
Overtime	…… % additional to normal time.
Travelling charges	…… $/per round trip excl VAT to site

7.1.1 Margins' percentages

The margins below are for the purpose of calculating variations to this contract in addition to the work in this specification: The prices shown and the percentages shall include all the margins, P & G's as a selling price to the client and shall also be applicable to sub-contractors.

Margin on bought out equipment and materials …… % on invoice value excl VAT.

7.1.2 Subcontractors

No work shall be performed by staff other than the tenderer's own staff except as nominated below – written permission shall be obtained from the client's representative prior to using any other sub-contractors than nominated below.

The tenderer shall complete the following table and name either their own company staff or a sub contracted company they intend to use for any work not performed by their own staff:

Sub contractor's company name	Work description
……..	…….
……..	…….
……..	…….

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7.2 DEVIATIONS AND ALTERNATIVES

The tenderer shall complete this page and forward a completed copy to the client's representative together with his/her tender letter.

Tenderers are welcome to offer valid savings with alternative equipment satisfying the same standard to those scheduled, subject to approval by the client's representative.

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8 TENDER PRICE BREAKDOWN:

8.1 MFMR AUKI – MALAITA PROVINCE, SOLOMON ISLAND- PRICE SUMMARY

Item No.	Description	Price ($)
1.	Liaison with Local Electricity Authority and client before commencing work for Utility metering and connection to the Main switchboards as indicated on the drawings.	$
2.	Supply & installation of mains cabling from the Existing Infrastructure connection point to the development as indicated on the drawings	
3.	Supply and installation of New MSB with metering, Bus Bars, MCCB's, MCB's, TVSS, Contactor, phase failure relay, 3 Phase Fuse & indicators, PFC as indicated in the Single Line diagram and all related drawings. Main MCCB's and shall be provided with shunt trip release for remote emergency controlling and monitoring. Sufficient dry auxiliary contacts shall be provided for these functions. No generic substitute is permitted.	$
4.	Supply and installation of Power Factor Correction (PFC). This shall have filter, setting stages and automatic discharged switch for safe handling during maintenance.	$
5.	Supply & Installation of new canopy type standby diesel generator, 415/240V, 3Ph, 4W, 50Hz with self bunding fuel day-tank with all accessories, warning alarm functions & remote monitoring functions. The generator control panel shall have a inputs/ outputs necessary for interfacing with BMS for remote monitoring. All necessary hardware and soft ware shall be supplied together with the generator to enable interface with the BMS system. The generator shall also have battery charger and starting batteries for this new generator	$
6.	Supply & installation of submains cabling from the Genset to MSB/ATS as indicated in the drawings	$
7.	Supply of fuel, for site testing purposes for the generator and commissioning (full tank of the genset)	$
8.	Supply & Installation of 2062L self-bunded fire rated genset backup diesel fuel storage tank complete with external visual guage, automatic refueling pump & remote monitoring system with accessories and refueling pipe work from fuel tank to refueling point. The refueling piping shall be installed in trench with appropriate protection and caustion slabs as per AS/NZ Standard.	$
9.	Supply & installation of UPS, UPS Battery Bank, UPS Static Switch, Service By-pass Panel, Isolator Panel and others as indicated on the drawings.	$
10.	Supply and installation of all Distribution boards complete with outgoing branches MCCB's, ELCB'S and MCB's as indicated on the drawings. All Distribution boards shall have a 25% spare pole capacity.	$

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11.	Supply & Installation of Submains Cabling from the MSB to each distribution boards as Indicated on the Drawings.	
12.	Supply & Installation of all Isolators, Switches and GPO's as indicated in the drawing. These shall be only as per consultant approved specifications.	$
13.	Supply and installation of all sub-circuit cabling.	$
14.	Supply & Installation of all cable trunking / trays / conduits, cable pits, etc. for all electrical services equipment	$
15.	Supply and installation of MV/ LV grounding system as indicated in the drawings.	$
16.	Application of Fire sealant on penetration made on fire wall pertaining to Electrical service.	$
17.	Making good any surfaces affected during the electrical construction works.	
18.	Warranty information of the various plants/ equipment/ fixtures (DB's, GPO's Lighting Fixtures, mains and submains etc.)	$
19.	Testing and commissioning of the completed installation. • Local Regulator Compliance Certificate • Local Utility Compliance Certificate • Mains & Submains Meggar Insulation Test Results • QA and Operational Test Results; room by room analysis (lighting, power outlets, switches, MSB, DB) • Genset, MSB, Distribution Board, Equipment Commissioning Test Result • Equipment FAT results (Generator, MSB etc.) • Thermographic Scan Test Results for all DB's, MSB, connections etc. • MSB Earth Test Result • Provide Test results for the Lightening Protection System. • Letter of Practical Completion • Client Training Certificate • Warranty Letter for all materials installed, workmanship	$
20.	Instruction/training to Principal's representatives on the Operation and Maintenance of all systems. Provision of client Training Certificates	$
21.	Provision of Shop Drawings. These shall be approved first by the consultant before commencing any fabrication and installation works.	$
22.	Submittal of As-Built & Operations & Maintenance Manuals. The O&M shall include the below information as a minimum. • Warranty information of the various plants/ equipment/ fixtures (MSB's, Gensets, GPO's Lighting Fixtures, mains and submains etc.)	$

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	• Maintenance Schedules and Procedures of the various plants/ equipment/ fixtures (MSB's, Gensets, GPO's Lighting Fixtures, mains and submains etc.) • Specification/ technical datasheet of all materials and equipment installed. • Equipment Schedule with Supplier contact details • MSB/Genset Changeover Process • Provision of Technical Specifications of the various plants/ equipment/ fixtures (MSB's, Gensets, GPO's Lighting Fixtures, mains and submains etc.)	
23.	Provide Poly logger reading for 48 hours after all installation has been complete. (allow for load balancing as maybe required)	$
24.	Contractor to allow for Thermo scanning of the new MSB at the 6th and 12th month from the date of practical completion and commissioning	$
25.	Contractor to allow for 12months of defects & liability period works.	$
26.	Approval from Utility prior to commencing work and after the installation is completed is required and shall be submitted to the consultant.	$
27.	Any other items required, please specify details.	$
	Sub-Total (VEP)	$
	Value Added Tax (Add VAT)	$
	Total Electrical Services (VIP)	**$**

Total Fixed Lump Sum Price. . . . . $_____

Amount in words: _____

_____ Dollars

The prices to be set out in this schedule are to provide a breakdown of the tender sum and shall be inclusive of all incidentals in accordance with the specifications. This is a comprehensive supply and

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installation contract and the tenderer shall take all responsibility for all items required to complete the Contract Works in accordance with the Contract Documents

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9 SCHEDULE OF UNIT RATES - ELECTRICAL

Item No.	Description	Unit	Unit Cost
1	Distribution Board, flush mounting, IP54 by PDL	Set	$
	1250A 3P ACB	Ea.	$
	800A 3P MCCB	Ea.	$
	630A 3P MCCB	Ea.	$
	500A 3P MCCB	Ea.	$
	400A 3P MCCB	Ea.	$
	250A 3P MCCB	Ea.	$
	200A 3P MCCB	Ea.	$
	160A 3P MCCB	Ea.	$
	100A 3P MCCB	Ea.	$
	125A 3P MCCB	Ea.	$
	80A 3P MCCB	Ea.	$
	63A 3P MCCB	Ea.	$
	32A 3P MCCB	Ea.	$
	16A 1P MCB/RCD	Ea.	$
	16A 2P MCB/RCD	Ea.	$
	20A 1P MCB/RCD	Ea.	$
	20A 2P MCB/RCD	Ea.	$
	32A 2P MCB/RCD	Ea.	$
	50A 3P MCB/RCD	Ea.	$
	Other MCCB/MCB rating	Ea	$
2	WIRING DEVICES:		
	1-gang switch, 1-way, 10A	Ea.	$
	2-gang switch, 1-way, 10A	Ea.	$
	6-gang switch, 1-way, 10A	Ea.	$
	Two way switch, 10A	Ea.	$
	Single GPO, 10A	Ea.	$
	Double GPO, 10A	Ea.	$
	Single Socket Outlet 15A, 1P	Ea.	$
	Single Socket Outlet 32A, 1P	Ea.	$
	Other GPO's with RCD protection	Ea	$
3	CABLES:		
	1x1Cx300mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx240mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx185mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx150mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx120mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx95mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx70mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx50mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx35mm² CU XLPE/PVC SHEATHED CABLE	Meter	$

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	1x1Cx25mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx16mm² CU XLPE/PVC SHEATHED CABLE	Meter	$
	1x1Cx120mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx95mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx70mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx50mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx35mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx25mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx16mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx10mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x1Cx6mm² CU PVC/PVC INSULATED EARTH CABLE, GREEN/YELLOW	Meter	$
	1x4Cx4mm² CU MICA/GLASS FIRE RESISTANT TAPE/COVERED BY FIRE RESISTANT SILICONE RUBBER, LSZH + E	Meter	$
	1x4Cx2.5mm² CU MICA/GLASS FIRE RESISTANT TAPE/COVERED BY FIRE RESISTATNT SILICONE RUBBER, LSZH + E	Meter	$
	1x2Cx4mm² CU MICA/GLASS FIRE RESISTANT TAPE/COVERED BY FIRE RESISTATNT SILICONE RUBBER, LSZH + E	Meter	$
	1x2Cx2.5mm² CU MICA/GLASS FIRE RESISTANT TAPE/COVERED BY FIRE RESISTATNT SILICONE RUBBER, LSZH + E	Meter	$
	1x4Cx95mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	1x4Cx70mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	1x4Cx50mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	1x4Cx35mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	1x4Cx25mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	1x4Cx16mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	1x4Cx10mm² CU PVC/PVC SHEATHED CONDUCTOR + E	Meter	$
	2c+E, 6mm sq. PVC/PVC	Meter	$
	2c+E, 10mm sq. PVC/PVC	Meter	$
	2c+E, 16mm sq. PVC/PVC	Meter	$
	2c+E, 25mm sq. PVC/PVC	Meter	$
	Other cable size required	Meter	$
4	RACEWAYS:		
	Flex PVC conduit 20mm	Meter	$
	Flex PVC conduit 32mm	Meter	$
	Cable Tray 200mm wide, hot dipped galv.	Length	$
	Cable Tray 300mm wide, hot dipped galv.	Length	$
	Cable Tray 600mm wide, hot dipped galv.	Length	$
	Cable Tray 800mm wide, hot dipped galv.	Length	$

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	PVC mounting block	Ea.	$
5	Earthing:		
	Bare copper wire (BCW) 120mm sq.	Meter	$
	Copper Rod 20mm dia. X 1500mm(L)	Each	$
	Rod Clamp 20mm	Each	$
	Earth Bar 50x6x300mm	Each	$
	Concrete Pit with Wording (Earth Pit)	Each	$

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