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Revision	Description of Change	Date	Revised By
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0.3	Added Data Collection forms	28-Nov-11	Stephen Arthur
0.4	Ergon third amendment capturing feedbacks	04-Apr-12	Phong Le

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1. INTRODUCTION

1.1 USING THIS WORKS SPECIFICATION

- 1.1.1 This Works Specification (referred to as “this Specification”) contains or references the Design and/or Construction requirements that apply to the Contractor performing the Works, and to all materials, equipment and services provided by the Contractor. Requirements for Design and for Construction have been separated for clarity, and also to support modular use of the Specification. This document forms part of the Tender Package and later becomes part of the Contract.
- 1.1.2 This document makes reference to Ergon Energy Substation Standards and other documents including Ergon Energy documents, Australian Standards, other standards, guides and handbooks.
- 1.1.3 This document is used by Ergon Energy to document the general and specific requirements pertinent to each Works project, in a common, repeated format for use across all Substation projects.
- 1.1.4 This document is used by the Contractor to formulate and develop a Works Program, and to outline the foreseen compliance in meeting each of the Requirements contained herein.

1.2 WORKS SPECIFICATION STRUCTURE

- 1.2.1 The structure of the Works Specification is summarised in Table 1 below.

Table 1 Works Specification Structure

Section	Purpose
Section 1 Introduction	Explains how to use the Works Specification and defines terms used in the Specification.
Section 2 Scope of Works	This section describes the deliverables from both Ergon Energy and the Contractor, and the division of responsibility between the two parties.
Section 3 General Requirements	This section documents the General Requirements for Contractor’s works.
Section 4 Substation Design Requirements	This section documents Ergon Energy’s Requirements pertaining to the Contractor’s design works.
Section 5 Substation Construction Requirements	This section documents Ergon Energy’s Requirements pertaining to the Contractor’s construction works.
APPENDIX A Deliverables List	This Appendix provides a summarised list of Contractor deliverables
APPENDIX B Design Brief	The Design Brief describes detailed primary plant scope requirements. This document is provided to the Contractor for information only, and includes the total project scope including scope to be executed by the Principal.
APPENDIX C Secondary Systems Design Brief	The Secondary Systems Design Brief describes detailed secondary systems scope requirements. This document is provided to the Contractor for information only, and includes the total project scope including scope to be executed by the Principal.
Appendix D Substation Standards	The Substation Standards are a series of documents which indicate Ergon Energy’s requirements for design and installation of various substation components.
Appendix E Z6-32 ZSS Template Drawings	The Z6-32 ZSS template drawings are a series of template drawing to be used as a basis for all substation design drawings.
Appendix F Civil Input Data	This Appendix contains civil input data such as Geotechnical reports and survey data for the site, as well as storm surge and services maps for the area.
Appendix G	Concept design drawings


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Table 1 Works Specification Structure

Section	Purpose
Appendix H, Relay Application Guides	This Appendix contains the Ergon Energy Relay Application Guides. These drawings indicate the standard wiring to be used for each protection relay.
Appendix I Environmental Management Plan	This Appendix contains the Ergon Energy Environmental Management Plan for the Avoca site.

1.3 REQUIREMENTS AND VERIFICATION

- 1.3.1 Wherever the term “must” is used, it identifies a Specification requirement that Ergon Energy considers essential from the Contractor to the fulfilment of project needs. Failure to verify compliance with a “must” requirement may result in Ergon Energy withholding payments and/or deducting the cost of all works required to achieve or verify compliance from the Contract.
- 1.3.2 For ease of reference to other text in this document, every paragraph also has a sequential and therefore unique number.
- 1.3.3 Ergon Energy envisages a progressive sign-off of the specified Requirements under the Contract.

1.4 ROLE DEFINITIONS


- 1.4.1 The role definitions given below are used throughout this specification.
- a) Ergon Energy – refers to the Principal
 - b) Project Manager – appointed by Ergon Energy and refers to the Ergon Energy project manager who is responsible for project delivery.
 - c) Principal’s Representative – appointed by Ergon Energy to administer Ergon Energy’s rights and obligations under the contract.
 - d) Contractor – refers to the Contractor

1.5 ACRONYMS AND ABBREVIATIONS

- 1.5.1 Acronym and abbreviation definitions are provided in Table 2.

Table 2 Work Specification Acronyms and Abbreviations

Term	Meaning
AC	Alternating Current
AFLC	Audio Frequency Load Control
AVR	Automatic Voltage Regulation
CAD	Computer Aided Design
CB	Circuit Breaker
CT	Current Transformer
CVT	Capacitor Voltage Transformer
DC	Direct Current
DDF	Dielectric Dissipation Factor
DGA	Dissolved Gas Analysis
EDMS	Electronic Document Management System
EESS	Ergon Energy Substation Standard
ESAA	Energy Supply Association of Australia
HDPE	High Density Polyethylene
HV	High Voltage
HVIA	High Voltage Isolation and Access
IED	Intelligent Electronic Device
ITP	Inspection and Test Plan
LCF	Local Control Facility
LIWV	Lightning Impulse Withstand Voltage

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LV	Low Voltage
MCB	Miniature Circuit Breaker
MEN	Multiple Earthed Neutral
MUX	Multiplexer
OD	Outer Diameter
OLTC	On Load Tap Changer
PD	Partial Discharge
PFWV	Power Frequency Withstand Voltage
PVC	Polyvinyl Chloride
RAG	Relay Application Guide
RCD	Residual Current Device
RTU	Remote Terminal Unit
RPEQ	Registered Professional Engineer of Queensland
RSR	Relay Setting Request
SCADA	Supervisory, Control And Data Acquisition
SF6	Sulphur-hexafluoride
SFRA	Swept Frequency Response Analysis
SS-x-x.x	Ergon Energy Substation Standard
SWP	Standard Work Practices
VT	Voltage Transformer
XLPE	Cross Linked Polyethylene
ZSS	Zone Substation Standards


1.6 REFERENCED DOCUMENTS

1.6.1 GENERAL

This section described the documents referenced in this Specification. Where any of the Ergon Energy documents below are not provided with this Specification, they will be made available to the Contractor on request.


1.6.2 ERGON ENERGY CONTROLLED DOCUMENTS:

- Substation Standard series SS-1-N.N
- EESS series of ZSS template drawings
- Safe Entry to HV Enclosures SWP SP0502
- Ergon Energy CAD Standards Manual – External Contractors and Agencies (Appendices 3 and 4)
- Ergon Energy Relay Application Guides
- Ergon Energy Substation Standards
- Ergon Energy Substation Standard Earthing Drawings (EESS-10031-01 to EESS-10031-55)
- Ergon Standard Work Practices
- MN000301R165 “Ergon Energy 8 Level Field Test Competency Reference”
- MN000301R166 Ver. 1 “Construction and Wiring Guidelines for Ergon Energy Substation Panels”.
- MN000301R167 Ver. 1 “Greenlining and Bluelining of Ergon Energy Substation Drawings”.
- MP000903R117 “Environmental Protection Requirements”
- Legislation and Regulation:
 - Queensland Government Electrical Safety Regulation 2002
 - Queensland Government Electrical Safety Act 2002
 - Work Health and Safety Act 2011 (Queensland)
 - Work Health and Safety Regulation 2011 (Queensland)

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1.6.3 STANDARDS AND GUIDES:


- AS/NZS ISO 9001
- AS/NZS ISO 10005
- AS 1000
- AS 1100
- AS 1101
- AS 1102
- AS 1384
- AS 1670 and Handbook AS HB20
- AS 1680.2.4 Item 15.1(a) Table E1
- AS 2067 Substations and high voltage installations exceeding 1 kV AC
- AS 2650
- AS 3000 SAA wiring rules
- AS 3883
- AS 4436
- AS 5000
- AS 62271.301-2005 – Dimensional Standardisation and Terminals
- AS/ACIF S008:2001 – Requirements for Authorised Cabling Products.
- AS/ACIF S009:2001 – Installation Requirements for Customer Cabling (Wiring Rules)
- BS 60051
- ENA EG1-2006 Substation Earthing Guide
- IEC publication 255-1971-1978 – Electrical Relays
- IEEE 80-2000 Guide for Safety in AC Substation Grounding
- National Electricity Code
- Current edition of the “Approved Listing of Fire Detection Equipment”.

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2. SCOPE OF WORKS

2.1 WORKS OVERVIEW

- 2.1.1 This Contract is for the Design and Construction works at Avoca substation.
- 2.1.2 Avoca substation is located at the corner of Cummins Road and Doblo Street, Bundaberg, and is henceforth referred to in the Contract as the "Site".
- 2.1.3 This project aims to establish a new 66/11 kV zone substation in accordance with this Specification, Local Authority requirements and Australian Standards. The works will be based on the concept design drawings provided by Ergon Energy (the **Principal**) and take into account the proposed ultimate configuration of the Substation.
- 2.1.4 The Contract scope of works for Avoca substation is generally the design, construction, supply, installation, connection, testing and pre-commissioning of the works, as well as the provision of drawings and documentation and other requirements as defined in this Specification.
- 2.1.5 The project will be undertaken with assistance from the Principal. The Principal will free issue the plant as per Section 2.4 of this Specification to the Contractor. The Principal will also perform the final commissioning of the substation and of various portions of the scope – a summary of the division of responsibility between the Principal and the Contractor is listed in Table 6.
- 2.1.6 The overall deliverables for the Project are;
- A) Primary plant systems (refer Design Brief in Appendix XXX);
- (1) Power transformers
 - (i) Two 66/11kV 20MVA power transformers.
 - (ii) The transformers must connect to the 11kV indoor switchboard via underground cables and to the 66kV bus by flexible busbar.
 - (iii) The transformers must have a noise wall as indicated on the concept drawings.
 - (iv) The transformer must have foundations, bunds and oil separation tank suitable for the ultimate installation of 32MVA transformers.
 - (2) 66kV outdoor bays
 - (i) Two 66kV bus sections, including one bus section bay, two feeder bays and two transformer bays.
 - (ii) Each bay must include circuit breakers, current transformers, voltage transformers, isolators, surge diverters, interconnections and support structures as necessary.
 - (3) 11kV indoor switchgear
 - (i) Three sections of 11kV indoor switchgear panels
 - (ii) Panels include two bus section circuit breaker panels, two bus riser panels, two transformer circuit breaker panels, eight feeder circuit breaker panels and one capacitor bank circuit breaker panel.
 - (4) Station supply transformers
 - (i) Two 315kVA 11000/415V ground-mounted local supply transformers
 - (5) Load control plant.
 - (i) Coupling cells, generators etc...
 - (6) Capacitor banks
 - (i) Two 11kV 5.4Mvar capacitor banks

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- (7) High Voltage Cables
 - (i) 11kV underground power cables from the transformers to the 11kV switchboard
 - (ii) 11kV underground power cables from the capacitor banks to the 11kV switchboard
 - (iii) 11kV underground power cables from the station transformers to the 11kV switchboard
- B) Secondary systems (refer Secondary Systems Design Brief in Appendix?);
 - (1) Protection
 - (i) Protection relays and associated equipment for each item, including 66kV circuit breaker bays, 11kV circuit breaker panels, 66/11kV transformers, and 11kV capacitors, must be installed in protection and control cubicles within the control building
 - (ii) The protection relays to be used are listed in the Secondary Systems Design Brief in Appendix XXX.
 - (2) SCADA
 - (i) SCADA equipment, including five C52 RTU's, one Local Control Facility and associated equipment, must be installed in SCADA cubicles within the control building
 - (3) Communications
 - (i) Communications equipment must be installed in a dedicated communications cubicle
 - (ii) Site communications must be established by cutting into the existing fibre optic cable running past the site.
 - (4) Protection signalling
 - (i) Protection signalling equipment must be installed in a dedicated communications cubicle
 - (5) Metering
 - (i) Statistical metering equipment must be installed in a dedicated metering cubicle
 - (6) DC Supplies
 - (i) 110V DC supply system, including one 110V DC distribution board, one 110V battery bank, one 110V battery charger
 - (ii) 48V DC supply system, including one 48V DC distribution board, one 48V battery bank and one 48V battery charger
 - (7) AC Supplies
 - (i) 415/240V AC supply systems including one 415V AC main LV switchboard with changeover contactor and LV mains from each station services transformer, one 415V AC control building LV sub-board and LV outlets in the 66kV switchyard
 - (8) Earthing System
 - (i) Buried earth grid and earth connections
 - (9) Secondary Wiring
 - (i) LV and control cabling, inter-panel wiring, cable racks, trays and support brackets
- C) Civil and structural works

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- (1) Control building
 - (i) Masonry control building and associated electrical, fire and mechanical services.
 - (ii) Provision must be made for all ancillary equipment including:
 - (iii) cupboards used for storage of spare equipment, earth sticks, operating gear, safety equipment
 - (iv) plan desk and chair etc
 - (v) cupboard/plan hanger for storage of book of substation drawings
 - (vi) The control building is to be in accordance with the Civil Specification in Appendix XXX and the Z6-32 Zone Substation Template Drawings.
 - (2) Civil works
 - (i) All site civil works including earthworks, road works, underground conduits (including for all current and future 11kV feeders), earth grid and drainage
 - (ii) Civil works are to be carried out in accordance with the Civil Specification in Appendix XXX.
 - (3) Structural works
 - (i) All site structures including concrete works, support structures, fencing, exterior lighting, lightning protection, acoustic walls and oil containment
 - (ii) Structural works are to be carried out in accordance with the Civil Specification in Appendix XXX.
 - (4) Landscaping
 - (i) Landscaping must be provided...
 - (ii) Landscaping works are to be carried out in accordance with the Civil Specification in Appendix XXX.
- D) Sundry Plant
- (1) CT and VT marshalling boxes
 - (2) Nameplates
 - (3) Operational advisory signs, equipment labels, and equipment danger labels


2.1.7 The concept design drawings provided by the Principal are listed in Table 3 and provided in Appendix XXX.

Table 3 Concept Design Drawings

Drawing Number	Revision	Description	Medium
AAAAAA	0A	Initial Single Line Diagram	dgn
BBBBBB	0A	Site Layout	dwg
CCCCCC	0A	Ultimate Single Line Diagram	dgn
AAAAAA	0A	Initial Single Line Diagram	dgn
BBBBBB	0A	Site Layout	dwg
CCCCCC	0A	Ultimate Single Line Diagram	dgn
AAAAAA	0A	Initial Single Line Diagram	dgn

2.2 DESIGN SCOPE OF WORKS

2.2.1 The design scope of the works for Avoca substation must be the design works required to establish Avoca substation, including the creation of RPEQ certified design drawings,

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providing site support during the construction phase and the provision of final as built drawings.

2.2.2 The Contractor must also provide supporting documentation, calculations, system studies, drawings, descriptions, manuals, quality control systems, progress reports and meetings with the Principal's Representative as set out in this Specification. Required supporting documentations may include but is not limited to the following:

- Earth Grid Study Report detailing Step and Touch Potentials for the site,
- Insulation Co-ordination Study,
- HV Cable Rating Study,
- Soil Resistivity Test Results,
- Soil Thermal Resistivity Test Results,
- Lightning Protection Study,
- DC Systems Requirement Study,
- AC Systems Requirement Study,
- Lighting Study Report (Indoor & Outdoor),
- Geotech Survey,
- All Site Surveying work and
- Council Approval for Road Access.

2.2.3 All engineering studies supporting detailed design such as those listed above must be RPEQ certified.


2.2.4 The design of Avoca substation must be in accordance with the concept design drawings, the Ergon Energy Z6-32 zone substation template drawings and the Ergon Energy Substation Standards. However the Contractor must be responsible for the content of all drawings created or modified as part of the project.

2.2.5 The Requirements set out herein represent the minimum Requirements acceptable to the Principal.

2.2.6 The Contractor may have approved sub-contractors for specified parts of the works, such approval being set out in the Contract.


2.2.7 The design scope of works must include;

- The full detailed design of the project scope listed in Section 2.1. The design must be based on the Z6-32 ZSS template drawings included with this Specification, and must include;
- General arrangements (plan and elevation)
- Single line diagrams (protection and metering, SCADA, plant and Operations)
- Control Building Design including Building Services Design
- Structures and footing drawings
- Earthworks/pad design
- Switchgear panel general arrangements and schematics
- Cable schedules
- AC and DC supply general arrangements and schematics
- Primary Plant Schedule for Procurement (8 weeks from date of Contract award)
- Engineering study reports supporting the detailed design as listed in section 2.2.2.

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- Provision of a full set of RPEQ certified “As Built” drawings incorporating all construction and commissioning mark-ups. Attention is drawn to the complete set of drawing requirements set out in Section 4.25 of this Specification.
- Submission of design drawings for Principal review as follows:
- First Design Progress Review –
 - a. Deliverables:
 - i. Single Line Diagram
 - ii. Single Line Operating Diagram
 - iii. Single Line Protection and Metering Diagram
 - iv. Single Line Comms & SCADA Diagram
 - v. General Arrangement
 - b. Acceptance Criteria – Bay Numbering and Operating Numbers must be in accordance with SS-1-1.2 Substation Equipment Identification and Substation Network Operational Identification Naming Guidelines. General Arrangement drawing must have ZSS layout where applicable and fully dimensioned. Drawings’ contents to be at least 80% accurate.
- Second Design Progress Review –
 - a. Deliverables:
 - i. General Arrangement of Foundations for Outdoor Switchyard
 - ii. Foundation drawings for major plant and outdoor equipment
 - iii. Cable Duct and Conduit Arrangement and Elevations
 - iv. Site Drainage Plan
 - v. Control Building Floor Plan & Building Services
 - vi. Cable Tray location drawing
 - vii. Sample Selection of secondary systems drawings
 - b. Acceptance Criteria – Layout of control building and conduit takes into account future requirements, Equipment ID and accurate dimensioning are shown on drawing, Drawings’ contents to be at least 90% accurate.
- Third Design Progress Review –
 - a. Deliverables:
 - i. All detailed design drawings incorporating comments and feedback from previous reviews.
 - ii. Completed “Bulk Load Spreadsheet” listing all drawings used during design for re-entry into Ergon’s EDMS.
 - b. Acceptance Criteria – detailed design drawings to be accurate and satisfactory in terms of functional and compliance with standards template. Bulk load spreadsheet to be accurately completed with relevant data. Drawings’ contents to be 99% accurate.
- Design 100% complete – “For Construction” detailed design drawings with RPEQ certification supplied.


2.2.8 The Contractor’s design must interface with the free-issue plant supplied by the Principal and must check the suitability of the free-issue plant for the purpose for which it was provided. The free-issue plant and availability of the corresponding plant drawings are listed in Section 2.4.

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- 2.2.9 The Contractor must perform a site visit prior to undertaking detailed design in order to determine site-specific conditions. In addition, the Principal's Representative must be informed two weeks prior to the visit taking place so they have the opportunity to attend the site at the same time.
- 2.2.10 The Contractor must provide site support during the construction period, in the form of remote telephone or email support rather than any presence on site. The Contractor will not be required to modify drawings during this phase, unless the request derives from a serious omission or error in the design.
- 2.2.11 The Contractor will be provided a set of marked-up drawings containing any modifications to the "For Construction" design drawings, following commissioning of the substation. The Contractor must incorporate these mark-ups into the drawings and issue a corresponding set of "As Built" drawings.
- 2.2.12 The Contractor must provide Software models used in production of the studies to the Principal.
- 2.2.13 The Contractor must provide calculations supporting the civil, structural and electrical design at the request of the Principal.
- 2.2.14 The Contractor must provide materials lists for all equipment or materials, excluding those explicitly listed on the design drawings.
- 2.2.15 The Contractor must incorporate the Principal's standard identification nomenclature and labelling into all design.

2.3 CONSTRUCTION SCOPE OF WORKS

- 2.3.1 The construction scope of the works for Avoca substation includes the construction, supply, delivery to site, installation, connection or assembly, testing and pre-commissioning of the works, commissioning of a portion of the works, assistance with commissioning of other portions of the works and training of the Principal's staff.
- 2.3.2 The Contractor must also guarantee satisfactory performance and the repair of defects as per the terms and conditions of the Contract.
- 2.3.3 The construction scope also includes the supply of drawings, descriptions, manuals, test records, and quality control systems, as set out in this Specification.
- 2.3.4 The Requirements set out herein represent the minimum Requirements acceptable to the Principal.
- 2.3.5 The Construction scope of works must include;
- Procurement of all plant and materials, excluding the items listed in Section 2.4, which are to be supplied free-issue by the Principal.
 - Construction and equipping of a new control building and associated electrical, fire and mechanical services.
 - Construction of all site civil works and structures including earthworks, road works, concrete works, fencing, earth grid and connections, exterior lighting, lightning protection, underground conduits, acoustic walls, oil containment, drainage, and landscaping.
 - Installation of all underground cable conduits and control cable ducts.
 - Installation, testing and pre-commissioning of 66kV circuit breakers, current transformers, voltage transformers, isolators, surge diverters and all support structures, bus work and interconnections.
 - Installation and testing of the power transformers and 11kV switchgear is by the Principal, however all primary and secondary connections to the equipment must be by the Contractor. The Contractor must provide reasonable site access for the purposes of installation, testing and commissioning of the equipment.

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- Installation and pre-commissioning testing of the 11000/415V station supply transformers
- Installation and pre-commissioning testing of protection and control, communications, SCADA and statistical metering cubicles.
- Installation and commissioning of the new 415V AC main LV switchboard, including LV mains from each station services transformer and changeover contactor, and new control building 415V AC sub-board.
- Installation and commissioning of the new 110V and 48V DC supply systems.
- Installation, termination and testing of all underground 11kV power cables (excluding 11kV feeders).
- Installation and commissioning of all LV and control cabling, inter-panel wiring, cable racks, trays, and support brackets.
- Supply a full set of marked-up "As Built" drawings incorporating all construction and commissioning mark-ups. Attention is drawn to the complete set of drawing requirements set out in Section 5.10 of this Specification.
- Installation of operational advisory signs, equipment labels, and equipment danger labels.
- Supply of special tools and test equipment as and where specified.
- Supply of spares as and where specified.
- Training of the Principal's operating and maintenance staff.

2.3.6 Installation, testing and pre-commissioning of all major plant must be in accordance with Section 5.1 of this Specification.

2.4 FREE-ISSUE PLANT & MATERIALS

2.4.1 GENERAL

2.4.1.1 The equipment for the construction of this Site will be a combination of;

2.4.1.2 Supply by the Principal as free-issue to the Contractor, and

2.4.1.3 Supply by the Contractor.

2.4.1.4 Items of plant to be supplied to the Contractor by the Principal are listed in the following sections. Items of plant which are not explicitly identified and confirmed by the Contractor for free-issue must be supplied by the Contractor.

2.4.1.5 For standard Ergon Energy stocked items other than major plants, the Contractor may elect to purchase through Ergon Energy's store. A full list of items for substation construction that are available through Ergon Energy's store can be provided upon request.

2.4.1.6 The Principal reserves the right to accept or reject any such request for free-issuing of minor materials based on stock availability and project priority.

2.4.1.7 Free issue items will be supplied to the Contractor in a timely manner.


2.4.1.8 The Principal will make the items available for pick-up by the Contractor from the following depots:

Ergon Energy

Searle St

Maryborough QLD

2.4.1.9 The Contractor must give the Project Manager at least seven (7) working days notice to collect equipment from the depot. It must be the Contractor's responsibility to transport and

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unload all items from the depot to site, except for power transformers which are delivered to site by the manufacturer.


- 2.4.1.10 The Contractor must complete and sign a “Materials Movement Form” prior to taking ownership of materials that Ergon have procured and stored, when these materials are to be transported to site. This form will include description of materials, quantities, date, name and signature of recipient.
- 2.4.1.11 For equipment and materials supplied by Ergon Energy, the Contractor must return all unused quantity or part of from site to Ergon Energy’s specified storage location.

2.4.2 MAJOR PLANT

- 2.4.2.1 The relevant drawings for the particular equipment are not included in this Specification; however they will be supplied to the successful Contractor. For the purpose of this Specification, typical transformer and switchgear drawings have been included in Appendix XXX.
- 2.4.2.2 Some major equipment including power transformers and indoor switchboards have pre-delivery conditions and inspection and hold points. These are set out in Section 5.1 and may not be negotiated out from the project.

Table 4 Major Plant – Principal Supply

Item	Qty	Manufacturer/ Stock code	Model/Reference No. & Drg No.	Availability	
				Plant	Drawings
66kV 3-phase Isolators	X	AK Power Solutions	X	X	X
66kV Surge Arrestors	X	Bowthorpe EMP	X	X	X
66kV 3-phase CBs	X	Alstom	GL 309 F1/3120/VR13	X	X
66kV single phase CVTs	X	Crompton Greaves	CVE72.5	X	X
66kV single phase CTs	X	Koncar	AGU-72.5	X	X
66kV Post Insulators	X	X	X	X	X
132/66/11kV 15/20MVA Power Transformers	X	X	X	X	X
11kV Indoor Metal-Clad Switchgear	X	X	X	X	X
11kV Earthing Transformer	X	X	X	X	X
11kV/415V 315kVA Station Service Transformer (pad-mount)	X	X	X	X	X
11kV 5.4Mvar capacitor bank	X	X	X	X	X
66kV Ripple Injection 225Hz Coupling Cell	X	X	X	X	X
Ripple Injection 225Hz Transmitter and Controller	X	X	X	X	X
HV Cables	X	X	X	X	X
110V DC Battery Charger, Battery Bank, Isolation Panel and Distribution Board	X	X	X	X	X

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2.4.3 PROTECTION EQUIPMENT

2.4.3.1 The Principal will supply as free-issue to the Contractor, all protection relays required as part of this project. The type of protection relays to be used is given in the Secondary Systems Design Brief in Appendix XXX.

2.4.3.2 The Contractor must confirm the quantity and the specific relay model number including multi-trip relays for the associated schemes as applicable to the project requirement.

2.4.3.3 A detailed schedule of available relays will be provided in Appendix XXX.

2.4.4 SCADA EQUIPMENT

2.4.4.1 The Principal will supply as free-issue to the Contractor all RTUs and LCFs required as part of this project. The quantity and type of SCADA equipment to be used is given in the Secondary Systems Design Brief in Appendix XXX.

2.4.5 METERING EQUIPMENT


2.4.5.1 The Principal will supply as free-issue to the Contractor, panel meters for statistical, revenue, and check metering, and ESAA test blocks required as part of this project. The quantity and type of metering equipment to be used is given in the Secondary Systems Design Brief in Appendix XXX.

2.4.6 COMMUNICATIONS AND PROTECTION SIGNALLING EQUIPMENT

2.4.6.1 The Principal will supply as free-issue to the Contractor, all specialised communications equipment such as mobile radio, antenna, MUX, Ethernet switches etc required as part of this project. The quantity and type of communications and protection signalling equipment to be used is given in the Secondary Systems Design Brief in Appendix XXX.

2.4.7 CUBICLES

2.4.7.1 The Principal will supply as free-issue to the Contractor, standard 19" cubicles and panel plates for protection and control, SCADA, metering and communications cubicles required as part of this project. Where a non-standard cubicle is required, the requirements in Section 4.23.9 must be met.

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2.5 CONTRACTOR / PRINCIPAL RESPONSIBILITIES AND INTERFACE POINTS

2.5.1 RESPONSIBILITIES

2.5.1.1 The extent of the Contractor's and Principal's responsibilities is set out in this section. Table 5 explains the terms and abbreviations used.

Table 5 Terms and Definitions for Responsibilities

Term	Meaning
P	Principal
C	Contractor
T	Third Party – Engaged direct by the Principal
Design	Preparation of detailed design drawings for the item. For items of plant free-issued by the Principal, the Contractor must be responsible for designing the equipment into the works.
Install	Installation work on site including crange and final positioning of equipment.
Terminate	Making off and termination of cabling in accordance with the Principal's wiring standards.
Check	Checking for correctness of assembly, mechanical operation, or connection.
Test	Testing as set out on the Contractor's approved Inspection and Test Plans, or as required by this Specification; and any other testing to prove the plant or equipment meets all the requirements of this Specification, relevant Standards and the drawings. It will include but not limited to, insulation tests, injection tests, and applied HV tests.
Commission	Energising or placing into service following "Test", including any further tests (such as metering accuracy), as set out in the Contractor's approved Inspection and Test Plan, or as required by this Specification. The equipment does not have to be placed into commercial service to be "commissioned". Where the Principal and Contractor are both listed, the Contractor must assist the Principal with commissioning.
Live	Energised or capable of being energised by normal HV operation.

2.5.1.2 Table 6 defines the extent of the Contractor's and Principal's responsibilities.

Table 6 Extent of Contractor's and Principal's Responsibilities

Item	Design	Install	Terminate	Check	Test	Commission
Power Transformers	C	P	C	P	P	P, C
66kV Termination Structures	C	C	P, C	C	C	C
66kV Isolators, CBs, CTs, CVTs, Surge Arresters	C	C	C	C	C	P, C
11kV Strung Bus Plant and Materials	C	C	C	C	C	C
11kV Indoor Switchgear	C	P	C	C	C	P, C
Ripple Load Control Plant	C	C	C	C	C	P, C
11kV Capacitor Bank	C	C	C	C	C	P, C
11kV Cabling (except 11kV feeders)	C	C	C	C	C	P, C
110V DC Supply System	C	C	C	C	C	C
48V DC Supply System	C	C	C	C	C	C
11kV/415V Station Supply Transformers	C	C	C	C	C	P, C
415V 3-Phase Switchboard & Sub-boards Mains to the Station Supply Transformers	C	C	C	C	C	C
AC Sub-circuits to HV apparatus and related equipment	C	C	C	C	C	C


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Table 6 Extent of Contractor's and Principal's Responsibilities

Item	Design	Install	Terminate	Check	Test	Commission
Protection and Control Cubicles	C	C	C	C	C	P, C
SCADA Cubicles	C	C	C	C	C	P, C
Metering Cubicles	C	C	C	C	C	P, C
Communications Cubicles	C	C	C	C	C	P, C
Protection Signalling	C	C	C	C	C	P, C
Control Cables	C	C	C	C	C	C
Cable trays and cable supports	C	C	–	C	–	–
Control Building (Including Electrical, Fire and Mechanical Services)	C	C	C	C	C	C
Civil Works (Including Site Preparation, Earthworks, Road Works, Earthing, Conduits, Earth Grid, Drainage, Landscaping etc.)	C	C	–	C	C	C
Structural Works (Including Concrete, Support Structures, Fencing, Exterior Lighting, Lightning Protection, Acoustic Walls, Oil Containment etc.)	C	C	–	C	C	C
Landscaping	C	C	–	C	C	C
Tools and Test Equipment (for Contractor's Works)	C	–	–	C	C	–
Spares	C	–	–	C	–	–

2.5.2 INTERFACE POINTS

2.5.2.1 The interface points between Contractor and Principal include the following items:

66kV Feeders


- The Principal will design, supply and install the landing spans from the existing 66kV Feeders to the substation 66kV termination structures.
- The Contractor must design, supply and install the substation 66kV termination structures and the droppers from the landing spans to the respective feeder bays.
- The Contractor must design the termination structures such that they are adequately rated to accept the landing spans.

11kV Feeders

- The Principal will supply, install, terminate, test and commission the 11kV feeder underground cables to the 11kV switchboard
- The Contractor must supply and install the feeder conduits from the control room to the substation boundary. Each conduit must terminate in a location suitable for the subsequent installation of feeder cable by the Principal.

Communications

- The Principal will free-issue to the Contractor, all specialised communications equipment to be installed within the substation. This equipment must be installed by the Contractor.
- The Principal will supply, install, terminate, test and commission the fibre optic cable into the substation communications cubicle

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- The Contractor must install communications conduits from the control room to the substation boundary. Each conduit must terminate in a location suitable for access for the subsequent installation of fibre optic cable by the Principal.

Protection Signalling Equipment

- The Principal will supply, install, connect & commission the protection signalling equipment.

Protection Relays

- The Principal will free-issue all protection relays and supply associated settings files to the Contractor for installation. Final Commissioning of the protection relays will also be the Principal's responsibility.
- The Contractor will be responsible for the design, installation and testing of the Protection and Control panels including relays and loading of the relay's setting files.

SCADA Systems

- The Principal will be responsible for programming of all SCADA systems, using design data provided by the Contractor.
- The Contractor will be responsible for the design, installation and testing of the SCADA systems using the software database setting files provided by the Principal.

Testing, Commissioning, Switching and Energising of Plant

- The Contractor must complete testing and commissioning as detailed in Section 5.9
- The Principal will commission all major plant, and organise and control switching and commissioning programs
- The Contractor must assist the Principal in developing commissioning plans, outage plans and network risk mitigation plans.
- Where applicable, the Contractor must provide assistance to supplier of specialist plant such as Load Control where such plant is to be commissioned by the supplier on behalf of Ergon.

2.6 INPUT DATA

2.6.1 LOAD DATA

- 2.6.1.1 The load at Avoca substation is predominantly residential/commercial.

2.6.2 SYSTEM DATA

- 2.6.2.1 High voltage equipment must have rated continuous voltages as specified in Table 7.

- 2.6.2.2 Other system electrical design conditions and parameters that are not defined in this Specification must be as set out in the Ergon Energy Substation Standards.

Table 7 Electrical Design Data

Item	Units	132 kV System	66 kV System	22 kV System
Phases and Wires:				
Number of Phases		3	3	3
Number of Wires		3	3	3
Voltage Ratings/Insulation Co-Ordination:				
System Nominal Voltage	kV	132	66	22


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Table 7 Electrical Design Data

Item	Units	132 kV System	66 kV System	22 kV System
System Highest Voltage	kV	145	72.5	24
66/22kV and 132/66/22kV Transformer LIWV	kVp	650	325	150
66/22kV and 132/66/22kV Transformer PFWV	kVrms	275	140	50
Other Equipment LIWV	kVp	550 or as specified	325 or as specified	150 or as specified
Other Equipment PFWV	kVrms	275	140	50
Frequency:				
Rated frequency	Hz	50	50	50
Minimum frequency	Hz	47	47	47
Maximum frequency	Hz	52	52	52
Current Ratings:				
Feeders: Max Load	A	–	800	630
	Equipment	A	–	800
Transformers: Max Load	A	–	800	1250
	Equipment	A	–	800
Bus Section: Equipment	A	–	800	1250
Earth Grid:				
Thermal rating of Grid	kA	Contractor's Design		
Design Earth Fault Current	kA	25		
Fault Clearance time	sec	1.5		
Design Fault Levels – Equipment:				
Fault Current	kA	25	25	25
Fault Clearance time	sec	3	3	3

2.6.3 SOIL RESISTIVITY TESTING

2.6.3.1 For estimation purposes the Contractor must assume the soil resistivity values specified in Table 8. These are considered typical for the soil types existing at the sites as shown in the Geotechnical Reports for the site in Appendix XXX.

2.6.3.2 The Contractor must perform soil resistivity tests on the site to confirm before designing the earthing system. The Contractor must submit the results of the soil resistivity tests to the Principal with the design of the earth grid and calculations used in the design.

Table 8 Soil Resistivity Values (for estimating purposes)

Site	Average Resistivity ($\Omega.m$)
Avoca substation	X

2.6.4 POLLUTION CLASSIFICATION

2.6.4.1 The Contractor must select equipment using a pollution classification for the site, as defined in AS 4436, deemed as:


Class III (Heavy Pollution)

2.7 SITE ACCESS

2.7.1 The Principal is in the process of acquiring the site of the proposed Avoca substation and has applied to the Local Authority for a Material Change of Use of the property. The Contractor must indicate the likely impact of late access to site on their ability to meet the Date of Practical Completion.


2.7.2 Contractor must adhere to Local Council regulations for site access to reduce disturbances during construction period.

2.7.3 The Contractor must be responsible for any induction programs (and associated costs) required for work on the site

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2.8 RELATED PROJECTS

2.8.1 At the time of writing there were no other designs or works being undertaken at this site.

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3. GENERAL REQUIREMENTS

3.1 CONDITIONS


- 3.1.1 The Contractor must perform the work covered by this Specification in accordance with the terms and conditions of Contract.
- 3.1.2 Unless otherwise specified, the equipment, materials, design, manufacture, site works, and testing must be in accordance with the latest edition (including all amendments up to the time of project commencement) of Ergon Energy Substation Standards and ZSS template drawings provided to the Contractor; this Specification; and the specified sections of the Australian Standards or other standards.
- 3.1.3 Where no Australian Standard exists, the latest edition and amendments of the appropriate International Electrotechnical Commission Standard (IEC), British Standard (BS), or the NATSPEC BASIC Standard, in that order of preference, are specified.

3.2 CONTRACTOR'S RESPONSIBILITY


- 3.2.1 The Contractor must provide the whole of the works which are described or implied in this Specification.
- 3.2.2 The Contractor must deem all works omitted from this Specification document that may be inferred to be obviously necessary for the completion of the works and the satisfactory performance of the equipment to be supplied, to be included in the Contract Price.
- 3.2.3 The Contractor must deem all works not shown on the Specification drawings but mentioned or described in the Specification to be included in this Contract. The Contractor must execute the Contract works covered by the Contract Price in the same manner as if information had been expressly shown upon the drawings and described in this Specification. In case of discrepancies between the drawings and this Specification, the Contractor must obtain clarification from the Principal's Representative.
- 3.2.4 The Contractor must not consider any omissions or inaccuracies in drawings that form part of this Specification to be reason for Contract variations. Drawings are included only to assist negotiations and development of the contract price.
- 3.2.5 The Contractor must give the Contractor's representative on the site full responsibility to enter into negotiations regarding issues arising out of erection, testing and commissioning, so that the work may proceed with as few delays as possible.
- 3.2.6 For all work included in the Contract, the Contractor must provide a qualified representative to supervise works. The Contractor must give full facilities and assistance to the Principal's Representative to check the works.
- 3.2.7 The Principal's Representative may inspect all aspects of construction and testing of the equipment on Site. By such Inspections, the Contractor must not in any way be relieved of responsibilities under the Contract. The Principal's Representative may also inspect any equipment that has been delivered to the site in a partly assembled condition.
- 3.2.8 The Contractor must prepare all detailed plans necessary for Local and Other Authorities permits or approvals and for the completion of the works.
- 3.2.9 The Contractor must provide Engineering certification that the whole of the Contractor's design works and completed construction, testing and commissioning works meet the requirements of the Queensland Professional Engineers Act, as well as comply with this Specification.
- 3.2.10 The Contractor must keep the site reasonably clean, removing all waste material resulting from the works as it accumulates and as reasonably directed.

3.3 SAFETY REGULATIONS AND WORKPLACE HEALTH AND SAFETY ACT

- 3.3.1 The Contractor must comply with the Ergon Energy Workplace Health and Safety and Electrical Safety Conditions as specified in the Contract.

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- 3.3.2 The Contractor must apply Ergon Energy Access Permit procedures as follows:
- Once the Contractor has issued to the Principal's Representative a completed Construction Safety Clearance – High Voltage Apparatus NI001301F107, indicating that all equipment is now to be treated as capable of being made alive and therefore no longer accessible to the Contractor, or
 - Once any HV plant in the substation is energised or capable of being energised (including plant installed under other contracts).
- 3.3.3 Details of the safety requirements during testing and commissioning of the substation equipment are provided in Section 5.9.
- 3.4 QUALITY ASSURANCE PROGRAM**
- 3.4.1 The Contractor must apply a Quality Assurance program in accordance with AS/NZS ISO 9001, except for the requirements detailed below, which take precedence.
- 3.5 CONTRACT QUALITY PLAN**
- 3.5.1 The Contractor must submit a Contract Quality Plan to the Principal's Representative within four (4) weeks of Project Agreement. The Contract Quality Plan must be prepared in accordance with AS/NZS ISO 10005.
- 3.6 SUBCONTRACTED WORK**
- 3.6.1 The Contractor must guarantee the quality standard of products and services provided by Subcontractors.
- 3.6.2 Where the Contractor is required by the Conditions of Contract to obtain the Principal's Representative's approval to subcontract work, the Contractor must include with the request for approval the following:
- A justification of the Quality Standard selected.
 - Details of the proposed Subcontractor's quality system.
 - An assessment of the proposed Subcontractor's ability to meet the standard.
 - The Contractor's Surveillance Plan for verifying the proposed Subcontractor's quality system and product conformance.
- 3.7 NOTICE OF INTENTION TO COMMENCE SUPPLY OR MANUFACTURE**
- 3.7.1 The Contractor must give the Principal's Representative written notice of the intention of the Contractor or the Subcontractors/Supplier to commence supply or manufacture of any product or service for use in this Contract.
- 3.7.2 The Contractor must give the written notice at least seven (7) working days in advance for work within Australia, and at least fourteen (14) working days in advance for Overseas Suppliers.
- 3.7.3 The Contractor must include in the written notice the name of the manufacturer/supplier, the address of the point of manufacture/origin, the name and phone number of the contact person, order number, Quality/Standard/category, Inspection and Test Plan (ITP) number and title, and the scope and description of the products/services to be supplied.
- 3.8 NOTICE OF INSPECTION OR TEST**
- 3.8.1 When witness or hold points for quality surveillance or tests require the presence of the Principal's Quality Assurance Representative (QAR), the Contractor must give notice, in accordance with the times referred to in Table 9.
- 3.8.2 Witness Points are inspections or tests normally shown on an ITP at which attendance by the QAR is at the Principal's Representative's discretion. Where the Principal's Representative elects not to attend a Witness Point, the Contractor must proceed past that point subject to inspection and test results (supported by appropriate quality system records), that are satisfactory to the Principal's Representative.

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- 3.8.3 Unlike Witness Points, attendance by the QAR at Hold Points is mandatory. The Contractor must not proceed beyond the Hold Point until the QAR has attended, or documented authorisation to proceed has been provided by the Principal's Representative.

Table 9 Notice of Inspection or Test

Location	Notice
On Site	2 working days
Queensland	5 working days
Interstate	10 working days
Overseas	15 working days

3.9 DISPATCH OF MANUFACTURED PRODUCTS

- 3.9.1 The Contractor must dispatch all manufactured products to the Site, or place of delivery, with an Inspection Certificate/Release Note issued by the Contractor and signed by the Contractor's Quality Assurance Representative or Agent.
- 3.9.2 By issue of the Inspection Certificate/Release Note, the Contractor must signify full conformance of the manufactured product to Contract requirements, unless otherwise stated.
- 3.9.3 The Contractor must detail any departure from conformance, and state the Non-Conformance Report number, on the Inspection Certificate/Release Note.
- 3.9.4 The Contractor must not dispatch a non-conforming manufactured product without prior permission from the Principal's Representative.

3.10 RIGHT OF ACCESS

- 3.10.1 The Contractor must provide access for the QAR to the Contractor's and the Subcontractor's premises or working area for the purpose of quality surveillance, progress assessment and quality audits. When the Principal's Representative elects to carry out verification at the Contractor's or the Subcontractor's premises, the Contractor must not deem such verification to absolve the supplier of the responsibility to provide acceptable product, nor to preclude subsequent rejection.

3.11 STOCK ITEMS


- 3.11.1 The Contractor must notify the Principal's Representative of any products supplied from their own inventory (stock) and if requested, demonstrate by objective quality evidence that they were manufactured under a recognised quality system.

3.12 RECORDS

- 3.12.1 The Contractor must retain sufficient records as objective quality evidence to assure the Principal that Contract requirements are being met. The Contractor must manage these in a Register of Records.
- 3.12.2 The Contractor must include Subcontractors' records and suppliers' certificates pertinent to the Contract in the Register of Records.
- 3.12.3 The Contractor must make available the Register of Records to the Purchaser's QAR for verification on request. The Contractor must provide Originals of records for examination on request.
- 3.12.4 The Contractor must retain minimum records for this Contract for three (3) months after the expiry of the Defects Liability Period including ITP for manufacture, Type Test Certificates, Routine Test Certificates, and any other documents as requested by the Principal.

3.13 REJECTION OF ITEMS

- 3.13.1 The Principal's Representative reserves the right to reject any plant or materials not complying with the Specification, whether on account of faulty design, material or workmanship.

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3.13.2 If the certified test results show that the performance of any plant or materials is not within the specified tolerances of the manufacturer's guaranteed performance figures as stated in the Guaranteed Performance Schedule for that item, then such items will be rejected.

3.13.3 In the event of a defect being of such a nature that the requirements of the Specification cannot be met by adjustment or minor modification, then the Contractor must replace such items to the satisfaction of the Principal's Representative, at no expense to the Principal.

3.14 PACKAGING

3.14.1 The Contractor must ensure each item of plant and materials supplied are packed properly or protected for shipment and transport from the place of manufacture to site, and for storage under the climatic conditions specified for the Site.

3.14.2 The Contractor must be entirely responsible for the packaging and handling of all items of plant and materials during transport to the site and during erection of the plant.

3.15 DELIVERY

3.15.1 The Contractor must arrange and co-ordinate the transport to the site and unloading of all the materials, plant, and equipment they supply, including any necessary craneage.

3.15.2 The Contractor must bear all expenses in connection with the importation and transport to the site of all plant not directly delivered to site by the manufacturer, material and equipment required for the satisfactory completion of the Contract including storage, handling, insurance and other charges. The Contractor must observe any regulations which limit loads on roads and bridges over which materials may be conveyed.

3.15.3 The Contractor must obtain all necessary road and rail traffic permits and be responsible for the payment of all charges.

3.15.4 The Contractor must ensure that no equipment is damaged as a result of reasonable handling during loading, transportation and unloading. Any damage and associated costs will be resolved by the Contractor at their expense.

3.15.5 The Contractor must ensure that all free issue plant, equipment and materials are in good working condition before leaving Ergon site. Any defect(s) or damage(s) found are to be reported to the Technical Representative and recorded on the Materials Movement Form. All equipment and materials leaving site without a defect register will be deemed supplied in good working condition.

3.16 COMMUNICATIONS WITH THIRD PARTIES

3.16.1 The Contractor must only correspond with the Local Authority and adjoining property owners/occupiers with the prior written authorisation of the Principal.

3.16.2 Where communication has been authorised, the Contractor must liaise with the above third parties via the Principal, and provide the Principal with copies of ensuing correspondence.


3.17 SPARES

3.17.1 The Contractor must provide a list of recommended spares considered necessary for the Principal to hold.

3.17.2 For spares ordered at the time of Contract award, the Contractor must deliver those spares no later than the Date of Practical Completion.

3.17.3 The Contractor must provide at least two days notice of delivery of spares, by contacting the Principal's Representative.

3.17.4 The Contractor must state the minimum period required by them for the delivery of any additional spares which may be ordered by the Principal after the date of Contract award. The Contractor must deliver additional spares at the prices listed subject to the qualification that, if any spares are ordered after the Date of Practical Completion, the price may be subject to adjustment.

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- 3.17.5 All spares supplied must be strictly interchangeable with the parts for which they are intended to be replacements. The Contractor must treat and pack all spares supplied for long storage under the climatic conditions prevailing at the Site.
- 3.17.6 The Contractor must provide any spares required by the Contractor up to the Date of Practical Completion at its own expense.
- 3.17.7 The minimum amount of spares that the Principal requires is shown in Schedule "TC". The Contractor must add to this list any additional spares recommended.
- 3.17.8 The Principal reserves the right to determine which additional spares will be purchased and no commitment is made to take all of those listed or suggested in the Schedule.
- 3.17.9 All spares supplied must be clearly labelled on the outside of the packing with description and purpose and, where more than one spare is packed in a single case or other container, a general description of its contents is to be shown on the outside of such case or container and a detailed list enclosed inside. All spares supplied must have all cases, containers and other packages suitably marked and numbered for purposes of identification.

3.18 SPECIAL TOOLS AND TEST EQUIPMENT


- 3.18.1 The Contractor must provide a list of special tools and test equipment in Schedule "TD" which the Contractor considers the Principal will need to install and service or to locate and rectify faults in the equipment supplied. This applies only to equipment supplied by the Contractor.
- 3.18.2 The Contractor must offer special tools and test equipment including (but not be limited to) the following:
- Any special tools or gauges required for the normal maintenance of the substation plant and equipment.
 - Any special lifting and handling appliances required for the normal maintenance of the substation plant and equipment.
- 3.18.3 The Principal reserves the right to determine which special tools and test equipment it will purchase and no commitment is made to take all of those listed or suggested in the Schedule.
- 3.18.4 Any special tools and test equipment will be stored in cupboards or on racks in the substation control building.

3.19 WORKS PROGRAM

- 3.19.1 The Contractor must develop the Works Program to be used as a basis for planning and executing the Contractor works. The Contractor must develop the Works Program prior to project pricing and commencement of negotiations, and keep it updated at monthly Contract meetings and whenever significant variation to the program occurs.
- 3.19.2 The Works Program must show all the dates and periods of time required for the design, preparation of drawings, placement of sub orders, the various stages of manufacture, testing, delivery, installation and commissioning including the Principal's activities. The Works Program must also show all associated activities by the Principal.
- 3.19.3 The Works Program must show all major milestones (i.e., important dates) required to meet the Contract completion dates and highlight the critical path for the project.
- 3.19.4 Within two (2) weeks from the "Date of Acceptance of Tender" the Contractor must supply an updated Works Program for approval by the Principal's Representative.
- 3.19.5 The Contractor must take the rainfall pattern into account in planning the program to complete the works. Wet weather is not admissible for extensions of time. It is the Contractor's responsibility to determine the likely extent of wet weather.

3.20 MEETINGS

- 3.20.1 The Contractor must allow for all costs involved in monthly Contract progress meetings with the Principal's Representative.

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3.20.2 The Contractor must schedule monthly Contract progress meetings starting at a time suitable to both parties immediately following award of the contract and then monthly or as required throughout the project.

3.20.3 The Principal's Representative will record items discussed at the meetings and document these into written minutes. The Contractor must confirm the written minutes.

3.21 LOCAL AND OTHER AUTHORITIES NOTICES AND FEES

3.21.1 The Contractor must comply with all By Laws and Regulations of Local and other Statutory Authorities having jurisdiction over the work. The Contractor must be responsible for the giving and receiving of all necessary notices and the payment of all fees and charges.

3.21.2 In the event that the Principal's Representative lodges and pays charges for Building, Plumbing, Workplace Health and Safety, and Fire Brigade applications in order to expedite the commencement of works, all such charges will be advised, and the Contractor must deduct those charges from the Contract Sum.

3.22 WORKMANSHIP AND MATERIALS

3.22.1 Unless otherwise specified, all materials used must be entirely suitable for the intended application, whether stated or implied, and be free from defects.

3.22.2 Where materials or work methods are included in the published Standards of the Standards Association of Australia, the materials and workmanship used must not be inferior to those in the relevant standard.

3.22.3 Where materials bearing the Australian Standards Mark are available, these materials must be the minimum standard for use.

3.22.4 The Contractor must carry out and complete all construction work to the satisfaction of the Principal's Representative.

3.23 ASBESTOS

3.23.1 All equipment and materials used must not contain asbestos.

3.24 VARIATION OF MATERIALS

3.24.1 The Contractor must substitute materials to allow for materials that become unobtainable, subject to the Approval of the Principal's Representative.

3.24.2 The Contractor must submit all such variations to the Principal's Representative for Approval, and include the variations in the Contract Sum at the time of authorisation.

3.25 MINOR ITEMS

3.25.1 The Contractor must allow for all items of a sundry and minor character necessary and intended for the thorough completion of the work, although they may not be specifically described herein or indicated on the drawings.


3.26 APPROVAL

3.26.1 Where terms such as 'approved', 'approval', 'selected', or 'as directed' are used in this Specification, the Contractor must obtain such approval, selection or direction from the Principal's Representative. The Principal's Representative may delegate such tasks to an authorised representative.

3.27 SITE CONDITIONS, SERVICES, AND HOURS OF WORK

3.27.1 The Contractor must ascertain and comply with site security/induction requirements and any other limitations imposed by the Principal and/or the Principal Contractor.

3.27.2 The Contractor must provide suitable facilities at the Sites to adequately protect all plant and equipment during the Site works.

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- 3.27.3 The Contractor must make arrangements for the installation of the Contractor's telephone, site offices, accommodation, sanitary facilities, water etc, in accordance with the latest Queensland Workplace Health and Safety Act and Regulations.
- 3.27.4 The Contractor must not use the substation buildings as site offices, unless authorised to do so by the Principal's Representative.
- 3.27.5 Where a work site is within an energised (or capable of being energised) substation, access is only available to authorised persons who have successfully completed Ergon Energy's Safe Entry to HV Enclosure training. Access can be granted to visitors who have not completed the training by maintaining direct supervision of them at all times by someone who has completed the training.
- 3.27.6 Access can be granted to visitors who have not completed the training by maintaining direct supervision of them at all times by someone who has completed the training.
- 3.27.7 Measures will also be implemented to inform the Principals agents and operational staff who may be required to enter the substation in the Principal Contractor's absence of potential hazards.
- 3.27.8 The Contractor must keep the site securely locked at all times.

3.28 SITE USAGE

- 3.28.1 The Contractor must confine the works to the immediate area of the Site.

3.29 DISCREPANCIES

- 3.29.1 Although care is taken to try to ensure consistency of documents, the Contractor must note that everything shown on the drawings, whether included in this Specification or not, is deemed to be included in the Specification. Similarly, the Contractor must not consider part of this Specification invalid on the basis of not being indicated on a Drawing. In the event of divergence between Drawings and this Specification, the Contractor must obtain and follow the Principal's Representative's decision.

3.30 ATTENDANCE ON APPROVED SUBCONTRACTORS

- 3.30.1 The Contractor must supervise and co-ordinate the work of approved sub-contractors, ensuring that the requirements of their work are carried out in proper sequence.
- 3.30.2 The Contractor must provide facilities and allow for attendance upon all Approved sub-contractors.
- 3.30.3 The Contractor must not make any claims for extensions of time for failure to include in the Works Program, the time required by the Approved sub-contractors to complete their works. No claims will be allowed for extra attendance due to failure to comply with this Requirement.

3.31 PROTECTION OF WORKS


- 3.31.1 The Contractor must ensure that no equipment is damaged as a result of reasonable handling during the progress of the works. Equipment and finished surfaces should be suitably protected during progress of the works, as necessary. For any plant, materials, or equipment subjected to injury or staining, the Contractor must be responsible for making good to "as installed new condition", all damage caused to such finished surfaces and materials during the progress of the contract.

3.32 PROTECTION OF ADJOINING PROPERTIES

- 3.32.1 The Contractor must take care not to damage public and private properties, land, streets, including public utilities and the soil and space beneath such properties and lands and streets abutting and/or adjacent to the works. The Contractor must make good any loss or damage caused.

3.33 ENVIRONMENTAL PROTECTION REQUIREMENTS

- 3.33.1 The Contractor must comply with Ergon Energy's MP000903R117 Environmental Protection Requirements.

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3.34 SEPARATE CONTRACTS

- 3.34.1 The Principal may at times let other separate contracts for works to be carried out within the building or site. The Contractor must negotiate with the Principal's Representative during the currency of the works to arrange access for other separate contracts for works to be carried out. The Contractor must grant access to the building or the Site and give reasonable conditions for carrying out the works of the other separate contracts.

3.35 SUBSTATION OPERATION MANUALS


- 3.35.1 As part of the establishment of a new substation at two (2) months prior to the project commissioning date, the Contractor must supply up to two (2) copies of preliminary Substation Operating Manual, properly printed and contained in suitable binders. The Substation Operating Manual must define the erection, maintenance and operating procedures for each item of plant included in the Contract.
- 3.35.2 A typical example of a Substation Operations Manual will be provided by the Principal on request.
- 3.35.3 The Substation Operations Manual must contain any additional descriptions, details, diagrams and charts requested by the Principal's Representative or found necessary or desirable by the Contractor to ensure the safe and efficient operation of the plant. The Substation Operations Manual must contain additional information to include (but is not limited to) information specified above as well as the following:
- Details of "as installed" alignment errors.
 - All modifications made to the plant during erection and commissioning.
- 3.35.4 Following acceptance of the preliminary manual, the Contractor must supply four (4) final version of the Substation Operations Manual contained in 4-ring binders suitable for the easy insertion of amendments by the Principal at a later date and be of durable construction. The Contractor must also supply one (1) copy of same Substation Operations Manual in electronic form, fully compatible with Microsoft Word.

3.36 RATING PLATES AND NAMEPLATES

- 3.36.1 All equipment must incorporate a Rating Plate showing all relevant data in accordance with the appropriate Australian Standard for that equipment.
- 3.36.2 Equipment Rating Plates and Nameplates must be of non-ferrous metal or stainless steel material with etched or engraved lettering and attached with stainless steel screws or Monel rivets. Equipment Rating Plates and Nameplates must be located on each item of equipment so that they can be read clearly and safely by a person standing at ground level.

3.37 LABELS

- 3.37.1 All equipment, operating devices, and relays must be suitably labelled such that they can be readily identified from drawings. Circuit breaker panels, control panels, and relay panels must also be labelled.
- 3.37.2 All equipment labels must be submitted to the Principal's Representative for approval, generally included within or as part of the design drawings.
- 3.37.3 Indoor equipment labels must be engraved traffolyte or other approved material including Brady stick-on printable label sheets. Labels installed on outdoor equipment must be aluminium or stainless steel and fixed with Monel rivets.
- 3.37.4 Equipment labels must be located such that they are easily read from normal operating positions and access ways around the equipment.
- 3.37.5 Cubicles and switchboard panels, which have rear access, must also be labelled on the rear of the panel.

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4. SUBSTATION DESIGN REQUIREMENTS

4.1 GENERAL

- 4.1.1 This section describes the Principal's substation design requirements.
- 4.1.2 Additional substation design requirements are defined in the Ergon Energy Substation Standard document, SS-1-1.4 Substation Design Requirements.
- 4.1.3 In the event of conflict between SS-1-1.4 Substation Design Requirements and this Specification, the Contractor must request clarification from the Principal's Representative.

4.2 DESIGN STAFF

- 4.2.1 The Contractor must provide sufficient staff to promptly rectify any design deficiencies discovered by the testing and commissioning activities.
- 4.2.2 Maximum expected turnaround times for response by design staff are:
- 1 week – where construction is planned but has not yet commenced and construction schedule is not delayed or impacted by the response.
 - 3 days – where construction has commenced but the construction schedule is not delayed or impacted by the response
 - 24 hours – where testing and/or commissioning activities has commenced.

4.3 DESIGN CRITERIA

- 4.3.1 The Contractor must design the works to suit the environmental and system conditions defined in SS-1-1.4 Substation Design Requirements.

4.4 SAFETY CONSIDERATIONS

- 4.4.1 The design must meet Safety Considerations requirements of SS-1-1.4 Substation Design Requirements.

4.5 ENVIRONMENTAL RESPONSIBILITY


- 4.5.1 The design must meet Environmental Responsibility requirements of SS-1-1.4 Substation Design Requirements.

4.6 SECURITY OF SUPPLY AND NETWORK PERFORMANCE

- 4.6.1 The design must meet Security of Supply and Network Performance requirements of SS-1-1.4 Substation Design Requirements.

4.7 SWITCHYARD

- 4.7.1 Switchyard design must meet the requirements of SS-1-1.4 Substation Design Requirements.
- 4.7.2 Lighting within the switchyard must be designed to achieve the following minimum lighting levels:
- 20 lux within the main working areas;
 - 60 lux at major plant items including marshalling boxes and control cubicles.
- 4.7.3 The design must also take into account neighbouring residences or building and the effect the switchyard lighting has on those areas, when considering required lux levels. The Contractor must perform a lighting study to confirm the lux levels around the substation yard and boundary. The lighting study must include a plan view of the switchyard with lux levels shown, details of the type and angle of light, and the location and height of the mast.
- 4.7.4 Switchyard lighting must consist of weatherproof floodlights, located on dedicated lighting poles and switched from inside the building. Floodlights should be a suitable high quality, energy efficient light installed at 45-60 degrees or an angle suitable to maximise the effectiveness of the light.

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4.7.5 Lighting poles must be Hot Dipped Galvanised and hinged at the base or mid-way up the pole to ensure maintenance is capable of being performed at ground level without the use of ladders or elevated work platforms. The design must check swing down or hinged poles with the proximity to HV equipment to ensure exclusion zones are not encroached when performing floodlight maintenance.

4.8 PROTECTION

4.8.1 GENERAL

4.8.1.1 Protection design must meet the requirements of SS-1-1.4 Substation Design Requirements, SS-2-2.1 Protection and the ZSS template drawings. Additional requirements are detailed below.

4.8.1.2 The Contractor must design protection systems for all transmission, sub-transmission and distribution feeders, busbars, power transformers, capacitor banks, and all ancillary equipment whether directly specified or not.

4.8.1.3 The Contractor must design everything necessary for, or usually supplied as part of, the Protection Systems, except for protection relays supplied by the Principal. All items supplied by the Contractor must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

4.8.2 PROTECTION RELAYS

4.8.2.1 The protection schemes and relays to be used are detailed in Secondary Systems Design Brief for the project. The Contractor must ensure the design incorporates all of the protection functions included in the Secondary Systems Design Brief and will operate correctly and safely.

4.8.2.2 The design must use relays selected from the Principal's current period contract where available. The Contractor may request a list of current period contract protection relays from the Principal. Where a relay is not available on the period contract for a particular application, the Contractor must obtain the Principal's approval for its use for that application.

4.8.2.3 The Principal will supply all protection relays as free issue to the Contractor, including any chosen by the Contractor that are not on the Principal's period contract. All protection relays selected must comply with the relevant standards, in particular IEC publication 255-1971-1978 – Electrical Relays.

4.8.2.4 The application of all relays must be as per Ergon Energy's Relay Application Guides where available. Relays must be wired and mounted in the protection cubicles in accordance with the ZSS template drawings.

4.8.3 INSTRUMENT TRANSFORMERS


4.8.3.1 The fault levels and system data provided in this Specification must be used in the design of the protection scheme and current transformer and voltage transformer performance requirements.

4.8.3.2 Current transformer and voltage transformer performance requirements not specified by the Principal must be determined by the Contractor and submitted to the Principal for approval.

4.8.3.3 The Contractor must check specified current transformer and voltage transformer performance for adequacy. If the performance is found to be inadequate, the required performance must be determined by the Contractor and submitted to the Principal for approval.

4.8.4 TRIP CIRCUITS

4.8.4.1 All protection relay contacts used for tripping, indication, or alarm must be of robust and reliable construction. All contacts must be clean and have appropriate current ratings to match the required duty.

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- 4.8.4.2 Where relays/systems do not provide adequate facilities or ratings to trip all required devices, tripping must be achieved by auxiliary trip relays initiated from the individual protection relays/systems.
- 4.8.4.3 Separate trip relays must be provided for transformer protection schemes and bus protection schemes. These relays must have latching contacts that can be reset locally and remotely via SCADA.
- 4.8.4.4 All other tripping relays must have self reset contacts and continuously rated operating coils.
- 4.8.4.5 Operation indicators must be provided on the transformer and bus protection systems trip relays but are not required on trip relays used for contact reproduction on feeder systems etc.
- 4.8.4.6 Flags or LED's are equally acceptable. Flags or LED's must be reset by the same system that resets the contacts.

4.8.5 RELAY - SCADA COMMUNICATION INTERFACE

- 4.8.5.1 All protection relays must have a rear communications port that communicates, via DNP3 protocol, with the SCADA Substation Remote Terminal Unit (RTU).
- 4.8.5.2 The communications link must transfer all measured analogue quantities (examples are shown in Table 10), alarms, and binary indications from the relays to the SCADA as well as commands from the SCADA to the relay.

Table 10 Analogue Quantities


	Analogue Quantity
Ia	A phase current
Ib	B phase current
Ic	C Phase current
In	Residual/neutral current
Vab	A to B phase voltage
Vbc	B to C phase voltage
Vca	C to A phase voltage
kW	Signed kW load
kVAr	Signed kVAR load

- 4.8.5.3 The following control functions shown in Table 11 must be initiated and their state monitored from the remote SCADA terminal via the communications link from the RTU to the relay.

Table 11 Control Functions

Item	Control Function
Circuit Breakers	Control OPEN/CLOSE
Auto Reclose	BLOCK/ENABLE
Sensitive Earth Fault Protection	BLOCK/ENABLE
Setting Group	SELECT
Alarms	RESET

- 4.8.5.4 Where discrete local controls are specified, they may be by means of protection relays that incorporate discrete programmable switches/pushbuttons and status indication by LED's or similar on their front panel. Failing this the alternative of discrete panel mounted switches and operation indication is acceptable.
- 4.8.5.5 An additional rear RS-232 serial or Ethernet communications port on each protection relay is provided to remotely facilitate full management of the relay. This includes remotely downloading setting revisions, comparison of relay settings with database values, and uploading of event and disturbance reports. A third non networked port is provided on the

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front of the relay to allow the same relay management functions locally as the engineering port specified.

- 4.8.5.6 The Contractor must provide fibre optic communications connections from the relays to all remote devices.
- 4.8.5.7 The Contractor must ensure adequate isolation is maintained between devices and that communication cables do not compromise the integrity of any interzone insulation that may be used (e.g. if a frame leakage protection system is used).
- 4.8.5.8 The Principal is responsible for the calculation of all programming and settings of the protective systems.
- 4.8.5.9 All relays/systems with internal clocks for event/disturbance recording must include a system to synchronise their clocks with the SCADA RTU.
- 4.8.5.10 The SCADA RTU clock must be the master clock in all cases.
- 4.8.5.11 Each protection relay must be provided with test facilities (Areva MMLG02 or equivalent) to enable secondary injection, equipment isolation, and rapid fault finding.
- 4.8.5.12 The test facilities must be readily accessible from the front of the cubicle and must be adequately labelled as to their function.
- 4.8.5.13 Fuses must be provided for the protection and isolation of control, alarm, indication and VT circuits. Fuses must be of HRC (High Rupturing Capacity) of GEC manufacture, type "NS" of the cartridge type or technically equivalent. Fuse carriers and bases must be coloured black.
- 4.8.5.14 Solid links must be supplied in the neutral circuits. Neutral link carriers and bases must be coloured white.
- 4.8.5.15 Separate fuses and links must be provided in the DC supply to the protection, control and alarm circuitry associated with each high voltage bay, such that the removal of the relevant fuse and link will allow work on the circuitry for that bay, without interruption to the supply to any other bay.
- 4.8.5.16 Test/Disconnect links must be provided on all CT & VT circuits.

4.9 CONTROL & SCADA

4.9.1 GENERAL

- 4.9.1.1 Control and SCADA design must meet the Control & SCADA requirements of SS-1-1.4 Substation Design Requirements, the SS-2-3.x series of SCADA substation standards and the ZSS template drawings. Additional requirements are detailed below.
- 4.9.1.2 The Principal has a Supervisory Control and Data Acquisition (SCADA) system. This system monitors significant substation parameters via Remote Terminal Units (RTU's) located at each substation. Communication links between the master station and the RTU's enables this data to be telemetered back to the control centre. Similarly, the ability to control remote plant is provided. Local Control Facilities (LCF's) may also be provided to allow operators to monitor and control plant locally.
- 4.9.1.3 The SCADA RTU system must provide the following automatic control features where applicable:
- Circuit breaker auto-reclosing if it cannot be carried out in protection relay;
 - Transformer automatic voltage control;
 - Tap changing;
 - Automatic capacitor control
- 4.9.1.4 All PLC's/RTU's/LCF's installed into the substation will be provided by the Principal.
- 4.9.1.5 The Contractor must have the point listing approved by the Principal prior to finalisation of the design.

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4.9.1.6 The Principal is responsible for all the programming and settings of the SCADA systems.

4.9.1.7 The Contractor must be responsible for the design of;

- Rack mountable 19" RTU bins with sufficient I/O and communications ports for the substation remote control and monitoring requirements, and connection to master station communication system.
- DC supplies and earthing of RTU bins
- All external cables from plant to the RTU
- All necessary contacts and terminals, wiring, transducers, and communications for inputs and outputs to/from plant and between distributed RTU's

4.9.1.8 The number of and location of RTU bins must be as defined in the ZSS template drawings. Where there is ambiguity, confirmation must be obtained from the Principal.

4.9.2 WIRING AND TERMINALS

4.9.2.1 All inter-panel copper cabling to the RTU bins must be terminated on suitable terminal strips within the cabinet in which the RTU is mounted, and then be wired to the RTU interface cards.

4.9.2.2 At the RTU panel, interface terminals/links must be provided such that there is one isolation link for each circuit. Terminals/links must be approved by the Principal before the design is completed.

4.9.2.3 All cabling and fusing must be suitably co-ordinated to protect the smallest cabling installed.

4.9.2.4 The following wiring must be used:

- DC supply – 2.5mm² copper conductor (7/0.67).
- Plant to RTU interface terminals – minimum 1.0mm² copper multi-strand conductor (7/0.40). All inter-panel cabling must have as a minimum a wrapped aluminium foil screen with drain wire. All control cabling must be overall screened.
- RTU interface terminals to RTU interface cards – minimum 7/0.2 (24AWG) multi-strand copper conductor.
- RTU to RTU (Distributed) and RTU to IED (Intelligent Electronic Device) – fibre optic preferred, or alternatively screened copper communications cable, provided isolation between devices of 2kVrms 1 minute can be achieved.

4.9.2.5 The Contractor must provide the intended basic design philosophy, including a complete list of all I/O and the intended source of I/O whether hard wired or via an IED, for determination of required RTU configurations, to the Principal.


4.9.3 IED PROTOCOLS

4.9.3.1 Unless otherwise approved by the Principal's Representative, the communications protocols to be used between any IED and the RTU, must be DNP3.00. The communications medium between the IED's and the RTU must be fibre optic or RS485 with isolation of 2kVrms for 1 minute. Where Fibre Optic is used, "star coupler" type devices must be provided to rationalise the number of fibre ports required on the RTU.

4.9.3.2 Equipment must be distributed on the communications ports such that there is:

- One fibre system per distribution (66/11kV) bus section,
- Each main transformer must be monitored on different fibre systems
- The transmission and sub-transmission system must be distributed across at least two fibre systems.

4.9.3.3 A typical installation would have 4 fibre systems back to the RTU.

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4.9.3.4 The Contractor must guarantee correct scanning and controlling of IED parameters between the IED and the RTU where these are nominated as the source of the I/O.

4.9.4 INPUTS AND CONTROLS

4.9.4.1 Digital inputs provide indications of plant status (e.g. Circuit Breakers) and alarm conditions (e.g. substation battery alarm). The preferred source of these inputs is hardwired points direct from the device to the RTU. Alternatively they may be either auxiliary contacts or interposing relays.

4.9.4.2 The Contractor must connect all analogue inputs via a transducer to the RTU. If the major plant or equipment already has transducers supplied for analogue inputs such as power transformers, then these can be connected directly to the RTU.

4.9.4.3 Transducers must supply a DC current output to the RTU inputs as well as provide electrical isolation.

4.9.4.4 The Contractor must provide digital controls as direct hardwired controls from the RTU to the plant or auxiliary relays.

4.9.4.5 Several panel switches must be installed as part of the SCADA installation. The status of these switches must be monitored by the SCADA system:

- Circuit Breaker Control Point Select Switch
- Transformer Tap-Changer Control Select Switch
- Work Clearance Switch (WC)
- Auto Reclose Switch (AR)
- Sensitive Earth Fault Protection Switch (SEF)

4.9.4.6 Make and model of switches, escutcheon plates, wiring and illumination lamps switches must be as specified in the ZSS template drawings.

4.10 METERING

4.10.1 GENERAL

4.10.1.1 Metering design must meet the Metering requirements of the SS-1-1.4 Substation Design Requirements, SS-2-4.1 Metering and the ZSS template drawings. Additional requirements are detailed below.

4.10.1.2 This section describes the metering requirements to be designed by the Contractor.


4.10.1.3 The metering installation must be designed to be entirely satisfactory for the service conditions and intended operational requirements, whether directly specified or not.

4.10.1.4 The Contractor must be responsible for the design of;

- Panel metering equipment on each control panel including all CB's, Battery Charger, and others.
- SCADA metering equipment comprising transducers and other hardware in the various panels (including all CB's, Battery Charger, and others), and connected to the SCADA RTU/s.
- A free standing 19" rack cubicle wired and fitted with statistical and/or revenue metering equipment. Meters and ESAA test blocks will be free issued to the Contractor.
- Local Supply metering to meter the total local supply kWh Meters. Meters and ESAA test blocks will be free issued to the Contractor.

4.10.2 PANEL METERING

4.10.2.1 Refer to SS-2-4.1 Metering and the ZSS template drawings for meter make, model, panel location and wiring.

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4.10.2.2 All analogue panel meters must conform to the requirements of BS 60051

4.10.3 STATISTICAL AND REVENUE METERING

- 4.10.3.1 All revenue metering drawings must be approved by the Principal prior to any finalisation of design drawings. The Contractor must issue relevant drawings to the Principal's Representative for this approval.
- 4.10.3.2 Meter types, mounting details and panel locations, and standard wiring must be as specified in SS-2-4.1 Metering and the ZSS template drawings
- 4.10.3.3 The statistical metering must record substation bus voltage and total station load, as well as any capacitor banks. Dedicated revenue Metering and associated VT's and CTs are required where a customer is to be supplied directly from a Substation feeder.
- 4.10.3.4 All Integrating meters, ESAA test blocks, GSM / NextG phones and modems (where applicable) will be free issued to the Contractor.
- 4.10.3.5 The Contractor must provide a connecting cable from the telephone isolation equipment to the meter panel or install a suitable GSM / NextG phone antenna to the exterior of the building. The modem requirements will be specified by the Principal.
- 4.10.3.6 The Contractor must design all cabling and terminations of metering cubicles. All terminals and marshalling boxes associated with revenue metering must be sealable.
- 4.10.3.7 Should matching or ratio correction CTs be required, the Contractor must calculate the required ratings. Matching or ratio correction CTs must be mounted inside the cubicle.
- 4.10.3.8 For statistical and revenue metering purposes, the CT and VT load information in Table 12 may be assumed.


Table 12 CT and VT load information

kWh 3Ph, 4w	Voltage Circuit	< 3 VA per phase voltage
	Current Circuit	< 0.5 VA per current coil
	Meter Burden	< 5 VA (Aux Supply with Voltage circuits de-energised)

4.10.3.9 Note that meter burden is shared across all 3 phases in normal operation.

4.10.4 METERING VOLTAGE TRANSFORMERS

- 4.10.4.1 The Contractor must design voltage selection relays and must provide the control necessary to automatically select the highest ranked VT according to the VT ranking advised by the Principal. Voltage selection relays must be specified by the Contractor and supplied by the Principal.
- 4.10.4.2 The VT rated burdens specified are based on estimated loads. The Contractor must design VT's with adequately rated burdens such that the load on each metering winding at rated voltage will lie between 25% and 70% of the winding's rated burden. Where this requires variation from the rated burdens specified, the Contractor must submit revised ratings to the Principal for approval.
- 4.10.4.3 Metering VT loads must be balanced on all three phases as far as possible. For any 3 single phase VT installation, the least loaded metering winding must not carry less than 80% of the load experienced by the most heavily loaded metering winding. The Contractor must follow Manufacturers' installation guides for transducers and meters with respect to metering inputs. VT balancing is to be achieved via appropriate assignment of auxiliary supply and single phase metering load. Any shortfall may then be made up with resistors having the appropriate temperature rating, and be connected close to and on the load side of the VT terminals such that the burden measured at the VT terminals will include the effects of the resistive burden. All resistors must be adequately ventilated and mounted so any generated heat does not affect other components.

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4.10.5 METERING CURRENT TRANSFORMERS

- 4.10.5.1 The CT rated burdens have been specified on the basis of estimated loads. The Contractor must ensure that CTs are rated such that the total burden at rated current on each metering winding lies between 25% and 70% of the winding's rated output. Where this requires variation from the rated outputs specified, the Contractor must submit revised ratings to the Principal for approval.
- 4.10.5.2 Each metering core of a 3 phase installation must be loaded to achieve an acceptable balance between phases. The least loaded core must carry not less than 80% of the load experienced by the most heavily loaded metering core. 3Ph, 3w transducers and meters must be wired to the preferred phases indicated in their appropriate installation guides.
- 4.10.5.3 Dummy loads may be fitted where necessary, for balancing purposes and to achieve the loadings stipulated above. Dummy loads must be connected close to and on the load side of the CT terminals such that the burden measured at the CT terminals will include the effects of the applied burden.


4.10.6 TRANSDUCERS

- 4.10.6.1 The transducers to be supplied are divided into three categories:
- Those with analogue outputs
 - Those with digital outputs
 - Those with pulsing contact outputs
- 4.10.6.2 Transducers from categories (a) and (b) supply inputs to the SCADA remote terminal units and in a few cases, panel metering. Statistical metering must utilise Category (c) transducers.
- 4.10.6.3 All analogue output transducers must conform to AS 1384 and must have provision for scale (span) adjustment so that 10mA output converts to full scale deflection on the related meter.
- 4.10.6.4 For the purpose of determining the specified rated burdens for CT's and VT's, output transducer burdens were based on the following loads:
- Active transducer, current circuit 0.5 VA
 - Active transducer, voltage circuit 1 VA
 - Active transducer, auxiliary supply 3 VA
 - Passive transducer, current circuit 1 VA
- 4.10.6.5 Should transducers with higher burdens be offered, the CT and VT ratings specified may need to be reviewed. The Contractor must submit any revised ratings to the Principal's Representative for approval.

4.11 COMMUNICATIONS

4.11.1 GENERAL

- 4.11.1.1 Communications design must meet the Communications requirements of SS-1-1.4 Substation Design Requirements and the ZSS template drawings. Additional requirements are detailed below.
- 4.11.1.2 In general the communications equipment within the substation will be supplied and installed by the Principal, however some communications related work is included in the scope of this contract;
- Public telephone services and telephone isolation equipment
 - Communications equipment cubicles
 - Communications power supplies (as specified in WS-1-5.1 DC Supplies)

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4.11.2 TELEPHONE SERVICES

- 4.11.2.1 Where required, the Contractor must arrange for the installation of a 10 Pair lead-in cable from the public telephone network for connection of public switched telephone services to the substation. This will include installation of telecommunications conduits from the property boundary to the substation control building, and, in consultation with the Carrier's contractor, from the property boundary to the public network connection point.
- 4.11.2.2 All materials used must be in accordance with AS/ACIF S008:2001 – Requirements for Authorised Cabling Products. All telecommunications equipment must be installed in accordance with AS/ACIF S009:2001 – Installation Requirements for Customer Cabling (Wiring Rules).
- 4.11.2.3 As a special requirement the telecommunications conduits and cables within the substation must be unbroken between the property boundary and the telephone line isolation unit in the substation building. The use of telecommunications pits within the substation boundary is not permitted. The Principal will be responsible for making application to the Carrier for the appropriate public telephone services.
- 4.11.2.4 Where required, a telephone Line Isolation Unit (LIU) must be installed in the substation to isolate the public telephone network from the telephone equipment installed in the substation. The telephone line isolation unit must be equipped with sufficient high voltage isolation links to allow for termination and isolation of the 10 pair lead-in cable.
- 4.11.2.5 The LIU must use optical isolation techniques to provide the isolation between the public telephone network and the substation telephone equipment. A minimum of 100kV electrical isolation is required between the incoming exchange line and the subscriber equipment in the substation.
- 4.11.2.6 The LIU must be equipped with sufficient isolation modules to isolate two PSTN telephone lines and be capable of expansion to provide isolation for four telephone lines by the addition of isolation modules.
- 4.11.2.7 The exchange side isolation unit must be powered from the Carrier's network. The subscriber side isolation unit must be powered from the substation DC supply.
- 4.11.2.8 The LIU must be manufactured from insulated material and must be located in the substation building such that there is a minimum of two meters clearance from any earthed metal object.

4.11.3 COMMUNICATIONS EQUIPMENT CUBICLES


- 4.11.3.1 Communications cubicles must be standard cubicles from the Principal's period contract supply.
- 4.11.3.2 The Contractor must allow a sufficient number of cubicles in the building layout for the communication cubicles. The Contractor must obtain approval for the number of cubicles from the Principal.

4.11.4 COMMUNICATIONS ANTENNA

- 4.11.4.1 Where indicated, the Contractor must design a concrete communications antenna pole based on the standard Communications pole drawings supplied by the Principal.

4.11.5 FIBRE OPTIC DUCTS AND TERMINATIONS

- 4.11.5.1 Where required, the Contractor must provide fibre optic cable ducts and termination enclosures as per drawing 899364-01 or 899364-02.
- 4.11.5.2 The termination enclosures, splice enclosures, and pits must be mounted in a position as agreed by the Principal. The internal OFS 800 termination enclosure must be mounted on the wall of the equipment room as close as practicable to the communications equipment cubicles.
- 4.11.5.3 Ducting suitable for the installation of fibre optic patch cables must be provided from the termination enclosure to the communications equipment cubicles and between termination enclosures.

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4.11.5.4 The location and type of the outdoor conduits, pits and termination enclosures will depend on the incoming optical fibre cable type and location of the terminating structure. Where more than one fibre optic cable enters the substation the conduits for each cable must follow diverse paths into the substation control building and must not use common pits or ducts or termination enclosures. The final position of conduits and cable pits must be subject to approval by the Principal.

4.12 AC AUXILIARY SUPPLIES

4.12.1 The design of AC supplies must meet the requirements of SS-1-1.4 Substation Design Requirements, SS-1-5.2 AC Supplies, AS 3000 Wiring Rules and the ZSS template drawings. Additional requirements are detailed below.

4.12.2 This section describes the general design requirements of the low voltage 415V AC supply system.

4.12.3 The Contractor must design everything necessary for, or usually designed as part of the 415V AC supply system. All items nominated by the Contractor must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

4.12.4 The Contractor **must**, design the 415V AC three phase main switchboard and sub-boards in accordance with SS-1-5.2 AC Supplies and the ZSS template drawings.

4.12.5 The metering requirements for the 415V AC system are as per Section 4.10 of this Specification.

4.13 DC AUXILIARY SUPPLIES

4.13.1 The design of DC supplies must meet the requirements of SS-1-1.4 Substation Design Requirements, SS-1-5.1 DC Supplies and the ZSS template drawings. Additional requirements are detailed below.

4.13.2 Within the substation there will be one or two 110V Substation DC Supply systems to supply the protection and plant within the substation, and a 48V Communications DC Supply System, if required, to supply communications and control equipment.

4.13.3 This section describes the general requirements of the batteries, battery chargers, battery stands, DC/DC converters, DC/AC converters, and DC distribution boards for the Substation DC Supply Systems and the Communications DC Supply System.

4.13.4 The design of the DC Supply Systems must allow for the ultimate development of the substation.


4.13.5 Each DC Supply System must be a high reliability standby system consisting of battery banks (each battery bank consists of 2 battery strings in parallel), (always required for 110V systems, conditionally required for 48V systems) supplied with individual isolation and protection (using Isolation and Test Panels) and connected to individual DC distribution boards and battery chargers (where batteries are included in the system). Where necessary, DC/DC Converters must be used to supply equipment at DC voltages other than 110V.

4.13.6 All items supplied by the Contractor must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

4.13.7 The Principal uses standard equipment based on the current period contract for DC systems. Drawings and specifications of all equipment can be supplied to the Contractor. The Contractor must use this standard equipment unless otherwise directed by the Principal.

4.13.8 The Contractor must design (including selection of suitable capacity and layout within control building) in accordance with SS-1-5.1;

- DC Distribution Boards
- Battery banks
- Battery chargers


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- Isolation and test panels
- DC/DC converters
- DC/AC inverters
- All cabling between the components

- 4.13.9 The 110V to 240V DC/AC inverter must be supplied from separate circuit breakers or fuses on the 110V DC Distribution Board or Boards. These circuit breakers or fuses may also supply a 110V to 50V DC/DC converter. Where both 'X' and 'Y' 110V DC Distribution Boards are required, the 110V to 240V DC/AC Inverter must be able to be supplied from the 'Y' 110Vdc supply as depicted in Drawing 907199-01.
- 4.13.10 The inverter must preferably be mounted within one of the communications equipment racks as shown in Drawing 907198-01. Alternatively the 110V to 240V DC/AC Inverter may be mounted in the AC Distribution Cabinet or wall mounted in a position as agreed by the Principal's Representative.
- 4.13.11 Bolts, nuts, washers and inter-connections must be of an inherently corrosion resistant material, or otherwise protected against corrosion in an acceptable manner.

4.14 HIGH VOLTAGE POWER CABLES

- 4.14.1 HV power cable design must meet the requirements of SS-1-1.4 Substation Design Requirements, SS-1-4.4 Substation Cables and Cabling and the cabling requirements of AS 2067. Additional requirements are detailed below.
- 4.14.2 The Contractor's responsibilities include the design of all the necessary high voltage cabling between equipment in accordance with this Specification.
- 4.14.3 The Contractor must design everything necessary for, or usually designed as part of the HV power cables. All items designed by the Contractor must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.
- 4.14.4 The Contractor must meet the following additional cable design requirements:
- Soil thermal resistivity must not be lower than 1.0 0K-m/W.
 - Conduits must be spaced to ensure required current ratings are met
 - Cables must be installed as to exclude cable wastage and cable damage
 - The finished cable routes must not undermine foundations of substation equipment or encroach on any other substation works
- 4.14.5 Each cable screen must be brought out under the heat shrink termination and terminated in a compression lug of suitable size in comparison to the screen conductor area. Screen tails must be of appropriate length to allow their connection to the earth points without the need for an additional linkage and routed so that phase to earthed metal clearances are not compromised.
- 4.14.6 Switchgear cable connection lugs must comply with AS 62271.301-2005 – Dimensional Standardisation and Terminals. The connections must be either two hole or four hole. A single hole connection must not be used.
- 4.14.7 HV power cables must be supported and clamped as the cables rise into the control building or onto the transformer. Cable clamps must be non-ferrous Cabus (or equivalent) two piece cast aluminium clamp or equivalent.
- 4.14.8 All cables from the power transformers must be permanently marked according to phase with appropriately coloured heat shrink PVC sleeving at four locations:
- Inside the transformer cable boxes.
 - Immediately outside the transformer cable boxes (single core cables).

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- Inside the indoor switchgear or the outdoor Ring Main Units.
- Immediately outside the indoor switchgear or outdoor Ring Main Units (single core cables).

4.14.9 All cables from the power transformers must be permanently labelled T1, T2 etc. at location (b) and feeder name/number at location (d).

4.14.10 For auxiliary transformer cables marking must be at locations (c), (d), and at or immediately beneath the cable outdoor terminations and permanently labelled Aux Transformer 1 or 2.

4.15 SECONDARY WIRING, TERMINALS AND MULTICORE CABLES

4.15.1 GENERAL

4.15.1.1 The design of secondary wiring, terminals and multicore cables must meet the requirements of SS-1-1.4 Substation Design Requirements, SS-1-4.4 Substation Cables and Cabling and AS3000 Wiring Rules. Additional requirements are detailed below.

4.15.1.2 This Section describes the design of secondary wiring, terminals and multicore cables for all AC and DC circuits, CT and VT secondary circuits, control, alarm and protection circuits.

4.15.2 SECONDARY WIRING

4.15.2.1 All Secondary Wiring must comply with the following common requirements.

- 0.6/1kV PVC/PVC insulated conductor conforming to AS 5000.1;
- Have stranded conductors;
- Have minimum conductor cross-sectional area of 2.5mm² for wiring associated with CT's and VT's and a minimum cross-sectional area of 1.0mm² for all other wiring associated with control, alarm and protection circuits. Voltage drop along control cabling must be allowed for when selecting cabling sizes.
- The cross-section of the multicore cables is selected to keep the loop resistance of CT secondary leads to 1Ω or less;
- Provide a separate conductor for the neutral in each 240Vac circuit;
- Be clamped at intervals of not more than 300mm or, alternatively, run in ducts;
- Earthing of equipment is arranged by each item being directly connected to the earth bar. Should looping of earthing wires be unavoidable it must be arranged so that removal of items of equipment from service during operation or maintenance must not interrupt the earthing connections to plant remaining in service;

4.15.2.2 All control and protection panel wiring must be grey.

4.15.2.3 Lettering and numbering must be in accordance with the Ergon Energy's standard system.

4.15.2.4 Secondary wiring associated with trip and closing circuits must be kept electrically separate from all other control wiring.


4.15.2.5 All secondary wiring terminal blocks, fuses etc, must be readily accessible through doors or readily removable plates which do not require the use of tools to open.

4.15.2.6 The Contractor must obtain the Principal's approval for Manufacturer's standard wiring within the item of equipment supplied.

4.15.2.7 All metallic cases of instruments, control switches, relays etc, mounted on control panels or in cubicles, must be effectively earthed to the nearest earth bar with stranded copper conductors of not less than 2.5mm².

4.15.2.8 All brass screened control cabling must be earthed to a suitable earth bar

4.15.2.9 All wiring, terminals and identification systems used on equipment of overseas origin must be supplied to the Principal's Representative for approval.

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4.15.3 CT SECONDARY LINKS AND TERMINALS


- 4.15.3.1 Terminals must be Klippon Type SAKC10 or equivalent. Not more than one connection must be made to each side of each terminal.
- 4.15.3.2 Terminal assemblies must be of the unit form suitable for mounting on a standard assembly rail, secured from the front and giving the required number of ways plus 25% spare.
- 4.15.3.3 All connections must be made at the front of the terminal boards and no live metal is to be exposed at the back.
- 4.15.3.4 Terminals in 415V and 240V AC circuits must be protected by inherent design features or an insulated cover to protect against inadvertent contact. All such terminal and surrounding barriers must be identified by red colouring and be marked in red "415/240V AC" by means of a label attached to the terminal barriers or covers.
- 4.15.3.5 The terminals in the SCADA panels must be as specified in Section 4.9.
- 4.15.3.6 The Contractor must submit detail on all terminal blocks they propose to use.

4.15.4 VT SECONDARY FUSING AND EARTHING


- 4.15.4.1 VT secondary circuits must be fused in the VT marshalling box. The VT terminal boxes must not contain any fuses.
- 4.15.4.2 Each VT secondary winding must be fused in each of A, B, C phases and for the star connected windings, a link must be provided in the neutral using a fuse holder and copper link.
- 4.15.4.3 Similarly a single phase VT secondary winding must be fused on the "a2" side and provided with a link on the "a1" side.
- 4.15.4.4 All fuses and links must be clearly labelled with the circuit function and fuse size or 'Link' as appropriate.
- 4.15.4.5 Where appropriate, warning labels must be fitted to fuses and links e.g. Distance Protection - Do Not Remove.
- 4.15.4.6 The secondary circuits of all VT's including auxiliary VT's must be earthed. Any disturbance to the connections must not at any time allow the VT to be unearthed. The earth connection must be made as close as possible to the VT's, with only one earth connection in each circuit.
- 4.15.4.7 In general the earthing must be by means of a solid connection between the earth bar and neutral. The following earth connections must be made:-
- Three phase voltage transformer circuits have their neutral terminals earthed at the VT marshalling box. The connection is made between the VT side of the link and the earth bar.
 - Single phase VT's earthed at the "a1" ends of their secondary windings at the VT marshalling box.
 - Open delta connected VT's earthed at the terminal corresponding to the C end of the A-C winding. The connection is made between the VT side of the link and the earth bar in the relay panel.

4.15.5 MULTICORE CABLES

- 4.15.5.1 Multicore secondary cables must generally be in accordance with AS 5000.3. At least 25% spare cores must be allowed in each cable. Cables must be sized with due regard for voltage drop and current rating.
- 4.15.5.2 All exposed outdoor wiring between terminal boxes and cubicles must be wired with PVC/PVC multicore cables protected from ultraviolet light by painting with single pack epoxy paint.

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- 4.15.5.3 PVC/PVC cables with double brass screen must be used for all cables which are laid in ducts or in PVC conduit. Control cabling must not be direct buried. Substation locations may have infestations of rats and termites.
- 4.15.5.4 The Contractor must provide adequate means of protection of all cables against attack by rats and termites to the satisfaction of the Principal's Representative. Insecticide impregnated outer cable sheaths must not be used. Where cables enter the building adequate vermin proofing must be installed.
- 4.15.5.5 The multicore cables must be connected to the station earth in a manner to reduce induced voltages. Both ends of each cable must have their screens earthed.
- 4.15.5.6 Cables must leave the concrete trench and then enter the equipment via suitable electrical grade PVC conduit set into the equipment foundations. Cables must enter the panels via an "in floor" ducting system designed by the Contractor.
- 4.15.5.7 Control cables must not be run in common ducts or conduits with HV cables. Cable segregation distances must be maintained in accordance with SS-1-4.4.
- 4.15.5.8 Core insulation and sheath material must be V75 grade PVC. Cables must be suitable for an operating voltage of 0.6/1kV. The cable must be routine tested to with-stand a 3.5 kV rms. voltage both between cores, and between cores and electrostatic screen.
- 4.15.5.9 In order to reduce induced voltages, cable runs **must**, wherever possible, be at right angles to the busbars. Where parallel runs are unavoidable, the multicore cables must be separated from the busbars by as large a distance as practicable.
- 4.15.5.10 Within the control building, so far as is possible, cables which extend outside the control building must be physically separated from internal cabling, and in particular from those cables containing low level signal circuits.
- 4.15.5.11 AC and DC circuits must be run in separate cables.
- 4.15.5.12 Where X and Y protections are used, X and Y secondary circuits must not be combined in the same cable.
- 4.15.6 WIRING DIAGRAMS**
- 4.15.6.1 The Contractor must provide a wiring schematic diagram, wiring connection diagram, and cable schedule for all secondary wiring to be installed.
- 4.15.6.2 The cable schedule must include the following details:
- Cable Number
 - Purpose
 - Destinations
 - Core Numbers or Colours Used
 - Cable Length
 - Cable Size
 - Cable Type
 - Spare Cores
- 4.16 EARTHING AND ISOLATION**
- 4.16.1 Earthing and isolation design must meet the requirements of SS-1-1.4 Substation Design Requirements, SS-1-7.1 Substation Earthing and SS-1-7.2 Safety Earthing.
- 4.16.2 The Contractor must design a complete earthing system strictly in accordance with the above standards.
- 4.16.3 The Contractor must ensure the earth resistance of the overall system is approved by the Principal's Representative. If earth resistivity measurements of the site are not supplied by

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the Principal, then the Contractor must conduct these measurements and submit them to the Principal's Representative for approval.

- 4.16.4 The Contractor must submit to the Principal's Representative the drawing for the proposed substation earth grid together with calculations and reports used in the design. The design of the earth grid must not be deemed to be satisfactory until approved in writing by the Principal's Representative. The Contractor must not proceed until such approval is given.
- 4.16.5 The design must comply with AS 2067, Clauses 5.6.2 "Design of Earthing System" and Clause 5.6.3 "Earthing of Fences and Outdoor Installations", and the requirements of IEEE Std 80. Where conflict arises in these documents, the more onerous requirement must be adopted in the design.
- 4.16.6 All equipment to be earthed must be connected to the earthing system.
- 4.16.7 The Contractor must refer to the Ergon Energy Substation Standard Earthing Drawings (EESS-10031-01 to EESS-10031-55) for all earthing connections.
- 4.16.8 The Contractor must liaise with Telstra Power Co-ordination Group to determine the maximum allowable earth potential rise.
- 4.16.9 The Contractor must provide main circuit operational safety earthing points (head connection terminals) for portable earths or fixed earthing devices at locations detailed in SS-1-7.2 Safety Earthing.
- 4.16.10 The Contractor must provide the Principal's Representative with a drawing for approval, showing proposed locations of main circuit earthing points and connection points to the substation earthing system. This drawing should also include the locations of any earthing stirrups on outdoor bus-work.

4.17 LIGHTNING SHIELDING AND SURGE PROTECTION

- 4.17.1 The design must meet Ergon Energy's Substation Design Lightning Shielding and Surge Protection requirements of SS-1-8.1 Substation Surge Protection and SS-1-8.2 Substation Lightning Protection.

4.18 SECURITY

- 4.18.1 The design must meet Security requirements of SS-1-1.4 Substation Design Requirements and SS-1-9.5 Substation Security.

4.19 CONTROL & SWITCHGEAR BUILDING

4.19.1 GENERAL

- 4.19.2 Control and switchgear building design must meet the requirements of SS-1-1.4 Substation Design Requirements, the project Civil Specification (where provided) and the ZSS template drawings.

4.19.3 BUILDING SERVICES

- 4.19.4 Refer Civil Specification

4.19.5 SECURITY

- 4.19.6 Refer Civil Specification

4.19.7 FIRE INDICATION & ALARM


- 4.19.8 Refer Civil Specification

4.19.9 AIR-CONDITIONING & VENTILATION

- 4.19.10 Refer Civil Specification

4.20 CIVIL WORKS

- 4.20.1 Civil design must meet the requirements of SS-1-1.4 Substation Design Requirements, the project Civil Specification (where provided) and the ZSS template drawings.

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4.21 STRUCTURAL WORKS

4.21.1 Structural design must meet the requirements of SS-1-1.4 Substation Design Requirements, the project Civil Specification (where provided) and the ZSS template drawings.

4.22 LANDSCAPING

4.22.1 Landscaping design must meet the requirements of SS-1-1.4 Substation Design Requirements, the project Civil Specification (where provided) and the ZSS template drawings.

4.23 SUNDRY PLANT

4.23.1 GENERAL

4.23.1.1 This section describes the general requirements of Sundry Plant.

4.23.1.2 The Contractor must supply everything necessary or usually supplied as part of the sundry plant. All Contractor supplied items must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

4.23.1.3 During commissioning, the Contractor must conduct a general check of all equipment which will include a check of the completeness, correctness and condition of all earth connections, labelling, painted surfaces, cables, wiring and auxiliary and ancillary items. The Contractor must include details of checks carried out in Inspection and Test Plans.

4.23.2 CT MARSHALLING BOXES

4.23.2.1 A CT secondary marshalling box must be provided for each three phase set of CT's. The marshalling box must be made of either stainless steel or aluminium. The construction and layout of internally mounted equipment must be as specified in EESS-10224 drawing series. The marshalling box must also have a rotating handle, not a key type access mechanism.

4.23.2.2 The secondary terminals of all CT cores must be connected by multicore cables to the terminals in the marshalling box. These cables must be a minimum of 8 cores with primary & secondary protection cores located in different cables.

4.23.2.3 Temporary earths must be made for each 3 phase set of CT cores in the marshalling box. This provision should take the form of a suitable link type terminal block with plug-in feature with the temporary earth connected to the cubicle earth bar.

4.23.3 VT MARSHALLING BOXES


4.23.3.1 A VT secondary marshalling box must be provided for each three phase set of VT's. The marshalling box must be made of either stainless steel or aluminium. The construction and layout of internally mounted equipment must be as specified in EESS-10225 drawing series. The marshalling box must also have a rotating handle, not a key type access mechanism.

4.23.3.2 The secondary terminals of all VT windings must be connected by a 4 core control cable to the terminals in the marshalling box. VT marshalling boxes must incorporate fuses as required by secondary wiring outlined in this Specification.

4.23.4 RATING PLATES AND NAMEPLATES

4.23.4.1 Rating plates and nameplates must be of non-ferrous metal or stainless steel material with etched or engraved lettering and attached with stainless steel screws or monel rivets. The plates must be located on each item of equipment so that they can be read clearly and safely from a person standing at ground level.

4.23.4.2 All CT & VT marshalling boxes must incorporate a rating plate showing all relevant data in accordance with this Specification.

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4.23.4.3 All equipment, operating devices, relays must be suitably labelled such that they can be readily identified from drawings. Circuit breaker panels, control panels, relay panels must also be labelled.

4.23.4.4 The contractor must submit a schedule and drawings of all switchyard operational signs with specific operating numbers that aligns with the approved Operating Single Line Diagram to the Principal's Representative for approval prior to manufacturing these signs.

4.23.5 LABELS

4.23.5.1 Indoor labels must be engraved traffolyte or other approved material. Labels installed on outdoor equipment must be stainless steel & fixed with monel rivets.

4.23.5.2 Labels must be located such that they are easily read from normal operating positions and access ways around the equipment.

4.23.5.3 Cubicles and switchboard panels, which have rear access, must also be labelled on the rear of the panel.

4.23.5.4 All labels, and in particular those supplied on equipment of overseas origin, must be submitted for approval prior to shipment of the equipment. All labels must be in the English language.

4.23.6 PAINTING

4.23.6.1 All surfaces of structures and equipment must be finished with an appropriate coating system which will provide the necessary protection against corrosion for the design life of the equipment.

4.23.6.2 Minimum coatings for all exterior surfaces not specified as hot dip galvanised must be one coat of primer, one undercoat and two finishing coats of an approved colour and quality paint. The top coat must be single pack epoxy.

4.23.6.3 The interior of outdoor control cubicles, cabinets must receive the same number of coats as the exterior. The Contractor must make good any damage to the paint incurred during delivery, erection or commissioning, before relinquishing possession of the site to the Principal.

4.23.6.4 The Contractor must make good any paint work which peels, flakes or shows signs of rust during the defects liability period.

4.23.7 LOCKS AND KEYS

4.23.7.1 Where locks are called for under this Specification, they must be flush mounting types suitable for the Principal's master key system. The Principal will supply lock barrels during the course of the contract.

4.23.7.2 Locks must be constructed and located on the equipment so that they remain serviceable in the climatic conditions specified for service life of the plant/equipment with suitable maintenance.


4.23.7.3 The Contractor must provide a shadow board mounted in each control room to hang all equipment door keys, operating handles and the like.

4.23.8 NUTS, BOLTS, STUDS AND WASHERS

4.23.8.1 All bolts and nuts must conform to the appropriate Australian Standard. Galvanised bolts, nuts and washers must be used on all structures & outdoor equipment. All bus connections must utilise stainless steel bolts, nuts with load spreading washers.

4.23.8.2 All cable connections to transformer & switchgear palms must incorporate load spreading washers.

4.23.8.3 Surge Diverters must utilise a crimped lug connection. Surge Diverters must not utilise bolted connections.

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4.23.8.4 The Contractor must have all washers, including locking devices and anti-vibration arrangements approved by the Principal's Representative. Taper washers must be fitted where necessary.

4.23.8.5 Where there is risk of corrosion, bolts and studs must be finished flush with the surface of the nuts.

4.23.8.6 All components must be chosen so they remain free of oxidation or reduction caused by the effects of electrolysis for the anticipated life of the substation. All components must be chosen to be relatively maintenance free.

4.23.9 CONTROL PANELS

4.23.9.1 The Contractor must use the cubicles currently on the Principal's period contract supply. Where a control panel is required that is not standard, the control panel must meet the following requirements:

- All control panels, cubicles, be fabricated from folded and welded sheet steel of minimum thickness 2mm attached to a steel frame. Where a free-standing floor mounted enclosure is called for, a base fabricated from 102 x 51mm x 10 kg/m channel section steel is bolted to the bottom of the enclosure. The stiffness is such as to prevent mal-operation of relays or other apparatus after impact. The front of the panel has a smooth well finished surface.
- Where the enclosure is provided with hinged sections the hinges are to be chrome lift-off pintle type. Neoprene strips are used around the edges of all hinged or removable sections to exclude dust. Hinged sections over 1,000mm high are fitted with a three point locking system operated by a single handle.
- Outdoor cubicles are weatherproof and fitted with vermin-proof louvers for ventilation. They are fitted with anti-condensation heaters in tropical regions (galvanised steel, stainless steel or aluminium material is acceptable but painted black steel is not acceptable).

4.23.9.2 All secondary equipment supplied must be housed in free-standing vermin and dustproof cubicles which are adequately ventilated to prevent condensation. The cubicles must have a maximum height of 2,250mm, a preferred width of 800mm and depth of 800mm with provision for either top or bottom cable entry. Rittal type panels or equivalent are acceptable.

4.23.9.3 All cabling in control panels must be tied using approved UV stabilised cable ties, loomed and in cable ducting where practicable. Slack must be provided in all wiring and cabling to facilitate disconnection and removal of equipment. Cables must be looped from the cable duct to each device terminal for testing purposes.

4.23.9.4 Where front and rear access doors are provided, they must be capable of being removed from the frame without the use of tools and when closed, not obscure clear visual observations of any operation indicator, switch or indicating lamps contained in the cubicle or obscure the cubicle label. The cubicles must be designed for maximum accessibility for ease of maintenance.


4.23.9.5 The rear of control panels must be illuminated by AC lighting.

4.23.9.6 The Contractor must provide an Inspection and Test Plan for Sundry Plant.

4.23.10 FUSES

4.23.10.1 Fuses must be provided for the protection and isolation of control, alarm, indication and VT circuits. Fuses must be of HRC (High Rupturing Capacity) of GEC manufacture, type "NS" of the cartridge type or technically equivalent. Fuse carriers and bases must be coloured black.

4.23.10.2 Solid links must be supplied in the neutral circuits. Neutral link carriers and bases must be coloured white.

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4.23.10.3 Separate fuses and links must be provided in the DC supply to the protection, control and alarm circuitry associated with each high voltage bay, such that the removal of the relevant fuse and link allows work on the circuitry for that bay, without interruption to the supply to any other bay.

4.23.10.4 Test/Disconnect links must be provided on all CT & VT circuits.

4.23.11 SIGNS

4.23.11.1 Signage design must meet the requirements of SS-1-1.4 Substation Design Requirements and SS-1-9.3 Substation Signage.

4.23.11.2 The Contractor must provide all the necessary warning and safety signs around and within the substation. Signs must also be installed to warn operators of dangerous voltage levels, correct operating procedures and safety requirements within the substation.

4.23.11.3 Warning signs must conform to the relevant Australian Standard and Workplace Health & Safety Act 2011.

4.23.11.4 The Contractor must provide a list of these signs with sizes and full details of lettering to the Principal's Representative.

4.24 SITE SERVICES

4.24.1 ELECTRICAL SERVICES

4.24.1.1 The design of electrical services must meet the requirements of SS-1-1.4 Substation Design Requirements and the ZSS template drawings.

4.24.1.2 The scope of works covered by this section includes all works originating at the AC and DC distribution boards, but excludes the installation of the distribution boards. Details of distribution board requirements are covered elsewhere in this Specification.

4.24.1.3 The Contractor must ensure that all materials supplied and all work carried out complies with the requirements of the latest addition of AS 3000 Wiring rules and amendments thereto, the regulations and by-laws of the Electricity Supply Authority and any other Authority having jurisdiction over the performance of the work.

4.24.1.4 The Contractor must design all 110V DC luminaries and 110V DC "T" pin un-switched outlets.

4.24.1.5 Cabling for 110V DC circuits must be as per Table 13.

Table 13 110VDC Circuits

Lighting circuits :	1.5mm ² TPS cable (unless directed otherwise)
Power outlet circuits:	2.5mm ² TPS cable

4.24.1.6 All circuit breakers (including RCD/MCB combinations) must be moulded case type to Current Australian Standards. Miniature circuit breakers (MCB's) will not be accepted.

4.24.1.7 The Contractor must ensure the final installation is evenly balanced across the three phase supply.

4.24.2 AIR CONDITIONING


4.24.2.1 The design of air conditioning must meet the requirements of SS-1-1.4 Substation Design Requirements and the ZSS template drawings.

4.24.2.2 The building must be totally Air Conditioned using refrigerant Split AC Units or approved equivalent. Circuit Breakers must be provided on the main switchboard.

4.24.3 LIGHTING

4.24.3.1 Lighting design must meet the requirements of SS-1-1.4 Substation Design Requirements and the ZSS template drawings.

4.24.3.2 Lighting levels within the building must be generally designed to meet the requirements of current Australian Standards, and in particular, meet the following specific lighting levels :-

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- 400 lux between rows at switchgear front panels within the Control Building;
- 400 lux at the front of control panel within the Control Building;
- 160 lux to the rear of switchgear in the Control building
- 160 lux adjacent to the Battery Storage, Load Management Equipment, AC and DC panels.

4.24.3.3 Emergency DC lighting must meet the following requirements:

- Designed to current regulations including “Test button facilities”
- 40 lux minimum at floor level for two hours after loss of AC power
- Controlled from a switch just inside the control room adjacent to the main entry doors
- Design criteria as per AS 1680.2.4 Item 15.1(a) Table E1

4.24.3.4 General external lighting must consist of weatherproof (IP56) luminaries, located under the control building eaves and controlled by movement sensor and switches both inside and outside the control building.

4.24.3.5 A photo-electric cell to control the external Security Lights must be provided, as well as an over-ride switch labelled “Test Switch for external security lights”

4.24.3.6 Switchyard lighting requirements are described in Section 4.7.

4.24.4 FIRE PROTECTION

4.24.4.1 The design must meet the fire protection requirements of SS-1-1.4 Substation Design Requirements, SS-1-9.1 Substation Fire Protection, the project Civil Specification (where provided) and the ZSS template drawings.

4.24.4.2 This section of the specification covers the design of the complete fire detection and alarm system comprising:

- Fire Indicator Panel
- Detectors
- Cables, conduits and accessories
- Fire Extinguishers

4.24.4.3 The Contractor must design a Fire Indicator Panel complying with Current Australian Standards and approved by the Insurance Council of Australia. A manual call point must be incorporated in the panel.


4.24.4.4 The Contractor must supply an “as installed” diagram of the complete installation. The diagram must indicate the position of the fire indicator panel, detectors, alarm groups and alarm zone circuit numbers. Contractor must also provide a detailed circuit diagram indicating all wiring and terminal connection details of the output contacts for alarm and/or control purposes.

4.24.4.5 The Contractor must provide details of provisions for future connection of the panel for system monitoring by the Fire Brigade.

4.24.4.6 Detectors must be listed as approved by the Scientific Services Laboratory (SSL) in the current edition of the “Approved Listing of Fire Detection Equipment”.

4.24.4.7 Spacing of detectors must be designed in accordance with Current Australian Standards.

4.24.4.8 The Contractor must design an air conditioning shutdown signal from the Fire Indication Panel to the AC distribution board, to shutdown the air conditioning in the event of a fire.

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4.25 DRAWINGS

4.25.1 GENERAL


- 4.25.1.1 The substation design must generally be in accordance with the Ergon Energy Zone Substation Standard (ZSS) templates. A copy of these, along with any other pertinent design examples must be requested by the Contractor prior to the start of any design work.
- 4.25.1.2 The Principal uses an Electronic Document Management System (EDMS). The Contractor must familiarise themselves with the Principal's process for drawing creation, revisions, approvals and releasing so as to properly coordinate with the Contractor's QA and standard processes.
- 4.25.1.3 Submitted drawings must be clear and legible without imperfection of any sort in the printing or reproduction. Drawings which are of an inadequate standard will be rejected.
- 4.25.1.4 Supplied drawings must be unique for this Contract and not include cross references to, or details of equipment supplied to other parties by the Contractor, subcontractors, or other suppliers.
- 4.25.1.5 On request, the Contractor must provide a document register (an electronic spread sheet) showing all Ergon Energy drawing and sheet numbers, revision number, all title lines and document state.
- 4.25.1.6 Where direct access to EDMS has been granted, the contractor must ensure that drawings that are being modified as part of the design are "Checked Out" prior to commencing drafting to prevent conflicting and parallel designs on the same revision. Where the Contractor has not been granted direct access to EDMS, the Technical Representative will be responsible for "Checking Out" drawings.
- 4.25.1.7 The Contractor must access EDMS to retrieve drawings required for design where access has been granted. Otherwise, the Technical Representative will transmit required drawings electronically or via postal services.

4.25.2 DESIGN DRAWINGS SCHEDULE & TRANSMITTAL

- 4.25.2.1 Within one (1) week from the "Date of Acceptance of the Tender", the Principal will supply a schedule of existing drawings to the Contractor for review and identification. The Contractor must submit in return, a schedule of identified drawings which are expected to be prepared for design modification during the contract.
- 4.25.2.2 Where additional drawings are required for an existing site, the Contractor must submit a request for creation of new drawings.
- 4.25.2.3 Within one (1) week from receiving the schedule from the Contractor, the Principal's Representative will revise identified drawings and/or allocate new drawings and issue these to the Contractor for design.
- 4.25.2.4 Where a common drawing is required for concurrent projects, access to the drawing will be negotiated between the Contractor and the Principal's Representative to include both design revisions and will be managed on a case by case basis.
- 4.25.2.5 The Contractor must make all reasonable effort to complete design modifications including RPEQ certification of a drawing to allow others to revise and add new amendments when requested by the Principal's Representative.

4.25.3 DRAWINGS REQUIREMENTS

- 4.25.3.1 The system drawings must include, but not be limited to, the typical drawings included in the ZSS template set. Additional drawings may be required where special plant or design is required.
- 4.25.3.2 Where the contract involves changes to an existing site, the Contractor must be responsible for modifying and/or replacing all existing design drawings to suit the new work and align with the ZSS template drawings.

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4.25.3.3 The Contractor must ensure that all drawings modified as part of the Contract are to be brought up to the latest Ergon CAD Standards.

4.25.4 CAD STANDARDS

4.25.4.1 The Ergon Energy Standard Microstation Workspace package must be used by the Contractor for all drafting works. The workspace provides standard drawing sizes, frames, title blocks, line and text styles, cells and other items.

4.25.4.2 The Contractor must refer to the Ergon Energy CAD Standards Manual P56N02R02 for assistance in using the workspace package and defining CAD standards. Sections 7, 8, and 10 as well as Appendix 3, 5, and 7 are relevant.

4.25.4.3 Drawings must be consistent in the dimensional units used throughout the Works. Dimensions of drawings must be in accordance with AS 1000, the International System of Units (SI) and its application.

4.25.4.4 Drawings must conform to AS 1100, AS 1101, AS 1102, and AS 3883, with qualifications as described in this document.

4.25.4.5 The Contractor must provide all drawings required by the Contract in a form which is fully compatible with Ergon Energy's CAD system as specified below:

- All electrical drawings produced by the Contractor must be Microstation V8 2004. Conversion from AutoCAD or other format is not acceptable.
- Other drawings (e.g. mechanical and civil) produced by the Contractor may be AutoCAD 2007, produced in accordance with the guidelines for AutoCAD users in the Ergon Energy CAD Standards Manual P56N02R02.
- Scanned drawings not produced by the Contractor but required under the Contract must be IRAS/B .cit format in accordance with the guidelines in the Ergon Energy CAD Standards Manual P56N02R02

4.25.4.6 The Contractor must supply drawing files to the Principal free of blocks, symbols, shared cells, line strings, and with the exception of Ergon Energy's standard border files, no external reference files attached.

4.25.4.7 Drawings must use Phase identification of A (red), B (white), C (blue).

4.25.4.8 Drawings must use equipment/component identification and cable/wire numbering in accordance with the Ergon Substation Standard SS-1-1.2 – Equipment Identification.


4.25.5 DRAWING AND DOCUMENT APPROVAL

4.25.5.1 The Contractor must submit one (1) electronic copy of all drawings, specific calculations, and study report documents prepared to the Principal's Representative for acceptance as soon as practicable and at least 28 working days before any work is scheduled to be carried out from these drawings.

4.25.5.2 The Contractor must submit up to a maximum of eight (8) paper copies of drawings and two (2) paper copies of all other documents where requested by the Principal's Representative. A Drawing Distribution List will be provided by the Principal which will details the intended recipient, purpose and stamp requirements for each copy to be issued. The Contractor must prepare and issue the paper copies as per the Drawing Distribution List.

4.25.5.3 Drawings will be returned to the Contractor with comments attached (either electronically or written). Any drawing or document which clearly requires considerable amendment will be returned for alteration without detailed review of all the corrections that may be required.

4.25.5.4 The Contractor must regard acceptance of the drawings and documents by the Principal's Representative as a general approval relating only to their sufficiency and compliance with the intent of the Contract. When drawings and documents are accepted, the Contractor must not in any way be relieved of responsibility for the design, supply, construction, and commissioning of the works under the Contract.

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4.25.5.5 When the Principal's Representative comments require the amendment of the drawings or documents, or if for any other reason amendments are required, the Contractor must include the amendments in the drawings and documents.

4.25.5.6 On completion of amendments to drawings and documents, the Contractor must resubmit one (1) electronic copy and up to two (2) paper copies to the Principal's Representative for checking and acceptance.

4.25.5.7 The Contractor must not proceed with manufacture, assembly, or erection until all the relevant detail drawings have been accepted by the Principal's Representative.

4.25.5.8 Once acceptance has been given on all drawings and documents, the Contractor must forward an electronic copy to the Principal's Representative with one copy in Adobe PDF format, and the other in Microstation (.dgn) or AutoCAD (.dwg) format. These must contain in the status field "1 – WORK MAY START".

4.25.6 TITLE BLOCK DETAIL

4.25.6.1 Drawings must be provided with the standard Ergon Energy drawing border and title block by using the Ergon Energy Workspace tool boxes.

4.25.6.2 The Contractor must insert their company logo or block on the right hand side of the revision comments section (adjacent to the drawing approvals section). The Contractor must insert the approving person's Name, RPEQ number, date, drawing revision and the applicable Ergon's project Work Request number in their block or on a separate block adjacent to the company logo.

4.25.6.3 The drawing approvals section containing names and dates must not be used by the Contractor; this is for Ergon Energy's use only.

4.25.6.4 The standard title block / drawing frame must not be altered by the Contractor. Drawings must retain the Smart tags within the title blocks, without them being deleted, removed or moved. Drawing Smart tags can be edited as required by the Contractor.

4.25.6.5 Drawings that are released for construction must have progressed through the EDMS approval process and the title block's Status field must read "1 – WORK MAY START".

4.25.7 DRAWING AND SHEETS NUMBERS

4.25.7.1 Drawings must only use Ergon Energy drawing numbers. These are either defined on the filename when new blank drawings are issued, or they already exist on old drawings.

4.25.7.2 Drawings must have all additional sheets under a single drawing number, created from the first sheet. The contractor must make themselves familiar with the numbering convention for series of drawings such as Single Line Diagrams series, Feeder Protection and Control Panel series etc. etc. when requesting the allocation of new drawing numbers for design.

4.25.7.3 Drawings must use Sheet Numbers appended to the main drawing number as a dash suffix e.g. 123-02 represents sheet 2 of drawing 123.


4.25.7.4 Drawings must be complete entities and should not span multiple sheets except for the provision of Tabulated Data, where additional sheets may be provided.

4.25.8 REVISION NUMBERS

4.25.8.1 The Contractor must maintain consistency with Ergon Energy's EDMS by using alphabetical revisions. i.e. 233-02-0C is revision "C" of sheet 2 of drawing number 233.

4.25.8.2 Every new revision of a design drawing (following either For Construction or Final Release) must have a new alpha revision. It is therefore of benefit to keep revisions to a minimum during construction (those drawings issued For Construction).

4.25.8.3 Final drawings (As Built) must be an alpha revision of the Released For Construction set, whether or not changes incurred during construction.

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4.25.9 DRAWING AMENDMENTS

4.25.9.1 Amended drawings submitted during the course of the Contract must retain the original drawing number followed by a revision letter as outlined above. If there is a need to supersede one drawing by a new drawing with a different number, then reference to the superseded drawing number must be made in the title block of the new drawing. The Contractor must bring attention to the change of number in the covering correspondence.

4.25.9.2 The Contractor must indicate the portions of a drawing which have been amended in a re-issue by means of an approved stamp such as a red triangle or arrow on the prints. Drawings must clearly indicate details of all revisions with a “cloud” or “balloon” adjacent to a revision reference number within a triangle and a detailed note in the revision column on the drawing. Drawings must have all references placed on a dedicated layer as defined in the Ergon Energy Workspace.

4.25.10 FINAL DRAWINGS AND DOCUMENTS

4.25.10.1 Within one (1) month before the Date for Practical Completion, the Contractor must submit final versions of all as-built/as-commissioned drawings for acceptance.

4.25.10.2 Within six (6) weeks of the Date for Practical Completion, the Contractor must provide, on compact disk, final CAD format copies of all approved drawings, including those of Sub-Contractors and other suppliers, in a format acceptable for direct input into the Principal’s CAD system as specified above. The status field in the title block must be “F – AS BUILT”. The Contractor must also provide an electronic spreadsheet showing all drawing and sheet numbers, revision number, all associated title lines and document state.

4.25.10.3 Additionally, the Contractor must provide a minimum of one (1) hard copy of each drawing to be kept at site. The Contractor must have final as-built drawings certified by the Contractor’s Registered Professional Engineer of Queensland meeting the requirements of the Queensland Professional Engineers Act, in particular complying with this specification and relevant Australian Standards.

4.25.10.4 The final drawings must include drawings showing the materials, finished sizes, tolerances and clearances of all the various parts of the works in sufficient detail to enable maintenance, routine inspections, repairs to and renewal of any part to be undertaken by the Principal without the necessity of dismantling any portion of the plant to obtain details of materials or dimensions.

4.25.11 ISSUING OF CONSTRUCTION DRAWINGS


4.25.11.1 The Contractor must provide up to a maximum of twelve (12) paper sets of drawings and two (2) paper copies of all other documents where requested by the Principal’s Representative.

4.25.11.2 A Drawing Distribution List will be provided by the Principal which will detail the intended recipient, purpose and stamp requirements for each set to be issued. The Contractor must prepare and issue the paper copies as per the Drawing Distribution List.

4.25.11.3 Each set of drawings are to be printed at minimum A2 size for Construction and/or Testing purposes and all pages in the set must be stamped with the relevant identifying set number where required.

4.25.11.4 Each set of printed copy must be accompanied by a transmittal note listing all drawings included in the issue, using the latest version Ergon QMS Transmittal Note (form NI000401F104).

4.25.11.5 Each set of drawings issued for construction must have a cover sheet of equal size to the printed drawings to protect the first page of the set from soiling and general wear. A template of this cover sheet is included in the Reference Documents section 9 – Misc Guides.


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5. SUBSTATION CONSTRUCTION REQUIREMENTS

5.1 PRIMARY PLANT

5.1.1 POWER TRANSFORMERS

- 5.1.1.1 Supply, delivery and installation of any power transformers required for the substation is the subject of a separate contract between the Principal and the transformer supplier (excluding station service transformers).
- 5.1.1.2 A representative from the transformer supplier will conduct a pre-delivery site visit to review the site access and discuss with the Contractor any requirements or coordination necessary before and during transformer delivery.
- 5.1.1.3 Before a power transformer is delivered and assembled, the Contractor must complete the following site works:
- The substation driveway must be substantially completed with compacted road base. This does not require the driveway edging, or bitumen to be completed, but a solid compacted road base which allows transformer delivery to proceed safely, and independent of weather conditions.
 - Ensure all of the conditions as agreed at the pre-delivery site meeting are in place.
- 5.1.1.4 The transformer supplier representative will carry out a second site visit approximately one week before the requested delivery to guarantee the above conditions are met. The transformer supplier will not deliver power transformers if the conditions are not met. The Contractor must meet the full expense of subsequent visits made necessary by delays in delivery where the Contractor did not meet the above requirements. The Contractor must jointly make the decision on delivery scheduling with the Principal's Representative.
- 5.1.1.5 During assembly and testing of the transformers, the Contractor must maintain the following conditions:
- Earthworks or any dust producing activity must not be programmed or carried out in the vicinity of the transformer compounds during the transformer assembly and test works. Dust is undesirable when access covers to transformer internals are removed and open trenches are safety hazards.
 - During assembly clear access is required to the transformers to complete the work. Generally there will be some crane work and oil filling and whilst this work is being undertaken it is generally unsafe for other activities to be happening in the area.
 - During testing no other work can take place on or around the transformer.
- 5.1.1.6 The Contractor must meet the full expense of additional time or charges resulting from non-compliance of the specified conditions during assembly and testing.
- 5.1.1.7 The transformer supplier will deliver the power transformers to the Contractor at the site. The transformer supplier will be responsible for the unloading, locating, assembly (erection), filling with oil, cleanup of any oil spills, and acceptance testing of the transformers, to prove their visual and electrical integrity following transportation.
- 5.1.1.8 As the Contractor responsible for the supervision of all Works carried out on the site, under the Workplace Health and Safety Act 2011, the Contractor must be responsible for supervision of the transformer supplier while the supplier is on site.
- 5.1.1.9 The Contractor must be responsible for connection, testing, and pre-commissioning of the following:
- The 415V, 63A AC supply for use by the transformer supplier.
 - All high voltage overhead connections and power cabling as specified.
 - All external control, protection and low voltage power supply cables and connections, including wiring to the SCADA RTU panel.

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- The provision and installation of any acoustic walls or screens necessary to achieve the sound levels required by this Specification and the Local Authority.
- Oil Containment System to SS-1-9.2 Oil Containment.

5.1.1.10 The requirements for the transformer foundation and bund construction are found within the project Civil Specification (where provided).

5.1.2 INDOOR METAL-CLAD SWITCHGEAR INSTALLATION

5.1.2.1 The supply and installation of any indoor metal-clad switchgear required for the Substation is the subject of a separate contract between the Principal and the switchgear supplier (excluding any Ring Main Units).

5.1.2.2 Before the installation of any indoor switchboard, the Contractor must complete the following site works:

- The switchroom floor must be prepared to the switchboard manufacturer's specification. The preferred method and finish are supplied with the switchboard drawings and data.
- The substation building must be completed.
- The switchroom is sealed, air-conditioners operational, and a power supply suitable to run the individual switchboard panel heaters is available.

5.1.2.3 These requirements are to provide a dust free and secure environment to ensure the longevity of the equipment. The Contractor must demonstrate these requirements are included and correctly sequenced in the Works Program. This is a hold and inspection point. The Contractor must not proceed with switchgear installation if the conditions are not met.

5.1.2.4 Switchgear may be supplied pre-installed in a transportable building, or packaged as individual panels to be installed in a masonry building.

5.1.2.5 Where the switchgear is pre-installed in a transportable control building, it will be delivered to site by the supplier.

5.1.2.6 Where the switchgear is packaged as individual panels and components as supplied by the switchgear supplier, it will be delivered to the local Ergon Energy depot by the supplier. The Contractor must be responsible for transportation of the switchgear from the depot to site, and lifting the switchgear into the control building.

5.1.2.7 As the Contractor responsible for the supervision of all Works carried out on the site, under the Workplace Health and Safety Act 2011, the Contractor must be responsible for supervision of the switchgear supplier while the supplier is on site.

5.1.2.8 Any further work including testing or witness testing associated with the switchboard is covered elsewhere in this Specification.


5.1.3 HV CIRCUIT BREAKERS (36, 72.5 AND 145KV)

5.1.3.1 The Contractor must be responsible for part of the works associated with installation of HV circuit breakers, while the circuit breaker supplier will complete the specialised parts of the assembly and on-site testing.

5.1.3.2 There are no inspection and hold points.

5.1.3.3 The Contractor must be responsible for pickup from the Principal's location, transportation to site, unloading, unpacking, locating, assembling, and erection of the circuit breakers on their support structures, including mechanism boxes. As per the supplier's manual there are no requirements for assembly or modifications of the SF6 gas supply pipes or connections.

5.1.3.4 As the Contractor responsible for the supervision of all Works carried out on the site, under the Workplace Health and Safety Act 2011, the Contractor must be responsible for supervision of the circuit breaker supplier while the supplier is on site.

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5.1.3.5 The Contractor must be responsible for returning the circuit breaker to full operating gas pressure from transport pressure, connection, testing, and pre-commissioning of the following:

- All high voltage overhead connections and power cabling.
- All external control, protection and low voltage power supply cables and connections, including wiring to the SCADA RTU panel.

5.1.4 HIGH VOLTAGE POWER CABLES

5.1.4.1 This section describes the general requirements of High Voltage Power Cables.

5.1.4.2 The Contractor must be responsible for the installation, terminations, testing and commissioning of all the necessary high voltage cabling between equipment as listed in accordance with this Specification.

5.1.4.3 The Contractor must supply everything necessary for, or usually supplied as part of, the installation, testing, and commissioning of the HV power cables. All Contractor supplied items must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

5.1.4.4 All cables and associated equipment supplied under this contract must be in accordance with SS-5-10.3.XLPE Cable Specification, SS-1-4.4 Cables and Cabling, and AS/NZS 2067 – Substations and high voltage installations exceeding 1 kV AC with construction requirements as follows:


- Stranded, circular, annealed, high conductivity copper wire conductors
- Semi-conductive conductor screen.
- Tree retardant TR-XLPE insulation.
- Semi conductive insulation screen.
- Water blocking swellable tape (semi-conductive).
- Metallic / Copper wire screen 25kA for 1 s.
- Water blocking Swellable tape (non-conductive).
- Composite flame retardant black HFS-90-TP PVC inner sheath.
- Insect protection by a nylon (polyamide 12) jacket or sheath with minimum 0.12% cypermethrin content.
- HDPE outer sheath.
- Semiconductive LD, polyethylene jacket.

5.1.4.5 The Contractor must install HV Cables in accordance with SS-1-4.4 Cables and Cabling. Testing and commissioning of HV cables must be in accordance with Section 5.5.


5.1.4.6 Cable protection must also meet the following requirements;

- Conduits be spaced to ensure required current ratings are met (in accordance with the cable rating design report)
- Conduits are to be a minimum of 50mm above the bottom of the trench.
- Cables to be installed as to exclude cable wastage and cable damage.
- The finished cable routes do not undermine foundations of substation equipment or encroach on any other substation works.

5.1.4.7 HV power cables must be supported and clamped as the cables rise into the control building or onto the transformer. Cable clamps must not cause circulating current problems (separation of the cable clamp from a steel bracket by spacer or similar).

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- 5.1.4.8 The HV power cable drum must be placed at an appropriate location to ensure that the cable can be pulled / installed efficiently. Generally the cable drum can be placed at the transformer and the cable can then be pulled from somewhere in the vicinity of the control building.
- 5.1.4.9 If Thermal Backfill is required to reach the required Soil Thermal Resistivity in the cable trench, Contractor must submit the material data to the Principal for approval before backfilling commences. The Contractor must include with submitted material data the following;
- Current thermal dryout curve to determine the moisture content
 - Compaction test results from a Geotech soils lab to determine compaction ranges, compaction methods including layer thickness, minimum moisture level, and number of passes for the chosen compaction method.
- 5.1.4.10 The Contractor must apply one of the following installation methods:
- Minimum of 6 passes using a hydraulic vibrating plate attached to an excavator should achieve a minimum of 95% compaction, with 250mm maximum layer thickness (loose thickness)
 - Minimum of 7-8 passes using a wacker should achieve a minimum of 70% compaction, with a minimum of 150mm maximum layer thickness (loose thickness)
- 5.1.4.11 For each of the above installation methods the Contractor must pass a water truck over each layer before compacting. The Contractor must not perform compaction by flooding.
- 5.1.4.12 The Contractor must wet and compact around the conduits with a compactor at the time of installing conduits.
- 5.1.4.13 The ideal moisture content for compaction is 7%. As the material to be used is unlikely to be anywhere near 7%, it is recommended that a water truck be used to wet down the stockpile and then turn the material over a few times while the material is being stored.
- 5.1.4.14 All cables from the power transformers must be permanently marked according to phase with appropriately coloured heat shrink PVC sleeving at four locations:
- Inside the transformer cable boxes
 - Immediately outside the transformer cable boxes (single core cables).
 - Inside the indoor switchgear or the outdoor Ring Main Units.
 - Immediately outside the indoor switchgear or outdoor Ring Main Units (single core cables).
- 5.1.4.15 All cables from the power transformers must be permanently labelled T1, T2 etc. at location (b) and feeder name/number at location (d).
- 5.1.4.16 For auxiliary transformer cables marking must be at locations (c), (d), and at or immediately beneath the cable outdoor terminations and permanently labelled Aux Transformer 1 or 2.
- 5.1.4.17 High or medium voltage cables are often terminated at indoor circuit breakers or switchboard and capacitor bank circuit breakers. Switchboards and circuit breakers are subject to partial discharge testing prior to commissioning and must be free of any external connections during testing.
- 5.1.4.18 Because the Partial Discharge testing and the termination of the cables requires coordination, the Contractor must seek direction from the Principal's Representative before any cables are terminated to the items listed above. This a hold point insofar as determining the interaction of the terminating and the Partial Discharge testing. This does not preclude the option to terminate the cables (without cable and termination testing) and removing the terminations and withdrawing the cables to allow the Partial Discharge testing. Upon reconnecting the cables, the full raft of tests as set out in this Specification are to be completed.


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5.1.5 LOAD CONTROL PLANT INSTALLATION

- 5.1.5.1 Load control plant supplied by the Principal will consist of an external coupling cell and internal cubicles housing a ripple control signal transmitter, a controller, and associated power supplies, as shown in the load control plant drawings.
- 5.1.5.2 The Contractor must be responsible for all works associated with the installation of the Load Control Plant, from pickup at the Principal's location through to assembly, erection and assistance to the load control plant supplier with testing and pre-commissioning.
- 5.1.5.3 As the Contractor responsible for the supervision of all Works carried out on the site, under the Workplace Health and Safety Act 2011, the Contractor must be responsible for supervision of the load control plant supplier while the supplier is on site.
- 5.1.5.4 The Contractor must design, supply, and erect the support structures for the outdoor coupling cell of the load control plant and the surrounding safety enclosure.
- 5.1.5.5 The Contractor must be responsible for connection of the load control plant following assembly and erection including the following:
- All high voltage power connections to the external coupling cell.
 - All cables and connections between the external coupling cell and the internal transmitter and controller.
 - All auxiliary supply connections.
 - All control cables and connections to the SCADA RTU panel.
- 5.1.5.6 The Principal's load control plant supplier will perform on-site testing and pre-commissioning of the load control plant after erection and connection by the Contractor. The Contractor must assist with this work and rectify any installation defects found, to the satisfaction of the load control plant supplier.

5.1.6 CAPACITOR BANKS

- 5.1.6.1 The Principal uses both cubicle enclosed and outdoor type capacitor banks. Either type, or both are relevant to the clauses below.
- 5.1.6.2 The supply and delivery of any capacitor bank(s) required for the Substation is the subject of a separate contract between the Principal and the switchgear supplier.
- 5.1.6.3 There are no specific requirements or inspection and hold points.
- 5.1.6.4 The Contractor must be responsible for supply and installation or erection of any enclosure fencing.
- 5.1.6.5 The Contractor must design, supply, and erect the support structures supplied with the bank(s).
- 5.1.6.6 The Contractor must be responsible for all works associated with the capacitor bank including pickup from the Principal's location, transportation to site, unloading, unpacking, locating, assembling, and erection of the capacitor bank(s).
- 5.1.6.7 As the Contractor responsible for the supervision of all Works carried out on the site, under the Workplace Health and Safety Act 2011, the Contractor must be responsible for supervision of the capacitor bank supplier while the supplier is on site.
- 5.1.6.8 The Contractor must be responsible for connection of the Bank(s) following assembly and erection including the following:
- All HV power connections to the bank.
 - All auxiliary supply connections
 - All control cables and connections.

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5.2 SECONDARY SYSTEMS

5.2.1 DC SUPPLIES

- 5.2.1.1 This section describes the general Construction requirements of the batteries, battery chargers, battery stands, DC/DC converters, DC/AC converters, and DC distribution boards for the Substation DC Supply Systems and the Communications DC Supply System.
- 5.2.1.2 The Principal will free issue to the Contractor the DC equipment including: battery chargers; battery banks; DC distribution boards; DC/DC converters; DC/AC inverters; and DC isolation and test panels. The Contractor must only use this standard equipment unless otherwise directed by the Principal.
- 5.2.1.3 The Contractor must be responsible for installation and commissioning of the DC Supply Systems in accordance with this Specification.
- 5.2.1.4 All Contractor supplied items must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.
- 5.2.1.5 The Contractor must install all DC Supply Systems as described in SS-1-5.1 DC Supplies.
- 5.2.1.6 The Contractor must be responsible for cabling between battery banks, isolation and test panels, DC distribution board, battery charger, DC/DC converter and DC/AC inverter. Bolts, nuts, washers and inter connections must be of an inherently corrosion resistant material or otherwise protected against corrosion.
- 5.2.1.7 Where specified, a suitably rated 110V to 50V DC/DC Converter will be free-issued for supply of communications and control equipment. The Contractor must install the converter in accordance with SS-1-5.1 DC Supplies.
- 5.2.1.8 Where specified, a 1000W true sine wave 110V to 240V DC/AC Inverter will be free-issued for supply of auxiliary equipment (typically communications and control systems). The Contractor must install and test the inverter.
- 5.2.1.9 The inverter must preferably be mounted within one of the communications equipment racks as shown in Drawing 907198-01, or alternatively the 110V to 240V DC/AC Inverter may be mounted in the AC Distribution Cabinet, or wall mounted in a position as agreed by the Principal's Representative.
- 5.2.1.10 The battery banks are supplied with suitable racks, signage and inter-cell/inter-tier/inter-row connectors.
- 5.2.1.11 Factory Acceptance Test results are available in the battery and battery charger manuals which is delivered with batteries and the battery chargers. The Contractor must be responsible for post-delivery inspection, installation and testing as per the manuals.
- 5.2.1.12 The Contractor must provide Test results as part of the approved inspection and test plans.

5.2.2 AC SUPPLIES


- 5.2.2.1 This section describes the general construction requirements of the low voltage 415V AC supply system.
- 5.2.2.2 The Contractor must be responsible for the installation, testing, and commissioning of the 415V AC supply system in accordance with this Specification.
- 5.2.2.3 The Contractor must supply everything necessary for, or usually supplied as part of, the installation, testing, and commissioning of the 415V AC supply system. All Contractor supplied items must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

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- 5.2.2.4 The Contractor must install and test Low Voltage AC installations in accordance with AS 3000 wiring rules. The Contractor must install additional RCD protection on LV circuits if required by AS 3000.
- 5.2.2.5 The Contractor must install, test, and commission station supply pad mounted or pole mounted 11/0.415 kV local transformers in the locations shown generally on Specification drawings, and in accordance with SS-1-5.2 AC Supplies.
- 5.2.2.6 The Contractor must install, terminate, test and commission the HV and LV cables to all the station supply transformers.
- 5.2.2.7 Where specified, the Contractor must install, test, and commission ring main units (RMU's) in the substation.
- 5.2.2.8 The Contractor must install, test, and commission the HV cables to the RMU/s and station supply transformers in accordance with SS-1-5.2 AC Supplies.
- 5.2.2.9 The Contractor must install, test and commission the 415V AC three phase main switchboard and sub-boards in accordance with SS-1-5.2 AC Supplies and the design drawings. The Principal has typical drawings that may be used for construction of the various boards.
- 5.2.2.10 The Contractor must have the 415V AC supply revenue metering drawings approved by the Principal prior to any construction.
- 5.2.2.11 Where Temporary LV AC Supply is required during construction, the Contractor must provide generating capacity and all necessary works to distribute power to the site for Construction, Testing and Commissioning purposes.
- 5.2.2.12 Where LV Supply to the site via the distribution network is readily available, the Contractor may request a Temporary Connection for the duration of the construction period. This connection will be subject to Ergon Energy Standard terms and condition for supply and will be metered and charged accordingly. Approval of any such request will solely be at the discretion of the Principal.
- 5.2.2.13 The Contractor must be responsible for:
- the connection of the source of Temporary Supply to the site AC distribution board
 - the operation of the Temporary Supply including any switching at the request of the Principal's Representatives
 - following Ergon's Tagging and Isolation Procedure (48102EHS-01) to limit access to live all parts after energisation including the use of appropriate locks
 - making safe all outstanding and/or uncompleted works relating to LV AC Supply including the final cut over from Temporary to Permanent arrangement
 - issuing a statement detailing the status of Temporary AC Supply and associated Isolations, Locks and Tags as part of the Certificate of Practical Completion

5.2.3 EARTHING SYSTEM


- 5.2.3.1 The Contractor must supply, construct and commission a complete earthing system strictly in accordance with Ergon Energy SS-1-7.1 Substation Earthing and Ergon Energy SS-1-7.2 Safety Earthing and the relevant Australian standards and guidelines:
- IEEE 80-2000 Guide for Safety in AC Substation Grounding
 - ENA EG1-2006 Substation Earthing Guide
 - AS 2067 Switchgear Assemblies and ancillary equipment for alternative voltages above 1kV.
 - Queensland Electrical Safety Act 2002 – Code of Practice: Works
- 5.2.3.2 All earthing connections must be in accordance with Ergon Energy Substation Standard Earthing Drawings (EESS-10031-01 to EESS-10031-55).

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- 5.2.3.3 All equipment to be earthed must be connected to the earthing system.
- 5.2.3.4 The Contractor must not carry-out back-filling of the earth grid conductor excavations before the Principal's Representative has been notified and provided time for inspection as defined in the approved civil and construction Inspection and Test Plans, or this Specification.
- 5.2.3.5 The Contractor must provide main circuit operational safety earthing points (head connection terminals) for portable earths or fixed earthing devices at locations detailed in SS-1-7.2 Safety Earthing.
- 5.2.3.6 The Principal will provide the required number of portable earthing sets. The Contractor must provide and install up to ten (10) racks for off floor storage of portable earthing sets.
- 5.2.3.7 The Principal will be responsible for measuring the resistance of the buried earth grid system to the general mass of the earth.
- 5.2.4 SECONDARY WIRING, TERMINALS AND MULTICORE CABLES**
- 5.2.4.1 This section describes the general requirements for secondary wiring, terminals and multicore cables for all AC and DC circuits, CT and VT secondary circuits, control, alarm and protection circuits.
- 5.2.4.2 In addition to compliance with the specified requirements in the relevant sections of this Specification, all secondary wiring must comply with the following common requirements:
- 0.6/1kV PVC/PVC insulated conductor conforming to AS 5000.1;
 - Have stranded conductors;
 - Be clamped at intervals of not more than 300mm or, alternatively, run in ducts
 - Have conductor markings strictly in accordance with those used on drawings.
 - Be installed in a neat and orderly manner.
 - Be clamped at intervals of not more than 300mm or, alternatively, run in ducts;
 - Earthing of equipment is arranged by each item being directly connected to the earth bar. Should looping of earthing wires be unavoidable it must be arranged so that removal of items of equipment from service during operation or maintenance must not interrupt the earthing connections to plant remaining in service;
 - Have at each end of each conductor an indelibly marked identification ferrule or sleeve that fits firmly over the insulation. Cable identification numbers must be of the interlocking, non-rotating type with non-deteriorating black lettering on a white background. No clip-on types are acceptable.
 - Have conductor markings strictly in accordance with those used on contract drawings.
- 5.2.4.3 All control and protection panel wiring must be grey.
- 5.2.4.4 The Contractor must install secondary wiring in accordance with MN000301R166 Ver 1" Construction and Wiring Guidelines for Ergon Energy Substation Panels".
- 5.2.4.5 All wiring, terminals and identification systems used on equipment of overseas origin must be supplied to the Principal's Representative for approval.
- 5.2.4.6 All fuse holders must be installed at the front of the terminal boards and no live metal is to be exposed at the back.
- 5.2.4.7 Terminals in 415V and 240V AC circuits must be protected by inherent design features or an insulated cover to protect against inadvertent contact. All such terminal and surrounding barriers must be identified by red colouring and be marked in red "415/240V AC" by means of a label attached to the terminal barriers or covers.
- 5.2.4.8 Fuse holders must be in accordance with this Specification.

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- 5.2.4.9 All fuses and links must be clearly labelled with the circuit function and fuse size or 'Link' as appropriate.
- 5.2.4.10 All fuses and links must have warning labels fitted e.g. Distance Protection - Do Not Remove.
- 5.2.4.11 All exposed outdoor wiring between terminal boxes and cubicles must be wired with PVC/PVC multicore cables protected from ultraviolet light by painting with single pack epoxy paint.
- 5.2.4.12 PVC/PVC cables with double brass screen must be used for all cables which are laid in ducts or in PVC conduit. No control cabling must be direct buried. Substation locations may have infestations of rats and termites. The Contractor must provide a schedule of Technical data on all control cables they intend to use.
- 5.2.4.13 The Contractor must provide adequate means of protection of all cables against attack by rats and termites to the satisfaction of the Principal's Representative. Insecticide impregnated outer cable sheaths must not be used. Where cables enter the building adequate vermin proofing must be installed.
- 5.2.4.14 Multicore cables must be connected to the station earth in a manner to reduce induced voltages. Both ends of each cable must have their screens earthed.
- 5.2.4.15 The Contractor must lay the cables external to the building in concrete trenches supplied and installed by the Contractor. The Contractor must document the number and size of the cables intended to be installed in each cable trench.
- 5.2.4.16 Cables must leave the concrete trench and then enter the equipment via suitable electrical grade PVC conduit set into the equipment foundations. Cables must enter the panels via an "in floor" ducting system supplied and installed by the Contractor.
- 5.2.4.17 Where cables exit from conduits and are to be terminated on equipment, they must be adequately protected against mechanical damage.
- 5.2.4.18 The Contractor must take care in the laying of cables. The Contractor must not use winches. Cables must be supported on rollers when running across another cable. Cables must be, as far as possible, parallel and not bunched or crossed so that each cable may be identified throughout its entire length.
- 5.2.4.19 In all cases, whether external to the building or internal within panels, cables must be adequately supported by clamps attached either to the panel or the structure. Upon the installation of cables both ends must be sealed with an approved cap to prevent ingress of moisture.
- 5.2.4.20 Control cables must not be run in common ducts or conduits with HV cables. Cable segregation distances must be maintained in accordance with SS-1-4.4.
- 5.2.4.21 Unless otherwise required, the outer sheath of the multicore and other low voltage cables must be removed immediately beyond the terminating gland or clamp.
- 5.2.4.22 The cores **must**, as far as possible, be arranged to run into the terminals horizontally such that identification ferrules are immediately visible and readable. All weight must be taken up by the cable gland or clamp and no pressure or tension must be exerted on the terminal.
- 5.2.4.23 All switchyard cable glands must be chrome or brass – PVC glands are not acceptable.
- 5.2.4.24 All cores must be terminated and terminals for spare cores provided in the equipment supplied.
- 5.2.4.25 All cables, each end of each core, excluding those cores which have colour-coded insulation or other identifying marks provided as part of the cable manufacturing process, must be provided with ferrules of insulating material to identify the core number. Spare cores must be marked with ferrules as "SPARE".
- 5.2.4.26 Ferrules must be fitted firmly on the insulation as close as possible to the terminal. Clip-on ferrules must not be used.

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- 5.2.4.27 Each cable must be fitted with permanent non-corroding cable marking tags, two at each end, one inside the equipment and one on the exterior stamped with a number which uniquely identifies the cable.
- 5.2.4.28 The cable markers must in addition indicate the origin and destination of the cable.
- 5.2.4.29 For long cable runs, additional markers must be provided at 30m intervals along the length of the cable.
- 5.2.4.30 All items that connect to remote equipment, must be terminated by means of approved type solderless lugs on the terminal blocks conveniently located for connection of multi-core control cables, and readily accessible while equipment is in service.
- 5.2.4.31 Forked lugs must not be used. All crimping must be to the lug manufacturer's recommendations. Bootlace lugs must be used in the panel terminal blocks for all flexible conductors. Use circular lugs must be used on all relay terminals.
- 5.2.4.32 Where more than one (1) cable is to be terminated in the same port, the Contractor must have the lug type approved by the Principal's Representative.
- 5.2.4.33 These terminal blocks must where possible be of the tunnel type and capable of accepting the 4mm² control cable cores, 6mm² for power supply cable core. Terminals blocks must be suitable for DIN rail mounting.
- 5.2.4.34 The connections for purposes of remote status indication or alarms must be terminated using an appropriate isolating link.
- 5.2.4.35 Core insulation and sheath material must be V75 grade PVC. Cables must be suitable for an operating voltage of 0.6/1kV. The cable must be routine tested to with-stand a 3.5kV RMS voltage both between cores, and between cores and electrostatic screen.
- 5.2.4.36 In order to reduce induced voltages, cable runs **must**, wherever possible, be at right angles to the busbars. Where parallel runs are unavoidable, the multicore cables must be separated from the busbars by as large a distance as practicable.
- 5.2.4.37 Within the control building, so far as is possible, cables which extend outside the control building must be physically separated from internal cabling, and in particular from those cables containing low level signal circuits.
- 5.2.4.38 AC and DC circuits must be run in separate cables.
- 5.2.4.39 Where X and Y protections are used, X and Y secondary circuits must not be combined in the same cable.
- 5.2.5 PROTECTION**
- 5.2.5.1 Protection requirements are specified in SS-2-2.1 Protection Standard and the design drawings. Additional requirements are detailed below.
- 5.2.5.2 The Contractor must provide protection systems for all transmission, sub-transmission and distribution feeders, busbars, power transformers, capacitor banks, and all ancillary equipment whether directly specified or not.
- 5.2.5.3 The Contractor must supply everything necessary for, or usually supplied as part of, the protection systems, except for protection relays which are supplied by the Principal. All items supplied by the Contractor must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.
- 5.2.5.4 The Principal will supply all protection relays as free issue to the Contractor, including those chosen by the Contractor that are not on the Principal's period contract. All protection relays selected by the Contractor must comply with the relevant standards, in particular IEC publication 255-1971-1978 – Electrical Relays, and must be subject to approval by the Principal.
- 5.2.5.5 Relays must be wired and mounted in the protection cubicles in accordance with the design drawings and the Principal's current version of the Relay Application Guide.

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5.2.5.6 The Contractor's responsibilities must include:

- Installation of protection relays, including wiring and associated equipment, into protection and control cubicles.
- Loading of configurations (using setting files supplied by Ergon Energy) into protection relays.
- Configuration of all protection devices to ensure that all relay and SCADA communications, and remote communications function correctly and accurately.
- Provide signed copies of the Protection Setting Requests and extracted configuration files to the Operational Technology group (via the Principal's Representative) prior to energisation of the plant.
- All extracted configuration files given to the Principal's Representative must be either in the same file format and version as issued or is compatible and able to be read correctly with the Principal's version of software.

5.2.5.7 All protection relay contacts used for tripping, indication, or alarm must be of robust and reliable construction. All contacts must be clean and have appropriate current ratings to match the required duty.

5.2.5.8 The Principal will supply the means of remote communication via Ethernet, remote dial-up Ethernet and terminal server equipment.

5.2.5.9 At least two of all items required to interface a laptop PC with the front ports must be provided per site.

5.2.5.10 The Contractor must take suitable precautions to ensure adequate isolation is maintained between devices and that communication cables do not compromise the integrity of any interzone insulation that may be used (e.g. if a frame leakage protection system is used).

5.2.5.11 The Principal will be responsible for the calculation of all programming and settings of the protective systems. These settings will be provided to the Contractor to load and test the relays.

5.2.5.12 The Contractor must carry out commissioning tests on all relays and systems with the approved settings applied.

5.2.5.13 Each protection relay must be provided with test facilities (Ergon CT/VT Test Rack Assembly or equivalent) to enable secondary injection, equipment isolation, and rapid fault finding.

5.2.5.14 The test facilities must be readily accessible from the front of the cubicle and must be adequately labelled as to their function.

5.2.5.15 The Contractor must provide any loose test plugs required for use of the test facilities on the basis of at least six (6) plugs per protection relay type per substation.

5.2.6 SCADA


5.2.6.1 SCADA requirements are specified in the SS-2-2.x series of substation standards and the design drawings. Additional requirements are detailed below.

5.2.6.2 The Principal has a Supervisory Control and Data Acquisition (SCADA) system. This system monitors significant substation parameters via Remote Terminal Units (RTU's) located at each substation. Communication links between the master station and the RTU's enables this data to be telemetered back to the control centre. Similarly, the ability to control remote plant is provided. Local Control Facilities (LCF's) may also be provided to allow operators to monitor and control plant locally.

5.2.6.3 The Contractor must refer to the SCADA and Communications Single Line Diagram which defines the high level communication requirements.

5.2.6.4 All PLC's/RTU's/LCF's installed into the substation must be provided by the Principal.

5.2.6.5 The Contractor must be responsible for:

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- Install rack mountable 19" RTU bins with sufficient I/O and communications ports for the substation remote control and monitoring requirements, and connection to master station communication system.
- Install a PC/screen based LCF in the control room within the substation building to facilitate controls, indications, alarm and event capture. The Contractor will connect the LCF to the substation RTU, in each case.
- Supply and install all necessary contacts and terminals, wiring, transducers, and communications for inputs and outputs to/from plant and between distributed RTU's
- Supply, install, and terminate all external cables from plant to the RTU
- Load configuration files into all RTU's/PLC's/LCF's
- Full functional testing of all RTU's/PLC's/LCF's, including testing of points back to the control centre, and assistance with the commissioning of the combined system.
- Providing any necessary plant operation and secondary voltage and currents required as part of the commissioning.

5.2.6.6 The number of and location of RTU bins is defined on the SCADA and Communications single line diagram for this project.

5.2.6.7 All inter-panel copper cabling to the RTU bins must be terminated on suitable terminal strips within the cabinet in which the RTU is mounted, and then wired to the RTU interface cards.

5.2.6.8 The Contractor must install DC supply cables at the nominated voltage from the DC switchboard, to the RTU.

5.2.6.9 At the RTU panel, interface terminals/links must be provided such that there is one isolation link for each circuit. Terminals/Links must be approved by the Principal before implementation.

5.2.6.10 The Contractor must supply and install within the RTU panel Earth terminals suitable for earthing the screened cable drain wires. Drain wires must be covered with appropriately sized green/yellow tubing.

5.2.7 METERING

5.2.7.1 Metering requirements are specified in SS-2-4.1 Metering and the design drawings. Additional requirements are detailed below.


5.2.7.2 This section describes the general requirements of the metering installation to be performed by the Contractor. The Contractor must be responsible for the supply, testing, installation, commissioning and guarantee of the metering equipment in accordance with this Specification.

5.2.7.3 The Contractor must supply everything necessary or usually supplied as part of the metering installation. All Contractor supplied items must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

5.2.7.4 The metering schemes are shown on the Protection and Metering Single Line Diagram.

5.2.7.5 The Contractor must install the following main items:

- Panel metering equipment on each control panel including all CB's, Battery Charger, and others.
- SCADA metering equipment comprising transducers and other hardware in the various panels (including all CB's, Battery Charger, and others), and connected to the SCADA RTU/s.
- A free standing 19" rack cubicle wired and fitted with statistical metering equipment. Meters and ESAA test blocks will be free issued to the Contractor.

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- Local Supply metering to meter the total local supply kWh Meters. Meters and ESAA test blocks will be free issued to the Contractor.

5.2.7.6 The Contractor must ensure all revenue metering drawings are approved by the Principal prior to construction. The Contractor must issue relevant revenue metering drawings to the Principal's Representative for this approval.

5.2.7.7 All Integrating meters, ESAA test blocks, GSM / NextG phones and modems will be free issued to the Contractor. The Contractor must supply all auxiliary equipment.

5.2.7.8 The Contractor must provide a connecting cable from the telephone isolation equipment to the meter panel or install a suitable GSM / NextG phone antenna to the exterior of the building. The modem requirements will be specified by the Principal.

5.2.7.9 The Contractor must wire and test, and install the metering equipment.

5.2.7.10 The Contractor must provide cabling (and termination) of cubicles. All terminals and marshalling boxes associated with revenue metering must be sealable.

5.2.7.11 Should matching or ratio correction CTs be required, the Contractor must provide the CTs. CTs must be mounted inside the cubicle.

5.2.7.12 Local supply meters and test blocks will be free issued to the Contractor. The Contractor must supply any auxiliary equipment needed, and install all equipment, wiring and mounting of equipment. Equipment must be mounted on the 415V switchboard.

5.2.7.13 The Contractor must install and commission voltage selection relays and must provide the control necessary to automatically select the highest ranked VT according to the VT ranking advised by the Principal. Voltage selection relays must be specified by the Contractor and supplied by the Principal.

5.2.7.14 Metering VT loads must be balanced on all three phases as far as possible. For any 3 single phase VT installation, the least loaded metering winding must not carry less than 80% of the load experienced by the most heavily loaded metering winding. Manufacturers' installation guides for transducers and meters must be followed with respect to metering inputs. VT balancing is to be achieved via appropriate assignment of auxiliary supply and single phase metering load. Any shortfall may then be made up with resistors having the appropriate temperature rating, and be connected close to and on the load side of the VT terminals such that the burden measured at the VT terminals will include the effects of the resistive burden. All resistors must be adequately ventilated and mounted so any generated heat does not affect other components.

5.2.7.15 Each metering CT core of a 3 phase installation must be loaded to achieve an acceptable balance between phases. The least loaded core must carry not less than 80% of the load experienced by the most heavily loaded metering core. 3Ph, 3w transducers and meters must be wired to the preferred phases indicated in their appropriate installation guides.


5.2.7.16 Dummy loads may be fitted where necessary, for balancing purposes and to achieve the loadings stipulated above. Dummy loads must be connected close to and on the load side of the CT terminals such that the burden measured at the CT terminals will include the effects of the applied burden.

5.2.7.17 The Contractor must perform the following site tests on the metering installations using precision metering equipment:


- Panel meter accuracy.
- Transducer accuracy and check of inputs into the SCADA RTU cubicle using a precision load resistor and digital voltmeters and ammeters.
- Statistical metering operation and accuracy.

5.2.8 COMMUNICATIONS AND SIGNALLING

5.2.8.1 Communications and signalling requirements are as specified in the design drawings. Additional requirements are detailed below.

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- 5.2.8.2 In general the communications equipment within the substation will be supplied and installed by the Principal, however some communications related work is included in the scope of this contract;
- Supply and installation of public telephone services and telephone isolation equipment.
 - Installation of communications equipment cubicles.
 - Installation of communications and control systems power supplies
- 5.2.8.3 Where required, the Contractor must arrange for the installation of a 10 Pair lead-in cable from the public telephone network for connection of public switched telephone services to the substation.
- 5.2.8.4 The lead-in cable installation must include telecommunications conduits from the property boundary to the substation control building, and, in consultation with the Carrier's contractor, from the property boundary to the public network connection point. All materials used must be in accordance with AS/ACIF S008:2001 – Requirements for Authorised Cabling Products. All telecommunications equipment must be installed in accordance with AS/ACIF S009:2001 – Installation Requirements for Customer Cabling (Wiring Rules).
- 5.2.8.5 Telecommunications conduits and cables within the substation must be unbroken between the property boundary and the telephone line isolation unit in the substation building. The use of telecommunications pits within the substation boundary is not permitted.
- 5.2.8.6 The Principal is responsible for making application to the Carrier for the appropriate public telephone services.
- 5.2.8.7 Where required, a telephone Line Isolation Unit (LIU) must be installed in the substation to isolate the public telephone network from the telephone equipment installed in the substation. The telephone line isolation unit must be equipped with sufficient high voltage isolation links to allow for termination and isolation of the 10 pair lead-in cable.
- 5.2.8.8 The isolation unit must use optical isolation techniques to provide the isolation between the public telephone network and the substation telephone equipment. The isolation unit must provide a minimum of 100kV electrical isolation between the incoming exchange line and the subscriber equipment in the substation.
- 5.2.8.9 The LIU must be equipped with sufficient isolation modules to isolate two PSTN telephone lines and be capable of expansion to provide isolation for four telephone lines by the addition of isolation modules.
- 5.2.8.10 The exchange side isolation unit must be powered from the Carrier's network. The subscriber side isolation unit must be powered from the substation DC supply.
- 5.2.8.11 The LIU must be manufactured from insulated material and be located in the substation building such that there is a minimum of two meters clearance from any earthed metal object.
- 5.2.8.12 Communication cubicles will be provided by the Principal from the current period contract supply. The Contractor will install all equipment within the communication cubicles.
- 5.2.8.13 The Contractor must supply communications DC supplies.
- 5.2.8.14 Where indicated, the Contractor must supply and install a concrete communications antenna pole based on the standard Communications pole drawings supplied by the Principal.
- 5.2.8.15 The Contractor must confirm details of the antenna mounting requirements with Principal's Representative prior to ordering the pole steelwork.
- 5.2.8.16 Where required, the Contractor must supply and install fibre optic cable ducts and termination enclosures as per Drawing 899364-01 or 899364-02.
- 5.2.8.17 The termination enclosures, splice enclosures, and pits must be mounted in a position as agreed by the Principal. The internal OFS 800 termination enclosure must be mounted on

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the wall of the equipment room as close as practicable to the communications equipment cubicles.

5.2.8.18 Ducting suitable for the installation of fibre optic patch cables must be installed from the termination enclosure to the communications equipment cubicles and between termination enclosures.

5.2.8.19 The location and type of the outdoor conduits, pits and termination enclosures will depend on the incoming optical fibre cable type and location of the terminating structure. Where more than one fibre optic cable enters the substation the conduits for each cable must follow diverse paths into the substation control building and not use common pits or ducts or termination enclosures. The final position of conduits and cable pits must be agreed by the Principal's Representative.

5.3 SUNDRY PLANT

5.3.1 GENERAL

5.3.1.1 This section describes the general requirements of Sundry Plant.

5.3.1.2 The Contractor must supply everything necessary or usually supplied as part of the sundry plant. All Contractor supplied items must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

5.3.1.3 During commissioning, the Contractor must conduct a general check of all equipment which will include a check of the completeness, correctness and condition of all earth connections, labelling, painted surfaces, cables, wiring and auxiliary and ancillary items. The Contractor must include details of checks carried out in Inspection and Test Plans.

5.3.2 CT MARSHALLING BOXES

5.3.2.1 A CT secondary marshalling box must be provided for each three phase set of CTs. The marshalling box must be made of either stainless steel or aluminium. The construction and layout of internally mounted equipment must be as specified in EESS-10224 drawing series. The marshalling box must also have a rotating handle, not a key type access mechanism.

5.3.2.2 The secondary terminals of all CT cores must be connected by multicore cables to the terminals in the marshalling box. These cables must be a minimum of 8 cores with primary & secondary protection cores located in different cables.

5.3.2.3 Temporary earths must be made for each 3 phase set of CT cores in the marshalling box. This provision should take the form of a suitable link type terminal block with plug-in feature with the temporary earth connected to the cubicle earth bar.

5.3.3 VT MARSHALLING BOXES


5.3.3.1 A VT secondary marshalling box must be provided for each three phase set of VT's. The marshalling box must be made of either stainless steel or aluminium. The construction and layout of internally mounted equipment must be as specified in EESS-10225 drawing series. The marshalling box must also have a rotating handle, not a key type access mechanism.

5.3.3.2 The secondary terminals of all VT windings must be connected by a 4 core control cable to the terminals in the marshalling box. VT marshalling boxes must incorporate fuses as required by secondary wiring outlined in this Specification.

5.3.3.3 All equipment must incorporate a rating plate showing all relevant data in accordance with this Specification.

5.3.4 RATING PLATES AND NAMEPLATES

5.3.4.1 Rating plates and nameplates must be of non-ferrous metal or stainless steel material with etched or engraved lettering and attached with stainless steel screws or monel rivets. The

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plates must be located on each item of equipment so that they can be read clearly and safely from a person standing at ground level.

- 5.3.4.2 All CT & VT marshalling boxes must incorporate a rating plate showing all relevant data in accordance with this Specification.
- 5.3.4.3 All equipment, operating devices, relays must be suitably labelled such that they can be readily identified from drawings. Circuit breaker panels, control panels, relay panels must also be labelled.
- 5.3.4.4 The contractor must manufacture and supply all switchyard operational signs as approved under section 4.23.4.3

5.3.5 LABELS

- 5.3.5.1 Indoor labels must be engraved traffolyte or other approved material. Labels installed on outdoor equipment must be stainless steel & fixed with monel rivets.
- 5.3.5.2 Labels must be located such that they are easily read from normal operating positions and access ways around the equipment.
- 5.3.5.3 Cubicles and switchboard panels, which have rear access, must also be labelled on the rear of the panel.
- 5.3.5.4 All labels, and in particular those supplied on equipment of overseas origin, must be submitted for approval prior to shipment of the equipment. All labels must be in the English language.

5.3.6 PAINTING


- 5.3.6.1 All surfaces of structures and equipment must be finished with an appropriate coating system which will provide the necessary protection against corrosion for the design life of the equipment.
- 5.3.6.2 Minimum coatings for all exterior surfaces not specified as hot dip galvanised must be one coat of primer, one undercoat and two finishing coats of an approved colour and quality paint. The top coat must be single pack epoxy.
- 5.3.6.3 The interior of outdoor control cubicles, cabinets must receive the same number of coats as the exterior. The Contractor must make good any damage to the paint incurred during delivery, erection or commissioning, before relinquishing possession of the site to the Principal.
- 5.3.6.4 The Contractor must make good any paint work which peels, flakes or shows signs of rust during the defects liability period.

5.3.7 LOCKS AND KEYS

- 5.3.7.1 Where locks are called for under this Specification, they must be flush mounting types suitable for the Principal's master key system. The Principal will supply lock barrels during the course of the contract.
- 5.3.7.2 Locks must be constructed and located on the equipment so that they remain serviceable in the climatic conditions specified for continuous periods of up to two years without operation or maintenance. Locks must be constructed and located on the equipment so that they remain serviceable in the climatic conditions specified for indefinite service with suitable maintenance.
- 5.3.7.3 The Contractor must provide a shadow board mounted in each control room to hang all equipment door keys, operating handles and the like.

5.3.8 NUTS, BOLTS, STUDS AND WASHERS

- 5.3.8.1 All bolts and nuts must conform to the appropriate Australian Standard. Galvanised bolts, nuts and washers must be used on all structures & outdoor equipment. All bus connections must utilise stainless steel bolts, nuts with load spreading washers.

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- 5.3.8.2 All cable connections to transformer & switchgear palms must incorporate load spreading washers.
- 5.3.8.3 Surge Diverters must utilise a crimped lug connection. Surge Diverters must not utilise bolted connections.
- 5.3.8.4 The Contractor must have all washers, including locking devices and anti-vibration arrangements approved by the Principal's Representative. Taper washers must be fitted where necessary.
- 5.3.8.5 Where there is risk of corrosion, bolts and studs must be finished flush with the surface of the nuts.
- 5.3.8.6 All components must be chosen so they remain free of oxidation or reduction caused by the effects of electrolysis for the anticipated life of the substation. All components must be chosen to be relatively maintenance free.

5.3.9 CONTROL PANELS

- 5.3.9.1 The Contractor must use the cubicles currently on the Principal's period contract supply. Where a control panel is required that is not standard, the control panel must meet the following requirements:
- All control panels, cubicles, be fabricated from folded and welded sheet steel of minimum thickness 2mm attached to a steel frame. Where a free-standing floor mounted enclosure is called for, a base fabricated from 102 x 51mm x 10 kg/m channel section steel is bolted to the bottom of the enclosure. The stiffness is such as to prevent mal-operation of relays or other apparatus after impact. The front of the panel has a smooth well finished surface.
 - Where the enclosure is provided with hinged sections the hinges are to be chrome lift-off pintle type. Neoprene strips are used around the edges of all hinged or removable sections to exclude dust. Hinged sections over 1,000mm high are fitted with a three point locking system operated by a single handle.
 - Outdoor cubicles are weatherproof and fitted with vermin-proof louvers for ventilation. They are fitted with anti-condensation heaters in tropical regions (galvanised steel, stainless steel or aluminium material is acceptable but painted black steel is not acceptable).
- 5.3.9.2 All secondary equipment supplied must be housed in free-standing vermin and dustproof cubicles which are adequately ventilated to prevent condensation. The cubicles must have a maximum height of 2,250mm, a preferred width of 800mm and depth of 800mm with provision for either top or bottom cable entry. Rittal type panels or equivalent are acceptable.
- 5.3.9.3 All cabling in control panels must be tied using approved UV stabilised cable ties, loomed and in cable ducting where practicable. Slack must be provided in all wiring and cabling to facilitate disconnection and removal of equipment. Cables must be looped from the cable duct to each device terminal for testing purposes.
- 5.3.9.4 Where front and rear access doors are provided, they must be capable of being removed from the frame without the use of tools and when closed, not obscure clear visual observation of any operation indicator, switch or indicating lamps contained in the cubicle or the cubicle label. The cubicles must be designed for maximum accessibility for ease of maintenance.
- 5.3.9.5 The rear of control panels must be illuminated by AC lighting.
- 5.3.9.6 The Contractor must provide an Inspection and Test Plan for Sundry Plant.

5.3.10 FUSES

- 5.3.10.1 Fuses must be provided for the protection and isolation of control, alarm, indication and VT circuits. Fuses must be of HRC (High Rupturing Capacity) of GEC manufacture, type "NS"

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of the cartridge type or technically equivalent. Fuse carriers and bases must be coloured black.

- 5.3.10.2 Solid links must be supplied in the neutral circuits. Neutral link carriers and bases must be coloured white.
- 5.3.10.3 Separate fuses and links must be provided in the DC supply to the protection, control and alarm circuitry associated with each high voltage bay, such that the removal of the relevant fuse and link allows work on the circuitry for that bay, without interruption to the supply to any other bay.
- 5.3.10.4 Test/Disconnect links must be provided on all CT & VT circuits.


5.3.11 SIGNS

- 5.3.11.1 The Contractor must provide all the necessary warning and safety signs around and within each substation. Signs must also be installed to warn operators of dangerous voltage levels, correct operating procedures and safety requirements within the substations as specified in Substation Standard SS-1-9.3 "Signage".
- 5.3.11.2 Warning signs must conform to the relevant Australian Standard and Workplace Health & Safety Act 2011.
- 5.3.11.3 The Contractor must supply and install weather proof, engraved stainless or aluminium signs fixed with monel rivets, displaying the operational name and number of each item of high voltage plant.
- 5.3.11.4 The Contractor must provide a list of these signs with sizes and full details of lettering to the Principal's Representative.


5.4 SITE SERVICES

5.4.1 ELECTRICAL SERVICES

- 5.4.1.1 This section describes the general requirements for total manufacture, supply, installation, testing, commissioning and maintenance of the complete electrical services.
- 5.4.1.2 The scope of works covered by this section includes all works originating at the AC and DC distribution boards, but excludes the installation of the distribution boards. Details of distribution board requirements are covered elsewhere in this Specification.
- 5.4.1.3 The Contractor must ensure that all materials supplied and all work carried out complies with the requirements of the latest addition of the SAA Wiring rules (AS 3000) and amendments there to, the regulations and by-laws of the Electricity Supply Authority and any other Authority having jurisdiction over the performance of the work.
- 5.4.1.4 The Contractor must consider all design drawings, and drawings for information, in conjunction with this Specification.
- 5.4.1.5 At the completion of the works, the Contractor must prepare 'as constructed' drawings, showing the final locations of all equipment as installed. Drawings must include building layouts showing the final locations and arrangement of all lighting and power outlets installed, and include single line diagrams to indicate the arrangement of circuits.
- 5.4.1.6 Drawings must be produced in accordance with this Specification.
- 5.4.1.7 At the completion of the works, the Contractor must provide all hard copy sets of the final 'As Constructed' drawings, with the Operation and Maintenance Manuals for the project.
- 5.4.1.8 Manuals must include instructions for operating all equipment (including fire indicator panel), test results, as constructed drawings, manufacturer's product data for all equipment provided, and safety instructions for the safe use of the installation.
- 5.4.1.9 The Contractor must confirm final locations of all fixtures, luminaries, light switches and the like with the Principal's Representative prior to commencement of the works.

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- 5.4.1.10 All light switches and GPO's must be flush mounted on blockwork. Where blockwork is required to be core filled, the Contractor must install conduits into flush mounted wall boxes, to allow drawing in of cables after core filling.
- 5.4.1.11 Residual Current Devices (RCD) must be installed in accordance with AS 3000 wiring rules.
- 5.4.1.12 Outlets of 63A capacity or greater rating (single or three phase) may be surface mounted.
- 5.4.1.13 The Contractor must supply, install and commission all 110Vdc luminaries and 110Vdc "T" pin un-switched outlets.
- 5.4.1.14 All circuit breakers (including RCD/MCB combinations) must be moulded case type to Current Australian Standards. Miniature circuit breakers (MCB's) will not be accepted.
- 5.4.1.15 The Contractor must supply and install "On Site" switches as shown on the drawings, and as directed by the Principal's Representative.
- 5.4.1.16 The Contractor must supply and install Personnel Emergency Switches as shown on the drawings and in accordance with this Specification.
- 5.4.1.17 The Contractor must provide engraved labels, fixed to the switches, or wall adjacent to the switch as directed by Principal.
- 5.4.1.18 The Contractor must supply and install wire from each switch to the AC distribution board using 2.5mm² TPS stranded copper conductors, and make final connections.
- 5.4.1.19 All socket outlets must be engraved or labelled to indicate its respective circuit number.
- 5.4.1.20 All joints in the building earthing grid must be made using compression type connectors.
- 5.4.1.21 The Contractor must ensure the final installation is evenly balanced across the three phase supply.
- 5.4.2 AIR CONDITIONING**
- 5.4.2.1 The Contractor must provide air-conditioning of the Control Building to meet requirements of this Specification.
- 5.4.2.2 The Contractor must ensure that all material supplied and all work carried out complies with the requirements of the SAA Codes and any amendments and all regulations and by-laws of any Authorities having jurisdiction over the performance of the work.
- 5.4.2.3 The Contractor must provide condensate drains and tun dish for the complete operation of the units.
- 5.4.3 LIGHTING**
- 5.4.3.1 Emergency Lights must be installed within the building to the current regulations including "Test button facilities". The Contractor must provide a log book for testing of individual circuited fittings.
- 5.4.3.2 General external lighting must consist of weatherproof (IP56) luminaries, located under the control building eaves and controlled by movement sensor and switches both inside and outside the control building.
- 5.4.3.3 A photo-electric cell to control the external Security Lights must be provided.
- 5.4.3.4 An over-ride switch labelled "Test Switch for external security lights" must be provided.
- 5.4.4 FIRE PROTECTION**
- 5.4.4.1 Fire protection must be provided in accordance with SS-1-9.1 Substation Fire Protection, the project Civil Specification (where supplied) and the design drawings.
- 5.4.4.2 This section describes general requirements for the supply, installation, testing and commissioning of the complete fire detection and alarm system comprising:
- Fire Indicator Panel;

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- Detectors;
- Cables, conduits and accessories;
- Fire Extinguishers.

- 5.4.4.3 The Contractor must supply, install and commission a Fire Indicator Panel complying with Current Australian Standards and approved by the Insurance Council of Australia. The Fire Indicator Panel must incorporate a manual call point.
- 5.4.4.4 The Contractor must supply and install an 'as installed' Location diagram of the complete installation, located adjacent to the Fire Indicator Panel. The Location diagram must indicate the position of the fire indicator panel, detectors, alarm groups and alarm zone circuit numbers. The Location diagram must be plastic laminated and mounted as directed by the Principal. The Location diagram must use symbols that comply with AS 1670 and Handbook AS HB20.
- 5.4.4.5 In addition to the Location diagram, the Contractor must provide a detailed circuit diagram indicating all wiring and terminal connection details of the output contacts for alarm and/or control purposes.
- 5.4.4.6 The Contractor must provide details of provisions for future connection of the panel for system monitoring by the Fire Brigade.
- 5.4.4.7 The Contractor must supply, install, and commission an air conditioning shutdown signal from the Fire Indication Panel to the AC distribution board, to shutdown the air conditioning in the event of a fire.
- 5.4.4.8 Signal cabling must be to the Current Australian Standards.
- 5.4.4.9 The Contractor must carry out final testing after completion of the installation, in accordance with current Australian Standards.
- 5.4.4.10 The Contractor must supply and install Fire Extinguishers as required under Current Australian Standards.
- 5.4.4.11 The Contractor must provide mounting brackets, identification signs in accordance with the codes.
- 5.4.4.12 Final locations of extinguishers must be selected to meet the requirements of the Workplace Health & Safety Act 2011 and be agreed with the Principal.

5.5 CONTROL & SWITCHGEAR BUILDING


- 5.5.1 The detailed requirements for control and switchgear building works are included in the project Civil Specification (where provided) and the design drawings. The Contractor must review these requirements in detail well before beginning any work at site.

5.6 CIVIL WORKS

- 5.6.1 The detailed requirements for civil and earthworks are included in the project Civil Specification (where provided) and the design drawings. The Contractor must review these requirements in detail well before beginning any work at site.

5.7 STRUCTURAL WORKS

- 5.7.1 The detailed requirements for structural works are included in the project Civil Specification (where provided) and the design drawings. The Contractor must review these requirements in detail well before beginning any work at site.
- 5.7.2 The Contractor must obtain a Certificate of Structural Adequacy for the buildings, substation structures and foundations, and submit the Certificate to the Principal's Representative, before site works are commenced. The Contractor must ensure the Certificate is provided by a Registered Professional Engineer of Queensland (RPEQ) in the appropriate area of practice.

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5.8 LANDSCAPING

5.8.1 The detailed requirements for landscaping works are included in the project Civil Specification (where provided) and the design drawings. The Contractor must review these requirements in detail well before beginning any work at site.

5.9 TESTING AND COMMISSIONING


5.9.1 TESTING RESPONSIBILITIES

5.9.1.1 The Contractor must be responsible for the following:

- Provision of Inspection and Test Plans (ITP's) for all testing works undertaken by the Contractor.
- Certification by the Contractor's Registered Professional Engineer of Queensland (RPEQ) that the Contractor's ITP's meet all statutory and regulatory requirements.
- On site construction testing, including:
 - Continuity testing of panel wiring, interpanel wiring, control cables.
 - Ductor testing of high voltage and earthing connections.
 - Insulation testing of wiring installed on site.
- Primary Plant testing, including insulation resistance, ratio, polarity, magnetisation, winding resistance.
- Test and commission AC and DC supplies.
- Loading/applying settings to all protection relays.
- Load configurations into all SCADA RTU's, LCF's and communications equipment.
- Connecting CT secondary connections to the required ratio and polarity configuration.
- Function test interconnection between components.
- Protection relay secondary injection and internal logic testing.
- End to end SCADA testing.
- Function test completed systems and schemes.
- Primary injection testing of completed schemes such as transformers differential and bus differential protection
- Certification by the Contractors RPEQ that all ITPS have been completed successfully, test and inspection results are satisfactory and that the primary and secondary systems tested are fit for service.

5.9.1.2 The Principal will be responsible for the final commissioning, including:

- Supply Contractor with protection relay settings, protection setting report, CT ratios and configuration files for SCADA RTU's and communication equipment.
- Specialised testing such as earth grid testing, partial discharge, DDF and SFRA testing.
- Audit testing of Contractor's works.
- Witnessing Contractor's critical works such as protection testing and primary injection testing.
- Remote end protection and communication works.
- Establishment of communications links and integration of protection with remote ends and existing systems including end to end protection tests.

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- Integration of new primary plant and secondary systems into existing live systems including function tests of completed systems and schemes that could not be carried out prior to integration.
- Energising and placing of the substation into service and carry out on load tests.

5.9.1.3 The Principal may elect for the Contractor to perform final commissioning. Where specified, the Contractor must perform final commissioning using staff that satisfy the required levels of competence, as specified by this Specification.

5.9.1.4 The Contractor must qualify all Test staff in accordance with MN000301R165 "Ergon Energy 8 Level Field Test Competency Reference"

5.9.1.5 The Contractor must stage works such that the Principal will provide any isolation between existing systems and new works to allow the new works to be tested by the Contractor as described in this Specification. The Principal will integrate the new works into existing systems following completion of testing by the Contractor. Note that such isolation by the Principal is to ensure that testing works do not impact on existing systems, NOT to provide a safe work zone to the Contractor.

5.9.2 GENERAL SITE TESTING CONDITIONS

5.9.2.1 Site Acceptance inspections and testing must be carried out as specified and as set out on Inspection and Test Plans.

5.9.2.2 In the event of abnormal or unexpected test results or circumstances, the Contractor must carry out additional testing to ensure the safety and correct operation of the plant and equipment under working conditions, at the request of the Principal's Representative. Such requests would not be made unreasonably.

5.9.2.3 The Contractor must meet the costs of all tests and inspections. The Contractor must deem the costs of all tests and inspections to be included in the contract sum. The Contractor must submit requirements for any additional testing (and resource requirements to complete the testing) to the Principal's Representative for approval prior to the commencement of any such works. Failure to comply with this process will result in a non-payment for any such works completed.

5.9.2.4 The Contractor must have regard for the Safety of personnel at all times.

5.9.2.5 The Contractor must ensure that at all times strict safety precautions are taken to avoid personnel contacting live equipment, including roping off appropriate areas and applying danger signs and tags.


5.9.2.6 These precautions are in addition to the Principal's system of safety procedures and work permits, which apply to equipment capable of being made alive from system voltages.

5.9.3 TRAINING AND SUPPORT

5.9.3.1 The Contractor must provide an onsite handover / training session for the Principal's Commissioning Officer and Test Technicians. The onsite handover / training session must cover overall familiarisation with the operation of major equipment, location and origin of alarms and switches and any special requirements deemed necessary. This training must occur prior to the Principal's staff commencing final testing and commissioning works.

5.9.3.2 The Contractor must prepare and carry out a training program for the Principal's 'call out' maintenance staff. The training program must cover overall familiarisation with the operation of major equipment, location and origin of alarms and switches and any special requirements deemed necessary.

5.9.3.3 The Contractor must provide support for the Principal's Commissioning Officer and Test Technicians during commissioning of any equipment installed and/or tested by the Contractor. As a minimum, the Contractor must provide telephone support by a suitably knowledgeable person who has been directly involved in the installation, checking and testing of the equipment.

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5.9.4 TEST PLAN AND PROGRAM


- 5.9.4.1 The Contractor must carry out sufficient inspection and testing to prove that all plant and equipment has been installed correctly, operates in accordance with the relevant drawings and specifications and is fit to be handed over to the Principal for placing into service. All test results must be approved by the Contractor's RPEQ before any plant is placed in service.
- 5.9.4.2 The Contractor is responsible for developing and obtaining RPEQ approval of all ITP's for all test works undertaken by the Contractor. These ITP's must include all tests that the Contractor's RPEQ may deem necessary to prove the plant or equipment ready for service.
- 5.9.4.3 Notification of tests must be in accordance with this Specification.

5.9.5 TEST EQUIPMENT

- 5.9.5.1 The Contractor must supply all personnel, test equipment, materials, instruments and tools necessary to carry out testing of all plant and equipment as described in this Specification. Each piece of test equipment must be assigned a unique designation and where appropriate the type and designation of the test equipment be recorded on the Test Result Sheet.
- 5.9.5.2 The test equipment used for measurement of contact resistance, connection resistance, main circuit resistance, circuit breaker timing, and transformer winding resistance, ratio, polarity and magnetisation must be equivalent in functionality to an Omicron CPC100.
- 5.9.5.3 The test equipment for relay secondary injection testing must be equivalent in functionality to an Omicron CMC 256, CMC 356 or Doble F6150 secondary test sets.
- 5.9.5.4 Prior to commencement of testing, the Contractor must calibrate the test equipment and instruments, or provide the Principal's Representative with Certification that the test equipment is covered by Clause 7.6 of AS/NZS ISO 9001.
- 5.9.5.5 If at any time during testing, doubt exists as to the accuracy of a piece of test equipment, the Contractor must repeat the calibration tests and affected testing at the request of the Principal's Representative. Defective instruments will cause associated testing to be rejected by the Principal. The Contractor must provide replacement test equipment and no extension of time will be allowed for this unless the Contractor can show that the delay was caused by reasons beyond their control.

5.9.6 TEST PERSONNEL

- 5.9.6.1 The Principal specifies Field Test competency levels applicable at each stage of testing and commissioning primary plant and secondary systems in Ergon Energy substations in accordance with MN000301R165 " ". That document includes a Competency and Authorisation Record for use by the Contractor.
- 5.9.6.2 The Contractor must submit Competency and Authorisation Records to satisfy the Principal's Representative as to the competence of all personnel on site during the testing phase by producing proof of qualification and experience on similar projects, for each test person, in accordance with the specified Levels of Competence. All test personnel must meet the competency levels required by the Standard Work Practices for the specific tests. It is not normally necessary for personnel to undergo assessment in accordance with the SWP's, provided their evidence of experience matches the appropriate competencies specified.
- 5.9.6.3 The Contractor must not subcontract the testing or pre-commissioning portion of the works.
- 5.9.6.4 The Contractor must ensure that Construction Testing (including continuity testing, insulation testing and ductoring) is not carried out by the same personnel that carried out the construction/assembly works.

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5.9.7 TEST SUPPLIES

5.9.7.1 The Contractor must provide the required voltage and current testing supplies (unless already provided on the site by the Principal). As a minimum the current supply must be 63A, 3 phase, 415V, 50 Hz.

5.9.8 WITNESSING AND APPROVAL OF TESTS

5.9.8.1 Witnessing by the Principal of any tests required to be carried out by the Contractor is at the Principal's Representative's discretion. The Principal's Representative will indicate which tests are intended to be witnessed. The Principal's Representative may alter the tests to be witnessed as the project continues and will make any changes clear to the Contractor.

5.9.8.2 Where the Principal's Representative has indicated that witnessing of tests will be required, the Contractor must ensure that such tests are not carried out without the Principal's Representative present, unless otherwise agreed by the Principal's Representative. All protection system secondary injection testing and primary injections must be witnessed by the Principal's Representative.

5.9.8.3 If, during witnessing of tests any doubt exists about the result of a test, the Principal's Representative may request a repeat or extension of such test or part thereof.

5.9.8.4 The Contractor must have all completed Test Result Forms certified by the Contractor's RPEQ and approved by the Principal's Representative. The Contractor must notify the Principal's Representative of any Test results that do not meet the required pass criteria for determination of required action which may include:

- Repeating of the tests,
- Acceptance of the results, or
- Replacement of the equipment.

5.9.8.5 The Principal may carry out random audits on the Contractor's testing by repeating some of the tests previously completed by the Contractor. Such audits will be at the Principal's cost unless an audit shows errors in the original tests, in which case the Contractor must be responsible for all costs associated with the audit. The Contractor must remedy any errors detected in this manner as required by this Specification.

5.9.9 REMEDIAL WORK

5.9.9.1 If, as a result of inspection or testing, remedial construction work is necessary, then the Contractor must cease testing on that particular section of work until the remedial work is complete. The Contractor must then repeat all relevant tests on that section of work.

5.9.9.2 The Contractor must meet the cost of all remedial work and repeat testing. The Contractor must report all remedial work on a Remedial Work Report and submit to the Principal's Representative for certification that the defect is rectified.


5.9.9.3 This Remedial Work Report must contain the following information:

- Substation site and item of plant affected.
- The test during which the defect was noticed.
- The nature of the defect.
- The remedial action which was taken.

5.9.9.4 Repeat testing must then continue following the set procedures of notice to the Principal's Representative and application of tests according to the appropriate ITP.

5.9.9.5 The Remedial Work Report must be signed by the Contractor and endorsed by the Principal's Representative.

5.9.9.6 The Contractor must ensure that defects found during commissioning are rectified and any associated testing is completed with minimal impact on the Principal's Works Program and Commissioning Plan.


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5.9.10 TEST RECORDS

- 5.9.10.1 The Contractor must record Test results on Test Result Forms for all tests. It is preferred that the Ergon Energy Test Results Forms and Supplementary Forms as listed on the Testing and Commissioning website are used. The latest version of these forms will be made available to the Contractor when requested from the Principal's Representative. Test results produced by automated test equipment, such as Omicron CPC100 are acceptable provided they contain the same information as the Test Result Forms and Supplementary Forms as available from the Principal.
- 5.9.10.2 In addition, each Test Result must have facilities for recording the following information:
- Location - i.e. Substation Name.
 - Circuit.
 - Plant/Equipment Description, Type and Serial Number.
 - Date of Test.
 - Tester's name.
 - Test Equipment Number.
 - Suppliers Name.
 - Name, signature and date for Contractor's Test Engineer.
 - Name, signature and date for Ergon Energy Commissioning Officer.
- 5.9.10.3 The Contractor must use Test Result Forms designed such that results for each piece of equipment on one particular circuit or section of the equipment (e.g. CTs, VT's, CB, isolators etc) can be filed together.
- 5.9.10.4 For accuracy or performance tests such as protection relay secondary injection tests, the Contractor must clearly detail on all completed Test Result Forms the expected result, allowable tolerance, actual result, and a pass/fail assessment.
- 5.9.10.5 The Contractor must clearly indicate on all completed Test Result Forms if any plant or equipment fails to meet the test requirements or is outside the tolerance allowed in the relevant Standard, Standard Work Practice, ITP or manufacturer's specification.
- 5.9.10.6 The Contractor must have all completed Test Result Forms approved by the Contractor's RPEQ prior to submission to the Principal, and the works considered substantially incomplete until such approval is provided.
- 5.9.10.7 The Contractor must ensure all completed Test Result Forms are professionally presented, clear and legible. Handwritten results that are ambiguous, poorly presented, difficult to read or illegible will not be accepted and the works considered substantially incomplete until acceptable Test Result Forms are provided.
- 5.9.10.8 The Contractor must provide a complete set of "greenlined" schematics as evidence of wiring checks in accordance with MN000301R167 Ver 1 Greenlining and Bluelining of Ergon Energy Substation Drawings.
- 5.9.10.9 The Contractor must perform all "greenlining" in accordance with MN000301R167 Ver 1 Greenlining and Bluelining of Ergon Energy Substation Drawings.

5.9.11 STANDARD WORK PRACTICES

- 5.9.11.1 Standard test requirements for various types of primary plant and secondary systems are indicated in the relevant Standard Work Practice (SWP) documents and Inspection and Test Plans (ITP's). These documents are available from the Principal, and are indicative only of the type of tests normally carried out on the Principal's plant and equipment.
- 5.9.11.2 If the Contractor's testing methods and ITP's do not specify an equivalent (at least) level of testing and inspection, then the Contractor must support these methods and ITP's with a

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documented risk assessment carried out by the Contractor and approved by the Principal prior to the commencement of testing works.

5.9.12 CONSTRUCTION TESTING

5.9.12.1 The Contractor must be responsible for carrying out Construction Testing, as indicated below. The Contractor must set out the extent of this testing on the appropriate ITP, including (but not be limited to):

- Continuity testing of all field wiring and cables in marshalling cubicles and site primary plant. Point to point testing of panel and primary plant internal wiring will generally have been completed by the relevant suppliers and accordingly does not need to be repeated, unless directed otherwise by the Specification.
- Continuity testing of all cables (and connections) entering the control/communications buildings and any additional inter-panel wiring, DC/AC supplies and any other wiring in the building that has not been checked during FAT testing of control/protection panels. (Unchecked wiring should be readily determined from the greened-out copies of schematics, marked up during FAT testing).
- Insulation testing (at 500V) of all wiring installed on site including control cables, panel wiring and inter-panel wiring. Care must be taken to disconnect or short out terminals of equipment which may be damaged during this testing and to restore any disconnected items to their exact original state.
- “Ductoring” of all earth mat connections. A minimum current of 50A is used for resistance measurement to check continuity of earth connections from all structures, plant, equipment and fittings to the main earth grid. Resistance is measured to a common reference point (the No 1 Transformer 11kV neutral connection point).
- “Ductoring” of HV connections.

5.9.12.2 The Contractor must ensure continuity testing of wiring verifies wiring correctness to AC and DC schematics, verification to construction schedules is not acceptable.

5.9.13 EARTHING SYSTEM

5.9.13.1 Earth grid testing, including grid resistance, step and touch potentials, and earth potential rise will be carried out by the Principal.

5.9.13.2 The Contractor must carry out “Ductoring” of earth grid connections as part of the construction testing.

5.9.14 PRIMARY PLANT TESTING

5.9.14.1 The Contractor must be responsible for carrying out primary plant testing to relevant Australian or ISO Standards in order to verify that the primary plant has been installed and erected correctly and that no damage to plant has occurred during transport or erection.

5.9.14.2 Modular substation buildings assembled at Ergon Energy’s Specialist Plant Services (SPS) workshop are subjected to initial testing by SPS staff prior to leaving the workshop, however the Contractor must repeat sufficient tests in order to verify that no damage to plant has occurred during transport or erection.

5.9.14.3 The Contractor must describe all testing in the appropriate ITP. Table 14 and Table 15 below are indicative of the testing normally carried out on the Principal’s plant and equipment.


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Table 14 Primary Plant Testing – Modular Buildings

Switchboard Primary Plant	Testing at SPS by the Principal	Testing on Site by Contractor
MV Switchboard Bus	a) Insulation resistance b) Ductor connections	a) Insulation resistance b) Commissioning Check List
MV Switchboard Circuit Breakers	a) Insulation resistance (across open contacts, between phases and to ground) b) Contact resistance, c) Timing (including contact time travel on all poles and interrupters and auxiliary switch timing) d) Reduced aux voltage operation e) SF6 alarm/lockout operation f) Interlock function	a) Insulation resistance (across open contacts, between phases and to ground) b) Commissioning Check List
MV Switchboard Current Transformers	a) Insulation resistance b) Winding resistance c) Ratio d) Polarity e) Magnetisation f) Revenue Metering accuracy compliance g) Secondary circuit loop resistance	a) Insulation resistance b) Magnetisation c) Secondary circuit loop resistance d) Commissioning Check List
MV Switchboard Voltage Transformers	e) Insulation resistance f) Winding resistance g) Ratio h) Polarity i) Revenue Metering accuracy compliance	a) Insulation resistance b) Ratio c) Commissioning Check List
MV Switchboard Isolators and Earth Switches	a) Insulation resistance b) Contact resistance c) Interlock function	a) Insulation resistance b) Commissioning Check List

Table 15 Primary Plant Testing – Conventional Substation Equipment

Substation Plant	Testing on Site by Contractor
Bus work	(a) Insulation resistance (b) Ductor connections (c) Commissioning Check List
HV Connections	(a) Ductor connections
Surge Diverters	(a) Insulation resistance (b) Commissioning Check List


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Table 15 Primary Plant Testing – Conventional Substation Equipment

Substation Plant	Testing on Site by Contractor
Circuit Breakers	(a) Insulation resistance (across open contacts, between phases and to ground) (b) Contact resistance (c) Timing (including contact time travel on all poles and interrupters and auxiliary switch timing) (d) Reduced aux voltage operation (e) SF6 alarm/lockout operation (f) Interlock function (g) Commissioning Check List
Current Transformers	(a) Insulation resistance (b) Winding resistance (c) Ratio (d) Polarity (e) Magnetisation (f) Revenue Metering accuracy compliance (g) Secondary circuit loop resistance (h) Commissioning Check List
Voltage Transformers	(a) Insulation resistance (b) Winding resistance (c) Ratio (d) Polarity (e) Revenue Metering accuracy compliance (f) Commissioning Check List
HV cables	(a) Sheath test (b) Insulation resistance (pre and post HV withstand) (c) VLF HV withstand (d) Phasing (e) Commissioning Check List
Isolators and Earth Switches	(a) Insulation resistance (b) Contact resistance (c) Interlock function (d) Commissioning Check List
Transformers (also refer to separate listings for internal CTs and VT's)	<i>Measurement of winding resistance, insulation resistance, voltage ratio as well as CT and VT tests must be completed by the transformer erection contractor. The Contractor is required to complete any Commissioning Checklist items such as alarms/controls that the transformer erection contractor was unable to complete due to incomplete secondary systems works at the substation at the time the transformer was erected.</i>
Capacitor Banks/Reactors	(a) Insulation Resistance (b) Capacitance/Reactance (c) Commissioning Check List
Insulating Oil	Any oil used as an insulating medium must be sampled from the plant and undergo oil tests including DGA, acidity, moisture content, resistivity, dielectric loss, dielectric strength. The Contractor must ensure that these oil test results are recorded in the Powerlink Qld (Virginia) oil testing laboratory database of results.


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Table 15 Primary Plant Testing – Conventional Substation Equipment


Substation Plant	Testing on Site by Contractor
Distribution Transformer/AC Supply	(a) Earth resistance (b) Insulation resistance (c) Ratio (d) Voltage Measurement (e) Phase Rotation (f) Polarity (g) Load Checks (h) Commissioning Checklist

5.9.15 HIGH VOLTAGE POWER CABLES

- 5.9.15.1 The Contractor must routine test the HV power cables supplied in accordance with SS-1-4.4 Cables and Cabling.
- 5.9.15.2 The Contractor must have HV power cables routine tested to in accordance with AS/NZS 1429.1 Table 3.1 at the manufacturer's works before being delivered.
- 5.9.15.3 The Contractor must type test the HV power cables supplied in accordance with SS-1-4.4 Cables and Cabling.
- 5.9.15.4 The Contractor must have HV power cables type tested to at the manufacturer's works before being delivered.
- 5.9.15.5 The Contractor must site test the HV power cables supplied in accordance with SS-1-4.4 Cables and Cabling.
- 5.9.15.6 As a standard procedure, the Contractor must test the medium voltage switchboards and capacitor banks that employ local circuit breakers for Partial Discharge (PD) before commissioning.
- 5.9.15.7 The Contractor must seek direction from the Principal's Representative at the time cables would normally be connected to any switchboard or capacitor bank with local circuit breaker.
- 5.9.15.8 The Contractor must not test cables on initial installation, where cables later need to be removed to allow PD testing. The Contractor must complete the full set of relevant tests upon reinstatement of the cables & terminations.
- 5.9.15.9 The Contractor must remove and replace any cable found faulty or not to the satisfaction of the Principal's Representative, at the contractor's expense.

5.9.16 SECONDARY WIRING

- 5.9.16.1 The Contractor must perform the following tests on the secondary wiring, terminations and multicore cables as part of his pre-commissioning checks:-
- Identification of all cables as to their labelling and location against approved drawings.
 - Identification and "belling" of all cores of the cable and ascertain correctness of wire termination numbers against approved drawings.
 - Megger the insulation of each core using a 500V Megger instrument, with every other core within the cable earthed.
 - All cores to be shorted together at one end and the insulation to earth tested with a 500V Megger instrument.
 - The tightness of each connection and the wire number verified against the termination diagram.

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- Check connection and/or insulation of cable screens in accordance with design requirements.

5.9.17 SUNDRY PLANT

5.9.17.1 In addition to other tests specified, the Contractor must perform the following tests on the all control panels and cubicles, both within the substation building and field panels:

- After short circuiting the terminals of all sensitive equipment with bare wire, test the insulation of the cubicle wiring with a 500V Megger. The insulation between different sources of supply is to be tested as well as insulation to earth. Care must be taken to disconnect or short out terminals of equipment which may be damaged during this testing and to restore it to its exact original state.
- Check that all equipment is mounted securely and that all electrical connections to equipment in the cubicle and at termination strips are properly crimped and lugged and screwed tightly.
- Check cable entries, fuses links and indicating lamps.

5.9.18 SPECIALIST PRIMARY PLANT TESTING

5.9.18.1 The Principal will carry out the following specialist primary plant testing on site, following erection of the MV switchboard/s and transformer/s, but prior to connection of any HV cables to the MV switchboard/s or transformer/s:

- DDF and capacitance measurement on all transformer windings and bushings (using Doble M4000 instrument).
- Transformer Frequency Response Analysis Test (using Doble M5200 instrument).
- Partial Discharge and high voltage withstand testing of assembled MV switchgear. The Contractor is to ensure that any HV cables are disconnected and pulled away from the switchgear terminals to allow PD and high voltage withstand testing to be carried out.

5.9.18.2 The Contractor must provide the Principal's Representative with four (4) weeks written notice of when the transformer/s and switchboard/s will be available for this testing.

5.9.19 AC AND DC AUXILIARY SUPPLIES

5.9.19.1 The Contractor must test the AC supply in accordance with AS3000 Wiring Rules and the tests nominated on the Contractor's ITP.

5.9.19.2 If testing such as voltage measurements, on-load measurements, phase rotation and polarity checks are unable to be completed, because the AC supply cannot be energised, the Contractor must clearly indicate this on the Authority for Energising Electrical Plant NI001301F101. The Contractor must immediately complete these tests upon energisation of the AC supply.

5.9.19.3 The Contractor must apply settings to and functionally test any AC changeover switches in accordance with the manufacturer's recommendations.

5.9.19.4 The Contractor must test the DC supply in accordance with the tests nominated on the Contractor's ITP.


5.9.19.5 The 415V AC distribution board must be routine tested in accordance with SS-1-5.2 AC Supplies.

5.9.19.6 The 415V AC distribution board must be type tested in accordance with SS-1-5.2 AC Supplies.

5.9.19.7 The 415V AC distribution board must be site tested in accordance with SS-1-5.2 AC Supplies and this Specification.

5.9.19.8 The 415V AC distribution board must be subject to the following site tests:

- Earth Resistance Tests

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- Insulation Resistance
- Correct Circuit Connections
- Polarity Testing
- Earth Fault-Loop Impedance
- Operation of Residual Current Devices
- Phase Rotation
- Date of Energisation

5.9.19.9 The Contractor must conduct the site tests in accordance with the approved Inspection Test Plan (ITP)

5.9.20 METERING

5.9.20.1 The Contractor must test all metering transducers by secondary injection, including verification of analogue inputs received at the SCADA RTU.

5.9.20.2 Revenue/statistical metering operation and accuracy will be tested by the Principal.

5.9.21 CONTROL / PROTECTION PANELS, OUTDOOR CUBICLES, AND MARSHALLING BOXES

5.9.21.1 The Contractor is required to test/inspect all control and protection panels, cubicles and marshalling boxes as detailed on Form P71B05B06C07 Panel Checklist.

5.9.21.2 The Contractor is required to check the accuracy of the panel “tick sheets” as supplied by the Principal against the installed protection and control panels.

5.9.22 FUNCTIONAL TESTS

5.9.22.1 The Contractor must carry out functional testing of all circuitry and plant items to verify that all plant, equipment and circuits function correctly and safely, in accordance with the intended design and in a manner fit for purpose as an energised substation supplying electrical load.

5.9.22.2 The Contractor must provide a comprehensive schedule detailing all tests carried out as evidence of functional testing, including a description of the initial circuit configuration, the testing action taken, the resultant outcome and verification that the outcome was correct.


5.9.22.3 The Contractor must verify and record operation of all switches, isolation links, contacts, interlocks and components during the functional testing stage, in both “operate” and “non-operate” (i.e. isolated) conditions.

5.9.22.4 If, prior to integration of new systems into existing live systems, functional testing cannot be fully completed then the Contractor must carry out as much function testing as possible on the new systems using temporary bridging or other methods to simulate the connections into existing systems.

5.9.23 SCADA AND PROTECTION RELAYS

5.9.23.1 The Contractor must be responsible for completing the following:

- Loading/Applying/Confirming settings of all protection relays as per Relay Setting Requests (RSR) to be provided by the Principal.
- Operate plant/equipment external to the protection relay such that protection relay inputs are toggled and confirm that the protection relay is registering these operations.
- Exercise all protection relay outputs and confirm that the appropriate plant and equipment operates correctly.
- Carry out secondary injection of all protection and auxiliary relays in order to verify pickup thresholds, timing, I/O and logic and confirm compliance with the requirements of the Protection Setting Report.

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- Loading configurations into all SCADA RTU's and communications equipment, as per setting files provided by the Principal.
- Operate plant/equipment external to the SCADA RTU such that the RTU digital inputs are toggled and confirm that the RTU is registering these operations.
- Exercise all SCADA RTU digital outputs and confirm that the appropriate plant and equipment operates correctly.
- Verify correct operation of SCADA RTU SAL code and compliance with the Principal's control system standards.

5.9.23.2 The Contractor must carry out pre-commissioning tests on each protection relay and each system to the satisfaction of the Principal in accordance with this Specification.

5.9.24 PRIMARY INJECTION TESTING

5.9.24.1 The Contractor must carry out primary injection testing of all differential protection schemes including bus differential and transformer differential (high impedance, low impedance and biased), using sufficient current to give definitive balanced and unbalanced indication on associated protection relays. The Contractor must ensure primary injection testing uses appropriate phase and earth injection configurations to give definitive verification of CT ratios, CT polarities, as well as protection relay ratio, vector and zero sequence correction.

5.9.25 ASSET DATA COLLECTION FORMS

5.9.25.1 For all plant installed or removed the Contractor must fill out an Asset Data Collection Form and take a nameplate and general photo. The Contractor must submit the forms and photos to the Principal's Representative. The two forms available are:

- NA000403F189 Commissioned Substation Plant Data Record Form
- NA000403F190 De-Commissioned Substation Plant Data Record Form

5.9.25.2 The forms must be completed prior to the completion of the Authorisation for Energising Electrical Plant Form. The forms are used by Ergon Energy to capture plant data information and installed location to ensure the item maintenance and records are accurate.


5.9.25.3 Forms are required for all major plant items also including transformer bushings, CT's, oil pumps, cooling fans, surge arresters and HV Links. Some secondary items will also require forms such as battery banks and chargers. If necessary, the Principal's Representative can provide a full list of items that will require the forms and photos

5.9.26 CONSTRUCTION SAFETY CLEARANCE

5.9.26.1 For each stage of the SAT works, following satisfactory completion of all pre-commissioning tests and submission of construction checklists and marked up drawings (3 sets) by the Contractor and approval of all test results by the Principal's Representative, the Contractor must provide to the Principal's Representative a completed Construction Safety Clearance - High voltage Apparatus NI001301F107 (or equivalent) for all equipment, including confirmation that all plant and equipment is now considered to be alive and no longer accessible to the Contractor. The Contractor must also provide the Principal's Representative with a copy of Authority for Energising Electrical Plant NI001301F101 with the "Construction" and "Testing" sections completed.

5.9.26.2 If construction and commissioning of the substation is occurring in stages, then the Construction Safety Clearance and Authority for Energising Electrical Plant may apply to a section of the equipment only, in which case any further work carried out by the Contractor on this equipment must be carried out under Ergon Energy's High Voltage Isolation and Access regime.

5.9.26.3 Upon receipt of the above documents, the Principal will carry out final testing and commissioning and HV switching of the installation to energise and load equipment.

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5.9.27 CONSOLIDATED TEST REPORT

- 5.9.27.1 Within two (2) days of completion of the testing works, the Contractor must supply the Principal's Representative with a preliminary copy of all Test Result Forms and a list of outstanding work and defects with proposed action for each item. The Contractor must also supply at this time certification by the Contractors RPEQ that all ITP's have been completed successfully, test and inspection results are satisfactory and that the primary and secondary systems tested are fit for service (excluding outstanding work and defects).
- 5.9.27.2 Within two (2) weeks of completion of the testing works, the Contractor must forward to the Principal's Representative two (2) printed copies plus an electronic copy of a Consolidated Test Report.
- 5.9.27.3 The Contractor must ensure the Consolidated Test Report includes detailed test records of all pre-commissioning testing, details of temporary installations (stating reasons and action taken to provide a permanent solution), problems and defects found during testing (and remedial action) and a list of outstanding work with proposed action for each item nominating who is responsible for such action.
- 5.9.27.4 The Consolidated Test Report must be an indexed fully detailed account of all tests including all test results and measurements that includes all files used for primary plant testing by automated test equipment.

5.9.28 OUTSTANDING ITEMS

- 5.9.28.1 The Contractor must list on the Certificate of Practical Completion all outstanding items which require additional work to be carried out after acceptance of the plant. The Contractor must have the list of outstanding items agreed between the Contractor and the Principal's Representative. The Contractor must include in the list of outstanding items the responsibility assigned for each item. The Contractor must not deem outstanding items as completed until the parties agree that it has been completed satisfactorily. After completion of the additional work, the Contractor must issue a further completion notice, signed to signify that outstanding items have been completed.


5.9.29 ELECTRICAL SAFETY REQUIREMENTS

- 5.9.29.1 The Contractor must at all times comply with the electrical safety rules and regulations as set out by Ergon Energy when working on, or in the vicinity of electrical apparatus that is alive, or is capable of being made alive from any source of supply.
- 5.9.29.2 Specifically, once the Contractor issues to the Principal's Representative the Construction Safety Clearance – High Voltage Apparatus NI001301F107, Ergon Energy's High Voltage Isolation and Access Procedures (HVIA) apply to those parts of the site capable of being made alive. The Contractor must ensure only those personnel who have successfully completed the required HVIA training and have been duly authorised are allowed entry to the site, unless accompanied at all times by a HVIA trained person.
- 5.9.29.3 The Contractor must comply with Safe Entry to High Voltage Enclosures SWP SP0502 at all times subsequent to the installation of any HV conductor including earthing conductors that are connected to, or within approach distance of a commissioned HV network.
- 5.9.29.4 The Principal reserves the right to evict any personnel from the site at any time should their presence on site be considered to constitute a hazard.


5.10 DRAWINGS

5.10.1 GENERAL

- 5.10.1.1 Construction works must not commence until a full set of Controlled and RPEQ approved drawings in "Released for Construction" state is received.
- 5.10.1.2 The party responsible for Design must provide the required number of paper copy sets as identified in the Controlled Drawings Distribution List.


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- 5.10.1.3 Each set of drawings are to be printed at minimum A2 size for construction purposes and all pages in the set must be stamped with the relevant identifying set number where required.
- 5.10.1.4 All Construction service providers are to transfer mark ups of any changes or deviation from the issued design drawings to the Master Copy (set no.1) prior to the completion of their respective trades.
- 5.10.1.5 All Test service providers are to obtain current mark ups from the master copy prior to testing and transfer any additional mark up's back to the Master Copy upon completion.
- 5.10.1.6 All Service providers must sign the Cover sheet on the Master Copy at the completion of their portion of works to certify that all mark up's has been recorded accurately on the Master Copy and/or it has been constructed as per design drawings with no change.
- 5.10.1.7 The Master Copy set of drawings must be kept at site and made accessible for other work groups and the Principal's Representative to copy or view at any time during the project.
- 5.10.1.8 All changes made during construction must be recorded on the drawings strictly in accordance with the Ergon Energy guideline Greenlining and Bluelining Ergon Energy Substation Drawings MN000301R167.
- 5.10.1.9 Once commissioning activity has completed, the Master Copy with all relevant mark ups are to be scanned and copied. One printed duplicate of the Master Copy must remain on site until such time that final As Built drawings are issued to replace them. One electronic copy must be forwarded to the Technical Representative.
- 5.10.1.10 The original Master Copy must be returned to the Design team to complete As Built drawings.
- 5.10.1.11 Where a project is commissioned in various stages with a period of three (3) months or more in between stages, a scanned copy of the Master Copy with all relevant mark ups must be forwarded to the Technical Representative at the completion of each stage.
- 5.10.1.12 All changes made during construction **shall** be recorded on the drawings strictly in accordance with the Ergon Energy guideline Greenlining and Bluelining Ergon Energy Substation Drawings MN000301R167.
- 5.10.2 REVISIONS DURING CONSTRUCTION**
- 5.10.2.1 Where design or construction clarifications are required, the Contractor must make contact with the designer to confirm the requirements. Communication with the designer must be through the appropriate channels as defined by the Principal's Representative.
- 5.10.2.2 For minor changes the Contractor may continue with the current revision, recording changes on the drawing. However for major changes or where significant detail is required, the design drawing should be revised and re-issued with the necessary corrections.
- 5.10.3 AS-BUILT DRAWINGS AND DOCUMENTS**
- 5.10.3.1 The Contractor must mark up each and every drawing in the Master Copy to indicate the final as-built state. The mark-ups must incorporate all site modifications, including any amendments provided by the Principal as part of the commissioning works, and must have the name, contact phone number and signature of the Contractor's Test Engineer (or authorised representative) inserted in the stamp, or on an accompanying letter or document.
- 5.10.3.2 Within one (1) week of completion of commissioning (or stage of commissioning, where commissioning is occurring in distinct stages), the Contractor must forward one (1) electronic copy and two (2) paper copies of each final marked-up drawing to the Principal.
- 5.10.3.3 The Contractor must sign and return drawings which do not have any changes, as confirmation of the as-built status of such drawings. This is particularly essential where commissioning is occurring in distinct stages, in order that the Principal is provided with a complete and accurate operating record of the developing substation at all times.

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5.11 CLEANING ON COMPLETION

- 5.11.1 On completion, the Contractor must take down and clear away all rubbish, waste, plant and temporary work, including sanitary conveniences, offices, sheds, hoardings, protective covers etc, unless otherwise required and make good the site to the satisfaction of the Principal's Representative. The Contractor must make good any damage done to the buildings, structures and plant or property at the Contractor's expense.
- 5.11.2 The Contractor must also check and ease all doors, windows, etc., examine and clear all drains and check all services to the satisfaction of the Principal's Representative.
- 5.11.3 The Contractor must clean the complete works including but not limited to the work described below.
- Clean all windows, both inside and out on all faces.
 - Remove all render and other spots on metal sashes, box sections and on other surfaces.
 - Dust all walls, ledges and projections.
 - Wash, if necessary, to clean all walls.
 - Remove all paint spots from floors and walls.
 - Clean all hardware, ironmongery and other fittings.
 - Thoroughly clean all porcelain insulators and bushings immediately prior to testing,
- 5.11.4 The Contractor must rake and grade surfaces adjacent to the Site building to even-finished levels. The Contractor must contain any oil and chemical spills, and dispose of resultant waste in a manner consistent with that as outlined in Section 3.33.

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APPENDIX A DELIVERABLES LIST

Design Deliverables

Meetings

- Contract progress meetings.

Studies

- Fault level study.
- Lighting study.
- Lightning protection study.
- Earthing study including soil resistivity testing.
- Insulation coordination study.
- Cable ratings study.
- Geotechnical investigation.
- All site surveying work.
- Software models from design studies.

Technical Lists

- List of recommended spares.
- List of special tools and test equipment.
- Schedule of technical data.
- Materials list.

Manuals

- Preliminary Substation Operating Manual.

Drawings

- Schedule of drawings and documents.
- Drawings.
- Final Release.
- For Construction.
- As-Built.
- As Commissioned.
- Protection drawings.
- Revenue metering drawings – For Approval.
- Specification drawings.
- File compression/decompression software.
- Design 15% complete – all electrical single line diagrams, general arrangement and civil design requirements.
- Design 50% complete – civil design requirements, materials list and RTU point list spreadsheet.
- Design 80% complete – all detailed design drawings.
- Design 100% complete – “For Construction” detailed design drawings with RPEQ certification.

Training


- Nil.

Testing

- Problem or non-conformance reports.

Clearances & Certification

- Request for approval to subcontract work.
- Local and other authority permits or approvals.
- Engineering Certification of Design.
- Variations.

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- Requests for metering approval.

Quality Program

- Quality assurance program.
- Contract quality plan.
- Works program.

Construction Deliverables

Meetings

- Pre-delivery site meeting.
- Contract progress meetings.

Studies

- Soil resistivity tests.

Technical Lists

- Revised ratings (metering).
- List of signs.
- Asset data collection forms.

Support

- List of recommended spares.
- List of special tools and test equipment.

Manuals

- Operation and maintenance manuals.
- Substation operations manuals.

Drawings


- Specified Drawings.
- Detailed circuit diagram.
- Wiring schematic diagram, wiring connection diagram, and cable schedule for all secondary wiring.
- Drawings.
- Final Release.
- For Construction.
- As-Built.
- As Commissioned.
- Revenue metering drawings – For Approval.
- File compression/decompression software.

Training

- Onsite handover/training session.
- Training program for Ergon Energy's 'call out' maintenance staff.

Testing

- Certified ITP's.
- Certification of test equipment.
- Test result sheets & supplementary sheets.
- Problem or non-conformance reports.
- List of outstanding work and defects.
- Consolidated test report.
- Remedial work reports.
- Register of records (objective quality evidence).
- Type Test Certificates.

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- Remedial work sheets.
- Routine Test Certificates.

Clearances & Certification

- Competency and authorisation records.
- Request for approval to subcontract work.
- Noticed of intention to commence supply or manufacture.
- Notice of Inspection or Test.
- Inspection Certificate/Release Note.
- Certificate of Structural Adequacy.
- Construction Safety Clearance - High voltage Apparatus NI001301F107 (or equivalent).
- Authority for Energising Electrical Plant NI001301F101.
- Certificate of Practical Completion.
- Variations.


Quality Program

- Quality Assurance program.
- Contract Quality Plan.
- Works Program.

	XXX ZONE SUBSTATION NEW SUBSTATION ESTABLISHMENT	CONTRACT No:	201X/0XXX/T
		REVISION:	
		EDMS No.	
	WORKS SPECIFICATION	DATE ISSUED:	25/07/12
		STATUS:	PRELIMINARY

APPENDIX B

DESIGN BRIEF

	XXX ZONE SUBSTATION NEW SUBSTATION ESTABLISHMENT	CONTRACT No:	201X/0XXX/T
		REVISION:	
		EDMS No.	
	WORKS SPECIFICATION	DATE ISSUED:	25/07/12
		STATUS:	PRELIMINARY

APPENDIX C

SUBSTATION STANDARDS