

# Substation Construction Manual



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*This material is made available on the basis that it may be necessary for a Registered Professional Engineer of Queensland (RPEQ) to undertake or oversee the engineering services to meet statutory obligations.*

## Revision History

Version	Description of Change	Date
1	Initial version	25/03/2013
2	Content revised and additional content added, including safety, working in substations, project delivery, quality, project documentation, environment, civil works, communications, control building electrical services, and the use of Substation Construction Tools. References updated and re-organised.	10/07/2014
3	References updated. Section 5.10.6 & Appendix A added, in relation to work in live substation panels. Section 9.5 updated in accordance with changes to greenlining/bluelining process. Section 14.5.5 Decommissioning and removal of LV cables added. Clause 16.1(c) IR testing amended to be 415/240 V wiring only.	03/01/2017

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## 1. PURPOSE AND SCOPE

This document is a reference for the constructors of Ergon Energy substations and it covers all aspects of substation construction for both Greenfield and Brownfield substation projects to meet the performance expected by Ergon Energy. The manual is applicable for all substation projects regardless of internal/external construction delivery mode.

The Substation Construction Manual is not intended to replace Asset Management Standards, but rather to act as a reference document that cross-references existing Standards and Process Documentation and plug any gaps where Asset Management Documentation does not exist.

## 2. RESPONSIBILITIES

The **Group Manager Works Enablement** is the Process Owner responsible for approving this Reference.

The **Manager Substation Design** is the Subject Matter Expert (SME) for the content and shall implement and maintain this Reference.

The **Manager Management Systems** is the Management System Representative and is responsible for the endorsement of this Reference prior to submission for approval.

## 3. DEFINITIONS, ABBREVIATIONS AND ACRONYMS

<b>AMO</b>	Asset Management Officer
<b>Brownfield Site</b>	An existing energised site
<b>DTRMP</b>	Daily Task Risk Management Plan
<b>Greenfield Site</b>	Is a term used to describe undeveloped land in a city or rural area.
<b>HVE</b>	High Voltage Entry
<b>HV</b>	High Voltage (greater than 1000 V a.c.)
<b>ITP</b>	Inspection and Test Plan
<b>LV</b>	Low Voltage (Exceeding 50 V a.c., but not exceeding 1000 V a.c.)
<b>NAR</b>	Network Access Restrictions
<b>OFLS</b>	Officer For Local Security
<b>PC</b>	Principal Contractor
<b>PPE</b>	Personal Protective Equipment
<b>QMP</b>	Quality Management Plan
<b>RPEQ</b>	Registered Professional Engineer Queensland
<b>SID</b>	Safety in Design
<b>SPRMP</b>	Simple Project Risk Management Plan
<b>SWMS</b>	Safe Work Method Statements
<b>SWP</b>	Standard Work Practice

## 4. REFERENCES

### 4.1 Ergon Energy Controlled Documents

#### 4.1.1 Substation Manuals

NI000401R121	Substation Design Manual
NI000401R122	Substation Construction Manual
MN000301R171	Test and Commissioning Manual
NA000403R328	Queensland Electricity Connection and Metering Manual (Reference)

#### 4.1.2 Substation Construction Tools

MN000301F188	Construction Tool – Earthing Transformer
MN000301F190	Construction Tool – Reactor
MN000301F191	Construction Tool – Ring Main Unit
MN000301F192	Construction Tool – Substation General
MN000301F193	Construction Tool – Transmission Cable
NA001101F110	Construction Tool – NOMAD
SP0233C10	Construction Tool – Recloser
SP0406C06	Construction Tool – Local Supply Transformer
SP0407C05	Construction Tool – HV Cable (up to 33kV)
SP0504C13	Construction Tool – Power Transformer
SP0507C06	Construction Tool – Current Transformer
SP0508C06	Construction Tool – Voltage Transformer
SP0509C06	Construction Tool – Circuit Breaker
SP0512C05	Construction Tool – Surge Diverter
SP0514C05	Construction Tool – Isolator/Earth Switch
SP0515C06	Construction Tool – Bus Assembly

#### 4.1.3 Policies and Business Rules

EP02	Health, Safety, Environment & Cultural Heritage Policy
EP101	Drug and Alcohol Policy
ES00100R100	Drug and Alcohol Policy Business Rules

#### 4.1.4 Work Instructions, Guides & Reference Documents

BS001401R112	Roles and Responsibilities of a Safety Observer (Field Instruction)
BS001403R114	Exclusion Zone Table (Reference)
BS001404R114	Laser Safety Guidelines: Optical Fibre Laser
BS001404R140	Management of SF <sub>6</sub> Gas and its By-Products (Reference)
BS001404R152	Inspect Insulated Tools Before Use (Field Instruction)

BS001405R100	Authorised Person (Quick Reference Guide)
BS001409R104	Hot Work (Field Instruction)
CS000501R110	Field/Workshop Personal Protective Equipment (Reference)
CS000501R123	Risk Management Overview (Quick Reference Guide)
CS000501W114	Prepare and Implement Daily / Task Risk Management Plans
ES000400R101	Hazard and Risk Assessment (Quick Reference Guide)
ES000702W100	Make Site Safe – Manage Environmental Spills (Work Instruction (Manual))
ES000704R100	Single Incident Management Framework (Reference)
ES000802R103	Manage Ergon Energy Site Inductions (Reference)
ES000900R102	Safety First – Your Guide to Safe Work (Reference)
ES000901R101	Asbestos Management Plan (Reference)
ES000901R102	Health, Safety, Environment, Cultural Heritage (HSECH) Risk Control Guide (Reference)
ES000901R148	Workplace Signage (Reference)
ES000901R150	Contractor Asbestos Related Work or Asbestos Removal Work (Reference)
ES000901R151	Confined Space Management Plan (Reference)
ES000901R163	Health, Safety and Environment Handbook (Reference)
ES000901R166	Management Asbestos (Quick Reference Guide)
ES000904R101	Environmental Control Measures (Reference)
ES000904R121	Soil Erosion and Sediment Control (Reference)
ES000904R122	Environmental Management of Fuel and Oil (Reference)
ES000906R100	Cultural Heritage Discovery Process (Field Instruction)
HR000500R101	Requirements for Supervision of Apprentices (Reference)
HR000500R105	Switching and Access Training and Authorisation
MN000301R166	Construction and Wiring Guidelines for Ergon Energy Substation Panels (Reference)
MN000301R167	Greenlining and Bluelining of Ergon Energy Substation Drawings (Reference)
MP000903R117	Environmental Protection Requirements (Reference)
NA000403R443	Network Risk Assessment Guideline
NI000401R117	Substation Controlled Drawings
NI000401R118	Substation Controlled Drawings (Quick Reference Guide)
NI000703R100	Project Environmental Management Plan (Reference)
P53H05B03	Appoint a Safety Observer (Work Instruction)
P53K05R03	Queensland Electricity Supply Industry Substation Barrier Chart (Reference)
RTHS4301	Ergon Energy Field Induction Program (Reference)
RTHS9702	Care and Use of Personal Safety Equipment (Training Material)

RTSW6602	Safe Entry to HV Enclosures Participant Guide (Training Material)
SB0301	Civil Works (Standard Work Practice)
SB0401	Installation of Photo Voltaic Systems (Standard Work Practice)
SGMM002	Substation Earthing Strategy
SP0502	Safe Entry to High Voltage Enclosures (Standard Work Practice)
SP0502R04	Safe Entry to High Voltage Enclosures SWP SP0502 – Field Instruction (Reference)
SP0510	Substation Earth System Injection Testing (Standard Work Practice)
SP0515	Bus Assembly Testing (Standard Work Practice)
SP0515C05	Commissioning Tool - Bus Assembly (Form)
SP0521R01	Working on High Voltage Enclosure Earths Job Safety Analysis (Reference)
SR000101R389	Working Safely (Reference)
STMP004	Standard for Communications Equipment Installation (Standard)
SWMS001 to 005	Working at Heights (>2m) (Safe Work Method Statement)
SWMS006	Working on or Near a Road or Railway (Safe Work Method Statement)
SWMS007	Live Work (Low Voltage) (Safe Work Method Statement)
SWMS007R01	Live Work Low Voltage Job Safety Analysis (Reference)
SWMS012	Temporary Support of Poles or Structures (Safe Work Method Statement)
SWMS014	Movement of Powered Mobile Plant (Safe Work Method Statement)
SWMS015	Excavations (Safe Work Method Statement)
SWMS015R01	Excavations – Job Safety Analysis (Reference)
SWMS016	Confined Space (Safe Work Method Statement)
WR000800R100	Contractor WHS Management Guidelines (Reference)
<b>4.1.5 Forms</b>	
BS001405M100	Request for Authorisation Letter (Training Material)
BS001409F101	Confined Space Entry Permit (Form)
BS001409F104	Hot Work Permit (Form)
CS000501F115	Daily Task Risk Management Plan (Form)
HR000506F104	Technical Training and Development Contractor Induction Nomination (Form)
MN000301F174	Commissioning Authority for Energising Electrical Plant (Form)
MN000301F175	Construction Release (Form)
MN000301F123	Construction Safety Clearance – High Voltage Apparatus (Form)
NA000403F189	Commissioned Substation Primary Plant Record/Data (Form)
NA000403F190	De-Commissioned Substation Primary Plant Record/Data (Form)
NI000401F104	Transmittal Note (Form)

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P53K45B01C01	Site Induction Checklist (Form)
PW000702F100	Simple Project Risk Management Plan (Form)
SWMS015F01	Permit to Dig – Ergon Energy Controlled Properties (Form)
WR001001F113	Construction Work – Pre Start Checklist (Includes a Sample Site Induction) (Form)

#### 4.1.6 Asset Management Substation Standards

SS-1-1.1 (STNW3000)	Substation Design Standard System
STNW3001	Substation Equipment Identification
SS-1-1.4 (STNW3003)	Substation Design Requirements
SS-1-1.8 (STNW3007)	Substation Standards on Climatic and Seismic Conditions
SS-1-3.1 (STNW3013)	Clearances in Air
STNW3014	Busbar Design
SS-1-4.1 (STNW3015)	Primary Plant Ratings
SS-1-4.3 (STNW3017)	Power Capacitor Applications and Shunt Capacitor Design Guide
SS-1-4.4 (STNW3018)	Cables and Cabling
SS-1-5.1 (STNW3022)	DC Supplies
SS-1-5.2 (STNW3023)	AC Supplies
SS-1-6.1	Civil Works
SS-1-7.1 (STNW3028)	Substation Earthing
SS-1-7.2 (STNW3029)	Safety Earthing
SS-1-7.3 (STNW3030)	Soil Resistivity Testing
SS-1-8.1 (STNW3031)	Substation Surge Protection
SS-1-8.2 (STNW3032)	Substation Direct Lightning Strike Shielding
SS-1-8.3 (STNW3033)	Selection of Surge Arresters
SS-1-8.4 (STNW3034)	Insulation Co-ordination
SS-1-9.1 (STNW3035)	Substation Fire Protection
SS-1-9.2 (STNW3036)	Oil Containment
STNW3037	Substation Signage
SS-1-9.5 (STNW3039)	Substation Security
STNW3040	Substation Lighting
SS-1-10.1 (STNW3041)	Audible Noise
STNW1002	Protection Standard
SS-2-3.1 (STNW3106)	SCADA Standard Point List
SS-2-3.2 (STNW3107)	SCADA Point Naming
SS-2-3.10	Capacitor Automatic Control
SS-2-3.11	SCADA Point List for ICCP
SS-2-3.12	OLTC AVR Control
SS-2-3.20	SCADA Point List for IGM
SS-2-3.21	SCADA Auto Reclose Implementation

SS-2-3.22	SCADA Auto Close
SS-2-4.1 (STNW3114)	Substation Metering
SS-2-4.2	Ripple Control Receiver Internal Program Features – Type RO
STNW1169	Network Operational Identification and Naming Standard Substation, Generation and Communication Equipment
STNW1004	Standard for Auto-Reclose
AM-P-SUP-0001	Risk Analysis for Distribution Sub-Transmission and Transmission Auto-reclose Standards

## 4.2 Australian/International Standards and Legislation

AS 1111	ISO Metric Hexagon Commercial Bolts and Screws
AS 1112	ISO Metric Hexagon Nuts, Including Thin Nuts, Slotted Nuts and Castle Nuts
AS 1214	Hot-Dip Galvanised Coatings on Threaded Fasteners (ISO Metric Coarse Thread Series)
AS 1670	Fire Detection, Warning, Control and Intercom Systems – System design, installation and commissioning
AS 2067	Substations and High Voltage Installations exceeding 1kV AC
AS 2436	Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites
AS 2601	The Demolition of Structures
AS 2791	High Voltage Switchgear and Controlgear – Use and Handling of Sulphur Hexafluoride (SF6) in High-Voltage Switchgear and Controlgear
AS 2865	Confined Spaces
AS/NZS 3000	Australian/New Zealand Wiring Rules
AS/NZS 4576	Guidelines for Scaffolding
AS/NZS 5000.1	Electric Cables – Polymeric Insulated – For Working Voltages up to and Including 0.6/1 (1.2) kV
AS 62271.301	High Voltage Switchgear and Controlgear – Dimensional Standardisation of Terminals
AS HB20	Graphical Symbols for Fire Protection Drawings
AS/ACIF S008	Requirements for Customer Cabling Products
AS/ACIF S009	Installation Requirements for Customer Cabling (Wiring rules)
AS/NZS ISO 9001	Quality Management Systems – Requirements
AS/NZS ISO 10005	Quality Management Systems – Guidelines for Quality Plans
ENA EG-1	Substation Earthing Guide
IEEE 80	Guide for Safety in AC Substation Grounding
Professional Engineers Act 2002	
Queensland Electrical Safety Code of Practice 2010: Works	
Queensland Electrical Safety Regulation 2013	

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Queensland Work, Health and Safety Act 2011

Queensland Work, Health and Safety Regulation 2011

Queensland Environmental Protection Act 1994

Queensland Workplace Health and Safety Scaffolding Code of Practice 2009

Queensland Workplace Health and Safety Confined Spaces Code of Practice 2011

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## 5. SAFETY LEGISLATION AND POLICIES

### 5.1 Ergon Energy Workplace Health and Safety Policy

Ergon Energy is committed to working in a way which ensures the health and safety of its Employees, Contractors, Customers and Members of the Public.

The Ergon Health, Safety, Environment & Cultural Heritage Policy (EP02) targets a level of zero work-related injuries and illness at all times. The full Policy document (EP02) is available on the Ergon Process Zone.

Refer also to the Ergon Drug and Alcohol Policy EP101 and Drug and Alcohol Policy Business Rules ES00100R100.

### 5.2 Queensland Safety Legislation

The Qld Electrical Safety Act 2002 provides that an electricity entity has an obligation to ensure that its works:

- (a) are electrically safe, and
- (b) are operated in a way that is electrically safe

This obligation includes the requirement that the electricity entity inspects, tests and maintains the works.

The Act also places obligations in regards to electrical safety on all persons, including employers, self-employed persons, designers, manufacturers, importers, suppliers, installers, repairers, persons in control of electrical equipment, workers and other people at a place where electrical equipment is located.

The Queensland Work, Health and Safety Act 2011 provides the framework to protect the health, safety, and welfare of all workers at work, and of all other people who might be affected by the work.

Under the WH&S Act everyone has duties (obligations), and the duties for a person conducting a business or undertaking are defined and involve:

- Management or control of workplaces
- Management or control of fixtures, fittings or plant at workplaces
- Design of plant, substances or structures
- Manufacture of plant, substances or structures
- Importation of plant, substances or structures
- Supply of plant, substances or structures
- Installation, construction, commissioning of plant or structures
- Officers, workers and all other persons also have duties to work and act in a manner which contributes positively to the protection of the health, safety and welfare of themselves and all others who might be affected by the work. In particular, personnel must comply at all times with all workplace health and safety directions, rules and guidelines given.

Site offices, accommodation, sanitary facilities, water etc., must meet the requirements of the latest issue of the Act and Regulations.

All construction work must be carried out under a Work, Health and Safety Management Plan or a Site Safety Plan, as required by the Queensland Work, Health and Safety Regulation 2011. This Plan must be complementary to Ergon Energy requirements for entering and working in

substations. Responsibility for preparation of the appropriate Plan will be defined in the project documentation or in MP000903R110 Work Health and Safety Conditions.

## 5.3 Safety in Design (Risk Management)

Section 17 Management of Risks of the Work Health and Safety Act 2011 states -

*“A duty imposed on a person to ensure health and safety requires the person—*

*(a) to eliminate risks to health and safety, so far as is reasonably practicable; and*

*(b) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable.”*

During design development, the Designers will assess and document any hazards or risks associated with the design, construction, ongoing operation and maintenance, or decommissioning of the various parts and components of the substation. Any residual risks assessed as higher than low risk and not covered by a relevant SWMS, SWP, or Work Instruction will be documented by the Designer in a Safety in Design Report.

All Constructors must refer to the Safety in Design (SID) report provided by the Design group, prior to commencing any construction work. For Ergon Energy workgroups, the SID Report is PW000702F100 Simple Project Risk Management Plan (SPRMP).

## 5.4 Daily Task Risk Management Plan (DTRMP)

All construction crews must complete CS000501F115 Daily Task Risk Management Plan (DTRMP), or equivalent prior to commencement of any work on site. This task requires careful review and identification of the likely hazards involved, plus the controls to be used in managing risk during the site activities. Completion of the DTRMP is covered in CS000501W114 Prepare and Implement Daily / Task Risk Management Plans.

## 5.5 Personal Protective Equipment (PPE)

The minimum PPE required for construction sites and particularly for substations can be found in CS000501R110: Field/Workshop Personal Protective Equipment. Particular attention should be given to the requirement to remove all metallic jewellery and eyewear, as well as any other metallic or non-metallic item that might get caught in panels, on structures, machinery, etc. (eg. watches, rings, necklaces, key chains, neck ties, etc.).

Refer also to RTHS9702 Care and Use of Personal Safety Equipment (Training Material).

## 5.6 Pre-Start Meeting

A pre-start meeting must be conducted prior to the commencement of any construction on site. Refer to WR001001F113: Construction Work – Pre-Start Checklist, to be used as a guide for all works. Refer also to Section 7.3 of this Manual in relation to inspection points required.

## 5.7 Site Inductions

To manage site inductions in Ergon Energy substations, refer to ES000802R103: Manage Ergon Energy Site Inductions and P53K45B01C01: Site Induction Checklist.

## 5.8 Construction Signage

Construction signage shall be supplied in accordance with the Queensland Work, Health and Safety legislation. Refer also to ES000901R148: Workplace Signage (Reference) and SR000101R389 Working Safely where Ergon Energy is the Principal Contractor.

## 5.9 Incident Reporting and Emergency Contacts

For guidance on reporting incidents, refer to [ES000704R100 Single Incident Management Framework](#), [ES000703R100 Incident Classification Table](#) and [ES000703R101 Guidelines for Incident Classification Table](#) for incident reporting requirements. Emergency Contacts and lines of communication must be established prior to commencement of work on site.

## 5.10 Working in Energised Substations

All personnel 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 live, or is capable of being made live from any source of supply.

Ergon Energy reserves the right to evict any personnel from the site at any time should their presence on-site be considered to constitute a hazard.

### 5.10.1 Substation Entry

In a Commissioned HV Substation, all personnel must comply with Standard Work Practice [SP0502: Safe Entry to High Voltage Enclosures](#) at all times. This document must be read in full and strictly adhered to as well as the site specific requirements in the project documents. Refer also to the Field Instruction version of this document [SP0502R04](#).

For all construction work in an energised substation, the Officer For Local Security (OFLS) must be contacted. The OFLS will advise on any potential hazards, conditions & approval of movement or routes of all mobile plant off designated roads including storage of materials & amenities etc. Refer to SWP [SP0502: Safe Entry to High Voltage Enclosures](#).

Only those Personnel who have successfully completed the required SEHVE Training and have been duly authorised are allowed entry to the site, unless accompanied at all times by a SEHVE Authorised Person. (Refer to Section 5.10.2 and 5.10.3 below). These requirements also apply to an uncommissioned construction site, as soon as any HV Conductor (including earthing conductors) becomes connected to, or within approach distance of a commissioned HV network.

In the event of a work crew containing a number of unauthorised persons (eg. civil contractor), there should not need to be one authorised person for every unauthorised person, but there must be a sufficient number of authorised personnel to ensure that the unauthorised persons are accompanied and supervised by an authorised person at all times. Reference document [HR000500R101](#) details requirements for supervision of apprentices and others without SEHVE training.

On arrival at the substation gate, it is essential that a check be done for any [Network Access Restrictions \(NAR\)](#). Check for notification signs on the gates and also check with the Operational Control Centre (OCC) 1800 615 784 for restrictions when checking into the substation. Current lists of NARs can be found in the Ergon Intranet. Contractors should seek advice from their relevant Ergon Energy contact person. Ie. Superintendent, Technical Representative, etc.

Particular attention must be given to the requirements for locking of gates and keeping them locked, except during entry and exit. At all times when gates are unlocked (eg. to receive deliveries), they must be manned.

For guidance in relation to management of non GCWI/unauthorised specialist workers who come onto site for very short, infrequent durations (eg. plumbers, concrete cutters, crane drivers, delivery drivers, etc.), refer to Section 6.5.3 of [WR000800R100 Contractor WHS Management Guidelines](#).

### 5.10.2 Exclusion Zones, Authorised Persons, Safety Observers

The [Exclusion Zones](#) for trained and untrained persons can be found in Schedule 2 of the Queensland Electrical Safety Regulation and are replicated in the Ergon Energy Reference

BS001403R114 Exclusion Zone Table. The Exclusion Zones are specified in two different categories, as follows:

- (a) Exclusion Zones for Authorised Persons and Instructed Persons (ie. under the supervision of an Authorised Person)
- (b) Exclusion Zones for Untrained Persons (neither Authorised nor Instructed)

However, for Authorised and Instructed Persons, the values listed in Table 1 of Ergon Substation Standard SS-1-3.1 Clearances in Air apply, as in some cases they are slightly larger than those given in the Safety Regulation and BS001403R114.

Authorised Persons and their required competencies are defined in the Queensland Electrical Safety Regulation and in the Ergon Energy Quick Reference Guide BS001405R100: Authorised Person. In general, an Authorised Person must be able to demonstrate competence in recognising communication, low voltage and high voltage conductors, understand the dangers involved in live high voltage substations and be familiar with the appropriate Exclusion Zones. The training requirements for Authorised Persons are indicated in Section 5.10.3.

A Safety Observer is required where it is possible that an Exclusion Zone may be compromised. Refer to Work Instruction P53H05B03: Appoint a Safety Observer, Field Instruction BS001401R112 Roles and Responsibilities of a Safety Observer and definition in the Queensland Electrical Safety Regulation. The person appointed to be a Safety Observer must be an Authorised Person and also have the knowledge and competencies indicated in the above Work Instructions, so generally will need to have had adequate experience working in similar situations in live HV substations. However, a formal electrical qualification is not essential.

Refer also to Section 11.2.3 of this Manual in relation to Civil construction work.

### 5.10.3 Training and Authorisations

To be authorised for unaccompanied entry into a HV substation, personnel must have successfully completed the training course RTSW66 – Safe Entry to High Voltage Enclosures. Prerequisites for this training are RTHS4301 Field Induction for Ergon personnel, or as indicated on HR000506F104 Contractor Training Nomination Form.

On successful completion of the training, the relevant supervisor or employer must forward a Request for Authorisation to Ergon Energy, either BS001405M100 (non-electrical) or BS001405M101 (electrical), as appropriate.

For personnel who require further authorisations, such as Individual of a Workgroup, Access Permit Recipient, Switching Operator Assistant, etc., further training courses are necessary, as indicated in Reference document HR000500R105.

### 5.10.4 Access to Substation Entry Keys

Only authorised personnel may hold substation entry keys and such keys are issued subject to strict conditions of use. Following authorisation for substation entry, personnel may apply for a key if required, by completing a Request for Issue of Key form and forwarding by email to the appropriate Officer for Local Security. Until the form becomes available online, for Ergon personnel it may be obtained from the local AMO, or for Contractors through the relevant Ergon contact person.

### 5.10.5 Construction Safety Requirements

Refer to reference documents SP0502, BS001404R152 and SB0301 for specific instructions in relation to use of mobile plant/equipment, carrying objects in a HV enclosure, use of 00 gloves and exclusion zones. Refer also to Section 5.10.2, in relation to exclusion zones.

In addition, the training material RTSW6602 Safe Entry to High Voltage Enclosures has additional material for safety requirements inside substations, including use of portable electric tools,

handling extension leads, battery rooms, barriers, safety signs, storage and handling materials and other specific hazards.

All high risk and non-standard construction activities must be carried out in accordance with appropriate Safe Work Method Statements (SWMS). A list of Ergon Energy's SWMS can be found in the document ES000901R102: Health, Safety, Environment, Cultural Heritage Risk Control Guide or at the front of the Daily/Task Risk Management Plan. If an appropriate SWMS is not available, then one must be developed prior to commencement of the high risk activity.

## 5.10.6 Working in Substation Secondary System Panels

For many projects in brownfield sites, work will be required in secondary systems panels (control, protection, AC & DC supplies, etc) where low voltage AC & DC circuits of various voltages including 110V DC & 415/240V AC are live and in service. Work in such panels carries safety risks not only for construction personnel, but also for the high voltage network and sometimes for the general public.

General policy is to isolate live panels as far as possible for the safety and convenience of construction personnel, however, full isolation is not always possible, due to network and/or public safety risks that may be introduced if the circuits are isolated.

Refer to APPENDIX A: Isolation of AC and DC Supplies and Wiring in Substation Panels for Ergon policy and approach in relation to such work.

## 5.10.7 Site Hygiene, Protection of Property and Final Cleaning

At all times during the course of work on a substation site, whether green-field or brown-field, the site must be maintained in as clean and tidy a state as possible, according to the state of the work, so as to minimise the risk of injury or illness, enable efficient and safe access for construction vehicles and personnel, etc. and otherwise meet Work, Health and Safety requirements. Appropriate bins shall be provided and used for disposal of rubbish, waste, etc. and arrangements made for appropriate removal of the rubbish from the site regularly, in accordance with local regulations.

Particular care must be taken not to cause any damage to public and private properties, land, streets, including public utilities and the soil and space beneath such properties abutting and/or adjacent to the works. The constructor must make good any loss or damage caused.

On completion of the works, all rubbish, waste, excess material, plant and temporary work, including sanitary conveniences, offices, sheds, hoardings, protective covers etc., must be taken down and cleared away as appropriate, unless otherwise agreed with the Ergon Project Manager. Any damage done to the substation buildings, structures, plant, earth grid, substation surfaces (driveways, access roads, gravel surfacing, etc.), drainage, or property must be made good, before departing the site. All gravel surfacing must be raked and graded to even-finished levels.

All doors, windows, etc., must be checked and eased to ensure proper operation and closure.

The complete works must be cleaned, including but not limited to the work described below:

- Clean all windows, both inside and out.
- 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.
- Sweep all building floors and dispose of rubbish.
- Check outdoor concrete slabs and roads for soil/gravel and sweep if necessary.

- Check and clear all drains.
- Check any other services not already done.

## 5.10.8 Construction Release and Safety Clearance

Following completion of the electrical installation, including construction testing in a part of the site (eg. the 66kV switchyard) and issue of MN000301F175: Construction Release for that area, the associated HV plant must now be considered as capable of being made live and therefore no longer accessible to personnel.

Refer also to Section 16.3 for further detail.

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## 6. LEGISLATION AND STANDARDS

All construction work, and the associated supply of materials and equipment, must be undertaken in accordance with **all** relevant Legislative and Regulatory requirements, the latest revisions of the relevant Ergon Energy Asset Management Standards, Specifications and EESS drawings, and the relevant Australian Standards.

Where no Australian Standard exists, then the latest revision of the relevant International Electrotechnical Commission (IEC) Standard, British Standard (BS), or the NATSPEC BASIC Standard (in that order of preference) applies.

A list of the most relevant Australian/International Standards & Queensland legislation is provided in Section 4.2 of this manual, but is by no means exhaustive.

Any deviations from the Ergon Energy Standards and Specifications must be with the approval of Asset Management and following approval must be clearly stated in the Project Design Documentation. A documented and approved risk assessment must be produced in consultation with the relevant SME's in instances where the Project Scope Statement or Project Sponsor directs work to be undertaken which is not in accordance with the standards.

A list of Ergon Energy Asset Management Substation Standards is provided in Section 4 of this manual. The Ergon Energy Standards provide reference to the applicable Australian Standards.

Safety legislation and policies are outlined in Section 5 of this manual. Electrical safety requirements are not negotiable and must be strictly complied with at all times.

## 7. QUALITY MANAGEMENT

### 7.1 Workmanship and Materials

Work must be done by appropriately qualified, competent tradespersons in an entirely sound, secure, neat, efficient and tradesman like manner, complying with the relevant Ergon Energy Standards. 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.

Unless otherwise specified, all materials used must be entirely suitable for the intended application, whether stated or implied, and be free from defects. Where materials bearing the Australian Standards mark are available, these materials must be the minimum standard for use. All manufactured materials must be used strictly in accordance with the manufacturer's instructions and recommendations.

### 7.2 Quality Management Plan (QMP)

All construction work must be covered by a Quality Management Plan in accordance with AS/NZS ISO 10005, which ensures the work is carried out in accordance with the project documents and the relevant Ergon Energy standards. Inspection and Test Plans must be included in the QMP.

The ITPs must clearly show all inspection witness and hold points, testing requirements and how the work will comply with the project documentation.

### 7.3 Inspection and Test Plans

All constructors must carry out sufficient inspection and construction testing of the works installed by them using ITPs, to confirm correct and adequate installation in accordance with the drawings and relevant Ergon Energy standards.

The relevant constructor is responsible for developing and obtaining RPEQ approval of ITPs for all construction testing to be carried out on their portion of the works. Form 16, inspection hold points and any additional tests required by the Certifying RPEQ must be integrated into the ITPs and discussed in the pre-start meeting.

#### 7.3.1 Electrical Works

The minimum requirements for electrical construction testing are described in Section 16 of this Manual.

Specialist testing of HV plant and functional testing of the secondary systems (protection, control, etc.) is the responsibility of the test and commissioning groups, but is dependent on adequate construction testing being completed first by the constructors.

#### 7.3.2 Civil Works

Refer to [SS-1-6.1 Civil Works](#) for testing frequency and acceptance criteria. The Constructor must have a training plan showing each workers qualifications, inductions, training, licences, competencies and authorisation status. This also includes workers of subcontractors that have been engaged by the Principal Contractor.

## 8. PROJECT DELIVERY

### 8.1 Project Phases

This section provides a general overview of the phases, milestones and deliverables involved in an Ergon Energy project. More specific deliverables for the constructors are indicated in Section 9 of this Manual.

The Ergon Energy project delivery model comprises four distinct phases being:

#### (a) Concept Phase

This phase normally commences with the issue of a Recommended Works Report (RWR) and is complete at the initiation of an approved project (PIA). During this phase, concept Single Line Diagrams and General Arrangement drawings are produced.

The milestone for this phase is WPIA (Works Planning Project Initiation Advice).

#### (b) Development Phase

This phase normally commences with the issue of a Project Initiation Advice (PIA) and is complete at the handover of the approved, integrated design to the Project Manager, as follows:

- Work Specification completed and approved
- All Design Drawings RPEQ approved, transitioned to “Released for Construction” state in EDMS, printed to an electronic drawing set (Adobe pdf) and issued to Project Manager together with Transmittal (NI000401F104), Work Specification and Bill of Materials.

The milestone for this phase is DC (Design Complete).

#### (c) Implementation Phase (construction, testing, commissioning)

This phase commences at the handover of the approved designs and is complete at the issuing of the Certificate of Practical Completion.

The milestones for this phase are CCM (Construction Commenced), FCA (First Capacity Available), and CPC (Certificate of Practical Completion)

The Design Groups provide construction support activities during the implementation phase of a project and provide deliverables as listed in NI000401R121 Substation Design Manual.

The constructors provide the majority of their deliverables during this phase of the project, as listed in Section 9.2 of this Manual.

#### (d) Finalisation Phase

This phase generally commences when First Capacity is available (FCA) and is completed by project close out.

The milestone for this phase is PCO (Project Close Out).

The constructors provide some further deliverables, also as listed in Section 9.2 of this Manual.

### 8.2 Project Staging and Contingency Planning

For project works in existing live substations (brownfield), construction, testing and commissioning are likely to need to be carried out in stages, to minimise outages of supply to customers. In such cases, access is available to only a portion of the works area at a time and sometimes may require work to be done under the strict conditions of an Ergon Access Permit.

In many cases (eg. feeder cut-overs), it will be necessary to energise the completed stage, before access to the next stage can be made available. Therefore it is essential that the Master copy drawings be fully marked up to reflect the current operating status of the substation. (Refer to Section 9.5 of this document). Depending on the complexity of the project and changes made to the substation, in some cases it may be necessary that the drawings be updated in EDMS and reissued for construction of the next stage.

When existing live circuits have to be taken out of service, generally a contingency plan will be essential, to enable the circuit to be returned to service quickly in the event of an emergency on the high voltage system. Such plan should be prepared by the relevant design group, in conjunction with input from the construction and/or commissioning groups.

Refer to the project documentation for the specific staging required on a particular project.

## 8.3 Bill of Materials

For each project, a Bill of Materials (BOM) will be prepared by the Electrical Designers, specifying all substation electrical materials required for the project, except for minor and consumable items such as bolts, nuts, screws, cable and wire numbering ferules, terminal lugs for LV cables, miscellaneous terminals, LV cable clamps and ties, grease, cleaning fluids, which would normally be sourced by the Constructor. The BOM will collate the requirements for each particular item listed, so as to assist with procurement of materials and should indicate the specific division of procurement responsibilities.

There may also be separate Bills of Materials from the Communications and/or Distribution design groups, in the event that the Constructor is also required to install equipment for those disciplines. However, a Civil Bill of Materials will not be produced, as it is expected that the Civil Constructor will need to use both the issued construction drawings and on-site measurements to estimate the quantities of the various materials required to complete the Civil Works.

## 8.4 Material Ordering (Electrical)

It is the responsibility of the electrical Constructor to confirm that all plant and materials have been ordered in a timely manner to meet the project schedule requirements, either through the Ergon Logistics system (store), or by direct purchase where necessary.

Long lead time items, as defined by the project delivery milestones (eg HV plant, protection relays etc.), will be ordered by the Designers (or Tech Rep for contract works), prior to Gate 3 (construction) funding approval, in order to meet the project schedule timelines. Estimated arrival dates for such items will be indicated on the Bill of Materials.

Following receipt of Gate 3 funding approval, the requisitions for all of the items ordered in advance as indicated above, will be modified to transfer the costs to the project, which will then enable those items to be collected by the Constructor from a holding location as advised by the Project Manager.

The Constructor (via the Tech Rep for contract works) will use the Bill of Materials to requisition all remaining items on the Bill of Materials from the Logistics system as required. These items will also be made available for pickup from the same holding location as for the long lead time materials, or as specified in the requisition.

On commencement of construction, the Constructor must take responsibility for maintaining the BOM, keeping it up to date with details of equipment and materials ordered, received, etc. Updates on the status of long lead time items will be forwarded to the Constructor by the Design Manager as available, so that the BOM can be updated accordingly.

The Constructor must be responsible for procurement of all other items required, which are not already on the BOM at the commencement of construction, either from the Logistics system or by direct purchase if necessary.

Where lead times on outstanding materials appear that they will impact on the project delivery schedule, the Constructor must notify the Project Manager as soon as possible and assist with finding a resolution that minimises the impact on project delivery and quality.

The status of each item and the precise allocation of procurement responsibilities on a specific project will be indicated on the BOM, but should be checked and confirmed between the relevant design and construction groups, to ensure no items are missed.

## 8.5 Delivery of Plant and Materials to Site

The Constructor must arrange and co-ordinate the transport to the site and unloading of all materials, plant, and equipment, including any necessary craning, except for any items being delivered directly to site under separate contract (eg. power transformers). This responsibility includes the costs of storage, handling, insurance and other charges.

Prior to pickup of the materials from the holding location, the Constructor must give the Project Manager at least seven (7) days notice of intention, to ensure that the materials will be available at that location.

On pickup of materials from the Ergon holding location, the Constructor must check off each item on a Materials Movement Form, sign and date the form and forward a copy of the signed off form to the Design Manager as soon as possible. This form will include the description of each item, quantity, date, name and signature of recipient.

The Constructor must check as far as practicable that the issued plant, equipment and materials appear to be in undamaged condition and are the correct items before leaving the Ergon storage depot. For major plant items in large wooden crates, visual inspection of the condition of crates and checking of contract/item numbers/ descriptions on the outside of the crates will be sufficient at this stage, to avoid the need for un-crating and re-crating before despatch. Smaller items, such as protection relays are generally more easily unpacked for a quick visual inspection and check of model number inside the box.

Any defects or damage found are to be reported to the Project Manager and/or Design Manager and recorded on the Materials Movement Form. All equipment and materials leaving the storage site without a defect register will be deemed to have been supplied in undamaged condition.

As soon as possible after arrival on site, all equipment must be fully un-crated to enable proper checking for transport or other damage and that the correct items have been received (in case of errors in the data on the outside of the crates). Again any defects or damage found are to be reported in writing to the Project Manager and/or Design Manager as soon as possible.

The Constructor must ensure that no equipment is damaged as a result of reasonable handling during loading, transportation to site, unloading and site works. Any damage caused by inadequate handling by the Constructor or their Sub-Contractors will be rectified at the expense of the Constructor.

The Constructor must obtain all necessary road and rail traffic permits and be responsible for the payment of all charges. All Regulations, including load limits on roads and bridges along the planned transport route(s) must be observed.

On completion of the construction works, all unused quantities of supplied items must be suitably packed and returned either to the storage location from which they were collected, or as otherwise advised by the Project Manager.

In relation to direct deliveries of plant to site under separate contract, such as power transformers, the Principal Contractor on site (generally the electrical Constructor) must be responsible for ensuring the site readiness and clear access for the arrival of the plant on site, on the agreed dates. Refer to Section 12.2 of this Manual and any relevant clauses in the project Specification.

## 8.6 Work Specifications

For all substation design and/or construction projects, a project specific Work Specification will be issued.

The Work Specification will include project specific information in relation to scope of works, staging, outages, procurement responsibilities, certification and inspection requirements, etc. The Specification will also include reference to the Design, Construction and Commissioning Manuals and should complement and clarify the construction drawings provided by the designers.

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## 9. DRAWINGS, DOCUMENTATION, AND RECORDS

### 9.1 General

In the event of conflict between the requirements of the issued construction drawings and the Work Specification or any other relevant document, the relevant Design Manager must be contacted for clarification. In the case of an externally designed and constructed project, the Contractor's Construction group should seek clarification first from their own Design Manager. If the issue appears to be a conflict in Ergon Energy's requirements, the Contractor's Design Manager or Representative will then contact the Ergon Technical Representative (Ergon Design Manager) for clarification.

### 9.2 Drawings (Physical, Schematics, Schedules)

Construction must be carried out only in accordance with drawings which:

1. Have been signed off by the relevant RPEQ who is either carrying out or directly supervising the design work, and
2. Have been transitioned to Released for Construction status in the Ergon EDMS, as indicated by:
  - (a) The tag "**1 – Work May Start**" in the Drawing Status box just above the Drawing Number,

and

  - (b) Ergon signatures populating the Checked and Approved slots of the Revision Control box, confirming that the drawing has been transitioned accordingly. The "Drawn by" slot may indicate "Contractor - XXXX". (where XXXX denotes the name of the Contractor).

Earlier issues of the drawings must not be used for construction, even if bearing a Contractor's "Approved for Construction" stamp, as the release of the drawings for construction is to be controlled by Ergon Energy. This ensures that the drawings are issued for construction only after all Ergon requirements have been satisfied, as well as locking the construction version in the Ergon EDMS, to ensure consistency for all work groups that may need to access the drawings.

Following Gate 3 approval for the project, the originating Ergon Substation Design group will print and collate the required number of construction sets of the drawings, appropriately stamped in accordance with the Substation Controlled Drawings process documents NI000401R117 & R118. The collated sets of printed drawings will be issued via the Ergon Project Manager, to all involved Constructors.

A Drawing Transmittal must accompany the issued drawings to confirm the correct drawings and their revisions to be used.

The Master copy set of the drawings will be issued to the first group in each of the Civil and Electrical disciplines to commence construction of the works. Use of the Master copy drawings is described in more detail in Section 9.6, but the Master copy set must be passed on to the next appropriate work group. (eg. Panel Construction group passes on marked up Master copies to Field Construction group, then to Test group, etc.).

### 9.3 Project Documentation and Deliverables

The project specification will define the specific requirements for a particular project, however the tables below summarise the minimum requirements for constructors during the Implementation and Finalisation stages of a project.

- (a) Implementation Phase

Construction Discipline	Deliverable
Principal Contractor	<p><b>Quality Program</b></p> <ul style="list-style-type: none"> <li>• Quality Assurance program.</li> <li>• Project Quality Plan.</li> <li>• Works Program/Schedule.</li> <li>• Environmental and Cultural Heritage Management Plan</li> <li>• Work, Health and Safety Management Plan.</li> <li>• Register of records (objective quality evidence).</li> <li>• Technical Data as required by Specification (eg. Thermal Backfill data)</li> </ul>
Substation Design	<ul style="list-style-type: none"> <li>• Printed, stamped design drawing sets issued to relevant construction groups, as per <u>NI000401R117</u> &amp; <u>R118</u>.</li> </ul>
Workshop Construction	<ul style="list-style-type: none"> <li>• Pre-start meeting.</li> <li>• Completed modular building &amp; panels, including point to point testing of wiring.</li> <li>• Building footing design details provided to Project Manager or delegated officer for use of site civil construction group.</li> <li>• Building(s) installed on site.</li> <li>• As-built drawing markups on Master copy drawing set forwarded to Project Manager or delegated officer for use of site construction groups.</li> <li>• Copies of greenlined circuitry drawings forwarded to Project Manager or delegated officer, confirming precise point to point testing completed, for reference of site construction &amp; test groups.</li> </ul>
Civil Work Construction	<p><b>Meetings &amp; Coordination</b></p> <ul style="list-style-type: none"> <li>• Pre-Start Meeting.</li> <li>• Project progress meetings.</li> <li>• Coordination with other work groups on site or preparing to come to site.</li> </ul> <p><b>Construction Work</b></p> <ul style="list-style-type: none"> <li>• All civil work defined in the project documentation completed in accordance with the Ergon Energy standards, procedures and this Manual.</li> <li>• As-built drawing markups transferred to the Master copies of the drawings.</li> </ul> <p><b>Inspection and Testing</b></p> <ul style="list-style-type: none"> <li>• Test Results and Certificates returned to Design Manager.</li> </ul>
Substation Construction	<p><b>Meetings &amp; Coordination</b></p> <ul style="list-style-type: none"> <li>• Pre-Start Meeting.</li> <li>• Project progress meetings.</li> <li>• Coordination with other work groups on site or preparing to come to site.</li> </ul> <p><b>Construction Work</b></p> <ul style="list-style-type: none"> <li>• All structures &amp; HV plant installed &amp; connected.</li> <li>• Secondary systems cabling &amp; panels, earthing, etc. completed.</li> <li>• Construction testing of electrical installations (except that already done by workshop on panels).</li> </ul> <p><b>Construction Testing</b></p> <ul style="list-style-type: none"> <li>• Certified ITPs.</li> </ul>

	<ul style="list-style-type: none"> <li>• Certification of test equipment.</li> <li>• Test result sheets &amp; supplementary sheets.</li> <li>• Problem or non-conformance reports.</li> <li>• List of outstanding work and defects.</li> <li>• Remedial work reports.</li> <li>• Completed Commissioned /De-commissioned Substation <b>Primary</b> Plant Data Capture Forms NA000403F189 /NA000403F190 &amp; associated plant nameplate photographs.</li> </ul> <p><b>Drawings</b></p> <ul style="list-style-type: none"> <li>• As-built drawing markups transferred to Master copies and made available for reference of other groups, including Communications, SCADA, Test, etc.</li> <li>• Greenlined working copies of schematic drawings, indicating construction testing completed.</li> <li>• File compression/decompression software, where necessary.</li> </ul> <p><b>Clearances &amp; Certification</b></p> <ul style="list-style-type: none"> <li>• Competency and authorisation records.</li> <li>• Request for approval to subcontract work.</li> <li>• Notice of intention to commence supply or manufacture.</li> <li>• Notice of Inspection or Test.</li> <li>• Construction Release <u>MN000301F175</u>.</li> <li>• Construction Safety Clearance - High voltage Apparatus <u>MN000301F123</u></li> <li>• Certificate of Practical Completion.</li> <li>• Variations.</li> </ul>
<p>SCADA Construction</p>	<p><b>Meetings &amp; Coordination</b></p> <ul style="list-style-type: none"> <li>• Pre-start meeting.</li> <li>• Project progress meetings.</li> <li>• Coordination with other work groups on site or preparing to come to site.</li> </ul> <p><b>SCADA Works</b></p> <ul style="list-style-type: none"> <li>• LCF programed (may occur off site before installation in panel).</li> <li>• All points from the LCF to the RTU tested and commissioned.</li> <li>• ABB &amp; LCF communicating correctly.</li> <li>• Miscellaneous configuration requirements.</li> </ul>
<p>Communications Construction</p>	<p><b>Meetings &amp; Coordination</b></p> <ul style="list-style-type: none"> <li>• Pre-start meeting.</li> <li>• Project progress meetings.</li> <li>• Coordination with other work groups on site or preparing to come to site.</li> </ul> <p><b>Communications Works</b></p> <ul style="list-style-type: none"> <li>• MUX configurations loaded.</li> <li>• Stride MUX and Cable drawings changed from Planned to existing during commissioning.</li> <li>• New cross-connects added.</li> <li>• Coordination with other work groups on site or preparing to come to site.</li> <li>• As-built drawing markups on Master copies forwarded to Communications Design group for finalising of drawings.</li> </ul>

<p>Field Test (division of responsibilities between Ergon &amp; external Contractor as per the project specification)</p>	<p><b>Meetings &amp; Coordination</b></p> <ul style="list-style-type: none"> <li>• Pre-start meeting.</li> <li>• Project progress meetings.</li> <li>• Coordination with other work groups on site or preparing to come to site</li> </ul> <p><b>Pre-commissioning &amp; Commissioning Test Works</b></p> <ul style="list-style-type: none"> <li>• Control/protection panels &amp; building services FAT tested.</li> <li>• HV plant, earthing, etc. SAT tested.</li> <li>• Functional testing of all secondary systems, including integration with existing systems (eg. Bus Zone, AC &amp; DC Supplies), OCC and remote end substations completed.</li> <li>• Completed works switched into live service &amp; carrying load as intended.</li> <li>• As-built drawing markups transferred to Site Initial Record copies to be kept on site.</li> <li>• As-built drawing markups transferred to Master copies and forwarded to Substation Design group for finalising of drawings.</li> </ul> <p><b>Training</b></p> <ul style="list-style-type: none"> <li>• Onsite handover/training session, as required.</li> </ul>
<p>Commissioning Group</p>	<p><b>Meetings &amp; Coordination</b></p> <ul style="list-style-type: none"> <li>• Pre-start meeting.</li> <li>• Project progress meetings.</li> <li>• Coordination with other work groups on site or preparing to come to site.</li> </ul> <p><b>Commissioning Works</b></p> <ul style="list-style-type: none"> <li>• Project commissioning plan &amp; schedule completed.</li> <li>• Coordination of all internal and external work groups associated with project commissioning.</li> <li>• Field Test and HV plant manufacturers' test results audit checked.</li> <li>• Authority to Energise form completed and submitted.</li> <li>• AFW's and other documents required for commissioning submitted.</li> <li>• Completed works switched into live service &amp; carrying load as intended.</li> </ul>

## (b) Finalisation Phase

The following list summarises the minimum project documentation and other commitments required as part of the project finalisation phase.

Construction Discipline	Deliverables
<p>Substation Construction (local AMO)</p>	<ul style="list-style-type: none"> <li>• Final Release (as-built) drawings (including Civil &amp; Communications) placed in the substation, with marked up copies and old revisions replaced.</li> </ul>
<p>Field Test / Commissioning Group (local AMO)</p>	<ul style="list-style-type: none"> <li>• Final Release (as-built) drawings (including Civil &amp; Communications) filed in the Test office, with marked up copies and old revisions replaced.</li> <li>• Test results &amp; signed off Protection Setting Requests (PSR's) filed in Test office (and copy forwarded to Design Manager).</li> <li>• Copy of signed off PSR's returned to Protection group via Design Manager.</li> </ul>

## 9.4 Interpretation of Revision Clouding on Drawings

Anything shown within the boundaries of the revision clouding on a drawing issued for construction must be interpreted as either new or modified in relation to the existing installation.

If any doubt or uncertainty exists, the Constructor must check against the previous Final Release version of the drawing to confirm exactly what is already existing and what has to be added or modified. The previous revisions are available for viewing in the EDMS, otherwise copies can be obtained on request to the Ergon Design Manager.

## 9.5 Greenlining of Electrical Drawings

Refer to Section 16 of this Manual for details of Electrical Construction Testing to be carried out. During the process of continuity testing and associated visual checking of secondary wiring, the Greenlining Test copy (Set 6) of each relevant schematic must be greenlined and marked up with corrections, in accordance with Ergon Energy Quality Document MN000301R167: Greenlining and Bluelining of Ergon Energy Substation Drawings. This provides a record not only of the as-built state of the works, but also of the progress of construction testing, for the benefit of both the Construction and the following Test groups.

All markups (corrections, additions, deletions) on the Greenlining Test Copy, but not the greenlining, must be transferred to the Master copy set as indicated in Section 9.6. (Bluelining is for functional testing to be carried out by the relevant Test Group). The Greenlining Test copy set must then be returned to the Project Manager, for forwarding to the appropriate Test group for Site Integration Testing (SIT). This is the reason why it is essential that the greenlining process be done on the Set 6 copy of the drawings.

## 9.6 As Built Drawings

All construction and test changes to the issued drawings must be marked up, firstly on the workgroup's working copy of the drawings, then transferred to the Master copy on site prior to departure from site (or earlier if a significant time period has elapsed since the changes were made and other workgroups on site are dependent on the up to date Master copy also).

The Master copy drawings provide the source of the latest information for each work group on commencement on-site, as well as the collation of all changes to be forwarded back to the Design Office on completion of commissioning. Refer to the reference documents NI000401R117 and NI000401R118 Substation Controlled Drawings.

Refer also to SS-1-6.1 Civil Works for additional requirements in relation to civil works drawings.

## 10. ENVIRONMENT

### 10.1 General

Ergon Energy is committed to responsible Environmental Management ensuring that all business activities associated with the supply of electricity are carried out with as little adverse impact on the environment as possible. Refer to the Health, Safety, Environment & Cultural Heritage Policy document EP02.

All activities carried out on the site must comply with the project Environmental and Cultural Heritage Management Plan and the environmental requirements of substation standard SS-1-1.4 Substation Design Requirements. Refer also to the reference documents MP000903R117 and NI000703R100 and the Queensland Environmental Protection Act.

Constructors must comply with all By Laws and Regulations of Local and other Statutory Authorities having jurisdiction over the work.

### 10.2 Noise

Noise emanating from substations may be of concern in sensitive environments eg. residential, rural, adjacent to schools, hospitals, etc. Substation standard SS-1-10.1 Audible Noise, in conjunction with the various Legislation, Standards and other documents referenced therein, sets out Ergon requirements in relation to management and limitation of substation noise. In addition, the Local Authority may have some specific requirements and some specific noise level limits may be included in the Construction specification for a particular project.

Noises created by substation plant such as transformers (hum, tap changer, fans, etc.), CT's, VT's, circuit breakers (tripping/closing) are generally addressed through appropriate design, such as appropriate positioning/alignment of plant, acoustic walls or screens, or in some cases specifying low noise HV plant. The constructors must ensure that the design features provided to manage noise level are implemented correctly to a high standard. For example, improperly fastened metallic fittings on structures or busbars may be a source of additional vibration noise; gaps left around the base or other part of acoustic screens are likely to reduce their effectiveness, etc.

Construction noises need to be managed through restriction of noise producing activities to the allowable working hours as specified by Ergon and the Local Authority, use of well maintained, low noise vehicles and construction equipment, scheduling particularly noisy activities to the time of day with highest background noise level if possible, use of noise shielding where possible (eg. within site workshop), etc. Refer also to AS 2436 for guidance on control of construction noise and vibration.

### 10.3 Oil Handling

Substation sites contain a considerable quantity of oil in transformers, CT's, VT's, vehicles and other operating equipment, which can pose a significant environmental & fire hazard risk, if not handled appropriately.

All handling of oil on site must be carried out in accordance with Ergon work instruction ES000904R122. Refer also to work instruction ES000702W100 for the requirements for management of any fuel or oil spill.

Any oil or chemical spills must be contained and the resultant waste, **including contaminated soil** disposed of in a manner consistent with the Environmental Protection requirements, Standards and Work Instructions referred to above.

Power transformers will generally require oil containment systems, consisting of bund walls, drainage & oil/water separation facilities to prevent transformer oil entering the environment in the event of any small or large loss of oil from the transformer. Refer to Ergon Standards SS-1-9.2 Oil Containment and SS-1-6.1 Civil Works for the requirements for oil containment systems.

## 10.4 SF6 Gas Handling

Sulphur Hexafluoride (SF<sub>6</sub>) gas and its toxic, corrosive by-products produced in the event of an arc due to an equipment fault, need to be handled carefully following strict procedures, to avoid or at least minimise the potential for environmental damage or personnel contamination.

The gas and its by-products must be handled, tracked and reported in accordance with AS 2791 and Ergon Energy Work Instruction BS001404R140, using appropriate PPE, as specified in that Instruction.

## 10.5 Erosion & Sediment Control

Reference document ES000904R121 sets out the Ergon Energy obligations and requirements in relation to Soil Erosion and Sediment Control Document. Document ES000904R101 tabulates a range of control measures available for field crews to mitigate potential environmental and cultural heritage risks. Specific control measures/mitigation strategies required for the site will be set out in the site Erosion and Sediment Control Plan (ESCP) and the Environmental Management Plan.

## 10.6 Cultural Heritage

In the event of discovery of items/areas of possible cultural heritage, work must be stopped immediately and the procedure of ES000906R100 Cultural Heritage Discovery Process (Field Instruction) followed to ensure that the cultural heritage value is protected from harm as far as possible. Refer also to the other cultural heritage documents referred to in the Field Instruction.

## 11. CIVIL WORKS

### 11.1 General

This section is a reference guide on how to comply with the minimum standards required by Ergon Energy for civil construction work inside or immediately adjacent to electrical substations. Civil construction work may include but not be limited to new substations, upgrade of existing substations and survey or geotechnical investigations.

This Section 11 must be read in conjunction with the other relevant sections of this document, the Ergon Energy Standards, the Reference documents and the project documents.

### 11.2 Civil Construction Work

Civil construction work includes but is not limited to Demolition, Earthworks, Roadworks, Footings, Buildings, Bunds, Oil/Water Separation, Hydraulics, Structures, Electrical Conduits, Cable Pits and Ducts, Earth Grids and Tails, Fences and Switchyard Surfacing. Relocating HV or LV cables is considered electrical construction work and shall be undertaken by suitably qualified personnel.

All civil construction work must comply with the following documents:

1. The project documents and the 'Work May Start' drawings (Refer to Section 9.2 of this Manual).
2. The Ergon Energy Standard SS-1-6.1 Civil Works – sets out the majority of the requirements for civil design and construction.
3. The Referenced Australian Standards and Codes
4. The Ergon Energy Safe Work Practices (SWP)
5. Queensland Workplace Health and Safety Code of Practices for Construction
6. All sections of this document.

Inspection requirements and acceptance criteria can be found in the project documents and the Ergon Energy Standard SS-1-6.1 Civil Works.

Standard Work Practice SB0301: Civil Works details the requirements for performing civil works inside a substation. This document must be read in full and strictly adhered to. Special attention must be given to the requirements for the safety of workers on roofs and high areas, in excavations and working in and around live electrical equipment.

All dimensions and levels must be verified on site prior to the commencement of construction work. Dimensions must not be scaled from drawings.

#### 11.2.1 Asbestos

Every Ergon Energy site has an Asbestos Register that must be reviewed before carrying out any work on-site.

The following documents are a reference to guide Constructors on the requirements for managing asbestos:

- ES000901R101: Asbestos Management Plan
- ES000901R150: Contractor Asbestos Related Work or Asbestos Removal Work Reference Guide
- ES000901R166: Manage Asbestos Quick Reference
- SWMS009 Disturbance of Asbestos Underground

## 11.2.2 Safe Work and Builders Area

The Safe Work Areas and the Builders Area (or Builder Storage Areas) are typically nominated on the plan but must be verified with the Substation Construction Co-ordinator during the pre-start meeting.

The Safe Work Areas must be demarcated by the appropriate barrier (i.e. fences, bunting, flags) as defined in P53K05R03: Queensland Electricity Supply Industry Substation Barrier Chart and the project documents. Civil works typically require steel mesh panels and green flags. Refer to the Temporary Fence Drawing EESS-10174-01, SWP SB0301: Civil Works and Section 13.2 of this manual for construction and earthing details. The Constructor must not hinder the operation of the substation and site access must be made available to Ergon Energy Crews at all times to respond to power outages or emergencies. In the Constructors absence, measures must be implemented to inform the Ergon Energy Crews of potential hazards within the site.

Builders Areas are typically outside the substation and must be away from the site accesses and where no harm can come to the public.

## 11.2.3 Exclusion Zones

The Ergon Energy Substation Construction Co-ordinator or the Electrical Constructor in control of the site must identify exclusion zones, safe work areas and no go areas to the Civil Constructor as part of the site induction. Refer also to Section 5 of this document.

## 11.2.4 Excavations

Extreme caution must be exercised when excavating inside or adjacent to substations to avoid damage to or contact with existing underground services.

A Permit to Dig is required for all excavations >300mm. For excavations outside the substation, a 'Dial before You Dig' and a Permit to Dig is required. Refer to the following Ergon Energy References:

- SWMS015 Excavations
- SWMS015F01 Permit to Dig - Form
- SWMS015R01 Excavations – Job Safety Analysis
- SWP SB301 Civil Works

Drawings provided by the Designers for the Permit to Dig should indicate with reasonable accuracy the locations of underground cables, conduits, drains, earth grid, etc., but cannot be guaranteed 100%. Therefore the responsibility still lies with the Constructor to check for the possibility of unexpected underground services or cables, before commencing excavations.

## 11.2.5 Star Pickets

A check of existing conduits, cables or services must be carried out and approval must be sought from the Ergon Substation Construction Coordinator before using star pickets on a brownfield site. Once approved, the star pickets must be driven no further than 300mm deep and a marker or obstruction must be placed on the star picket to prevent overdriving. Refer also to Section 5.9 in the SWP SB0301 Civil Works document.

## 11.2.6 Earth Grid

The substation earth grid installation must meet the requirements of Sections 13.1 and 13.2 of this Manual, Ergon standard SS-1-6.1 Civil Works, Standard Work Practice SB0301: Civil Works and the project Specification. The electrical materials required for the earth grid will be identified in the Bill of Materials prepared by the electrical designers and generally provided as free issue by Ergon

Energy. (except that backfill materials remain the responsibility of the Civil constructor, as indicated in Section 8.3 of this Manual).

The Civil Constructor must advise the Design Manager or other appropriate Ergon contact person in writing when the earthing materials will be required. Arrangements will then be made to provide the materials for pickup by the Constructor, as per Section 8.4 of this Manual. Pickup location, date of availability and any other specific detail required will be provided in the Specification.

## 11.2.7 Confined Spaces

Working in confined spaces must be avoided wherever possible. If this is not possible, the work must comply with the Queensland WHS Confined Spaces Code of Practice, AS 2865 and the documents below.

- ES000901R151 Confined Space Management Plan
- BS001409F101 Confined Space Entry Permit
- SWMS016 Confined Space

## 11.2.8 Hot Works

Any hot works performed on-site (welding, grinding etc.) requires a permit and must comply with the following documents:

- BS001409R104 Hot Work Field Instruction
- BS001409F104 Hot Work Permit

All hot works must be performed by a qualified and experienced boilermaker. Welding must only be performed by experienced personnel who are certified in accordance with AS1796.

## 11.2.9 Scaffold Certificate

Where scaffolding is used on-site a Certificate of Compliance is required in accordance with AS/NZS 4576 and the Queensland WHS Scaffolding Code of Practice.

## 11.3 Mobile Plant

Refer to SWMS014 Movement of Powered Mobile Plant for guidance of Ergon Energy's requirements for movement of mobile plant in substations.

## 11.4 Other References

Other references include

SWMS001-005 Work at Heights (>2m)

SWMS006 Working on or near Road or Railway

SWMS012 Temporary Support of Poles or Structures

SWP SB401 Installation of Photo Voltaic Systems

ES00900R102 Safety First – Your Guide to Safe Work

ES00901R163 HSE Handbook

## 12. PRIMARY PLANT

### 12.1 General

Typically, primary plant consists of the high voltage equipment, associated structures and the cable and busbar interconnections, that make up the high voltage installation of the switchyard, as indicated in the following sections.

All items of primary plant must be located and installed with the orientations shown on the General Arrangement and Section Drawings and must be erected strictly in accordance with the appropriate manufacturer's detailed Installation Manual.

Generally, primary plant must not be installed until all erection of poles, towers, termination structures and overhead works (landing spans, strung busbars, overhead earthwires) have been completed, unless absolutely necessary and agreed by the Ergon Project Manager or Design Manager.

All HV plant will be purchased by Ergon Energy under period contracts and received into the Logistics system. Refer to Section 8.4 in relation to requisitioning items out of the Logistics system. Except for power transformers (refer section 12.2), all requisitioned items must be collected from the appropriate Ergon Energy storage depot as advised and transported to site, by the Constructor.

As soon as possible following arrival of plant at site, the Constructor must open all crates sufficiently to enable inspection and checking that all required components have been received and are in good condition. Any equipment damage or deficiencies must be reported promptly in writing to the Project Manager and/or Design Manager for follow up. This action will help to minimise potential construction delays in the event that the equipment manufacturer needs to be contacted for supply of missing components or rectification of damage.

The Constructor must provide all galvanised bolts, nuts, washers, etc. required for mounting the equipment to the support structures, unless supplied by the Manufacturer. Bolts and nuts, etc. must be ISO metric of the appropriate size in accordance with AS1111 and AS1112 and galvanised in accordance with AS1214.

### 12.2 Power Transformers

Supply, delivery to site, installation and testing of any power transformers required for the substation is generally the subject of a separate contract between Ergon Energy and the Transformer Supplier (excluding station service transformers).

A Representative from the Transformer Supplier will conduct a pre-delivery site visit to review the site access and discuss with the Constructor any requirements or co-ordination necessary before and during transformer delivery.

Prior to delivery of a power transformer, the following site works must be completed:

- The base course of the substation driveway must be completed. This does not require the concrete edging, kerb and channelling, or bitumen to be completed, but a solid compacted road base which allows transformer delivery to proceed safely, independent of weather conditions.
- The transformer footing and bund wall must be complete and have had sufficient time to cure, so as to achieve a significant percentage of the design strength. (Typically 28 days – If a shorter lead time is absolutely necessary due to unavoidable project constraints, this must be negotiated with the project team, including civil and electrical SME's). Painting of the slab and bund can be done at any suitable time after curing of the concrete is complete as above, either before or after delivery of the transformer, dependent on the urgency of transformer delivery. (Allow two to three days to complete painting).

- Ensure all of the conditions as agreed at the pre-delivery site meeting are in place.
- Installation and test of the 415V, 63A AC supply for use by the Transformer Installation Crew.

The Transformer Supplier will not deliver the power transformers if the conditions are not met. To avoid the possibility of delays and disruption due to the site not being ready when required, the Constructor and Project Manager (or Design Manager) must liaise regarding the site preparedness and the transformer delivery schedule.

During assembly and testing of the transformers, the following conditions must be observed:

- Earthworks or any dust producing activity must not be carried out in the vicinity of the transformer assembly area at this time, so as to avoid dust entering the transformers or oil via open pipework connections, access covers, etc.
- Clear access to the transformer assembly area must be maintained to enable the transformer installation crew to complete the work safely and efficiently. 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.

Following completion of transformer installation and testing and subsequent hand-over of the transformer by the Manufacturer's Installation Crew, external HV, LV and multi-core cable connections can be installed on the transformer, in accordance with the relevant Design Drawings.

## 12.3 HV Circuit Breakers (Outdoor)

HV circuit breakers must be erected on their support stands and assembled, in accordance with the Manufacturer's Installation Manual.

Some specialised aspects of the assembly (e.g. gas pipe connections, re-gassing from transport pressure to full operating pressure) and testing may be required to be completed by the Circuit Breaker Supplier, or other person Trained and Authorised by the Supplier. This requirement depends on the Manufacturer of the circuit breaker and may change from time to time, therefore should be checked for each project.

Responsibility for sourcing appropriately qualified personnel for all aspects of the circuit breaker installation lies with the Substation Constructor, unless specified otherwise in the project documentation.

## 12.4 Current Transformers, Including CT Marshalling Box

Current transformers are generally fully assembled and filled with insulating oil ready to be erected on their support structures. CT's must be stored on-site and handled strictly in accordance with the Manufacturer's Instruction Manual.

CT marshalling boxes must be fabricated and fitted out in accordance with the latest versions of the standard CT marshalling box drawings EESS-10224-01 to 06. Wiring and cable termination details will be indicated on the Project Specific Substation Drawings.

A second set of CT rating plates is provided by the CT Manufacturer. These are to be fixed to the side of the CT marshalling box with stainless steel fasteners in the positions indicated on the standard marshalling box drawing EESS-10224-02, with the plates arranged in phase order A-B-C from top to bottom.

Spare CT secondary cores must be earthed at the marshalling box, as should be indicated on the Project Design Drawings.

Cable screens and other earth connections must be bonded to the earthing bar internal to the marshalling box.

Cables must be fitted with approved glands at the entry point through the gland plate in the bottom of the marshalling box. Refer also to Section 14.5.

## 12.5 Voltage Transformers, Including VT Marshalling Box

Voltage transformers are generally fully assembled and filled with insulating oil ready to be erected on their support structures. VT's must be stored on-site and handled strictly in accordance with the Manufacturer's Instruction Manual.

VT marshalling boxes must be fabricated and fitted out in accordance with the latest versions of the standard VT marshalling box drawings EESS-10225-01 to 06. Wiring and cable termination details will be indicated on the Project Specific Substation Drawings.

A second set of VT rating plates is provided by the VT Manufacturer. These are to be fixed to the side of the VT marshalling box with stainless steel fasteners in the positions indicated on the standard marshalling box drawing EESS-10225-02, with the plates arranged in phase order A-B-C from top to bottom.

Cable screens and other earth connections must be bonded to the earthing bar internal to the marshalling box.

Cables must be fitted with approved glands at the entry point through the gland plate in the bottom of the marshalling box. Refer also to Section 14.5.

## 12.6 Disconnectors and Earthing Switches

Disconnectors and earthing switches must be erected strictly in accordance with the erection instructions in the Manufacturer's Instruction Manual.

Care must be taken to ensure that all disconnectors and earthing switches are erected with the correct orientation, as indicated on the Switchyard General Arrangement and Section Drawings issued for the Project. i.e. The earthing switches must be at the correct end of their associated disconnectors and the operating mechanisms must be on the correct side of their structures, as indicated on the design drawings. Generally, the objective will be to facilitate easy viewing of operating number plates and handles by an Operator walking from the control building towards the switchyard.

## 12.7 Surge Diverters and Station Post Insulators

Surge diverters and station post insulators must be erected strictly in accordance with the Manufacturer's Instruction Manual.

In the event that surge diverters or station post insulators are supplied in more than one section, these sections must be joined together to form one unit before being erected onto the support structure.

## 12.8 Load Control Plant

The load control plant must be assembled and installed as indicated in the Load Control Drawings, plus the Manufacturer's Assembly Instruction Manual.

Erection and installation includes (but is not necessarily limited to) the following activities:

- Erection of suitably designed structures and surrounding safety enclosure for the outdoor coupling cell.
- Connection of high voltage conductors to the coupling cell
- Installation of the internal cubicles housing the ripple control transmitter, controller, etc.
- Cabling and connections between the external coupling cell and the internal transmitter and controller

- Auxiliary supply connections
- Control cabling and connections to the SCADA RTU panel.

The Load Control Plant Supplier will perform on-site testing and pre-commissioning of the plant. The Construction Workgroup must assist with this work, particularly rectifying any installation defects to the satisfaction of the Load Control Plant Supplier.

## 12.9 Capacitor Banks

Capacitor banks (either cubicle enclosed or outdoor type) must be installed and erected in accordance with the Project Design Drawings and the Manufacturer's Instruction Manual, as required.

Erection of support structures and an enclosure fence may be required for outdoor type capacitor banks.

HV connections, auxiliary supply and control cable connections must be made in accordance with the relevant Project Design Drawings.

## 12.10 HV Switchboards

Switchboards may be supplied pre-installed by SPS in a transportable building, or packaged as individual panels as supplied by the Switchgear Supplier, to be installed in a building on site. In some cases, installation may be carried out by the Switchboard Supplier, under the supply contract.

In the case of switchboards requiring on-site installation, the panels must be requisitioned and collected from the appropriate Ergon Energy storage depot and transported to site, as for most other items of HV plant.

Before installation of a switchboard in a building on-site, the following requirements must be met:

- 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 and vehicle access must be sufficiently completed and clear to enable the installation to proceed unhindered.
- The switchroom must be sealed, air-conditioners or other ventilation systems operational (as installed), and a power supply suitable to run the individual switchboard panel heaters must be available.

These requirements are to provide a dust free and secure environment to ensure the longevity of the equipment. This is a hold and inspection point. Installation must not proceed if the conditions are not met.

Installation of the switchboard must be carried out in accordance with the Manufacturer's Installation Manual.

## 12.11 HV Cables

### 12.11.1 General

Installation and termination of HV and LV cables must be carried out in accordance with SS-1-4.4 Cables and Cabling.

The Constructor must supply all tools and equipment, plus minor materials required for the installation, termination and testing of the HV power cables. All 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.

Cable-laying must also meet the following requirements:

- Conduits must be spaced to ensure required current ratings are met (in accordance with the Cable Rating Design Report).
- Cables to be installed so 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.
- 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 (e.g. separation of the cable clamp from a steel bracket by a non-metallic spacer or similar; use of non-magnetic cable clamps).
- Cable glands must be nickel plated brass. Refer also to SS-1-4.4 Cables and Cabling.
- 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.
- Refer also to Section 10.2 of SS-1-6.1 Civil Works for further information on laying of conduits.

### 12.11.2 Thermal Backfill

If thermal backfill is required to reach the specified Soil Thermal Resistivity in the cable trench, the material data must be forwarded to the Ergon Design Manager, for checking and confirmation by the Network Rating and Utilisation Officer, before backfilling commences. The material data must include the following:

- Current thermal dry out curve to determine the moisture content
- Compaction Test Results from a Geotechnical Soils Laboratory to determine compaction ranges, compaction methods including layer thickness, minimum moisture level, and number of passes for the chosen compaction method.
- Demonstration of compliance with the project specific requirements.

Refer also to the Ergon Energy Cable Trench Installation Specification. Backfilling of the trench must be in accordance with the Geotechnical Soils Laboratory recommendations and the requirements in the Ergon Energy Standard SS-1-6.1 Civil Works.

### 12.11.3 Cable Marking and Identification

All cables from the power transformers must be permanently marked according to phase with appropriately coloured heat shrink PVC sleeving at four locations:

- (i) Inside the transformer cable boxes.
- (ii) Immediately outside the transformer cable boxes (single core cables).
- (iii) Inside the indoor switchgear or the outdoor Ring Main Units.
- (iv) Immediately outside the indoor switchgear or outdoor Ring Main Units (single core cables).

In addition, all HV cables from the power transformers must be permanently labelled T1 or T2 etc. at location (ii) and feeder name/number at location (iv).

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

### 12.11.4 Cable Terminations

Cable terminations must be done in accordance with the relevant manufacturer's instructions and Ergon standard SS-1-4.4 Cables and Cabling.

High voltage cable connection lugs must comply with AS 62271.301-2005 – Dimensional Standardisation and Terminals. The connections must be either two hole or four hole as appropriate. A single hole connection must not be used.

HV cable screens must be earthed at one or more ends, in accordance with SS-1-4.4 Cables and Cabling and any project specific requirements of the design drawings and/or specification. The stranded copper screen must be brought out under the heat shrink termination, the strands twisted together and inserted into an appropriately sized crimp lug with ring termination. The size of the crimp lug must be consistent with the total screen conductor area. The screen tail must be of appropriate length to allow connection to the earth point without the need for any additional linkage and routed so that phase to earthed metal clearances are not compromised. Refer also to Section 13.5.

Indoor switchboards and circuit breakers are subject to partial discharge testing prior to commissioning and must be free of any external cable connections during testing. Therefore the timing of cable termination works and testing needs to be co-ordinated between the Construction and Testing groups. In some cases, the cables may be terminated and connected to the switchboard, then unbolted from the switchboard terminals later for testing purposes.

## 12.12 Busbars and Conductors

### 12.12.1 Overhead Conductors

Landing spans, strung busbars and overhead earth wires must be installed in accordance with the Substation General Arrangement and Section Drawings, plus the relevant Standard Assembly Drawing(s). The conductors must be strung to the correct sags and/or tensions as specified on the appropriate drawing.

Conductor drums must be stored on level ground with the axis horizontal and must not be dropped off vehicles or distorted in any way which might lead to difficulty in running off the conductor. The protecting battens must remain in place on the drums as long as possible to prevent damage to the outer layers of conductors.

After being run off the drum, the conductor must be supported above the ground on rollers or similar, until erected. The conductor must not be driven over or walked on by pedestrians. Every precaution must be taken to ensure that the conductors when erected are left without any scratches, cuts, protruding strands, bird caging, rough welds, deposits of grease or dirt, deformation or adhesions.

Only conductor which is free of imperfections must be used for compression terminations. All grease and foreign matter must be wiped away and any light scratches must be removed by rubbing down with fine emery cloth. Steel wool must not be used.

EPV Operators must have successfully completed the appropriate training and assessment and properly secured harnesses must be worn at all times while working in the EPV.

### 12.12.2 Rigid Busbars

Rigid aluminium tubular busbars must be fabricated in accordance with the relevant Fabrication Drawings and erected as indicated on the Substation General Arrangement and Section Drawings.

Busbar supports must be expansion, sliding or fixed type, and busbar joints must be either butt or expansion type, as indicated on the Substation General Arrangement and Section Drawings and the relevant Assembly Drawings.

All welding of aluminium must be carried out by a skilled Welder using the Metal Inert Gas (MIG) process. The weld filler alloy to be used on all B6101 aluminium alloy must be aluminium alloy B4043.

Individual weld runs must be completed as quickly as possible and time for cooling must be allowed between successive runs to limit distortion and loss of strength in the weld zone. When

welding terminal palms, earth loops, etc. to tubular busbars, the cross-sectional area of the welds must be at least equal to the cross-sectional area of the palm, loop, etc. or the busbar, whichever is less.

Vibration damping conductors must be laid loosely along the whole length inside the busbar tube and tack welded at one end to prevent migration along the bus.

### 12.12.3 Droppers and Flexible Connections

Droppers and flexible conductor connections between HV plant must be installed as indicated on the Substation General Arrangement and Section Drawings and the relevant Assembly Drawings.

All conductor ends must be cleaned with a wire brush, imperfections smoothed with fine emery cloth and coated with Penetrox A or equivalent jointing compound before insertion into the compression or bolted connectors.

Compression must be continued until the two halves of the compression die meet solidly. Multiple, overlapping compressions must be carried out over the whole of the available compression length. Where compression connector detail drawings specify a dimension across the flats after compression, the compression must be continued until this dimension is achieved.

Where it is necessary to bolt an aluminium terminal lug onto a copper equipment terminal palm (or vice versa), the copper palm must be tinned and positioned underneath the aluminium. This is to minimise the risk of any corrosive copper salts being washed onto the aluminium by moisture.

Bolted electrical joints must be made using stainless steel bolts, nuts and washers. For aluminium to aluminium connections, a load spread washer must be placed on each side of the connection, with the addition of a spring washer between the nut and the load spread washer on that side. For tinned copper connections, the load spread washer can be replaced by a standard flat washer. An anti-seize compound such as Loctite 767 or equivalent must be added to each nut and bolt prior to assembly.

All bolted connections must be made in accordance with Australian Standard AS 62271.301: High Voltage Switchgear and Controlgear – Dimensional Standardisation of Terminals. The torque applied to each bolted connection must be in accordance with the relevant table in the Standard.

### 12.13 Clearances

Ergon Energy Substation SS-1-3.1 Clearances in Air sets out all Safety and Electrical Clearances that must be observed through both Design and Construction Practices.

Table 1 of the above Standard, sets out the minimum phase to earth and phase to phase clearances that must be observed for all parts that will become energised at some time. Flexible conductor connections between HV plant, droppers, and HV cable terminations and lugs must be installed so as to avoid compromise of those clearances through bending, sagging or swaying of conductors, or protrusion of cable termination lug bolts towards each other, etc. Generally, it is desirable to arrange HV flexible conductors to curve upwards between two items of plant, using the natural curve of the conductors, if possible.

The arrangement of overhead strung bus, droppers and flexible connections must also ensure that the appropriate section clearances (also in Table 1) are achieved.

In 3 phase HV cable termination boxes, the cable lugs and bolts should preferably be installed with all the lugs on the same side of the equipment terminal palm for each phase and the bolts facing in the same direction, with the toes of the bolts pointing into the larger clearance gap. This is not always possible (e.g. in switchgear panels, etc.), so may have to be modified on site for particular cases, but the principle is always to arrange so as to obtain the largest possible phase to earth and phase to phase clearances in all parts of the cable termination box (subject to achieving the minimum values in Table 1 of SS-1-3.1 Clearances in Air).

In exposed outdoor situations, at the lower voltages, consideration needs to be made of the possibility of infringement of the minimum clearances by birds, reptiles, or climbing animals. Insulation of exposed live terminals, etc. may need to be provided to prevent contact by vermin, whether specified in the design or not.

## 12.14 Lightning

Lightning protection, consisting of an integrated combination of lightning masts and overhead earthwires above the incoming feeder landing spans must be installed in accordance with the Substation General Arrangement and Section Drawings, plus the relevant Standard Assembly Drawing(s) and Substation Standard SS-1-8.2 Substation Lightning Protection.

In the event of any lightning fixtures, or other LV auxiliary circuits needing to be installed on lightning towers, care needs to be taken to achieve sufficient clearance and insulation between the lightning current circuit and the LV circuit to prevent lightning current causing any back flash-over in the LV system of the substation.

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## 13. EARTHING

The substation earthing system must be constructed and commissioned strictly in accordance with Ergon Energy Standards SS-1-7.1 Substation Earthing and SS-1-7.2 Safety Earthing and the relevant Australian Standards and Guidelines: Refer to:

- 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 Code of Practice 2010: Works

The work shall be carried out by an Electrical Fitter Mechanic possessing a current Queensland Electrical Workers and Contractors Board Certificate of Competency.

### 13.1 Main Earth Grid

Earth grid conductor crimp connections, including lugs must be well compressed such that all conductor strands make solid contact with other conductors and the outer strands are solidly compressed into the inner surface of the surrounding crimp connector. Gaps between conductors must be minimal.

Quality of crimp connections is dependent on factors such as crimp type, compression pressure, calibration and serviceability of compression tool and dies, care and skill of the operator. Prior to commencement of the earth grid connections, the Ergon Design Manager (or Representative) may require to inspect a random sample of three (3) to five (5) completed earth grid joints of each type and may request to view a small number of further samples on a random basis during the course of the work, to ensure consistency is maintained. These samples must be cut through by hacksaw to expose the cross-section of the joint, for the approval of the Design Manager (or Representative). Refer to the specification on a particular project for project specific requirements.

Back-filling of the earth grid conductor excavations must not be carried out until the Ergon Energy Design Manager (or Representative) has been notified and had time for Final Inspection of the laid earth grid conductor and jointing. Refer to reference documents SB0301 & SWMS015 for requirements in relation to excavating for the earth grid and to the SS-1-6.1 Civil Works for details of back-filling requirements.

All earth grid connections must be ductored as part of the Construction Testing, as described in Section 16 below.

Other earth grid testing, including measurement of the resistance of the buried earth grid system to the general mass of the earth, Step and Touch Potentials, Earth Potential Rise (EPR), etc. will be carried out as part of Commissioning, by the Specialist Test Workgroup, as per the Test and Commissioning Manual.

To prevent the transfer of dangerous voltages outside the substation, all conducting services leaving the earth grid area (metallic pipes, fences, control, protection and communication cables, etc.) must be isolated as specified in SS-1-7.1: Substation Earthing.

### 13.2 Extending Fences and Earth Grids in Energised Substations

When erecting a fence inside or near the outside of an energised substation, the construction procedures must ensure that no connection is made between the substation earth grid and any remote earth. There must also be no possibility of any Personnel (Staff or Public) being able to contact both the substation earth potential and remote earth potential at the same time, as the substation earth grid potential may be considerably different from that of remote earth.

Refer to Standard Work Practice SB0301: Civil Works for procedures to be followed when constructing fences or working on the earth grid in and near a HV substation. Supply of insulation

mats, gloves, temporary jumper leads, and other safety equipment required is the responsibility of the relevant Constructor.

When constructing a new section of earth grid in an area adjacent to the existing earth grid of the substation, due consideration must be given to the risks associated with transferred potentials in the event of an earth fault occurring during installation of the new earth grid. Following are the minimum requirements:

- (a) A Work Method Statement must be prepared indicating how the risks will be minimised.
- (b) Prior to commencement of installation of conductors, a 3 metre isolation zone must be cordoned off with tape, measured from the existing metal fence or other defined boundary between the existing earth grid and the new work area.
- (c) Installation and connection of the new section of earth grid must be carried out in two stages, as described in (d) and (e) below.
- (d) The new earth grid conductors must be installed, commencing at the boundary of the work area furthest from the existing grid and working back towards that existing grid, until the boundary of the isolation zone is reached. No conductive material is permitted to breach the Isolation Zone, including earthing conductors, fencing materials, construction AC supply cabling (unless electrical isolation provided), etc. No special safety requirements such as insulating gloves and mats are required at this stage, provided the Isolation Zone is not breached.
- (e) Following completion of the work in (d) above, including making of connections, backfilling and compacting, the task of connecting the conductors across the Isolation Zone to the existing grid can be commenced, subject to the following safety requirements:
  - The principle of working towards the existing grid must be adhered to as much as possible.
  - Whenever conductors are handled, 00 insulated gloves must be worn.
  - When connections are made to the existing earth grid, insulating mats must be used also.
  - Temporary jumper leads must be applied between the existing and new earth grid conductors, before the final connection is made.
  - A new fence must not be extended across the Isolation Zone until the earth grid is completely finished.

### 13.3 Support Structures, Equipment, Cable Trench Covers

All support structures, equipment earth points, marshalling boxes and cable trench covers, etc. must be connected to the main earth grid, in accordance with Ergon Energy Substation Standard Earthing Drawings (EESS-10031-01 to EESS-10031-55). These drawings are readily available in the Substation Design module on the Design and Constructors page on the internet.

(<http://www.ergon.com.au/contractors,-suppliers--and--developers/design-and-construction-contractors>)

The earthing tails from the earth grid must be fitted neatly into the provided slots in the foundation, shaped to the structure earth connection point, cut to length and fitted with the appropriate compression terminal lug.

Bare copper strap and lugs must be tinned over the whole connection area where earth connections are made to equipment and structures.

The Constructor must supply all compression tools and dies, plus minor materials such as hot dip galvanised bolts, nuts, etc. required for jointing and fastening the earthing conductors to structures and equipment. All fasteners must be both non-corroding and non-corrosive.

Portable earthing device attachment saddles must be fabricated in accordance with Drawing EESS-10031-53, then fitted at each point indicated by an asterisk "\*" on the relevant Substation Elevation Drawings and indicated generally in the Standard Earthing Drawings EESS-10031-01 to 55.

Cable trench covers must be earthed in accordance with Drawings EESS-100301-24 and 55, if made of conductive material.

All bolted earth connections must use a minimum of two bolts, unless indicated otherwise in the Standard Drawings.

Electrical plugs/sockets, etc. installed in the switchyard should have the earth pin connected to the substation earth grid as near as practicable to the outlet.

## 13.4 Panels and Building Equipment

Project Drawings should indicate the main earthing requirements for the building equipment, but may miss some of the detail, due to the complexity that arises from the number of connections required. Hence, some guidelines are provided for the assistance of the Construction Workgroup.

All control and protection panels, switchboards, battery chargers, cable trays and ladders and sundry metalwork in the Control Building must be connected to the main earth grid.

Each separate HV Switchboard or GIS must have at least two earthing tails connected directly back to the main earth grid in the ground, one at each end of the switchboard or GIS. In a Control Building Room containing a single row of control/protection panels, exactly the same arrangement must be applied to the row of panels. Where there are two or more sets of panels, including some possibly along the walls (AC and DC supply panels, etc.), the earth bars of the different sets of panels must be bonded together via the earth bar in the overhead cable tray and again two connections made directly back to the grid, one from either end of the cable tray earth bar.

Cable tray and other sundry metalwork may be earthed via tails off any of the main earth connections indicated above.

Each individual switchboard panel or control/protection panel must be connected to the main earth bar run in the cable tray above. The earth bars at the top and bottom of each panel must also be connected together with an insulated green/yellow earthing conductor of equivalent cross-sectional area to the earth bars themselves.

Bare copper strap and lugs must be tinned over the whole connection area where earth connections are made to panels, switchboards, battery chargers, cable trays, etc.

Earthing of the Control Building itself – walls, roof, etc. – must be separate from the internal substation equipment earthing and have its own direct connections to the main earth grid, so that the equipment earthing is not dependent on the building earthing or vice versa.

## 13.5 Cable Screens

Cable screens are to be earthed at either one or both ends, dependent on the function of the cable, as specified in Ergon Energy Substation Standards [SS-1-4.4 Cables and Cabling](#) and [SS-1-7.1 Substation Earthing](#).

The Constructor must prepare the cable and provide all necessary materials required for effective connection of the screen, including the required length of earthwire.

The cable screen must be bonded to an earth strap where available, otherwise to the appropriate earthing terminal of the panel, marshalling box, etc.

For both HV and multicore cables, the cable termination/screen earthing arrangement must provide sufficient clearance in air from the live parts to ensure that the rated impulse withstand and power frequency withstand levels are not compromised.

Stranded copper screens (generally on HV cables) must be earthed in accordance with Section 12.11.4. Brass tape screens on multicore cables must be earthed to a suitable earth bar via a stranded copper conductor earth tail, of minimum cross section of  $2.5\text{mm}^2$ , with standard green-yellow insulation.

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## 14. SECONDARY SYSTEMS

### 14.1 Protection and Control Panels

Protection and Control Panels are supplied as single panel cubicles which must be installed in the locations indicated on the relevant Building Layout Drawings, bolted together using the joining brackets provided at the top of each panel and dyna-bolted securely to the floor. Four dyna-bolts (minimum 12mm diameter) plus square washers (approx. 25mm) are required per panel.

Panels must be lifted only by the eye bolts provided at the top of each panel.

Earthing of panels is covered in Section 13.4.

Lift-off rear panel doors must be removed and placed out of the way during internal fit-out and wiring of the panels to provide safe passage and exit for Personnel in the event of an emergency.

Relays and other panel equipment must be mounted in the panels and wired in accordance with the approved design drawings, which should be based on the latest versions of the relevant Relay Application Guides and ZSS template drawings. Wiring construction work must meet the detailed requirements and standards in [MN000301R166: Construction and Wiring Guidelines for Ergon Energy Substation Panels](#).

Where a modular building is specified, the substation control/protection panels and other building equipment, including MV switchboards and overhead cable tray, etc. will be constructed and installed off site as part of the building construction, whereas for a brick/block building, installation of panels and equipment will need to be done on site, following sufficient completion of the building construction (subject to agreement with the building constructor).

### 14.2 Remote Terminal Units and Local Control Facility

The SCADA Remote Terminal Unit (RTU) racks must be installed in the panel locations indicated on the relevant Design Drawings for the Project.

The Local Control Facility (LCF) (also referred to as a HMI –Human Machine Interface) must be installed either on the desktop or in the allocated panel, as indicated on the Drawings, dependent on which type of LCF is provided. A touch screen LCF will be installed in an allocated panel.

Any spare cards in an RTU rack must be fully wired out to terminals, as indicated on the Design Drawings for the RTU, so as to be readily available in the future if needed.

Loading of RTU configuration files into RTU's and functional testing will be carried out by the appropriate Secondary Systems Group and programming of the LCF will be carried out by Ergon Energy SCADA Group.

### 14.3 Communications

Communications and signalling requirements are generally designed, supplied and installed by Ergon Communications work groups, but some associated work is generally the responsibility of the substation constructor. Specifically,

- Installation of completed communications equipment cubicles, including the 48V DC supply panel (where required), supplied by Communications work group.
- Provision of AC & DC power supplies from the appropriate Distribution panels to the Communications panels.
- Installation of fibre optic cable ducts and termination enclosures as per Drawings 899364-01 and 899364-02, as required.

- Installation of a concrete communications antenna pole based on the standard Communications pole drawings supplied by the Communications designers. – Orientation is to be in accordance with the site specific layout drawing.
- Supply and installation of public telephone services and telephone isolation equipment, if required by the design. (In most new substations, the telephone service will now be provided by the Ergon Communications workgroup, via the communications panels).

The DC power supply cabling from the substation 110V DC Distribution Panel, or from the 48V DC Supply Panel as required, must be installed in accordance with the design drawings, Ergon Substation Standards SS-1-5.1 DC Supplies and SS-1-4.4 Cables and Cabling and STMP004 Standard for Communications Equipment Installation.

The location and type of the outdoor conduits, pits, termination enclosures and splice 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 internal OFS 800 termination enclosure must be mounted on the wall of the equipment room as close as practicable to the communications equipment cubicles and in accordance with AS/ACIF S009:2001 – Installation Requirements for Customer Cabling (Wiring Rules). The final position of conduits, cable pits, termination enclosures, etc. must be determined in conjunction with the Communications workgroup.

The required orientation of the communications antenna and of any future microwave dish to be mounted on the concrete pole must be double-checked before installation of the pole. - Orientation is to be in accordance with the site specific layout drawing, as is the antenna mounting arrangements.

If a direct connection to the public telephone network is required, a 10 Pair lead-in cable must be installed from the public telephone network to the substation. This includes 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 S008:2010 – Requirements for Customer Cabling Products. All telecommunications equipment must be installed in accordance with AS/ACIF S009:2006 – Installation Requirements for Customer Cabling (Wiring Rules).

Where required, a telephone Line Isolation Unit (LIU) must be installed in the substation building 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, as well as sufficient optical isolation modules to isolate two PSTN telephone lines, with capability of expansion to four telephone lines by the addition of isolation modules.

The exchange side of the isolation unit must be powered from the Carrier's network. The subscriber side of the isolation unit must be powered from the substation DC supply.

During any work on the network side of the LIU, any accessible exposed earthed metal within two metres of the LIU must be covered with insulating rubber mats of appropriate rating (10kV), to prevent any inadvertent personnel contact with the earthed metal. This is to protect personnel against potentially dangerous touch potentials between the substation earth grid and the external public telephone network.

Telecommunications conduits and cables within the substation must be unbroken between the property boundary and the telephone line isolation unit. The use of PSTN telecommunications pits within the substation boundary is not permitted.

## 14.4 Metering

All metering must be installed in accordance with Substation Standard SS-2-4.1 Metering, the Queensland Electricity Connection and Metering Manual NA000403R328 (QECMM) and the relevant Design Drawings.

Revenue metering circuits must be sealable at the locations as indicated in SS-2-4.1 Metering and the EESS-100316 Series of Drawings.

Metering VT and CT loads must be balanced on all three phases as far as possible. For any 3 phase installation, the least loaded metering winding must carry not less than 80% of the load experienced by the most heavily loaded metering winding. Transducers and meters must be connected to the preferred phases as indicated in the Manufacturers' Installation Guides. In the event of contradiction with the Project Design Drawings, the Designers must be consulted for clarification.

## 14.5 LV Cabling, Secondary Wiring and Terminals

### 14.5.1 General

This Section describes the general requirements for all LV cables, secondary wiring and terminals for all AC and DC circuits, CT and VT secondary circuits, control, alarm and protection circuits.

All secondary wiring must comply with the following common requirements, in addition to the specific requirements of other relevant Sections of this Manual:

- 0.6/1kV PVC/PVC insulated conductor conforming to AS/NZS 5000.1
- Stranded Conductors
- All Control and Protection Panel wiring must be grey.

### 14.5.2 Installation

- All LV cables and wiring must be installed and terminated in accordance with Ergon substation standard SS-1-4.4 Cables and Cabling and quality document MN000301R166 Construction and Wiring Guidelines for Ergon Energy Substation Panels.
- In order to minimise 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.
- Within the Control Building, so far as is possible, cables which extend outside the Control Building must be physically separated from internal cabling and particularly from those cables containing low level signals.
- Where cables enter the building adequate vermin proofing must be installed.
- AC and DC circuits must be run in separate cables.
- Where X and Y protections are used, the X and Y secondary circuits must also be run in separate cables.
- Cables exiting the Control Building must be laid neatly in concrete trenches, then, exit the trenches at appropriate points in electrical grade PVC conduits to reach the switchyard equipment, as indicated on the appropriate Cable Route Diagrams and other Associated Drawings. Control cables must not be direct buried and must not be run in the same ducts or conduits as HV cables. Cable segregation distances between LV AC power cables, control cables and instrumentation cables must be maintained in accordance with Sections 6.3 and 6.4 of SS-1-4.4 Cables and Cabling.
- Due care must be taken to avoid damage to cables during laying. Large heavy cables may need to be supported on rollers when running across other cables, but winches should not be

used, unless absolutely necessary. Cables must be laid parallel with one another as far as possible, not bunched or crossed, so that each cable may be identified throughout its entire length.

- Where cables exit from conduits, or enter equipment cubicles for termination, they must be adequately protected against mechanical damage and adequately supported by clamps attached either to the panel or the structure. Cables not enclosed within ducts or conduits must be clamped at intervals not exceeding 300mm (approximately).
- Upon installation of cables, both ends must be suitably sealed to prevent ingress of moisture, dirt, or vermin (until glanded and terminated).
- Any 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.
- Each cable must be fitted with a permanent non-corroding cable marking tag at each end just before the cable gland, stamped with the unique cable number, as per the Cable Schedule and appropriate Connection Diagram.
- For long cable runs, additional markers must be provided at 30m intervals along the length of the cable.
- Cable screens of multicore cables must be connected to the substation earth grid at both ends of the cable. Refer also to Section 13.5 of this manual and Section 6.3.3 of SS-1-4.4 Cables and Cabling.

### 14.5.3 Cable Cores and Terminations

- All Switchyard cable glands must be chrome or brass – PVC glands are not acceptable.
- Cable cores must be labelled strictly in accordance with the numbering specified on the relevant Connection Diagrams.
- Wire number ferrules must be interlocking, non-rotating type, fitted firmly over the insulation at both ends of each conductor, as close as possible to the terminals and indelibly marked with non-deteriorating black lettering on a white background. Clip-on type ferrules are not acceptable.
- Earthing of equipment generally requires that each item be individually connected to the earth bar. Should looping of earth wires be unavoidable, it must be arranged such that disconnection of any item of equipment from its earth connection during test or maintenance will not interrupt the earthing connections to other plant remaining in service.
- 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 terminals 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.
- All fuse holders must be installed at the front of the terminal boards and no live metal is to be exposed at the back.
- All fuses and links must be clearly labelled with the circuit function and fuse size or 'Link' as per the approved Design Drawings.
- All cable cores must be terminated, including spare cores, as indicated in the approved Design Drawings.
- Connections to equipment terminals must be made with appropriate crimp lugs to suit the particular equipment, as generally indicated by MN000301R166 "Construction and Wiring Guidelines for Ergon Energy Substation Panels". Circular lugs must be used where possible,

rather than forked lugs. The latter are to be used only where the type of equipment dictates that these are the most suitable type of lug.

- Document [MN000301R166](#) indicates the minimum required Standards for termination of cores and crimping of lugs. The lug manufacturer's recommendations must also be followed.

#### 14.5.4 Optical Fibre Cables

Optical fibre cables must be run in white conduits, as specified in the design and segregated from all other cables. The optical fibre conduit may be run in the main cable duct or cable ladder, but must be clamped to the side of the duct or ladder to be kept clear of the other cables.

Refer also to Sections 11 and 14 of [STMP004 Standard for Communications Equipment Installation](#), Section 14.3 of this manual, and documents [MN000301R166](#) and [BS001404R114](#) for other essential requirements in relation to installation of optical fibre cables.

#### 14.5.5 Decommissioning and Removal

- Cables that are no longer required must be isolated, proven de-energised, and disconnected.
- All cables that have been disconnected must be completely removed and not left in cable trays, conduits, and cable ducts.
- To facilitate the identification of cables to be removed after being disconnected and/or cut away, the ends of the cable must be covered with a red insulation tape, and using a white paint pen mark the cable with the cable identifier and "to be removed".
- Where cables have been disconnected, left in an outdoor cable duct/tray, or will not be removed during the current project being worked on, then a more permanent system of marking and insulating must be used. This should consist of the application of a heat shrink cap over the cable end, and the application of a suitable indelible label detailing the Cable Identifier, Project no., Date, Disconnected by, and "To be removed". As a secondary measure, the cable identifier must also be marked using an indelible pen or paint on the side of the cable as a precaution against longer term deterioration of the label.
- Where a cable is no longer required and has been identified as being direct buried, it is highly recommended that the cable be removed. If it is deemed not practical or high risk to excavate for its removal, then it is still a requirement to identify and mark the cable ends in the manner described above for outdoor cables not being removed for 12 months or later. A record of the decommissioned direct buried cable must be kept on substation plan drawings (eg. identified and notes included on General Arrangements, Foundation Plans etc.) and the cable is to be retained on the cable schedule drawing with appropriate decommissioning notes.

## 15. MISCELLANEOUS

### 15.1 Substation Auxiliary AC Supplies

This Section describes the General Construction requirements of the low voltage 415V AC supply system for the substation equipment and services plus the on-site construction power needs, **within the earth grid area only**. *It is not intended to apply to the constructor's site office, workshop and amenities AC supply, which must be installed as a separate system, where these facilities are outside the substation earth grid area.*

The major AC supply equipment, as required by the design, will be specified and procured by the appropriate design team and will be available for collection by the constructor as indicated in Section 8.4 of this Manual and the project specification.

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

The AC supply system must be installed and tested in accordance with AS/NZS 3000 Wiring Rules. Additional RCD protection must be installed on LV circuits if required by AS/NZS 3000.

The station supply pad mounted or pole mounted 11kV/415V transformers, RMU's, associated HV and LV cables, the 415V AC three phase main switchboard and sub-boards must be installed and tested as indicated on the relevant Design Drawings and in accordance with Ergon Energy Substation Standard SS-1-5.2 AC Supplies.

Prior to commissioning of the 11kV/415V station supply transformers, a temporary source of LV AC supply for on-site construction, operation and testing purposes (eg. battery chargers, fans, tap changers, etc.) will be needed. The substation Constructor must arrange either:

- (a) Sufficient LV generating capacity, or
- (b) LV Supply to the site from the Ergon Energy Distribution Network, if readily available. The temporary connection is to be requested for the duration of the Construction/Commissioning period. This connection will be subject to Ergon Energy Standard Terms and Condition for supply and will be metered and charged accordingly.

The following conditions apply to the use of temporary supplies:

- The temporary supply must be connected to the substation AC supply panel, so as to function, as far as possible, in the same manner as the final permanent supply will do.
- **The temporary supply must remain wholly within the substation earth grid area and not be used to supply equipment outside that area**, so as to avoid the possibility of touch potential problems due to transference of the substation earth potential to an area that might be at a different earth potential.
- Access to all live parts must be restricted in accordance with the requirements of AS/NZS 3000 and any related document, to minimise the risk of accidental contact by personnel.
- All outstanding and/or uncompleted works must be made safe at all times, including the cutover from temporary to permanent arrangement.
- A written statement detailing the status of the temporary AC supply and associated isolations, locks and tags must be provided in handing over to the next work group (Test/Commissioning, etc.)

Within a live substation site (brownfield), power supply for on-site construction, office and facilities purposes may be available directly from the existing AC supply system for the site, provided the tools and equipment connected do not overload the relevant circuits used, or otherwise impact on the supply to the live substation equipment.

## 15.2 DC Supply Systems

This Section describes the General Construction requirements of the batteries, battery chargers, battery stands, DC isolation and test panels, DC/DC converters, DC/AC inverters, and DC distribution boards for the Substation DC Supply Systems and the Communications DC Supply System.

The major DC supply equipment items as indicated above are selected (by the Designer) from the standard Ergon Energy inventory items sourced on the Ergon Energy Period Contract for DC supply equipment.

All items, whether sourced from the Period Contract or elsewhere (for non-contract items) must be entirely satisfactory for the service conditions and intended operational requirements, whether such conditions or operational requirements are directly specified or not.

Installation of the DC Supply Systems, including all cabling between battery banks, isolation and test panels, DC distribution board, battery charger, DC/DC converter and DC/AC inverter must be carried out as described in Ergon Energy Substation Standard SS-1-5.1 DC Supplies.

Bolts, nuts, washers and inter-connections must be of an inherently corrosion resistant material or otherwise protected against corrosion and must be supplied by the Construction Workgroup.

Racks, signage and inter-cell/inter-tier/inter-row connectors are supplied by the Battery Manufacturer, together with the batteries and must be installed in accordance with the Instruction Manual supplied.

The Battery and Battery Charger Instruction Manuals (supplied with the equipment) also contain Factory Acceptance Test results. The batteries and chargers must be inspected, installed and tested in accordance with the requirements of the Instruction Manuals.

## 15.3 Lighting

All switchyard and building lighting must be installed in accordance with Ergon Energy substation standards SS-1-9.6 Substation Lighting and Section 9.3 of SS-1-1.4 Substation Design Requirements, in locations and orientations as shown on the relevant design drawings.

All switchyard lights must be able to be maintained without need for an outage of any HV equipment. For example, swing-down lights and their counter-balances must not encroach within the relevant exclusion zones for nearby HV plant, at any point of their swing-down paths.

Cabling to each light must be connected as indicated on the relevant Design Drawings. Minor materials required to complete the connections are to be supplied by the Constructor.

## 15.4 Nameplates, Signage, Labelling

### 15.4.1 General Requirements

Rating plates, nameplates, signs and labels installed on outdoor equipment must be of stainless steel or non-ferrous metal, with etched or engraved lettering and fixed with stainless steel screws or monel rivets. Indoor labels must be engraved traffolyte or other approved material.

Rating plates, nameplates, signs and labels must be located such that they can be easily and safely read from normal operating positions and access ways around the equipment, at ground or floor level.

Full details of all signs, labels, etc. required, including content, sizes and details of lettering, in accordance with the respective Template Drawings will be provided in the Project Design, for ordering purposes. All fasteners required must be supplied by the Construction Workgroup.

## 15.4.2 Rating Plates, Nameplates and Operational Signs

All CT and VT marshalling boxes must incorporate rating plates showing all relevant rating data of the associated HV plant. A second set of rating plates is usually sourced from the CT or VT Manufacturer for installation on the appropriate marshalling box.

All switchyard operational signs must align with the approved Operating Single Line Diagram. The Standards for content, sizing, and layout of operational signs are indicated on typical Drawings eg. 963817-01 to 07.

Switchyard Operational Number signs are required on each HV operational point only. i.e. circuit breakers, disconnectors, earthing switches, voltage transformers, power transformers (all ratings), HV fuses, disconnectors and earthing switches in RMU's and HV switchboards. Current transformers and surge diverters are not operating points and therefore must not be allocated Operating Numbers, although they may have been shown on the Operating Diagram for information.

## 15.4.3 Labels

All equipment, operating devices, relays, etc. must be suitably labelled such that they can be readily identified from drawings. Circuit breaker and transformer control cubicles, control panels and relay panels must also be labelled. Cubicles and switchboard panels with rear access must also be labelled on the rear of the panel.

On manufactured equipment, most labels should be supplied and installed by the Equipment Manufacturer, however, some additional labelling may be provided by the Project Designer to match the equipment identifications shown on the Project Drawings. e.g. bay numbering, device identification, etc.

All labels must be in the English language.

## 15.4.4 Safety Signs

Warning and Safety Signs must be installed around and within the substation, as specified in the Ergon Energy Standard SS-1-9.3 Substation Signage.

These signs warn Personnel of dangerous voltage levels, correct operating procedures and safety requirements within the substations.

Warning signs must conform to the relevant Australian Standard and Work Health and Safety Act 2011. The required signs and locations will be provided in the Project Design Drawings, however the Constructor should still double check that all the necessary signs have been provided and that the specified locations are suitable.

## 15.5 Painting

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.

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.

The interior of outdoor control cubicles, cabinets must receive the same number of coats as the exterior. The Constructor must make good any damage to the paint incurred during delivery, erection or commissioning, before completion of the works.

## 15.6 Locks, Keys, Operating Equipment, Miscellaneous Control Building Furniture

Where building locks are required, they must be flush mounting types, suitable for Ergon Energy's master key system.

Locks must be constructed and located on equipment so that they remain serviceable in the whole range of Queensland climatic conditions for an indefinite lifetime, including continuous periods of up to two years without operation or maintenance.

Building entry & internal door lock barrels are to be replaced by the appropriate Ergon lock barrels, according to the substation region.

All HV operating points (circuit breakers, disconnectors, earthing switches, VT secondary fuses) must be fitted with the appropriate Ergon switching padlock (again according to the substation region).

Panel, cubicle and miscellaneous equipment keys, equipment operating handles and the like must be hung on a shadow board(s) mounted in the control building, in the same room(s) as the associated equipment. The control building must also include a plan desk, chair, drawing hanger for storage of substation drawings and two drawer filing cabinet (to fit under desk).

Operating equipment such as portable earthing devices (PED's), HV test sticks, DNOB's, HV gloves, etc must be neatly stored in an efficient manner that ensures the equipment remains in serviceable condition and is readily accessible when required. PED's must be hung neatly and singly on smoothly curved brackets, either in the control building, or in an external operating equipment shed, as specified by the designers. Circuit breaker trolleys for MV switchboards should be stored in the switchboard room in readily accessible position, but parked neatly so as to be clear of personnel access paths. A substation sign-in/out log book must be placed on the control room desk, near the telephone.

Switching padlocks, door lock barrels and operating equipment as listed above are available as Ergon Energy stores stock. Quantities and voltage/current ratings as appropriate, will be specified by the designers for the specific project.

## 15.7 Control Building Electrical Services

This includes control building lighting and power circuits, air conditioning, fire protection and security systems as required.

All materials supplied and all work carried out must comply with the requirements of the latest addition of the Australian/New Zealand Wiring rules (AS/NZS 3000) and amendments thereto, the Queensland Electrical Safety Act and Regulations, other relevant SAA Codes, Ergon Energy Standards and the design drawings provided for the project.

All light switches and GPO's must be flush mounted on blockwork, except that outlets of 63A capacity or greater rating (single or three phase) may be surface mounted. 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.

Each electrical socket outlet must be engraved or labelled to indicate its respective circuit number. In some cases, labels may be fixed to the wall adjacent to the switch, if fixing to the switch is not suitable.

The control building electrical circuits must be cabled and connected to the appropriate circuit breakers on the AC Distribution Board, as indicated on the project electrical design drawings.

The AC Distribution Board will be provided as free-issue to the building constructor for installation as indicated on the building layout drawings, to enable the connection of the building electrical circuits as in the paragraph above.

The final installation must ensure that the loads are as evenly balanced as possible across the three phase supply.

Equipment Manuals provided by equipment suppliers must include full operating instructions, as constructed drawings, test results, manufacturer's product data and safety instructions for the safe installation and use of the equipment.

The air-conditioning system must be supplied, installed and commissioned in accordance with the requirements of the project Specification, Section 21.4 of SS-1-1.4 Substation Design Requirements, the design drawings and the relevant SAA Codes and other relevant Regulations.

A fire protection system must be installed in accordance with SS-1-9.1 Substation Fire Protection, the project Civil Specification (where supplied), the Workplace Health and Safety Act and Regulations, the appropriate Australian Standards referenced in SS-1-9.1 Substation Fire Protection and the design drawings. The system must include Fire Indicator Panel (including manual call point), detectors, cables, conduits, accessories and fire extinguishers, as indicated generally by the Fire and Communications Services Layout drawing. The Fire Indicator Panel must be approved by the Insurance Council of Australia.

A plastic laminated 'as installed' Location diagram of the complete installation must be securely mounted on the wall adjacent to the Fire Indicator Panel. The Location diagram must use symbols that comply with AS 1670 and Handbook AS HB20 and must indicate the position of the fire indicator panel, detectors, alarm groups and alarm zone circuit numbers. A complete circuit diagram indicating all wiring and terminal connection details of the output contacts for alarm and/or control purposes, plus details of provisions for future connection of the panel for system monitoring by the Fire Brigade are also required.

The fire protection system must include an air conditioning shutdown signal from the Fire Indication Panel to the relevant circuit on the AC Distribution Board, in the event of a fire. Fire extinguishers must be mounted securely on suitable brackets, enabling ready access to the extinguishers if required, with appropriate identification signs in accordance with the Regulations and located as indicated on the design drawings.

A building security system, including Intruder Alarm Panel where required, must be supplied, installed and commissioned in accordance with the project specification, SS-1-9.5 Substation Physical Security and Monitoring and the relevant Standards and Regulations, etc references therein.

## 15.8 Commissioned / De-commissioned Plant Data Capture Forms

Following installation of each item of new HV plant or protection relay into its correct position in the substation, a Commissioned Substation Primary Plant Data Record Form NA000403F189 must be completed for each item and a clear, readable photograph of the nameplate(s) attached.

Similarly, for any existing items of plant de-commissioned and removed from their service positions, a De-Commissioned Substation Plant Data Record Form NA000403F190 must be completed and nameplate photo attached.

The form(s) should be completed prior to issue of the Construction Release MN000301F175, in case access to HV plant is still needed to view and photograph plant details. As well as the nameplate photograph (essential), a general photograph of the item of plant is also useful.

As well as major HV plant items, completed forms will be required for items such as transformer bushings, CT's, oil pumps, cooling fans, surge diverters and HV links. Secondary items needing to be recorded include protection relays, battery banks, chargers, revenue and statistical meters, metering CT's, RTU cards, etc.

A single form can be used for a set of 3 single phase items of plant (eg. CT's, VT's, surge diverters). The completed forms and nameplate photos must be forwarded to the regional AMO (Asset Maintenance Officer) through the Project Manager, as early as possible prior to commissioning of the plant.

## 16. ELECTRICAL CONSTRUCTION TESTING

### 16.1 General Scope

All construction groups must monitor and ensure the quality of their completed work, by carrying out Construction Testing and rectifying any deficiencies found, prior to handover to the Test group.

The construction work & testing must be verified by completion of the relevant Substation Construction Tools, which are available individually on the Process Zone and conveniently grouped as a package on Ergon's internet website for Design and Construction Contractors (under Zone Substation Design and Construction).

The extent of Construction Testing done must be indicated in the completed Construction Tools and include (but not be limited to):

- (a) 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 the wiring has been modified since completion of the F.A.T. In the event that the Field Construction group are also responsible for wiring of the control, protection and other panels (either directly or by sub-contract), then that group will also be responsible for continuity testing of the panel wiring.
- (b) 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).
- (c) Insulation Resistance Testing (at 500V) of all 240/415 V wiring installed on site including control cables, panel wiring and inter-panel wiring.
- (d) "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). Refer also to Section 5.3 of SGMM002 Substation Earthing Strategy and Section 5.7 of SP0515 Bus Assembly Testing SWP. Results must be recorded on Earth System Continuity Test Report or equivalent.
- (e) "Ductoring" of HV connections to primary plant. Refer to Section 5.6 of SP0515 Bus Assembly Testing SWP. Results must be recorded on SP0515C05 Commissioning Tool - Bus Assembly or equivalent.

All construction works must be verified by the Substation Construction Coordinator or equivalent Contractor representative supervising and coordinating the work, through a combination of checking the completed Construction Tools and adequate inspection of the completed work.

At the completion of construction, a verified electronic copy of all relevant completed Construction Tools must be saved to Ergon's nominated Network Storage drive for maintenance and quality records and a copy forwarded to the Ergon Project Manager. Where the constructor does not have suitable access to the Ergon network, the Ergon Project Manager will arrange for saving of the electronic copy on the network drive.

### 16.2 Specific Requirements for Secondary Wiring and Associated Equipment

Ergon Quality Document MN000301R167: Green-lining and Blue-lining of Ergon Energy Substation Drawings provides further details of the requirements for Continuity Testing and Visual

Identification of Cabling, Wiring and Terminations. A working copy of each relevant Schematic must be green-lined progressively, in accordance with the procedure outlined in the same document. (Blue-lining is for Functional Testing to be carried out by the relevant Test Workgroup).

All cabling, wiring and termination of wiring must meet the Requirements and Standards of Ergon Energy Quality Document MN000301R166: Construction and Wiring Guidelines.

Check that all equipment is mounted securely and that all electrical connections, including cable screens are properly crimped, with the correct type of lugs and tightened properly (tug test).

Check connection and insulation of cable screens in accordance with Design Requirements. i.e. Are they connected correctly and earthed at the correct end(s).

For Insulation Resistance Testing of Cables, each core is to be meggered individually, with every other core in the cable earthed.

With all cores in a cable shorted together at one end, megger the insulation of the whole cable to earth.

Megger the insulation between different sources of supply in panels. 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.

Check cable entries, fuses, links, indicating lamps and any other equipment.

## 16.3 Construction Release and Handover

On completion of all Construction Inspection/Test Checklists and rectification of any outstanding works identified therein, each involved Construction group must provide to the Ergon Commissioning Officer/Engineer a completed MN000301F175: Construction Release. All plant to which the Release applies must be identified clearly and concisely on the form. This Release is to provide confirmation :

- (i) that all construction has been completed fully in accordance with the design drawings and the Construction Manual, and
- (ii) that the relevant construction group(s) is/are now clear of the listed plant and now consider all the relevant HV plant and equipment to be live.

As the HV Equipment will now be subject to test voltages used by the Test Workgroup carrying out Site Integration Testing, any further access required (e.g. to correct an error or omission) will be done under the coordination of the Commissioning Officer/Engineer and the Test Workgroup. Ergon Energy's High Voltage Isolation and Access Procedures (HVIA) apply to those parts of the site now considered as capable of being made live.

If Construction and Commissioning of the Substation is occurring in stages, then the Construction Release may apply to a Section of the equipment only, in which case access to other areas of the work may still be available.

Upon receipt of the above document, Site Integration Testing (SIT) will be commenced, followed by final pre-energisation testing, HV Switching, energisation and post energisation on load testing, in accordance with the Test and Commissioning Manual.

## 16.4 Construction Safety Clearance

On completion of all Site Construction Works, as indicated above, each involved Construction group must provide to the Project Manager a completed MN000301F123: Construction Safety Clearance – High Voltage Apparatus, confirming that all personnel in the group are now clear of all parts of the electrical works and now consider all the relevant HV plant and equipment to be live. This will assist to enable the Project Manager to sign off his agreement that final commissioning and subsequent energisation of the complete works may now proceed.

## 16.5 Outstanding Items

In the event of any outstanding items of work unable to be completed at the time of handover of the Construction Release, these need to be noted clearly on the Construction Release, and discussed with the Ergon Energy Commissioning Officer and Project Manager for follow up.

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## APPENDIX A ISOLATION OF AC AND DC SUPPLIES AND WIRING IN SUBSTATION PANELS

### A.1 Summary

The Commissioning and Maintenance group is responsible for outworking the Commissioning Plan for a project, as well as the associated Outage Plan, to be able to identify whether or not isolation of supplies or wiring to an in-service panel will have an impact on the Ergon network or Ergon customers

If it is identified that there is minimal impact when supplies are isolated, the Constructor should be advised "Please be aware that isolation of supplies to this panel will have minimal impact on the Ergon network and Ergon customers". This advice should only be given in the situation where:

- a. There is no switching and any outage is less than 10 domestic, 4 shops or 4 hours; or
- b. The only network impact is short term isolation of backup or duplicate protection

If it is identified that there is an impact when supplies are isolated, the Constructor should be advised "Please be aware that isolation of supplies to this panel will have an impact on the Ergon network and Ergon customers". It is anticipated that all work done in this situation would use control measures no less than SWMS007.

### A.2 Background

Ergon frequently receives enquiries from Internal Constructors and Contractor Constructors to isolate all supplies from a substation panel in order to be able to carry out panel modifications associated with a project. Based on legal advice received, it is the Constructor's responsibility to make a decision whether to work live or dead, and they should be provided with sufficient information to allow them to make this decision in alignment with their own safe system of work.

The Electrical Safety Regulation 2013 (Qld) allows electrical work to be carried out on energised equipment only under certain conditions, as indicated below in Clause A.4 **Electrical Safety Act and Work Health and Safety Act**.

### A.3 Risk Assessment

Using the baseline scenario as working in a live panel in compliance with SWMS007, a number of alternative work methods were reviewed. Refer to Risk Assessment Table A.3 below.

The following were the primary documents used in the review and should be revisited (on the Process Zone) each time work is to be carried out in substation panels:

- SWMS007 Live Work (Low Voltage) Safe Work Method Statement
- SWMS007R01 Live Work Low Voltage Job Safety Analysis
- CS000501R123 Risk Management Overview (Quick Reference Guide)
- ES000400R101 Hazard and Risk Assessment (Quick Reference Guide)
- NA000403R443 Network Risk Assessment Guideline

When assessing the safety risks associated with different work methods, safety to the worker (for example inadvertent contact with energised equipment), direct safety to the public (faulted power line remaining energised) and indirect safety to the public (inoperative traffic signals contributing to a vehicle accident) have been considered.

**Risk Assessment Table A.3**

Scenario	Consequence	Likelihood	Risk
<b>Baseline</b> Working in live panel in compliance with SWMS007 (cover energised apparatus, isolate apparatus being worked on, test before you touch)	<b>Minor</b> Injury requiring first aid caused by inadvertent contact with live LV in panel	<b>Rare</b> Highly unlikely, may occur in exceptional circumstances, but probably never will (if control measures of SWMS007 are implemented)	<b>Very Low</b>
<b>Case 1a</b> Total isolation of panel where isolation can be done without network impact (no outage or minor outage only)	<b>Minor</b> Injury requiring first aid caused by inadvertent contact with live LV in panel	<b>Rare</b> Highly unlikely, may occur in exceptional circumstances, but probably never will	<b>Very Low</b>
<b>Case 1b</b> Total isolation of panel with consequential planned network outage to allow panel isolation	<b>Minor</b> Injury requiring first aid caused by impact of loss of supply to health infrastructure, medical equipment, water, sewerage, communications, traffic lights, streetlights	<b>Unlikely</b> Not expected to occur, but there is a slight possibility it may occur at some time	<b>Low</b>
<b>Case 2</b> Field switching to allow total isolation of panel without loss of supply	<b>Minor</b> Injury requiring first aid caused by failure of field switching device	<b>Unlikely</b> Not expected to occur, but there is a slight possibility it may occur at some time	<b>Low</b>
<b>Case 3</b> Remote switching to allow total isolation of panel without loss of supply	<b>3 (Minor Subs) to 6 (Major Subs)</b> Outage due to incorrect switching operation or failure of field switching device	<b>3 Unlikely</b> Have heard of it happening occasionally before	<b>9 – 18 Moderate</b>
<b>Case 4</b> Removing <u>main</u> protection from service to allow total isolation of panel without loss of supply (reliance on <u>backup</u> protection)	<b>Minor</b> Injury requiring first aid caused by reduced protection performance (failure to see fault or increased clearance times)	<b>Unlikely</b> Not expected to occur, but there is a slight possibility it may occur at some time	<b>Low</b>
<b>Case 5</b> Removing <u>backup/duplicate</u> protection from service to allow total isolation of panel without loss of supply (reliance on <u>main</u> protection only)	<b>Minor</b> Injury requiring first aid caused by reduced protection performance (failure to see fault or increased clearance times)	<b>Rare</b> Highly unlikely, but may occur in exceptional circumstances (due to low probability of primary fault and failure of main protection at the same time that backup is oos)	<b>Very Low</b>
<b>Case 6</b> Removal of N-1 plant from service to allow total isolation of panel (without loss of supply)	<b>3 (Minor Subs) to 6 (Major Subs)</b> Outage due to failure of remaining plant or inadvertent trip of remaining plant	<b>3 Unlikely</b> Have heard of it happening occasionally before	<b>9 – 18 Moderate</b>

The outcome of this risk assessment is that three low risk methods of working in live panels have been identified:

### Method 1 – Work in Live Panel

This method can be used in all panels when the control measures of SWMS007 are utilised.

## Method 2 – Total Isolation of Live Panel (no protection impact)

This method can be used where isolation can be done with minimal network impact (no switching and outage less than 10 domestic, 4 shops or 4 hours).

## Method 3 - Total Isolation of Live Panel (minimal protection impact)

This method can be used where the only network impact is short term isolation of backup or duplicate protection.

The choice of the method to be used depends on the applicable circumstances.

### **A.4 Electrical Safety Act and Work Health and Safety Act**

Both Ergon Energy and its contractors are a person conducting a business or undertaking (PCBU) for the purposes of safety legislation, and have obligations under the *Electrical Safety Act 2002* (Qld), *Work Health and Safety Act 2011* (Qld) and corresponding regulations.

The *Electrical Safety Regulation 2013* (Qld) provides that a PCBU must ensure that electrical work on energised equipment is not carried out unless:

- it is necessary in the interests of health and safety that the electrical work is carried out on the equipment while the equipment is energised (i.e. it may be necessary that life-saving equipment remain energised or in the interests of road safety);
- it is necessary that the electrical equipment to be worked on is energised in order for the work to be carried out properly;
- it is necessary for the purposes of testing whether electrical equipment is energised; or
- there is no reasonable alternative means of carrying out the work (i.e. it may be necessary in order to avoid widespread outages).

A PCBU with the management and control of the workplace will have the primary safety obligation in relation to work. In order for Ergon Energy to eliminate or reduce its risk of prosecution in the event of a safety incident, it is important that the PCBU is not directed to perform work live.

Ergon Energy will assume a higher level of risk if it responds to a request for isolation by instructing or directing the constructor to perform work live or otherwise advising the constructor that performing the work isolated is not practical. Legal advice received includes a recommendation that Ergon Energy places the onus on the constructor to determine whether the work can be performed safely while the circuit or panel is live.

It is important to note that each request for isolation should be considered on a case by case basis. Ergon Energy should consult with the constructor to provide any information within its knowledge which is relevant to the work to be performed by the constructor on its network.

Prepared by Robert Bates, Commissioning and Maintenance Manager (using information supplied by Minter Ellison Lawyers), 31 October 2014