

Overhead construction standards manual

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MCI 0005 – Overhead construction standards manual Am. 7

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For any enquiries relating to the content of this document please contact the Standards Coordinator on 13 10 81.

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Documentation content coordinator: Asset Engineering Manager

Contents

1	Introduction	6
1.1	Scope	6
1.2	References	8
1.3	Actions	11
1.4	Authorities and responsibilities	11
2	General Requirements	13
2.1	Underground services searches prior to commencement of works	13
2.2	Property tenure arrangement and easements, or legal equivalent	13
2.3	Network records	13
2.4	Quality of Materials	13
2.5	Duty of care	13
2.6	Approved materials	13
2.7	Environmental requirements	14
3	General Construction Requirements	15
3.1	Mains construction	15
3.2	Footpath allocation for Endeavour Energy assets	17
3.3	Common constructions and fittings	17
3.4	Equipment / asset numbering	21
3.5	Clearances	26
3.6	Pole details	26
3.7	Crossarms	26
3.8	Pole footings	27
3.9	Stays	27
3.10	Stay footings	27
3.11	Installation of communication cables on Endeavour Energy poles	27
3.12	Underslung earth wires (USEW)	27
3.13	Railway crossings	28
3.14	Aerial marker balls	29
3.15	Conductor restraint treatment	29
3.16	Tree trimming for new construction	31
3.17	Conductor position on poles	31
3.18	Unused phase conductors	31
3.19	Conductor fittings	31
3.20	Pole steps	32
3.21	Prevention of unauthorised climbing	32
3.22	Conductor sagging and tensioning	32
3.23	Pole mounted operational equipment	32
3.24	General construction drawings	33
3.25	Parts and accessories drawings	35
3.26	Parts and accessories list	36
3.27	Assemblies	59
4	Low voltage mains constructions	61
4.1	LV mains requirements and common constructions	61
4.2	LV aerial services	61
4.3	Suspended overhead service (flying fox)	62
4.4	LV ABC mains constructions	63
4.5	LV bare mains constructions	64
5	11kV and 22kV mains constructions	65
5.1	HV mains general requirements and common constructions	65
5.2	CCT mains constructions	66
5.3	11kV NMSHVABC mains construction	77
5.4	Bare mains constructions	80
5.5	12.7kV SWER mains constructions	81

6	Transmission constructions	82
6.1	33kV and 66kV mains constructions	82
6.2	132kV mains constructions	84
6.3	Earthing, OHEW and OPGW	86
6.4	Assemblies and general requirements	87
6.5	Parts and fabrication drawings	88
7	Stringing tables	89
7.1	Bare mains	89
7.2	Low voltage aerial bundled cable (LVABC)	93
7.3	High voltage aerial bundled cable (NMSHVABC)	98
7.4	11kV covered conductor thick (CCT)	101
7.5	22kV covered conductor thick (CCT)	108
8	Substations, regulators, reclosers and other equipment	110
8.1	General construction requirements (all equipment)	110
8.2	Pole substation fuses	111
8.3	Pole substation constructions	112
8.4	Pole mount voltage regulator construction (No new installations)	121
8.5	Pole mount recloser and load break switch (LBS) construction	123
8.6	Pole mount sectionaliser construction	125
8.7	Line fault indicator (LFI)	126
8.8	LV Statcom	127
8.9	Pole mount batteries	128
9	Street lighting	130
9.1	Street lighting standard – LCI 0001	130
9.2	Streetlight construction drawings	130
10	Earthing	131
10.1	Earthing standards EDI 100	131
10.2	General earthing drawings	131
10.3	ABS earthing drawings	131
10.4	UG/OH earthing drawings	131
10.5	Recloser/load break switch earthing drawings	132
10.6	Sub-station earthing drawings	132
11	Testing	134
11.1	Testing standard – SDI 120	134

Overhead construction standards manual

AMENDMENT RECORD

This entire document was issued as Amendment no. 0. Since that time the following amendments have been made:

Section no.	Page no..	Amend. no.	Date	Staff responsible	Approved by	Brief description of amendment
All	All	1	1/5/04	G Ford	G Ford	Complete review after initial issue to correct minor errors
All	All	2	06/05/09	G Ford	G Ford	A complete review. Part drawings, part description list and assemblies sections added. Construction drawings and layouts modified. Overhead hardware modified to suit new pole designs. Re-issue of complete manual.
Section 11	All	2	28/06/10	R Thiagarajah	J Perera	Section amended to incorporate new Standard SDI 120
Section 9	All	3	08/09/11	G Ford	J Perera	Section amended due to amendment to LCI 0001
Section 10	All	3	08/09/11	G Appuhamy	J Perera	Section amended due to amendment to SDI 100
Section 11	All	4	08/09/11	G Ford	J Perera	Section amended due to amendment to SDI 120
All	All	5	04/12/14	S Daniel	D Mate	Cyclic review- All technical bulletins included
3,5,6	All	6	09/10/17	J Byrnes	D Mate	SWER drawings relocated to Section 5, drawings previously in MDI0031 / MDI0047 relocated to Sections 3 & 6.
All	All	7	22/05/26	R Danam	S Paton	Complete review
SECTION 4,6,8		7.1	21/07/26	R.DANAM	S Paton	Light touch amendment to update drawing revisions and remove drawings.

1 Introduction

This manual sets out in detail the acceptable standards for the construction of overhead mains, and mains related equipment on the Endeavour Energy network.

1.1 Scope

This Construction Manual shall apply to the construction of all new installations. Older installations may have been reticulated using different materials and methods to those given here. Details of these older installations may be obtained by contacting Endeavour Energy's [Asset Management & Digital branch](#).

This Instruction covers all high voltage and low voltage overhead mains, overhead service mains, pole substations, reclosers, sectionalisers and the like.

The Standards must be followed. If it is considered that the Standards do not cover a particular situation or, it is not practical to follow them, liaison is required with [Asset Management & Digital branch](#) so that an approved solution can be developed. Any deviation from the Standards must be approved by [Asset Management & Digital branch](#).

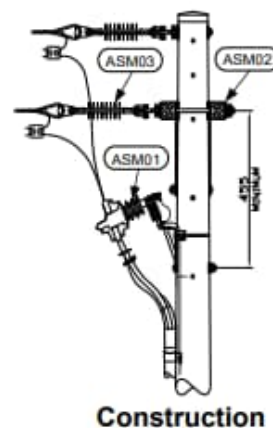
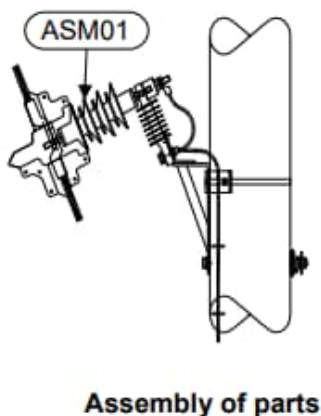
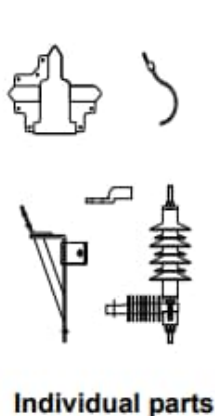
Endeavour Energy's network has had, and will continue to have, enhancements carried out for the purpose of providing a more reliable and secure electrical distribution system. Existing constructions that may not comply with this Standard are generally deemed acceptable except where a specific risk assessment indicates a significant risk to Endeavour Energy or the public.

1.1.1 Manual Structure

The key to the drawing system is that it is broken into three (3) main groups.

These groups are:

- a) Parts - the basic build blocks
- b) Assemblies - created by grouping parts into common components
- c) Constructions - combines groups of assemblies into general arrangements



Overhead construction standards manual

Table 1.1 Table of constructions

Construction type	LV ABC	LV BARE	HV ABC	HV BARE	HV CCT		SWER
Through suspension – 1 crossarm	A01-B	B01	A21	B21	C21-C	C21-V-C	SW21
Through suspension – 2 crossarms	A02-B	B02	-	B22	C22-C	-	SW22
Through strain – 1 crossarm	A03	B03	A23-J-I	B23	C23	C23-V	SW23
Through strain – 2 crossarms	-	B04	-	B24	C24	-	-
Termination – 1 crossarm	A05	B05	A25-F-I-S	B25-F-X	C25-F-X	C25-V	SW25
Termination – 2 crossarms	-	B06	-	B26-F-X	C26-F-X	-	-
Combination constructions							
Tee-off from bare	B01+ A05	B01+ B05	B21+ A25-F	B21+ B25-F-X	B21+ C25-F-X	-	2x SW25
3 way tee-off- same conductor	A03+ A05	B01+ B05	A23-I-J+ A25	B23+ B25	-	C23-V+ C25-V	3x SW25
4 way tee-off- same conductor	A03+ A03	B03+ B03	A23-I-J+ A23-X	B23+ B23	-	C23-V+ C23-V	-
USL	LUSL-??	LUSL-??	HUSL-??	HUSL-??	HUSL-??	-	-
UGOH	LUGOH-?	LUGOH-?	HUGOH	HUGOH	HUGOH	-	-
ABS	-	-	HABS-??	HABS-??	HABS-??	-	-
LBS	-	-	HLBS-R	HLBS-R	HLBS-R	-	-
Recloser	-	-	HREC-??	HREC-??	HREC-??	-	-
Services below 100A	LS01	-	-	-	-	-	-
OPTIONS ON CONSTRUCTIONS							
Prefix	A = ABC, B = BARE, C = CCT						
Suffix	-? or -?? = MAINS OPTIONS - AA, AB, AC, BB, BC, CC (As in prefix, for example, ABC to CCT = AC)						
	-B = BREAK AWAY (LVABC)						
	-C = CCT						
	-F = DROP OUT FUSE						
	-I = INSULATOR SUPPORTED TERMINATION (HVABC)						
	-J = JOINT-NON TENSION (HVABC)						
	-R= REMOTE CONTROL FITTED						
	-S = SURGE DIVERTER (HVABC)						
	-V = VERTICAL (CCT)						
	-X = 150x100 CROSSARM						

1.2 References

External Regulations
NSW Work Health and Safety Act 2011
NSW Work Health and Safety Regulation 2025
Service and installation rules of New South Wales 2019
TS 03773:1.0 Transport for NSW – Requirements for Electric Aerials Crossing Transport for NSW Heavy Rail Infrastructure November 2024

External Standards		
Standard No.	Year	Title
ENA Doc 01	2019	ENA National Electricity Network Safety Code
AS/NZS 3000	2018	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3599.2	R2017	Electric cables - Aerial bundled - Polymeric insulated - Voltages 6.35/11(12) kV and 12.7/22(24) kV - Non-metallic screened
AS/NZS 3675	R2017	Conductors - Covered overhead - For working voltages 6.35/11(12) kV up to and including 19/33(36) kV
AS 3891.1	2021	Air navigation – Cables and their supporting structures – Marking and safety requirements
AS/NZS 4325.1	R2016	Compression and mechanical connectors for power cables with copper or aluminium conductors - Test methods and requirements
AS 62771.3001	2022	High voltage switchgear and controlgear Part 301: Dimensional standardization of terminals
AS/NZS 7000	2016	Overhead line design

Company Policies and Procedures	
Company Policy (Network) 9.1.5	Network Waterway Crossings
Company Policy (Network) 9.1.6	Approved material list
Company Policy (Network) 9.7.1	Network Asset Construction
Company Policy (Network) 9.8.3	Network Operations
Company Policy (Network) 9.9.1	Network Asset Maintenance
Company Procedure GAM 0001	Network Standards Framework: Preparation and Amendment of Network Standards

Overhead construction standards manual

Company Procedure GAM 0045	Management of network crossings of navigable waterways
Company Procedure GAM 0114	Granting dispensation for engineering documents

Company Standards

Earthing Design Instruction EDI 001	Earthing design risk assessment
Earthing Design Instruction EDI 004	Earthing design, construction and testing of overhead transmission mains
Earthing Design Instruction EDI 100	Distribution earthing design
Environmental Management Standard EMS 0001	Environmental impact assessment and environmental management plans
Environmental Management Standard EMS 0004	Managing vegetation Near Electrical Infrastructure and Pest, Weed and Disease Mitigation
Environmental Management Standard EMS 0006	Maintenance and construction of access tracks
Environmental Management Standard EMS 0007	Waste management
Environmental Management Standard EMS 0008	Environmental incident response and management
Environmental Management Standard EMS 0012	Notification of access to National Parks and Water NSW Special and Controlled Areas
Equipment Technical Specification ETS 0050	In line service connectors for 100A overhead services
Equipment Technical Specification ETS 0052	Timber poles
Equipment Technical Specification ETS 0057	Pole nails
Equipment Technical Specification ETS 0059	Aerial Bundled Cable
Equipment Technical Specification ETS 0060	Covered Conductor Thick (CCT)
Equipment Technical Specification ETS 0061	Timber crossarms
Equipment Technical Specification ETS 0064	Bare overhead conductors
Equipment Technical Specification ETS 0071	Distribution fuses
Equipment Technical Specification ETS 0104	Overhead line fittings
Equipment Technical Specification ETS 0107	Composite crossarms
Equipment Technical Specification ETS 0108	Composite line post insulators
Lighting Construction Instruction LCI 0001	Public lighting construction
Mains Construction Instruction MCI 0002	Attachment of Broadband communication cables to Endeavour Energy poles
Mains Construction Instruction MCI 0003	Attachment of communications transmitters to Endeavour Energy structures

Overhead construction standards manual

Mains Construction Instruction MCI 0004	Overhead service mains installation for Level 2 Accredited Service Providers and authorised persons
Mains Construction Instruction MCI 0006	Underground distribution construction manual
Mains Design Instruction MDI 0024	Attachment of non-network items to poles and streetlight columns
Mains Design Instruction MDI 0026	Isolation points on the high voltage distribution network
Mains Design Instruction MDI 0031	Overhead line design
Mains Design Instruction MDI 0044	Easements Property Tenure
Mains Maintenance Instruction MMI 0001	Pole and line inspection and treatment procedures
Mains Maintenance Instruction MMI 0005	Control and prevention of television and radio interference in 11kV – 132kV overhead power lines
Mains Maintenance Instruction MMI 0013	Vegetation Clearance Management
Standards Asset Data SAD 0004	Recording and lodgement of WAE network information
Standards Asset Data SAD 0009	Network Asset Numbering
Standards Design Instruction SDI 120	Testing and commissioning of distribution system
Standards Maintenance Instruction SMI 113	Distribution and field transmission data asset structure and nameplate details
Standards Maintenance Instruction SMI 124	Maintenance data entry and defect prioritisation

Abbreviation	Meaning
AAAC	All aluminium alloy conductor
AAC	All aluminium conductor
ACSR	Aluminium conductor steel reinforced
ABC	Aerial bundled cable
ABS	Air break switch
ASP	An individual or single entity accredited in accordance with Part 3 of the Electricity Supply (Safety and Network) Regulation 2014.
CBL	Calculated breaking load – in relation to a conductor, the calculated minimum breaking load determined in accordance with the relevant Australian Standard.
CCT	Covered conductor thick
Distribution network	The collection of assets (distribution lines, cables, substations and associated equipment) whose purpose is to distribute power from zone substations to distribution substations, which feed the low voltage network
DOF	Drop out fuse
HDPE	High density polyethylene
HV	High voltage - a voltage exceeding or equal to 1000V AC. Refers to 11kV, 12.7kV and 22kV in this instruction.

Overhead construction standards manual

LV	Low voltage - a voltage exceeding 32V AC but less than 1000V AC.
Network	The Endeavour Energy electrical network of poles, wires, substations and the like by which electrical power is transmitted/distributed to customers.
NMSHVHBC	Non-metallic screened high voltage aerial bundled cable.
PVC	Poly-Vinyl Chloride
Public land	For the purpose of this instruction, public land is defined as public roads and associated footpaths. A public road is defined under the Roads Act 1993.
SAP	Endeavour Energy's asset management database
Sub transmission network	The collection of assets (transmission lines, cables, zone substations and associated equipment) whose purpose is to distribute power in bulk transmission to zone substations, which feed the distribution network or a particular customer substation. Sub transmission voltages in Endeavour Energy's network are typically 132kV, 66kV and 33kV.
SWER	Single wire earth return - a single phase electrical system where the return path for the load current is through the ground.
SWMS	Safe work method statement
Transmission systems	The collection of assets (transmission lines, cables, zone substations and associated equipment) whose purpose is to transmit power in bulk from TransGrid supply points to sub-transmission substations. The transmission voltage in Endeavour Energy's network is typically, but not exclusively, 132kV.
UG	Underground
UG/OH	Underground to overhead - a pole used to connect underground cables to overhead mains.
USL	under slung link
XLPE	Cross linked polyethylene

1.3 Actions

The design, construction and commissioning of assets shall be carried out in accordance with Endeavour Energy's Health and Safety Management Systems, Endeavour Energy Electrical Safety Rules, Policies, Procedures and Standards.

Systems must be implemented and maintained to consider the range of human capacity, both physically and mentally, during the design of assets, plant and equipment.

The works must be carried out only by persons or organisations authorised to do so by Endeavour Energy and in accordance with the guidelines set by the **NSW Climate and Energy Action**.

1.4 Authorities and responsibilities

General Manager Future Grid and Asset Management has the authority and responsibility for:

- Approving major changes to this instruction in accordance with GAM0001.

Head of Asset Management and Digital has the authority and responsibility for:

- Approving minor changes to this instruction in accordance with GAM0001.
- Endorsing major changes to this instruction in accordance with GAM0001.

Asset Engineering Manager has the authority and responsibility for:

- periodic review of and any required amendments to this standard;
- managing dispensation requests for variations to requirements of this standard.

Overhead construction standards manual

Head of Customer Network Solutions has the authority and responsibility for:

- All designs comply to all requirements of this instruction before they are certified;
- All installations and constructions carried out by Level 1 ASPs are inspected and must comply to all requirements of this instruction;
- All external employees or organisations carrying out and constructing installation works are currently authorised to do so.

Public Safety and Authorisations Manager has the authority and responsibility to:

- authorise external employee or organisations carrying out installation works on the Endeavour Energy Network.
- All installations and constructions carried out by Level 1 ASPs are inspected and must comply to all requirements of this instruction;
- All external employees or organisations carrying out and constructing installation works are currently authorised to do so.

Endeavour Energy employees and Accredited Service Providers have the responsibility for the following:

- All new installations and constructions performed by them conform to the requirements of this instruction;
- The latest issue of any instruction or drawing relevant to or listed in this manual is available and used during the construction of any project.

2 General Requirements

2.1 Underground services searches prior to commencement of works

An underground records search must be conducted prior to the commencement of any underground works (including underboring and pole boring).

The on-line free Dial before You Dig service must be used to assist in the location of existing underground services.

2.2 Property tenure arrangement and easements, or legal equivalent

New network assets must be installed in accordance with the requirements of MDI 0044:

- In situations where network assets need to be installed in any location other than public land (such as substations), an easement benefiting Endeavour Energy, or legally equivalent status, must be granted to Endeavour Energy to retain, maintain and operate all network assets installed in that land, without any restrictions.
- New network assets are only permitted within or under a building or structure if they have been approved in writing by the Asset Engineering Manager.

2.3 Network records

The locations of all Endeavour Energy assets are kept in Endeavour Energy's official records databases. To accurately determine these locations on site, it will be necessary to advise Endeavour Energy of equipment installation works taking place each day.

The locations and details of all project work, maintenance work or emergency work that amends or alters the network assets or their locations and the installation of conduits, cables, joints and terminations are recorded on the day of installation and in accordance with SAD 0004 Recording and lodgement of WAE network information.

Numbering of poles, switches, substations, streetlights and the like must be carried out in accordance with the requirements of Section 3 of this document (MCI 0005).

2.4 Quality of Materials

All materials used must be new (unless prior approval is given by the Asset Engineering Manager) and of a quality and class most suitable for working under the conditions specified without distortion, deterioration or setting up undue stresses on other equipment.

2.5 Duty of care

All employees/contractors working on the Endeavour Energy network, including any subcontractor, have a duty of care to the public, other service providers and employees of Endeavour Energy. If a potential safety issue is identified, it shall be corrected or made safe for repair at a later date.

The design, construction and commissioning of assets shall be carried out in accordance with Endeavour Energy's Health and Safety Management Systems, Endeavour Energy Electrical Safety Rules, Policies, Procedures and Standards. Systems shall be implemented and maintained to consider the range of human capacity, both physically and mentally, during the design of assets, plant and equipment.

2.6 Approved materials

All materials used on Endeavour Energy's network must comply and be tested in accordance with Endeavour Energy's current specifications.

Materials, other than those used by Endeavour Energy, may be used provided they have been approved for the particular application on the Endeavour Energy network. A current approved material list (AML) is available on the Endeavour Energy website. It is the responsibility of the user to confirm materials used are approved at the time of installation.

2.7 Environmental requirements

Reference should be made to all Endeavour Energy Environmental Management Standards (EMS) for preparation and implementation of environmental management plans, dust and noise suppression, protection of drains and waterways from oil, silt, waste water etc.

Notwithstanding the requirements of these Standards, all workers working on the Endeavour Energy network must also comply with any other regulatory requirement regarding protection of the environment.

3 General Construction Requirements

3.1 Mains construction

This section sets the minimum standards for construction and any particular construction practices that the Network Operator may have.

Company Policy 9.2.5 sets out the design requirements for electrical reticulation within Endeavour Energy's franchise area. Also refer to MDI 0031 for more specific details of overhead line design requirements.

This manual contains the construction details for overhead electrical reticulation of low voltage and high voltage (11/22kV/SWER) equipment where this has been deemed the required method of reticulation.

3.1.1 Urban areas

Reticulation of new residential subdivisions shall be underground.

Extensions to the existing overhead HV network (not associated with a subdivision) shall be underground and any proposal to deviate from this requirement shall be submitted to the Asset Engineering Manager. Bare conductor may be used for conductor replacements and augmentations except in treed or bushfire prone areas where CCT must be used.

CCT is generally used in treed or built-up areas to benefit from shielding provided by trees or nearby structures. Where there is less shielding, the separation distance between surge arresters should be closer to minimise the potential of lightning strikes compromising the reliability / lifetime of the CCT line. For exposed locations, surge arresters are recommended on every structure where practical.

No new spans of NMSHVABC will be allowed. Where a new unassisted failure occurs, in a section of conductor (between adjacent tension points) that has already had a previous failure (in the past two years) and that has been repaired (e.g. contains a joint), that section of HV ABC (between the adjacent tension points) is to be removed from the network and replaced with CCT. Where the HV ABC cannot be rebuilt to CCT under Fault & Emergency, a planned project is to be initiated to replace the impacted section of HV ABC.

Extensions to the existing overhead LV network (not associated with a subdivision) shall either be underground or aerial bundled cable.

LV conductor replacements greater than 100m in route length shall utilise aerial bundled cable and will include the replacement of any open wire service mains; like for like replacement of the LV conductor is acceptable for smaller route lengths.

3.1.2 Non urban areas

Subdivisions and extensions may be overhead or underground.

Extensions to the existing overhead HV network and conductor replacements and augmentations that are greater than 100m in length shall be either underground or covered conductor. Bare conductor may be used only in circumstances where covered conductor is not practicable, such as long gully crossings, river crossings or SWER. CCT shall not be installed where shielding from trees is insufficient.

Extensions to the existing overhead LV network (not associated with a subdivision) shall be either:

- Underground; or
- CCT in substantially treed or built up areas; or
- Bare conductors in areas not substantially treed, and typically for:
 - Long gully crossings
 - SWER lines
 - Joint use with 33 kV, 66 kV or 132 kV lines

- Distribution lines using transmission construction

LV conductor replacements greater than 100m in route length shall utilise aerial bundled cable and will include the replacement of any open wire service mains; like for like replacement of the LV conductor is acceptable for smaller route lengths.

3.1.3 New overhead LV extensions (where permitted)

Where LVABC is being used, breakaway constructions must be used for all situations except where the lines cross public roads or it is otherwise particularly specified. In these cases, the structures either side of the road must use non-breakaway constructions.

3.1.4 New overhead HV extensions (where permitted)

Where CCT is being used, the standard constructions are vertical arrangements for new works. Delta CCT arrangements may be used only where existing conductors are being augmented and vertical construction compromises ground clearances or the CCT is to be erected between two (2) delta/flat constructions, for example, ABS to substation.

3.1.5 Underground residential commercial and industrial distribution (URD, UCD, UID)

Developments that involve underground residential, commercial and industrial distribution of electricity shall be direct buried systems with spare ducts for LV and HV cables, except where cables cross roads or pass along easements or pathways, where cables shall be installed in ducts in accordance with MCI 0006 Section 4 – Trenching, **Conduits** and Cable Installation.

3.1.6 URD development where existing overhead mains will remain

Where underground residential development takes place in roads with existing overhead mains, these will be removed unless some special circumstance prevails. Such circumstances may include an existing overhead transmission feeder and/or the need for existing overhead distribution assets to remain that cannot be reasonably removed, supplying previously established developments.

Where existing overhead mains will remain after the installation of underground mains, the following shall apply:

- a) Streetlight columns shall not be erected on the side of the road occupied by **any** aerial mains (Transmission, HV or LV) that will remain after the installation of underground mains.
- b) Where a property is subdivided to form new residential lots in a street where existing overhead low voltage mains exist and will remain, the method of supplying the new lots shall be determined by the method of supply supplied by Endeavour Energy's **Customer Network Solutions** branch.
- c) Where only an overhead sub-transmission line will remain after construction, then the lots developed will be supplied as a normal underground development.
- d) In laying out the distribution system where existing overhead mains will remain, easements shall be acquired for padmount substation sites for future development. These easements shall be acquired in the normal manner for URD areas.

The layout of the development shall cater for the removal of pole mounted substations at a later date.

3.1.7 Telecommunication services

When supply is taken from the Endeavour Energy overhead system, the jointing enclosure (Telstra's consumer terminal box) will generally be mounted on the pole three (3) metres above ground.

When supply is taken from the Endeavour Energy underground system, the jointing enclosure (Telstra's fuse pit) will generally be installed within six (6) metres of the connection point.

Refer to MCI 0003 for further information.

3.1.8 Distribution assets on transmission poles

Refer to section 7.2.6 of MDI 0031 for the relevant requirements.

3.2 Footpath allocation for Endeavour Energy assets

3.2.1 Minimising the risk of vehicles colliding with power poles

When positioning poles for a new overhead line it is important that reasonable steps be taken to minimise the risk of motor vehicles colliding with the poles and on new project work this requirement is considered as a function of the design. However, when positioning a replacement for a condemned pole, vehicle impact pole and the like, it is important that reasonable steps are also taken to minimise the risk of motor vehicles colliding with the replacement pole.

The number of pole collisions is a function of the number of poles in the road corridor and their position in the corridor. In broad terms, reducing the number of poles in the road space reduces the number of accidents as does positioning them further from the edge of the traffic lane.

Often the layout and structure of the overhead system will prevent any major shift in pole location, however it is required that some consideration be given to the possibility of improving the situation and minimising the risk. Tools for doing this are provided in MDI 0031- Overhead distribution design standards manual.

Of particular importance is the replacement of street light only poles and cross road service poles due to condemnation, vehicle impact and the like that are located directly behind the kerb line. Wherever practical these poles must be relocated into the electricity allocation adjacent to the property line.

For details of footpath allocations refer to clause **3.23 - General construction drawings**.

3.2.2 Reinstatement of relocated poles in concrete pathways

Where poles to be relocated are to be set in concrete, restoration must be made by means of a 50mm layer of cold mix bitumen to a distance of 400mm around the pole, unless other reinstatement methods are agreed to by Endeavour Energy and the local council. The relocated poles must be installed as close to the property line as possible.

3.3 Common constructions and fittings

3.3.1 Joints and terminations

Within 5km of the coast or major sea inlet all indoor/outdoor connections between aluminium and copper must be made with a suitable bimetallic connection/lug.

Bimetallic lugs are to be used for CCT connections to drop out fuses.

The mixing of aluminium and copper at joints is to be avoided. If this is unavoidable, check that the aluminium is above the copper and that the copper has been tinned.

Prior to jointing, all conductors, whether copper, steel or aluminium, must be scratch brushed (to remove oxide, conductor to be shiny) with the appropriate brush and have an approved corrosion inhibitor applied (Alminox or other suitable jointing compound). All compression or mechanical lugs and links must be checked before use to establish that there is sufficient corrosion inhibitor in the barrel for adequate joint protection.

Compression die sizes, number of crimps, crimping tool, and link/lug must be compatible with the manufacturer's instructions. All burrs shall be removed from lug barrels after crimping.

When carrying out bimetallic joints, the aluminium conductor must always be located above the copper conductor.

Where preformed splices are being used for electrical joints, again, the conductors must be scratch brushed and corrosion inhibitor applied.

Earth braids and neutral connection in Consac cable shall be plumbed unless an approved clamp is supplied with the joint kit.

All joints in mains under tension must be located at least 1.2 metres away from a conductor support point or termination, or from any other joint on that conductor. There must be no more than two (2) joints on a conductor in each bay/span.

3.3.2 Bolted connections

All electrical bolted connections must comply with AS 62271.301. All electrical connections must be made using at least a single hole lug (two [2] hole lugs where indicated in some cases) and the appropriate bolt hardware. U-bolt, clamp or spade connections are not acceptable. Where an existing U-bolt, clamp or spade type connection is found, it must be replaced with a suitable lugged connection.

Bolts must be fitted with the appropriate hardware as follows:

- Bolt heads or nuts in contact with metal must be fitted with appropriate size flat round washers.
- Bolt heads or nuts in contact with wood must have the appropriate size flat square washers.
- Bolted connections on equipment associated with 11kV and above must have the suitable equipment (e.g. volute washers) fitted to reduce radio interference. This includes cross arm braces, kingbolts and other fittings where tracking may occur.
- Connections carrying current must also be fitted with spring washers.
- Stainless bolts must have threads lubricated with a nickel based solid lubricant (Molykote 1000 or similar).

All bolts, nuts and washers must meet the relevant Australian Standards. Stainless steel and galvanised bolts only are permitted. The bolts must be supplied with the maximum thread length permitted under the standard – AS 62271. The torque values indicated in Table 3.1 are a guide and apply to bolted electrical connections where manufacturers have not specified torque values.

Washer sizes are detailed in Table 3.1 unless approved otherwise by Endeavour Energy.

The torque values indicated in Table 3.1 may need to be increased depending on the plated finishes, effect of hard and smooth mating surfaces, and the application of lubricants.

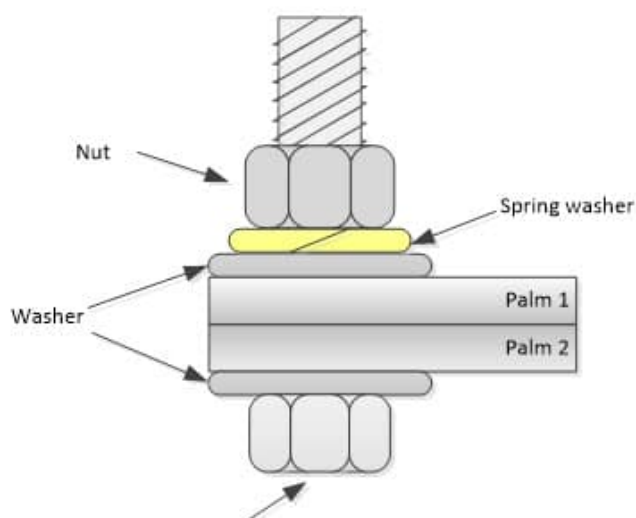


Figure 3.1: A typical bolted connection

Table 3.1 Connection bolt and washer details

Bolt size	Palm bolt hole	Torque	Washers		
			Min. thickness	Max. ID	Min. OD
mm	Qty	Nm	mm	Mm	mm
10	1	20	2.5	12	30
12	1	20	3	14	30
	2 or more	45	3	14	37
16	2 or more	90	3	18	50
20	2 or more	110	4	22	60

Coach screws must be fitted with a round washer but require an additional volute washers to reduce radio interference (as shown on the construction drawings and MMI 0005), if used in constructions $\geq 11\text{kV}$.

3.3.3 Lugs and links

Lugs and links must be installed in accordance with the manufacturer's recommendation.

In new installations, generally mechanical (screw type) lugs will be used in lieu of crimp lugs/links, provided Endeavour Energy has approved them, for a particular use.

Generally, links will be supplied in manufacturers' jointing kits. They will normally be suitable for a range of cable types and sizes and will contain either torque or shear head screws. In the case of torque screws, the links must be tightened to the manufacturer's specified torque. The wrench used to achieve this torque must be within calibration and carry a current calibration sticker. Mechanical links must comply with the relevant section/s of AS/NZS 4325.1 or BS 4579-2 or equivalent.

Care must be taken to check for foreign material, such as sand or grit, does not come into contact with grease applied to screws used to secure cables. Links must be installed strictly in accordance with manufacturer's instructions.

Where crimp lugs are used, it is essential that the correct size die is used and that the specified number of crimps is made.

3.3.4 Sealing of conductors

All un-energised LVABC and NMSHVABC cables must have BOTH ends of the cores sealed with suitable size end caps after the cores have been cut. This also applies to the balance of the cable left on cable drums.

The end caps must be installed in accordance with their respective manufacturer's instructions.

NMSHVABC cannot be energised unless it has a proper HV termination fitted. If it is to be left un-energised, cores should be capped and be fitted with a test wire.

It is not necessary to end cap CCT conductors after cutting as the conductor is water blocked to prevent the migration of water along the conductor. CCT conductors must be capped at terminations and tee-offs where tails are not lugged to prevent contact with live cores.

For un-energised underground cables, including the balance of the cables on cable drums, all cables shall be sealed at both ends to prevent the ingress of moisture into the cable before, during and after installation – Refer MCI 0006.

3.3.5 Pole dressing

Holes drilled in wood poles must be 4mm larger than the bolt size. For example, a 20mm bolt must be provided with a 24mm hole. For crossarms, a hole, 2mm larger than bolt size is generally acceptable.

Wood poles must not be scarfed. Gain blocks must be used to produce a level surface. Minor imperfections (10mm – 15mm maximum) may be removed from the pole surface to obtain a smooth curve for the gain block to rest against but the area affected must be coated with copper naphthenate paste to prevent wood deterioration.

Gain blocks must also be used to produce level surfaces on concrete poles.

3.3.6 Cable saddles

All single core conductors and conduits (except as indicated below) are to be saddled every 300-400mm when mounted on the pole and cross arms. Where single insulated cables are allowed, the saddles must be fitted with flexible conduit to protect the cables.

Larger multi-core power cables shall be attached to the pole with suitable size and fit for purpose saddles. Excess cable serving of a similar size and flexibility shall be used between the saddle and clamp to cushion and protect the cable serving. The saddles shall be spaced evenly, with a maximum spacing between saddles of 1,200mm. The uppermost saddle shall be fitted below the breakout to allow sufficient core length to carry out the termination effectively.

3.3.7 Attaching cables to a pole

Wherever possible, cables will be installed so that the first 3m of cable (measured from ground line) is orientated on the side of the pole that is opposite to oncoming traffic.

Where it is necessary to bring the cable around to the side of the pole facing the traffic to make connections to overhead mains, this will be done on the footpath side of the pole.

When installing and securing the cable to the base of the pole, the minimum bending radius of the cable must be considered. The cable shall be covered by a layer of clean sand and mechanical protection such as approved polymeric cable cover or electric bricks installed. Clean sand shall be used to backfill around the pole base.

An approved cable cover guard shall be fitted over the cable at the pole base and shall protect the cable from a minimum 100mm below the ground line to not less than 2400mm above ground. The cable cover guard shall be secured to the pole using the following methods:

- Wooden poles – galvanised coach bolts and washers
- Concrete and composite poles – stainless steel bandit straps and buckles.

All underground service and street light cables shall be mechanically protected (enclosed in conduit) for the complete length installed on the pole.

3.3.8 Vermin guards

All HV terminations must be insulated with approved vermin guards.

3.3.9 Equipment breathers

Most new equipment (such as transformers and regulators) is designed to be sealed and must remain sealed while in service. Some equipment may be free breathing and must be checked for the correct breathing method once installed. Free breathing transformers removed from the network must not be re-used.

When the equipment is free air breathing, a check must be made to establish that the equipment is free to breathe, that is, any seal fitted to prevent oil spillage during transport is to be removed (refer to the accompanying equipment tag for details).

3.3.10 Coastal equipment limitations

The corrosive action of a salt laden atmosphere can have an adverse effect on electrical equipment and limitations apply for a range of equipment installed along the coastline and adjacent to inlets. The limitations are a function of the distance from the coastline or inlet and the following shall be observed.

Within 2km of the coast or inlet

- LV ABC 3 phase switches not to be used. All switches to be individual single phase units.
- Porcelain DOF units not to be used.
- Pole substations to be the “coastal design”. Urban pole subs design will be considered.
- Galvanised transformers must be used.
- Steel poles not to be used.
- HV ABS units not to be used. Switching to be with enclosed load break switches (LBS).
- All connections between aluminium and copper must be made with a suitable bi-metallic connection/lug.

3.4 Equipment / asset numbering

3.4.1 Asset identification

Endeavour Energy's policy is for all poles, columns, pillars, street light control points, streetlights (except for street light brackets and lanterns), substations, switches, transformers that form part of the network, to have asset functional locations (FLOC) and equipment numbers.

Generally, an asset such as a pole will have the FLOC number which will be affixed to the pole e.g. if the FLOC number is POLE00012345 then the pole will be numbered as PL12345.

FLOC numbers are related to the location where an asset is located, Equipment installed at these locations will have separate unique equipment numbers issued in SAP.

An equipment number in SAP is related to the physical asset in the field such as a wood pole.

When an asset in the field is to be replaced such as a wood pole then the FLOC number will be retained, and a new SAP equipment number must be created. The status old equipment in SAP must be changed to reflect what has happened to the old equipment. Examples of status are: Out of service, Decommissioned or retired.

This will ensure that the history related to the asset at that location is not lost when the physical asset is replaced. The history is retained in the FLOC even when the equipment is removed/decommissioned.

These FLOC numbers will be issued by Endeavour Energy's Customer Network Solutions Branch to ASPs (designers), so that they can be shown on project drawings and affixed to the assets at the time of installation.

It will be the responsibility of the relevant Customer Network Officer/Engineer or Endeavour Energy Project Manager to verify that all the required asset/FLOC numbers are shown on the project drawings.

The SAP equipment numbers are unique to each asset or piece of apparatus and must not be transferred from one asset to another. When an asset or piece of apparatus is removed, its SAP equipment number must not be re-issued. When an asset or apparatus is replaced, such as a condemned pole, the replaced asset must retain the original SAP number (FLOC) but will be issued a new SAP equipment number. This will also apply to any apparatus on the pole, for example, an air break switch. In SAP this means that the functional location is retained while the equipment is replaced. If the old switch is transferred from the old pole to the new, the FLOC number must be transferred.

Where a pole/column or piece of equipment is replaced or removed under fault and emergency conditions, a new SAP equipment number must be created.

Table 3.2 Examples of when new FLOCs or SAP equipment numbers are required

Examples of when a new FLOC or SAP equipment number is required	New FLOC and new SAP equipment number	Keep old FLOC but create new SAP equipment number
When installing a brand-new asset. i.e. Greenfield site; New pole (new FLOC = POLE) Adding a new switch to an existing pole; (new FLOC = SWIT) or Adding a streetlight to an existing pole; (new FLOC = SLGT) or Creating a new feeder out of a substation (new FLOC = FDTR or FDHV)	X	
When the location changes significantly (more than 6 metres). This is a business rule that will help to keep the operational purpose of an asset specific to its location.	X	
In the example of a pole, if it is only being moved (less than 6 metres) then you should retain the FLOC. (Generally a new pole will be placed in the ground and the conductors are transferred from the old pole to the new pole)		X
When changing an asset out and GIS has different symbology or modelling for the two similar assets. i.e. USL conversion to ABS ABS conversion to LBS	X	
Replacing an electrical asset in stages that would result in the existence two of the same operational (switch) number at the same time. e.g installing an ABS one pole up from the ABS it is replacing.	X	
New pole with a different crossarm assembly (B21 to B23)		X
Replace ABS like for like Replace a pole transformer with the same capacity Replace a pole transformer with a different capacity		X
Replace a pole transformer with a different capacity – the pole TX floc capacity is independent of the equipment capacity; Note in this case the rating may be changed to reflect the upgraded equipment rating.		X
Change a manual load break switch to an auto-load break switch	X	
Changing a padmount transformer (renewals or new)		X
Replacing HV or LV switchgear in a distribution substation	X	

3.4.1.1 Assigning asset identification numbers

It will be the responsibility of the designing ASP (for contestable projects), or the responsible Endeavour Energy Project Manager/Officer (for internal works), to obtain the relevant FLOC and equipment numbers for each construction project or maintenance job.

Asset identification numbers must be affixed to the asset/apparatus in accordance with this instruction and before the asset or apparatus is placed into service.

3.4.1.2 Data Capture

For contestable projects, it will be the ASP's responsibility to provide the required information, as set out in SMI 113, to update Endeavour Energy's database (SAP).

Details such as the location (street name, locality/town) of the asset or apparatus, and the pole disc/manufacturer's nameplate details for the poles or apparatus, are required.

Signs shall conform to the details in this document on location, materials and fixing methods.

Endeavour Energy's Project Managers/Officers must verify that the required information, as set out in SMI 124, is entered into the database.

Any defects found must also be entered, as set out in SMI 124.

3.4.1.3 Retired assets /apparatus

Retired assets/apparatus must retain their SAP equipment numbers. Should a retired asset or apparatus be placed back into service, for example, a condemned pole that has been shortened and is re-used for a service pole, then it must keep its old SAP equipment number.

3.4.2 Form and fitment of numbers

3.4.2.1 Pole, column and structure numbers(timber, steel or concrete)

Identification numbers must be mounted on the normal access side of the pole or structure, that is, kerb or access track side. The numbers must be mounted vertically, numbered from top to bottom down the column, for example, column number 123456 would be as shown here.

The numbers must be located at two (2) metres above ground line, with care being taken to avoid obscuring the metal data disc or plate on timber or concrete poles. Pole identification numbers may need to be located slightly higher or lower on some occasions to avoid these discs or plates.

Private property poles must be further identified by the use of both the ownership code prefix shown in clause 3.4.3 and a private pole sign (see clause 3.4.2.5 - Private pole signs)

Pole, column and structure identification numbers and letters shall be 38mm x 25mm self-adhesive BLACK numbers/letters on a YELLOW background, applied to an aluminium ezi strip.

The ezi strip is to be affixed to a timber pole using five (5) 45 x 3mm flathead, fluted shank nails (Endeavour Energy material no. 1000005292). For fixing to concrete/steel poles and columns, the strip shall be attached to the pole with either two 19mm Band It stainless steel bands or alternatively, a weatherproof construction grade adhesive, such as Liquid Nails, may be used.

Self-adhesive numbers applied directly to the pole surface are optional for the marking of street light columns. Numbers shall be 64mm x 40mm BLACK numbers on a reflective WHITE background.

Where self-adhesive numbers are applied directly to the pole, the surface must be prepared before application of the label by removal of any loose or corroded material. The surface shall be cleaned with the manufacturer's recommended solvent to remove any contaminants such as grease. After the label is attached, the edges shall be sealed with a suitable sealer such as 3M Scotchcal Edge Sealer or clear lacquer (suitable for outdoor use).



3.4.2.2 Operational numbering on structures (such as ABS no., pole sub no.)

Operational numbering, lettering, (such as air break switch numbers), pole substation numbers, high voltage isolating link numbers, drop out fuse numbers and phasing discs, must be located at three point seven (3.7) metres above ground line. The numbers shall be mounted vertically with numbering from top to bottom. Where several sets of apparatus are mounted on a single pole or structure, numbering must commence with the number for the highest mounted piece of apparatus attached above the number for the next lowest piece of apparatus, and so on down the pole. The numbers must be fixed so that the group of numbers are centred at three point seven (3.7) metres above ground line.

Operational numbers and letters must be 64mm x 40mm engraved, UV stabilised plastic ezi tags with BLACK numbers/letters on a reflective SILVER background fitted into an aluminium ezi strip.

The ezi tag style of numbering is to be affixed to a timber pole using five (5) 45 x 3mm flathead, fluted shank nails. For fixing to concrete/steel poles and columns, the strip shall be attached to the pole with either two 19mm Band It stainless steel bands or alternatively, a weatherproof construction grade adhesive, such as Liquid Nails, may be used

The strip has two (2) holes at the top and bottom with an additional hole in the centre to allow fixing to a timber pole and after the tags are affixed to the mounting strip, the edges of the strip must be crimped over.



3.4.2.3 Feeder structure numbers

Transmission feeder structure numbers and signs indicating feeder numbers and direction must be fixed at three (3.0) metres above ground line. Signs indicating feeder direction and number must be installed where directed by Endeavour Energy.

Where structures consist of more than one pole, such as an H pole, or three (3) pole structure such as in long span design, the pole that is normally most accessible must have a structure number attached so that subsequent poles take that number plus a letter, for example, 1- 1A - 1B. Each pole must also carry an individual asset number.

Numbers shall be manufactured from the same material with identical fixing methods as indicated for pole numbering (clause 3.4.2.1 Pole, column and structure numbers (wood, steel or concrete)), however the number shall be mounted horizontally.

3.4.2.4 Phase identification discs

Phase identification discs shall be mounted as close as possible to the phase conductor that the disc is required to identify, generally on the same crossarm, insulator support or switchgear cable termination.

They must be coloured as follows to indicate the phases:

RED - A phase, **WHITE** - B phase, **BLUE** - C phase

Phase indication discs must be metal or plastic discs, 76 millimetres in diameter, with a 5mm hole through the centre for fixing. They must be durable enough to withstand fixing to timber crossarms and poles by nailing.

When discs are required to be fitted to when discs are required to be fitted to the surface of a concrete or steel pole, a weatherproof construction grade adhesive, such as Liquid Nails will be required.

3.4.2.5 Private pole signs

Private pole signs are attached to those poles that have been identified as owned by the customer. The signs are attached to the pole 3.0m above ground level.

Private pole signs are approximately 150 x 100mm UV resistant plastic signs with the words *Private Pole* embossed into the surface. The letters are BLACK on a YELLOW background with 4mm diameter fixing holes in each corner.

Concrete and steel private poles may have the private pole sign as a self-adhesive label measuring approximately 114mm x 110mm with BLACK letters on a YELLOW background.

3.4.2.6 Over crossing marker discs

Over-crossing markers are used to indicate the proximity of a line crossing above a marked line for when low level aerial line inspections are being performed.

Marker discs must be installed on all feeders where low level flying inspections are likely to take place such as, but not limited to, on Endeavour Energy transmission feeders and any feeder with limited vehicle access to the entire feeder (typically in remote and bushfire prone areas).

The crossing markers must be installed on the bottom feeder passing under the other, facing away from the crossing on the second and third structures either side of the crossings location.

The marker discs must be mounted near the top of the pole, positioned either above or directly below the crossarm of the highest mounted circuit on the pole.

Over-crossing marker discs must be manufactured in accordance with Drawing no. 279811.

The discs (material no. 1000000974) are attached to timber poles using two M12 x 75mm coach screws (material no. 1000000109) and two (2) M12 galvanised round washers (material no.1000000099).

Over-crossing marker discs are to be attached to concrete and steel poles using two (2) Band-It D021 flared leg mounting brackets, complete with stainless steel bolts and washers. The bracket must be attached to the pole with 19mm wide bands.

3.4.2.7 Other utilities sign

Signs belonging to other utilities must be mounted at a maximum height of 2.4 metres (top edge) and a minimum height of 1.8 metres (bottom edge) above ground. They must not interfere with or obscure any of Endeavour Energy's equipment or pole identification as specified in clause 5.1 of MDI 0024 – Attachment of non-Network Items to Poles and Streetlight Columns. It should be noted that it is no longer a requirement to fit Telstra joint use and common use signs to Endeavour Energy poles.

The utility owner shall be responsible for fixing their signs onto Endeavour Energy poles or structures. They shall use the same nails as detailed in this section for timber poles and a waterproof adhesive for concrete and steel poles.

The utility owner must NOT attempt to attach signs where they will interfere with Endeavour Energy assets, such as earth wires, underground cables, ABS operating shafts, asset identification numbering, or operational numbering.

3.4.3 Additional pole numbering requirements

Table 3.3 Additional requirements

General	
Poles/apparatus owned by customers	Numbering of poles/apparatus is required beyond the meter point.
Poles	
Private property	High voltage customer (Q* category) poles, up to and including the metering point, and F* category poles, must be numbered. All D* category poles must be numbered

Fire hose poles	Includes those owned by fire brigades and Endeavour Energy. They must be numbered.
Endeavour Energy depots and subs	These poles must be numbered. Access to live switchyards must take place only when accompanied by authorised staff.

* - Refer to MMI 0001 for clarity.

3.5 Clearances

3.5.1 Clearances of conductors from ground

All overhead lines, except insulated conductors of an overhead service line and facade mounted insulated cable systems, must be erected so that the clearances to ground, in any direction, must as a minimum meet the requirements of Endeavour Energy Drawing no's 086232 and 086242.

Refer to section 5.1.1 of MDI 0031 for mains clearances over all roads and transversable/non-transversable sites.

3.5.2 Clearances of insulated service lines from ground

The insulated aerial conductors of an overhead service line must be erected and so that the distances to ground in any direction from any position to which any part of the conductors may sag under operational conditions are not less than the distances specified in Endeavour Energy drawing no. 011985.

3.5.3 Clearances between conductors on the same pole

Aerial conductors must be erected such that the distances to each other shall be in accordance with Endeavour Energy Drawing no. 012000, without compromising ground clearances as indicated above.

Where conductors from other utilities are involved and may need relocation, the appropriate utility shall be contacted.

3.6 Pole details

All poles must comply with the requirements of Endeavour Energy specifications.

All Distribution concrete and steel poles must comply with the requirements of drawing no. 078310.

Transmission poles refer to drawing no. 367719.

3.7 Crossarms

All crossarms must comply with the requirement of Endeavour Energy specifications. Effective mid-2022, all distribution and some transmission crossarms are composite crossarms. Existing stock of timber crossarms will be used until depleted.

All composite crossarms are delivered with pre-drilled pattern and the following universal brackets must be used instead of drilling.



Fig. 3.2
Type A supporting bracket for 100x 100
Composite crossarm – 1000008816



Fig. 3.3
Type B supporting bracket for 125 x125
Composite crossarm - 1000008815

25mm self-tapping screws (1000008869) can be used to attach wiring to composite crossarms with standard saddles.

Refer to drawing no. 537367 and 53427 for distribution and transmission composite crossarms.

Refer to this link for further information: <https://youtu.be/HkkmEpNHVpU>

3.8 Pole footings

All Distribution and Transmission pole footings must comply with the requirements of drawing no. 011981 and 367719 respectively.

3.9 Stays

Where it is necessary for a pole to be stayed, the existing practice of using bollard poles in urban areas and ground stays in non-urban areas should continue. Bollard poles may be installed in private property where it is considered that stock may rub against a ground stay resulting in conductor clashing or stay damage.

Distribution ground or aerial stays must comply with drawing no's 011987, 011988, 011989 and 011991.

Transmission stays must comply with drawing no's 48342 and 48343.

3.10 Stay footings

All stay footings must comply with the requirements of drawing no. 011990 and 48343.

3.11 Installation of communication cables on Endeavour Energy poles

For full details of how to attach overhead broadband communications cables to Endeavour Energy poles, refer to MCI 0002 – Attachment of Broadband Communication Cables to Endeavour Energy Poles.

3.12 Underslung earth wires (USEW)

Installation of USEW is not a standard practice and generally should be avoided. Where the designer considers that USEW is necessary, a dispensation request must be submitted to Assets Engineering Manager for assessment and approval. Proposals from ASP's must be submitted via Customer Network Solution sections. The installation may only proceed if a design has been completed to determine that required clearances will be achieved.

Installation of USEW is limited to three (3) consecutive spans.

To achieve a similar sag profile, the conductor material for USEW should generally be matched with other conductors in the span. Following conductors are permitted for use as USEW:

- Mercury – 7/4.50 AAC
- Hydrogen – 7/4.50 AAAC
- Cherry – 6/4.75+7/1.60 ACSR/GZ

The termination and intermediate construction assemblies for USEW are shown in Figures 3.4 and 3.5.

A USEW marker green and yellow disc (material no: 1000006394) as shown in **Figure 3.6** must be installed on each pole and must be positioned next to the insulator supporting the USEW.

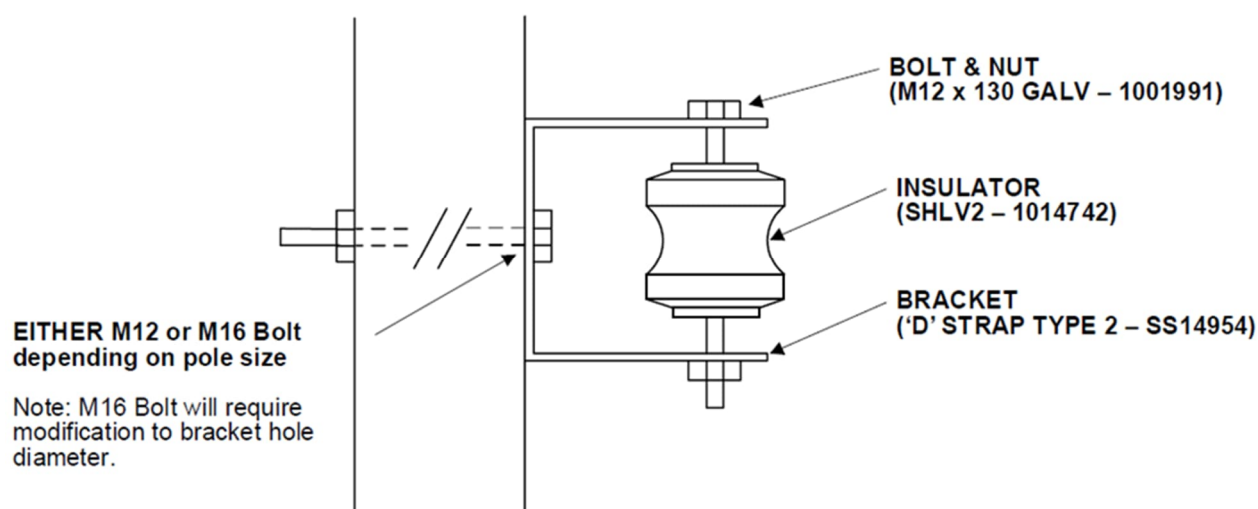


Fig. 3.4 Termination assembly

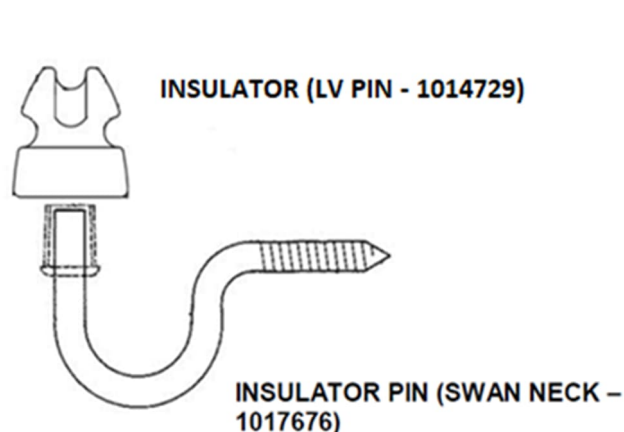


Fig. 3.5 Intermediate assembly

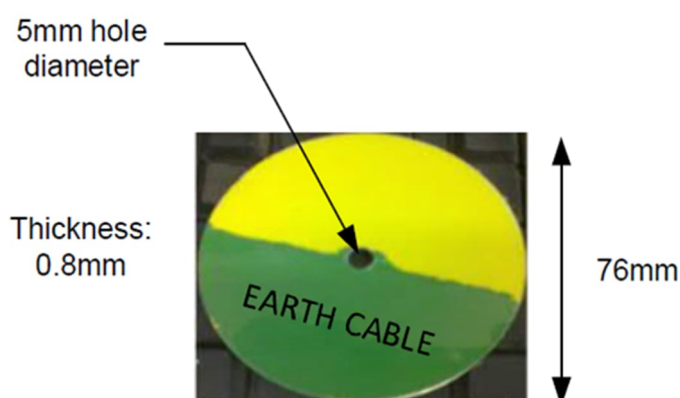


Fig. 3.6 USEW Marker disc

3.13 Railway crossings

The following requirements must be met when constructing lines across railway property:

- Construction to be in accordance with TS 03773:1.0 – Requirements for Electric Aerials Crossing Transport for NSW Heavy Rail Infrastructure.
- The angle of crossing between the railway tracks and line must not be less than 45°.
- Endeavour Energy's conductors must not be supported on TfNSW structures
- Poles must be located so that in the event of failure, no part can fall within 1.8m of railway tracks. If this condition cannot be achieved, poles must be stayed away from railway tracks.
- Guy wires for pole stays must not be buried in the ground and where a possibility of vehicle collision exists, high visibility sight guards must be provided on all ground anchors.

Overhead construction standards manual

- Where practicable, poles must be placed outside land vested in or under control of the TfNSW. If a pole is to be located within the rail corridor, a written agreement must be first obtained from TfNSW.
- Pole raisers are not permitted on spans across railway lines.
- For single crossarm arrangement, the crossarm must be installed on the side of the pole remote from the railway tracks. Where bolts are used through wooden crossarms, suitable measures to prevent splitting of the crossarm must be applied.
- Steel conductors must not be installed. ACSR and ABC conductors are permitted.
- There must be no joints in tension in the crossing span.
- Bridges (bonds) connecting a span must not be connected to the conductor in tension across the railway line.
- Crossing must not be over three or more main line tracks.
- Each crossing span must be terminated on each end.
- Pole height extension brackets must not be used to carry conductors on crossing spans.
- Conductors with operating voltage of 2kV or less, including communication cables, must not be installed directly over electrified railway tracks, however, OHEW and OPGW installed as part of a HV circuit are allowed. Conductors with operating voltage of less than 2kV are only permitted over non-electrified tracks.

Typical overhead rail crossing drawings – construction HRAIL (refer to Drawing no. 332025).

All crossings must be erected in accordance with the design plan submitted to and approved by Transport for NSW.

Existing crossings must not be altered, augmented or modified in any way without prior approval from Transport for NSW.

3.14 Aerial marker balls

The standard marker balls to be used for all aerial markers on overhead conductors are 600 mm in diameter and either white or yellow in colour.

The material number for these items are:

- 1000006253 – 600 mm Yellow aerial marker ball
- 1000006257 – 600 mm White aerial marker ball

Refer to section 4.8 of MDI 0031 for the design and fitment of aerial marker ball.

3.15 Conductor restraint treatment

3.15.1 Low voltage spreaders

Low voltage spreaders are required to be installed on bare LV spans if any of the following situations exist:

- the span length exceeds 45 m in a bushfire prone area; or,
- a stay wire passes between the conductors; or,
- the span is adjacent to overhanging trees (within horizontal distance equal to the tree height); or,
- the conductors in the span are in line with trees requiring regular lopping.

Where mid-span separation requirement (k-factor) isn't met, low voltage spreaders are to be installed accordingly.

Where low voltage spreaders are required, the quantity to be installed must be as follows:

Table 3.4 Quantity of LV spreaders required

Minimum crossarm length in span	One spreader required	Two spreaders required	Three spreaders required
2.1m	Span ≤ 90m	90m < Span ≤ 135m	135m < Span ≤ 180m
2.4m	Span ≤ 110m	110m < Span ≤ 165m	165m < Span ≤ 220m

Note: For span lengths not covered in this table, spreaders are to be evenly spaced so that they are no further than 45 / 55 metres apart depending on crossarm length.

Where one spreader is required, it is to be installed at the centre of the span.

Where two spreaders are required, they are to be installed at positions 1/3 and 2/3 along the span.

3.15.2 Vibration damping

The conductor vibration damping requirements of AS/NZS 7000 Section Y5 is the minimum acceptable level for all overhead line construction in the Endeavour Energy franchise area. In addition, all spans above 300 m in length must have vibration dampers fitted.

Where vibration dampers are required to be fitted, the quantity must be in accordance with [Table 3.5](#). Due to the increased potential of laminar wind flow at water/gully/ravine crossings, an additional 2 dampers are required to be added at these locations.

Dampers must be installed with half the total number at each end of the span.

Up to three spiral vibration damper (SVD) may be bundled together (overlapped). For instance, if a total of six dampers are required on a span, then a bundle of three is placed at both ends of the span. If a total of eight dampers are required, then two bundles of two dampers are placed at both ends of the span.

Table 3.5 Spiral vibration damper requirements

Span length (m)	Non full damped system		Fully damped system	
	Flat terrain	Water / gully / ravine crossing	Flat terrain	Water / gully / ravine crossing
≤ 244	0	0	2	4
245 - 299	0	0	4	6
300 - 488	4	6	4	6
489 - 732	6	8	6	8
>732	Consult vibration damper manufacturer			

Table 3.6 SVD material numbers

Material number	Conductor diameter range (mm)
1000006093	4.42 – 6.34
1000007644	6.35 – 8.29
1000000859	8.30 – 11.74
1000000860	11.75 – 14.3
1000007643	14.31 – 19.30

Stockbridge (dog-bone) vibration dampers may be installed on transmission lines as an alternative to spiral vibration dampers. The location and quantity of stockbridge dampers must be determined in accordance with manufacturer recommendations.

Every effort should be made to install the SVDs at each end of the span. Where site conditions are such that this requirement proves impractical, the Asset Engineering Manager is to be contacted to provide a workable solution.

3.16 Tree trimming for new construction

Tree trimming for construction of new overhead distribution lines must be carried out in accordance with EMS 0004 and MMI 0013. Clearances between overhead distribution lines and trees must be in accordance with the requirements of Section 9 of MMI 0013.

3.17 Conductor position on poles

Care must be taken when using LVABC, NMSHVABC and vertical CCT, that angle poles are dressed/stood so that the conductors are not pulling in against the pole. The pole in these instances must always be on the outside of the angle.

Service conductors attached to a pole in a vertical formation shall be installed in the order down from the top of the pole of - neutral, A phase, B phase and C phase.

LVABC terminated in a switch fuse box mounted in a horizontal plane shall have the phase conductors in the order out from the pole of – A phase, B phase and C phase. The bonding through of the Neutral conductor shall be located above the switch fuse box.

All equipment including fuses and links that may be mounted on a pole in a vertical plane shall have the supply connected to the equipment's upper most terminals.

3.18 Unused phase conductors

Any un-used low voltage phase conductor of a LVABC cable is to be tied back and secured with cable ties.

3.19 Conductor fittings

A selection for varying conductor fittings can be found in this manual in clause 3.25 - Parts and accessories list. These items will vary depending on the conductor size and type of termination.

3.20 Pole steps

Pole steps are required to be installed on ALL distribution poles (including wood poles) from 8.3m above ground level. Where normal vehicle access is not available (off road) pole steps will be required from 6m above ground level.

Pole steps shall be located in relation to the top of the pole as shown on Drawing no. 331149. Ground level is defined as where a ladder footing would be located for climbing the specific pole in its final location.

3.21 Prevention of unauthorised climbing

Poles or structures and the adjacent area shall be assessed to establish that effective measures have been employed to prevent, as far as reasonably practicable, access by any member of the public to a position near any live aerial conductor or apparatus, where injury from electric shock may be possible.

Basically, this requires that all live parts must be inaccessible without the use of a ladder.

3.22 Conductor sagging and tensioning

All conductors erected as part of the Endeavour Energy network shall be correctly sagged/tensioned in accordance with the details provided in project drawing. Dynamometer or sighting boards will be required for the correct sag/tension measurement, together with a thermometer for the determination of the ambient temperature.

Due to the tension loading limits on ACSR dead ends and full tension sleeves, all projects incorporating ACSR conductor that require the Endeavour Energy standard stringing tables maximum span length or tension limit to be exceeded, shall be approved by the **Asset Engineering Manager**.

3.23 Pole mounted operational equipment

Pole mounted operational equipment such as USL, DOF, LBS, and the like are to be constructed such that their operation may be performed with the use of an extendable link stick which has the top 900mm tested for use. Where the link stick is required to pass through or adjacent to any high voltage conductor or cable break-out point of a UGOH construction, the equipment's operating point must be within 900mm of that conductor or cable break out.

Effective December 2018, all new operational equipment must be constructed such that their switching mechanism is no higher than 10m from the ground.

3.24 General construction drawings

Drawing No.	Amend. No.	Subject
Clearances		
011985/1	J	Clearances – service mains (sheet 1)
011985/2	E	Clearances – service mains (sheet 2)
012000/1	F	Clearances – between mains on same pole
012000/2	G	Clearances – between mains on same pole
086232	L	Clearances – Endeavour Energy mains
086242	H	Clearances – consumers mains
287044	C	Clearances – mains to streetlight
Stays		
011976	C	O/Head construction, 11/22kV aerial & ground stays
011987	E	O/Head construction, ground stay Type G1
011988	E	O/Head construction, ground stay Type G2
011989	G	O/Head construction, ground stay Type G3
011990	H	Stay footing detail
011991	G	O/Head construction, aerial stays type A1, A2 and A3
Footpath allocation		
011986/1	E	Footpath – space allocation before 1-1-91
011986/2	C	Footpath – space allocation after 1-1-91
Overhead ties, bonding and transposition arrangements		
011910	L	Ties – conductor to pin insulator
078145	E	Overhead LV constructions bonding requirement
078146	F	Overhead HV Constructions bonding requirement
Standard pole details		
011981	F	Pole footing detail
078310	L	Pre-drilled pole selection chart
Warning signs/markers		
279811	B	Aerial over-crossing warning marker disc
303319	A	U/G HV cable route marker post
306255	B	Cable location warning for railway crossing

3.24.1 Drawings in drawing number order

Drawing No.	Amend. No.	Subject
011910	L	Ties – conductor to pin insulator
011976	C	O/Head construction, 11/22kV aerial & ground stays
011981	F	Pole footing detail
011985/1	J	Clearances - service mains (sheet 1)
011985/2	E	Clearances - service mains (sheet 2)
011986/1	E	Footpath – space allocation before 1-1-91
011986/2	C	Footpath – space allocation after 1-1-91
011987	E	O/Head construction, ground stay Type G1
011988	E	O/Head construction, ground stay Type G2
011989	G	O/Head construction, ground stay Type G3
011990	L	Stay footing detail
011991	G	O/Head construction, aerial stays type A1, A2 and A3
012000/1	F	Clearances between mains on same pole
012000/2	G	Clearances between mains on same pole
078145	E	Overhead LV constructions bonding requirement
078146	F	Overhead HV Constructions bonding requirement
078310	L	Pre-drilled pole selection chart
086232	L	Clearances – Endeavour Energy mains
086242	H	Clearances – consumers mains
279811	B	Aerial over-crossing warning marker disc
287044	C	Clearances – mains to streetlight
303319	A	U/G HV cable route marker post
306255	B	Cable location warning for railway crossing

3.25 Parts and accessories drawings

The following section contains drawings for most of the parts and accessories used in the construction process.

These drawings may also contain other reference information such as Endeavour Energy stock codes where multiple items need to be listed to accommodate a range of possibilities, such as dead ends for various conductor sizes.

Drawings included in this section are listed in number order.

Drawing No.	Amend. No.	Subject
010650	F	Post insulator 6.6kV with and without coach screw insert detail
011962	J	O/Head const. crossarm brace detail
011963	K	O/Head const. 11/22kV & LV shackle & pin ins. detail
011992	G	Std const. attachment 'J' & 'Q' hook service LV fabrication detail
015320	C	O/Head trans. strap right angle twist detail
015354	F	O/Head trans. pole band 66kN - 2 piece detail
015367	E	O/Head const. pole step for wood poles
015368	E	O/Head const. short HV link bracket detail
015369	F	O/Head const. long HV link bracket detail
015370	B	O/Head const. cap for wood pole detail
050167	K	O/Head const. eyebolt detail
050169	E	O/Head const. M20 eye nut fabrication detail
052499	H	O/Head const. mid-pole bracket detail
053990	C	Concrete pole band type 'S' fabrication detail
053991	C	Concrete pole band type 1-6 fabrication detail
053993	E	Installation of crossarm bracket on concrete pole
053999	K	Pole ID plate details
054014	D	Crossarm mounting bracket type 'T2' outline
057041	B	LVABC pole sub strain clamp fabrication detail
059556	D	O/Head const. volute coil spring washer fabrication detail
059560	C	LV aerial bundled cable hook bolt detail
059851	F	LV aerial bundled cable & XLPE twisted service cable data
060243	A	11kV Aerial bundled cable data (Metallic screen)
061828	G	11kV ABC suspension bracket
063900	F	O/Head const. pole mounted bolts preferred sizes
064521	E	Condemned pole tape and nailed pole identification disc detail
074590	F	O/Head const. pole top bracket 750mm long fabrication detail
074741	D	HVABC tee connection insulator mount bracket fabrication detail

Overhead construction standards manual

077643	D	11/22KV polymeric SD mounting bracket fabrication detail
078107	C	Non-metallic screened HVABC cable data
078257	D	O/Head LV 'D' strap type 2 detail
078258	E	O/Head LV shackle strap detail
078938	G	Covered conductor thick cable data
079037	C	Washer steel flat square gal. 12, 16, 20 & 24mm
240379	B	Concrete pole crossarm mounting bracket detail
240672	F	Pole sub transformer support bracket fabrication detail
240872	B	Wood pole crossarm mounting bracket detail
241511	C	O/Head construction coach screw 12x100 long outline
245493	B	O/Head transmission 22kV long rod insulator detail
279811	B	Aerial overcrossing warning marker disc fabrication detail
282831	C	Stay pole hole former and ferrule layout
316946	C	Voltage Regulator concrete pole hole former and ferrule layout
331149	F	Concrete/steel pre-drilled pole Hole former and ferrule layout
332003/1	B	OH construction crossarm fabrication detail
332003/2	B	OH construction crossarm fabrication detail
332070	A	Surge diverter and Ins. support 250mm fabrication detail
332071	A	ABS critical dimensions and loads for fabrication
332072	A	O/Head const. pole step for pre-drilled pole
332074	B	Angled electrical connection palm – 110°
370399	A	O/Head const. M16 pole step detail steel & concrete poles

3.26 Parts and accessories list

The following section contains a table/list of information relevant to all parts and is to be used in conjunction with the assemblies and construction sections of this manual.

The information included is a key reference to the items numbered in the assemblies section 3.25

The list supplies the following details:

- Unique identifier for each item.
- Endeavour Energy stock code.
- Drawing reference for the part (if available).
- Basic description of the item.

Groups the items into similar categories.

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description				
Poles	1	-	282831, 316946 & 331149	Length	Strength	Concrete	Steel	Wood
				6.5	Service pole	-	1000005141	-
				8	4	-	-	-
				8	30	1000007987	1000005820	1000007929
				9.5	4	-	-	1000007930
				9.5	8	N/A	N/A	1000007931
				9.5	12	1000005827	1000005821	1000007952
				11	4	-	-	1000007932
				11	8	N/A	N/A	1000007933
				11	12	1000005828	1000005822	1000007935
				12.5	4	-	-	1000007936
				12.5	8	1000005829	1000005823	1000007939
				12.5	12	1000005830	1000005824	1000007940
				12.5	20 C&S – 18 Wood	1000005831	-	1000007942
				14	8	1000005832	1000005825	1000007943
				14	12	1000005833	1000005826	1000007944
				REG 14	12	1000005384	N/A	N/A

Crossarms	2	Distribution standard crossarms	
		1000004964	332003/1 CROSSARM (XA010) 2100x100x100 LV STD
		1000004965	332003/1 CROSSARM (XA020) 2100x100x100 HV STD
		1000004960	332003/1 CROSSARM (XA030) 2100x150x100 HV
		1000005004	332003/1 CROSSARM (XA040) 2700x100x100 HV + RECLOSER/REG
		1000005838	332003/2 CROSSARM (XA050) 1465x100x100 SUB LV BOX-IN URBAN
		1000007502	332003/2 CROSSARM (XA055) 1800x200x100 SUB PLATFORM URBAN
		1000005036	332003/2 CROSSARM (XA060) 1800x100x100 SUB HV STANDOFF URBAN
		1000005839	332003/2 CROSSARM (XA065) 2700x100x100 SUB LV URBAN
		1000005840	332003/2 CROSSARM (XA070) 3000x125x100 SUB LV COASTAL
		1000005373	332003/2 CROSSARM (XA075) 4000x150x100 REG PLATFORM
		1000008681	537367 Crossarm, composite (XA010) 2100x100x100 LV
		1000008727	537367 Crossarm, composite (XA020) 2100x100x100 HV
		1000008790	537367 Crossarm, composite (XA030) 2100x125x125 HV
		1000008786	537367 Crossarm, composite (XA040) 2700x100x100 HV + RECLOSER
		1000008794	537367 Crossarm, composite (XA040A) 2700x125x125 HV for SMR projects

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
		1000008789	537367	Crossarm, composite (XA050) 1465x125x125 LV sub box
		1000008801	537367	Crossarm, composite (XA055) 1800x125x125 HV sub platform
		1000008803	537367	Crossarm, composite (XA060) 1800x100x100 HV sub standoff
		1000008799	537367	Crossarm, composite (XA065) 2700x100x100 LV sub urban
		1000008810	537367	Crossarm, composite (XA070) 3000x100x100 LV sub coastal
		1000008806	537367	Crossarm, composite (XA075) 3000x100x100 Crossarm regulator
		Transmission standard crossarms		
		1000007504		Crossarm, wood. undrilled - 3000x100x100
		1000007505		Crossarm, wood. undrilled - 2700x100x100
		1000000466		Crossarm, wood. undrilled - 2700x125x100
		1000007503	079042	Crossarm, wood. predrilled O/H transmission type 2 - 2100x125x100
		1000007526	079043	Crossarm, wood. predrilled O/H transmission type 3 - 3300x150x125
		1000005446	079044	Crossarm, wood. predrilled O/H transmission type 4 - 2700x100x125
		1000005447	079045	Crossarm, wood. predrilled O/H transmission type 5 - 1800x100x125
		1000007552	079046	Crossarm, wood. predrilled O/H transmission type 6 - 6300x200x125
		1000005448	079047	Crossarm, wood. predrilled O/H transmission type 7 - 3300x100x125
		1000005449	079048	Crossarm, wood. predrilled O/H transmission type 8 - 3300x100x125
		1000005450	079049	Crossarm, wood. predrilled O/H transmission type 9 - 2400x100x125
		1000005451	079050	Crossarm, wood. predrilled O/H transmission type 10 - 2400x100x125
		1000008812	53427	Crossarm, composite O/H transmission type 3 – 3300x125x125
		1000008814	53427	Crossarm, composite O/H transmission type 4 – 2700x100x100
		1000008808	53427	Crossarm, composite O/H transmission type 6 – 6300x125x125
		1000008809	53427	Crossarm, composite O/H transmission type 7 – 3300x100x100
		1000008820	53427	Crossarm, composite O/H transmission type 9 – 2400x100x100

Bolts - pole	3 & 4		050167 and 063900	Length	Item 3	Item4						
					Eyebolt M20	Gal. M24	Gal. M20	S/S M20	Gal M16	Gal M12	Gal. M16	Gal. M12
				100							1000000 058	10000000 47
				150	165- 1000007399	-	1000000 072	-	1000000 060	1000000 049		

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description								
				200	1000000088	1000005378	220-1000000074	-	1000000062	1000000051		
				300	1000000089	-	1000000077	1000004973	1000000066	1000007377325-1000000054		
				350	1000000090	-	1000000079	1000004974	1000000068	1000001067		
				400	1000000091	-	1000000081	1000004975	1000000069	-		
				450	1000000092	1000005377	1000000083	1000004976	1000000070	-		
				500	1000000093	-	1000000084	1000004929	1000000071	-		
				600	1000000095	1000005376	1000000086	1000006054	1000007383	-		
				700	1000000096	-	1000007393	1000006055	1000007381	-		
				800	-	-	-	-	-	-		
Bolts - connections S/S and Gal.	5				M10		M12		M16			
					S/steel	Gal.	S/steel	Gal.	S/steel	Gal.		
				20	1000000979	-	-	-				
				25	1000000119	1000000038	1000000126	1000000044			1000000055	
				30	1000000120	1000007375	-	-	-	-	-	
				35	1000008072	-	-	1000001022	-	-	-	
				40	1000000121	1000007374	1000000127	1000007380	-	-	1000000069	
				45	-	-	-	-	-	-	-	
				50	1000000122	1000000039	1000000128	1000000045	1000000132		1000000056	
				60	-	-	-	-	-	-	-	
				65	-	1000007373	1000000129	-	-	-	-	
	10					250mm		350mm		450mm		

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description			
Bolts/nuts special			059560	BOLT HOOKBOLT M20	1000000909	1000000908	1000000910
	11	1000000097	050169	EYENUT STEEL GALV M20			
	12	1000007900	-	NUT LOCK Z/P M20 (DOTLOCK)			
	13	1000000930	-	NUT STEEL HEX GALV M20			
	14	-	-	NUT SUPPLIED WITH BOLT			
	15	1000008002	-	RING M16 (LV SERVICE - LIDBURY)			
	16	1000000866	-	SHACKLE BOW 16mm 70KN			
Service hooks	17	1000005886	-	THREADED ROD CLASS 8.8 - 20mm HIGH TENSILE GALV. 1M LGTH			
	20	1000007363	-	HOOK PLATE GAL. 16mm 2 BOLT			
	21	1000000422	011992	SCREWHOOK STEEL GAL. 12mm 'J' HOOK			
Coach screws	22	1000007716	011992	SCREWHOOK STEEL GAL. 12mm 'Q' HOOK			
	25	1000000111	241511	COACH SCREW M12 x 130 LG			
		1000007519	-	COACH SCREW M16 x 130 LG			

					M10	M12	M16	M20	M24
Washers	30			WASHER S/S VOLUTE COIL	-	1000008270	1000008270	1000008269	1000008269
	31		079037	WASHER GAL. FLAT SQ	-	1000008252	1000008251	1000000104	-
	32			WASHER GAL. RND FLAT	1000000098	1000000099	1000000100	1000000101	1000000102
	33			WASHER S/STEEL FLAT	1000000141	1000000138	1000000139	-	-
				WASHER S/STEEL THICK	-	-	-	-	-
	34			WASHER S/STEEL SPRING	1000000137	1000000142	1000000144	1000000143	-

					500	600	750	900	920-Trans.
Braces, Gain blocks, Pole steps	35		011962	BRACE CROSSARM	1000007418	1000007417	1000007416	1000007415	1000000468
	36	1000007431	240379	GAIN BLOCK CONCRETE POLE					
		1000000469	240872	GAIN BLOCK WOOD POLE SUIT 100mm CROSSARM					
		1000001859	-	GAIN BLOCK WOOD POLE SUIT 125mm CROSSARM					
	37	-	-	GANG NAIL PLATE					

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
	38	1000000477	015367	POLE STEP (WOOD POLES)
		1000006147	370399	POLE STEP 16MM (STEEL & CONCRETE POLES)
		-	-	POLE STEP 720MM LONG (THROUGH POLE KINGBOLT HOLE)

Brackets, straps	40	1000007357	074590	BRACKET DELTA - 750 LG
	41	1000001815	-	BRACKET INSULATOR MOUNT 45 DEG
	42	1000007406	052499	BRACKET MID POLE MOUNT
	43	1000007442	-	BRACKET USL 45° MOUNT (OLD 2 INSULATOR STYLE)
	44	1000007422	015369	BRACKET LINK 600x40x10mm 5 HOLE (USL+LVABC)
		1000007434	015368	BRACKET LINK 170x40x10mm 3 HOLE (USL)
	45	1000005837	332070	BRACKET MOUNT INS/SD 250x40x8mm 3 HOLE
		1000001854	-	BRACKET MOUNT INS/SD ' L ' (OLD)
		1000001095	-	BRACKET MOUNT INS/SD ' T ' (OLD)
	46	1000007367	077643	BRACKET MOUNTING UGOH SD
	47	1000007359	074741	BRACKET MOUNT INS. 3PH (HVABC-VERTICAL)
	48	1000007360	061828	BRACKET SUSPENSION HVABC
	50	1000007468	057041	BRACKET LVABC STRAIN SUB '†' (OLD)
	51	1000000950	-	HOOK DOUBLE SUSPENSION STEEL GALV. 16mm
	52	1000008127	078257	STRAP SHACKLE 'D' LV TYPE 2
	53	1000000424	078258	STRAP SHACKLE LV SHORT
	55	-	011966	STRAP STIRUP 115 LONG - OBSOLETE
	56	1000001994	-	STRAP LINK SHORT (CCT- OBSOLETE)
	57	1000008116	015320	STRAP RIGHT ANGLE TWISTED
	58a	1000002425	-	EARTH BRACKET S/S HOOK TYPE
	58b	-	-	EARTH STUD STEEL GALV. OR S/S
	59	1000004977	240672	BRACKET TRANSF. HANGING > 63KVA
		1000005836	240672	BRACKET TRANSF. HANGING ≤ 63KVA

Pole bands, Bandit	60		POLE BAND 66KN – 2 PIECE, 1 WAY – SIZE AS PER TABLE							
			230	260	290	320	350	375	400	425
		015354	-	-	-	1000007402	-	-	1000007403	1000007404
	61		POLE BAND 66KN – 2 PIECE, 1 WAY – SIZE AS PER TABLE							
		DIA. >>	150	220	280	330	380	430		

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description							
			053991	100000742 4	100000742 5	100000742 6	100000742 7	-	100000743 2		
	62	1000007428	053990	POLE BAND TYPE 'S'							
	63	1000007429	054014	BRACKET CROSSARM MOUNTING TYPE – T2							
	65	1000007437	-	19mm WIDE 'BAND IT' STRAP WITH RETAINING CLIP x 30M							
		1000007447	-	19mm BUCKLE TO SUIT BANDIT STRAP							

Cable clamps	67	1000005436	-	CABLE CLAMP 50-200mm S/S STRAP TYPE							
					51mm	60mm	68mm	84mm	90mm		
				SADDLE GAL CABLE	1000000486	1000008088	1000008087	1000008089	1000008158		
					57-63mm	63-70mm	70-76mm	83-89mm	95-102mm		
				2 BOLT DIE CAST Al.	1000007539	1000007536	1000007554	1000001893	-		

Voltage regulator special steelwork	70	-	316948	ITEM 1 – STEEL BOX FRAME 1000KVA – VOLTAGE REGULATOR							
		1000005371	316948	ITEM 1 – STEEL BOX FRAME 2000, 3000 & 4000KVA – VOLTAGE REGULATOR							
		1000005381	316948	ITEM 2 – SAFETY BARRIER HV EARTHED							
		1000005380	316948	ITEM 3 – SUPPORT ANGLE HV BARRIER							
			316948	ITEM 4 – BRACE PLATFORM TO BOX FRAME							
		-	316948	ITEM 5 & 6A – 2 x 'U' BOLTS & STRAP – BOX FRAME MOUNT-VOLTAGE REGULATOR							
		-	316948	ITEM 5 & 6B – 2 x 'U' BOLTS & STRAP – BOX FRAME MOUNT-VOLTAGE REGULATOR							
			316948	ITEM 7 – SPACER PLATE FOR CENTRE REGULATOR							
		1000005382	316948	ITEM 8 – CONTROL BOX MOUNTING FRAME							
		1000005379	316948	ITEM 9 – OPERATING INSTRUCTION PLATE							
		1000005383	-	PHASE LINK MARKER DISC Ø75MM Al, 1MM THICK, R _S , R _L , W _S , W _L , B _S , B _L							

Insulators	80	1000000408	011963	I01-INSULATOR PIN LV							
		1000000462	011963	I01-PIN FOR LV INSULATOR							
	81	1000000410	011963	I02-INSULATOR SHACKLE LARGE LV							
	82	1000000404	011963	I04-INSULATOR PIN 22kV							

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
		1000000460	011963	I04-PIN FOR 22kV INSULATOR
		1000008282	-	I05-INSULATOR LONG PIN 11kV CCT
		1000008284	-	I06-INSULATOR LONG PIN 22kV CCT
	85	-	-	I07- SPARE
		1000001811	-	I08-INSULATOR SHORT PIN 11kV CCT
		1000008283	-	I09-INSULATOR SHORT PIN 22kV CCT
	87	1000006335	-	I20-INSULATOR STANDOFF 22kV - LVABC ON CONDUCTIVE TRANS. POLES
	89	1000004953	245493	I10-INSULATOR LONGROD 22kV
		1000000402	011965	I11-INSULATOR DISC 11kV - OBSOLETE
		1000001813	-	I12-INSULATOR STRAIN 11kV CCT - OBSOLETE
		1501808	-	I13-INSULATOR STRAIN 22kV CCT - OBSOLETE
	90	1000008281	-	INSULATOR 11kV (CARTON OF 3) HVABC
	91	-	-	INSULATOR STATION POST 22KV HVABC - OBSOLETE
	92	1000008285	-	INSULATOR POST 6.6KV STANDOFF SUPPORT WITH COACHSREW (ABS-Handle)
		1000008286	-	INSULATOR POST 6.6KV STANDOFF SUPPORT THREADED BOTH ENDS (ABS-Handle)

Insulator hardware	100	1000000865	-	CLEVIS THIMBLE F202 OR TO SUIT ALL CONDUCTORS UP TO 19/3.75				
	101	1000007921	060885	CLEVIS PIN				
	102	1000007720	-	HVABC HOOK 16mm DIA+PLATE & PIN CLAMP SUSP.				
	103	1000007782	-	LABEL (NMS HVABC)				
				CONDUCTOR SIZE – mm ²	80	120	180	22kV-120
	105			CLAMP STRAIN – CCT	1000001816	1000001817	1000001818	1000001817
				CONDUCTOR SIZE – mm ²	25	50	95	150
	106			CLAMP SUSP. – HVABC		1000007477	-	1000007476
	107			CLAMP SUSP. – LVABC NON BREAK	-	-	1000007480	1000005563
	108			CLAMP SUSP. – LVABC BREAK AWAY	-	-	1000007561	1000005562
	109			CLAMP STRAIN – LVABC	-	-	1000005259	1000005259
	110			CL AMP STRAIN – LVABC SERVICE	1000000957	-	-	-

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
				CLAMP STRAIN/SUSP. – S/L – NON BREAK
			1000007481	-
			-	-
			-	-
	112	1000007922	074504	PALM TEE-OFF CONNECTION INS/SD MOUNT (HVABC)
LV Spreaders	117	1000000959	-	LV SPREADERS 2M x M12 FIBREGLASS
		1000008051	-	LV SPREADERS 2.8M x M12 FIBREGLASS
	118	1000000960	-	LV SPREADER CLIPS S/S M12
Surge arrestors and accessories	120			
				SURGE ARRESTOR NO DISCONNECT
				1000004971
				1000004970
				SURGE ARRESTOR WITH DISCONNECT
				1000005440
				1000005458
		1000001096	-	SURGE ARRESTOR INSULATOR MOUNT
		1000005989	-	SURGE ARRESTOR 10mm FLEXIBLE EARTH LEAD
		1000005565	-	SURGE ARRESTOR BRACKET- NOJA STEELWORK (OBSOLETE)
	123	1000005530	-	SD 90° CONNECTION PALM S/S 2mm
Vermin covers	130	1000005387	-	COVER SURGE DIVERTER (3 WAY) – GREY – ADAPT
		1000004949	-	COVER SURGE DIVERTER (1 WAY) – GREY – ADAPT
		1000007483	-	COVER SURGE DIVERTER (2 WAY) – RED – TYCO
		1000005385	-	COVER BUSHING HV REGULATOR – BRI-TECH
	131	1000001819	-	COVER STRAIN CLAMP 80mm & 120mm SQ. CCT
		1000001820	-	COVER STRAIN CLAMP 180mm SQ. CCT
	132	1000001821	-	COVER EARTHING POINT CCT
	133	1000001822	-	COVER PG CONNECTOR CCT
	134	1000007478	-	COVER TEE-OFF CONNECTOR HVABC
IPC	140	LV INSULATED MAINS TO LV INSULATED MAINS		
		1000005255	-	IPC 2 BOLT INS. 50-185 TO INS. 50-150
		1000000903	-	IPC 2 BOLT INS. 25-95 TO INS. 25-95
		1000005102	-	IPC 2 BOLT INS. 50-150 TO INS. 35-95
		1000005935	-	IPC 2 BOLT INS. 50-185 TO INS. 50-150-GENERATOR CONNECTOR
	142	BARE MAINS TO LV INSULATED MAINS		

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
		1000005257	-	IPC 2 BOLT BARE Al. 50-150 (9-15.7 Ø) TO INS. 50-150
		1000001040	-	IPC 2 BOLT BARE Cu. 7-95 (3-12.5 Ø) TO INS. 25-95
		1000001039	-	IPC 2 BOLT BARE Cu. 50-150 (9-15.7 Ø) TO INS. 35-95
		1000005258	-	IPC 2 BOLT BARE Cu. 50-150 (9-15.7 Ø) TO INS. 50-150
	BARE MAINS TO LV INSULATED MAINS			
	144	1000007575	-	IPC 1 BOLT BARE Al. 7/1.75-19/3.75 (5-19 Ø) TO INS. 6-35 x 2
		1000006057	-	IPC 2 BOLT BARE Al. 7/1.75-19/3.75 (5-19 Ø) TO INS. 6-35 x 2
		1000007489	-	IPC 1 BOLT BARE Cu 7/1.00-19/3.00 (3-15 Ø) TO INS. 6-35
		1000006058	-	IPC 2 BOLT BARE Cu 7/1.00-19/3.00 (3-15 Ø) TO INS. 6-35
	LV INSULATED CABLE TO LV INSULATED SERVICES			
	146	1000007495	-	IPC 1 BOLT INS. 6-35 TO INS. 4-35 NEUTRAL BOND
		1000000906	-	IPC 1 BOLT INS. 6-54 TO INS. 6-35
		1000000907	-	IPC 1 BOLT INS. 16-95 TO INS. 1.5-10 (STREET LIGHT)
		1000005753	-	IPC 1 BOLT INS. 35-150 TO INS. 1.5-25 (STREET LIGHT)
		1000000905	-	IPC 1 BOLT INS. 25-95 TO INS. 6-35
		1000005256	-	IPC 1 BOLT INS. 50-150 TO INS. 6-35
	LV HOUSE SERVICE CONNECTOR (HSC)			
	148	1000007488	-	HSC 1 BOLT Al OR Cu INS. 4-35 TO INS. 4-35
		1000006056	-	HSC 2 BOLT Al OR Cu INS. 4-35 TO INS. 4-35
	HV CCT – HV CCT MAINS			
	149	1000006069	-	IPC 2 BOLT 11KV INS. 40-120 TO 40-120

Connections non tension sleeves (NTS)	150			O.D.mm	AAC	AAAC	ACSR	CCT
		1000000873		6 - 8	7/2.25 – 7/2.50	7/2.25 – 7/2.50	6/1/2.50 & 3/4/2.50	-
		1000005333		8 - 10	7/2.75 - 7/3.00 -50 ABC	7/2.75 – 7/3.00	6/1/3.00 & 4/3/3.00	-
		1000008082		10 - 12	7/3.75 -95 ABC	7/3.75	6/1/3.75	80
		1000000874		12 - 13.5	7/4.50	7/4.50	7/4.50	-
		1000005140		14 - 16	7/4.75-19/3.25 -150 ABC	7/4.75 - 19/3.25	6/4.75+7/1.60	120
		1000008081		16.5 - 19.5	19/3.75	19/3.75	30/7/2.50	180
		1000007816			150mm HVABC Conductor - CENTRE WATERBLOCKED			
					For non-tension joint in catenary of HVABC at pole use a PG clamp			
		1000007844	-		240mm Al - CENTRE WATERBLOCKED – SECTOR SHAPE			

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
		1000005818	-	70mm Cu – 95mm Al - CENTRE WATERBLOCKED
				Copper
		1000005643		7/0.67 – 2.5mm
		1000000282		7/1.70 – 16mm
		1000001866		19/1.35 – 25mm
		1000000286		19/1.78 – 50mm
		1000000283		19/2.14 – 70mm
		1000000284		37/1.78 – 95mm
		1000000285		37/2.03 – 120mm
Connections reducing link Cu (NTS)	150	1000006267	-	16mm ² - 70 mm ² (7/0.064 to 19/0.083)
		1000006268	-	25mm ² - 70 mm ² (7/0.080 to 19/0.083)
		1000006269	-	35mm ² - 70 mm ² (7/0.104 & 19/0.064 to 19/0.083)

Connections Full-tension sleeves (FTS)	155			O.D.mm	Length	AAC	AAAC	ACSR	CCT
		1000008125		6 - 8	165	7/2.25 – 7/2.50	-	-	-
		1000000869		6 - 8	344	7/2.25 – 7/2.50	7/1.75 – 7/2.50	6/1/2.50	-
		1000005332		8 - 10	379	7/3.00	7/3.00	6/1/3.00	-
		1000008084		10 - 12	203	7/3.75	-	-	-
		1000000870		10 - 12	470	7/3.75	7/3.75	6/1/3.75	80
		1000000983		12 - 13.5	203	7/4.50	-	-	-
		1000000871		13 - 14.5	505	7/4.75	7/4.75-50mm Cat	6/4.75+7/1.60	120
		1000005139		14 - 16	279	19/3.25	-	-	-
		1000008083		16.5 - 19.5	318	19/3.75	-	-	180
		1000001089		16.5 - 19.5	580	19/3.75	19/3.75-150mm Cat	-	-
		1000001016	-	95mm LVABC INSULATED SLEEVE					
				O.D.	mm²	Copper – Imp.		Copper - Metric	
		1000000292		3.35	6.75	7/0.44		-	
		1000000293		3.66	8.1	7/0.48		-	
		1000000294		4.88	14.28	7/0.64		-	
		1000000295		6.1	22.7	7/0.80		-	
		1000000296		7.9	38.4	7/1.04		-	
		1000000297		10.5	65.1	19/0.83		-	
		1000000298		5.10	16	-		7/1.70	

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description			
		1000000300		4.8-5.25	16.8	-	7/1.75
		-		6.0-6.27	25	-	7/2.00
		1000000301		8.1-8.75	42	-	7/2.75
		1000000299		8.9	50	-	19/1.78
		1000000302		10.70	65.1	-	19/2.00
		-		14.5-15.0	130	-	19/3.00

PG clamps (non-tension)	160			Range: AAC & AAAC		Range: ACSR	Range: CCT
		1000007518	-	(1 BOLT) 7/1.7 - 7/3.75			-
		-	-	(2 BOLT) 7/2.50 -19/3.75 HVABC Cat		6/1/2.50 to 6/4.75+7/1.60	40-180mm ²
		1000007553	-	(3 BOLT) 19/3.25 - 61/3.75			-
		1000005528	-	(2 BOLT) BI-METAL Size 16-70Al to 6-50Cu			
		1000005529	-	(2 BOLT) BI-METAL Size 25-150Al to 10-95Cu			
		1000000985	-	(3 BOLT) BI-METAL Size 95-240Al to 70-185Cu			
	163	1000005528	-	(2 BOLT) BI-METAL Size 16-70Al to 6-50Cu			
		1000005529	-	(2 BOLT) BI-METAL Size 25-150Al to 10-95Cu			
		1000000985	-	(3 BOLT) BI-METAL Size 95-240Al to 70-185Cu			

Split bolt	165	1000000253	-	SPLIT BOLT CONNECTOR SUIT 19/2.14 Cu. B26 Max 12.5mm			
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Palms	168	1000006028	332074	PALM 110° ANGLED 2 BOLT PER SIDE M12			
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Compression lugs. Al (2 hole- straight)	170			Range: AAC	Range: AAAC	Range: ACSR	Range: CCT
		1000007773	-	7/2.50 - 50mm ABC	7/2.50	-	-
		1000007838	-	7/3.75 - 95mm ABC	7/3.75	6/1/3.75	80mm
		1000007817	-	7/4.50 - 150mm ABC	7/4.50	6/4.75+7/1.60	120mm
		1000007826	-	19/3.25	19/3.25	-	180mm
		1000007823	-	240mm SECTOR	-	-	
Compression lugs. Cu (2 hole- straight)	170	1000005953	-	70mm ² 19/2.00 (M12)			
		1000006295	-	120mm ² 37/0.83 (M12)			

	175			Range: AAC	Range: AAAC	Range: ACSR	Range: CCT
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Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description			
Compression lugs. Al (hammer)		1000007777	-	-	7/2.50	-	-
		1000007775	-	7/3.75 - 95mm ABC	7/3.75	6/1/3.75	80mm
		1000007776	-	7/4.50 - 150mm ABC	7/4.50	6/4.75+7/1.60	120mm
		1000007778	-	19/3.25	19/3.25	-	180mm
		1000004981	-	19/3.75	19/3.75	-	-

Compression lugs. Al (1 hole)	180	1000004979	-	LUG Al 40mm ² COMP. ST. (M12 HOLE) CCT			
		1000007837	-	LUG Al 95mm ² COMP. ST. (M12 HOLE)			
		1000000992	-	LUG Al 120mm ² COMP. ST. (M12 HOLE) CCT			
		1000000876	-	LUG Al 150mm ² COMP. ST. (M12 HOLE) NMSHVABC			
		1000000877	-	LUG Al 185mm ² COMP. ST. (M12 HOLE) UG			
		1000000943	-	LUG Al 240mm ² COMP. ST. (M12 HOLE) UG SECTOR CABLE			
Compression lugs. Cu (1 hole)	180	1000007780	-	LUG Cu 19/2.14 CRIMP (M10 HOLE) - 70mm ²			
		1000000271	-	LUG Cu 19/2.14 CRIMP (M12 HOLE) - 70mm ²			
		1000000274	-	LUG Cu 37/2.03 CRIMP (M12 HOLE) - 120mm ²			
		1000007804	-	LUG Cu 37/2.03 CRIMP (M16 HOLE) - 120mm ²			
Compression Lugs Bi Metal (1 hole)	180	1000007842	-	LUG Al 37/1.78 - Cu PALM (M12 HOLE) - 95mm ²			
		1000001679	-	LUG 95mm ² Al - Cu PALM (M12 HOLE) - INS. BARREL			
		1000005553	-	LUG 150mm ² Al - Cu PALM (M12 HOLE) - INS. BARREL			
		1562271		LUG 40mm ² Al - Cu PALM (M12 HOLE) – CCT			

Bail clamps Copper	190			O.D.mm	Width	AAC/AAAC	Range: ACSR
		1000007474	-	6.75 – 18.8	1 bolt - 65mm	7/2.25 – 19/3.75	6/1/2.50 – 30/7/2.50
		1000007475	-	6.75 – 18.8	2 bolt - 112mm	7/2.25 – 19/3.75	6/1/2.50 – 30/7/2.50

Line taps Aluminium	195			Range: Main	Range: Tap		
		1000008217	-	7/3.00 – 7/4.50	7/1.75 Al.		
		-	-	19/3.25 – 19/3.75	7/1.75 Al.		

Preformed deadends (AAC, AAAC, ACSR)	200	1000007637	-	50mm HVABC ANTI-BIRDCAGING (PAIR)			
		1000007635	-	150mm HVABC ANTI-BIRDCAGING (PAIR)			
	201			'#' = standard conductor size, other sizes are shown for maint.			
				Colour	Std	Range: AAC & AAAC	Std Range:ACSR

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description				
		1000004978	-	BLUE		7/0.912 CTWCF84 - 7/1.042 F82C3CTWN/S - 7/1.70 2C Al N/S comp - Black neoprene coated - (50mmOH earth wires)		
		1000000841	-	PURPLE		7/1.75		3/4/31.75
		1000007614	-	BROWN		7/2.25		-
			-	BLUE	#	7/2.50 -1000006481	#	6/1/2.50 & 3/4/2.50 - 1000000843
		1000000836	-	RED		7/3.00		-
		1000007631	-	RED		-		6/1/3.00 & 4/3/3.00
		-	-	BLUE		7/0.134"		-
			-	BLACK		7/3.75 - 1000006482	#	6/1/3.75 & 4/3/3.75 - 1000000842
		1000007622	-	GREEN	#	7/4.50		-
		1000007616	-	BLUE		7/4.75		-
		1000000839	-	BLUE		-	#	6/4.75+7/1.60
		1000007619	-	BLUE		50mm HVABC CATENARY		-
		1000007621	-	ORANGE	#	19/3.25		-
		1000000837	-	BLACK	#	19/3.75		-
		1000007615	-	BLUE		150mm HVABC CATENARY		-
Preformed deadends (SC/GZ)	201	1000000496	-	WHITE		7/2.75 GALV STEEL STAY WIRE 7/12 GALV STEEL		
		1000000495				7/1.60 SC/GZ		
		1000000497	-	ORANGE		3/8 GALV STEEL or 7/3.25 SC/GZ		
		1000007620	-	BLACK		SC/GZ STAY WIRE 11.80-12.20mm		
Preformed deadends (Copper)	201		-	ORANGE		7/1.064		
		1000000303	-	PURPLE		7/1.175		
		1000000304	-	YELLOW		7/2.00, 7/1.080"		
		1000000305	-	WHITE/PURPLE		7/2.75		
		1000000306	-	YELLOW		7/3.50, 19/2.00, 19/2.14		

Preformed ties	205			O.D.mm	Tie	Neck	CCT	AAC/AAAC	ACSR
		TBA	-	15.7	Side	73	40	-	-
		1000001823	-	18.3	Side	73	80	-	-
		1000001824	-	21.3	Side	73	120	-	-

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description					
		1000001825	-	24.5	Side	73	180	-	-
		1000008932		18.3 – 23.3	Top	76	80, 120		
		1000010920			Top		11kV – 180, 22kV - 120		
		1000008245	-	9.00 - 9.34	Top	76	-	7/3.00	6/1/3.00 – 4/3/3.00
		1000008234	-	14.1 - 15.09	Top	76	-	7/4.75	6/4.75+7/1.60
		-	-	22.90 – 24.34	Top	76	-	19/4.75	30/7/3.50
		-	-	-	Side	112	-	-	6/1/2.50

Tie wire	205	1000000834	-	ALUMINIUM - 5.00MM					
		1000000963	-	COPPER- 3.0MM DOUBLE ANNEALED					

Spiral vibration dampers	210	1000006093	-	4.42 – 6.34mm 7/1.75 AAC, 3/2.00 – 7/2.00 SC/GZ					
		1000007644	-	6.35 – 8.29mm 7/2.50 AAAC					
		1000000859	-	8.3 – 11.72mm 7/3.0 AAC					
		1000000860	-	11.73 – 14.31mm 7/4.50 AAC					
		1000007643	-	14.32 – 19.3mm 19/3.25 and 19/3.75 AAC					

Armour rods	215			AAC/AAAC	ACSR	
		1000000847	-	7/2.50	6/1/2.50	
		1000000848	-	7/3.00	6/1/3.00	
		1000000850	-	7/3.75	6/1/3.75	
		1000000845	-	7/4.50	-	
		1000008009	-	19/3.25	-	
		1000000844	-	19/3.75	-	
		1000000849	-	-	6/4.75+7/1.60	
		1000008042	-	19/4.75	-	

Tape armour	220	1000000835	-	ALL CONDUCTORS 10mm x 1.4mm x 3m					
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Cables and conductors	230	1000008329	-	CABLE COPPER SD 19/2.14 SDI XLPE/PVC BLACK - 70mm ²					
		1000008317	-	CABLE COPPER SD 19/2.14 SI PVC BLACK - 70mm ²					
		1000005093	-	CABLE COPPER SD 37/2.03 SDI PVC BLACK - 120mm ²					

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description				
	232		-	CABLE ALUMINIUM 95mm ² SDI PVC BLACK				
	233	1000008344	-	CABLE COPPER FLEXIBLE 70mm ² XLPE INSULATED				
				INSULATED OVERHEAD CONDUCTORS				
	235		059851	Service	1x25-1000008365	1x50-1000004963	2x25-1000008356	4x25-1000008357
	240		059851	LVABC	4x95-1000000904	4x150- 1000005254	-	
					95+SL- 1000001833	150+SL- 1000005601	-	
	245		078107	HVABC	50- 1000008306	150- 1000008307	-	-
	250		078938	11-CCT	40- 1000001948	80- 1000001027	120- 1000001028	
				22-CCT	-	-	120- 1000001989	
				BARE OVERHEAD CONDUCTORS				
	255			AAC	AAC	7/4.50- Mercury 1000008323	19/3.25- Neptune 1000008322	19/3.75- Pluto 1000008321
				AAAC	AAAC	7/2.50- Chlorine 1000008368	7/4.50- Hydrogen 1000001082	19/3.25- Krypton 1000005683
				ACSR	ACSR	3/4/2.50-Raisin 1000005653	6/1/2.50-Almond 1000000830	6/1/3.75- Banana 1000000831
						6/4.75+7/1.60- Cherry 1000000832	30/7/2.5- Grape	-
				COPPER	COPPER	7/1.70- 1000008310	7/2.00- 1000000193	19/2.00- 1000000194
	260	1000000513	-	COPPER ROD 10mm x 3.6m				
	262	1000008346	-	CABLE COPPER SD 19/2.14 BARE - 70mm ²				

HV switchgear	300	1000005469	-	AIR BREAK SWITCH WITH MID POLE OPERATING MECHANISM				
		-	-	AIR BREAK SWITCH 11/22KV WITH GROUND MOUNTED OPERATING MECHANISM (OLD)				
	305	1000006357	-	LOAD BREAK SWITCH 11KV – MANUAL – POLE TOP / MID POLE MOUNT				
		1000006369	-	LOAD BREAK SWITCH 22KV – MANUAL – POLE TOP / MID POLE MOUNT				
		1000005693	-	LOAD BREAK SWITCH 22KV – AUTOMATED with VT, without radio				
		1000005694	-	LOAD BREAK SWITCH 11KV – AUTOMATED with VT, without radio				
		1000006795	-	LOAD BREAK SWITCH 22KV – AUTOMATED with VT, with radio				
		1000006794	-	LOAD BREAK SWITCH 11KV – AUTOMATED with VT, with radio				
		1000002425	-	LOAD BREAK SWITCH EARTH STIRUP				
		1000006074	-	ABS OPERATION KEY (MID POLE MECH-INSULECT)				
	306				11kV	22kV	33kV	

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
				RECLOSER with VT
				1000005399
				1000005419
				RECLOSER with 240V AC CONTROL
				1000005398
				1000005418
				RECLOSER with 110V DC CONTROL
				1000005400
				1000005417
	307	1000005975	-	VT 11KV / 27.8V 50VA (Schneider auto LBS)
		1000005976	-	VT 22KV / 27.8V 50VA (Schneider auto LBS)
		1000010050		VT 11kV/230V (ABB auto LBS)
		1000010052		VT 22kV/230V (ABB auto LBS)
		1000010560		VT 11kV/240V (NOJA recloser)
		1000010570		VT 22kV/240V (NOJA recloser)
		1000010551		VT 33kV/240V (NOJA recloser)
	308	1000005565	-	NOJA SURGE DIVERter BRACKET
	310	1000006013	-	UNDER SLUNG LINK 11/22KV (POLYMERIC)
	310a	1000006014	-	UNDER SLUNG LINK 45° MOUNTING BRACKET
	310b	-	-	BRACKET USL 0° MOUNT (NEW DOF STYLE - COMES WITH USL)
	315	1000000386	-	FUSE ASSEMBLY DROP OUT 11/22KV EXPULSION (PORCELAIN) Obsolete
		1000005912	-	FUSE ASSEMBLY DROP OUT 11/22KV EXPULSION (POLYMER)
	315a	-	-	DOF MOUNTING BRACKET
	316	1000005444	-	FUSE ASSEMBLY DROP OUT HOLDER 22KV TYPE SMD-20
		1000002154	-	FUSE ASSEMBLY DROP OUT HOLDER 33KV TYPE SMD-20

HV fuses elements (Drop out fuses)	320			11/22kV - WIRE FUSE TYPE		24KV- POWDER FUSE		33KV- POWDER FUSE	
				A	Material no.	A	Material no.	A	Material no.
				3.15	1000000393	3.0	1000005902	5	1000002265
				8	1000000395	8	1000005442	-	-
				16	1000000396	-	-	-	-
				20	1000000397	20	1000005443	-	-
				40	1000000398	40	1000005869	-	-
				63	1000000916	65	1000006169	50	1505346
				80	1000000917	80	1000006170	-	-
				100	1000000918	100	1562263	-	-

LV switchgear	340	1000007797	-	LINK LV SOLID 630A OPEN WIRE
	341	1000007798	-	LINK LV SWITCH/FUSE 400A OPEN WIRE

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
	345	1000005322	-	FUSE-SWITCH 400A LV ABC 3 PHASE (IPC)
		-	-	FUSE-SWITCH 400A LV ABC 3x1 PHASE (IPC)
	346	1000008086	-	FUSE-SWITCH 100A LV ABC 1 PHASE (SERVICE)
		1000008085	-	FUSE-SWITCH 100A LV ABC 3 PHASE (SERVICE)
		1000007672	-	FUSE HOLDER 100A - IPC INS. 6-35 TO 6-35 INS. (SERVICE)
	348	1000007556	-	LV CB 1250A POLE MOUNT FOR LOADS UP TO 550A

LV fuses	350			SERVICE FUSE BARREL TYPE		2 BOLT TYPE		DIN 02 - BLADE TYPE	
				22.2mm Dia.		30mm Dia.			
				A	Material no.	A	Material no.	A	Material no.
				60	1000000382	60	-	80	1000000363
				80	1000000383	80	-	100	1000000364
				100	1000001069	100	1000000384	160	1000000365
				-	-	-	-	200	1000000366
				-	-	-	-	250	1000000341
				-	-	-	-	315	1000000367
				-	-	-	-	400	1000000368
				-	-	-	-	-	-
				-	-	-	-	LINK	1000005323

Transformers Pole	400			Trf with normal mineral oil – (Enviro. friendly FR3 oil special order)				
					1Ø-11kV	1Ø-22kV	3Ø-11kV	3Ø-22kV
				25kVA	1000008639	1000008640	1000008633	1000008642
				50kVA	10000086451	-	-	-
				63kVA	-	-	1000008648	1000008638
				100kVA	-	-	1000008634	1000008643
				200kVA	-	-	1000008635	1000008649
				315kVA	-	-	1000008636	1000008650
				400kVA	-	-	1000008637	1000008641
				SWER Trf -12.7kV		SWER 25kVA		
						1000008644		
				SWER Isol Trf - HV TO 12.7kV	11kV - 100/100/10		22kV - 100/100/10	
					1000005540		1000005541	

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description						
Voltage Regulators	410	1000006679	-	11kV single phase 100A pole mount VR with 304SS tank, natural ester oil and CL7 controller						
		1000006680	-	11kV single phase 200A pole mount VR with 304SS tank, natural ester oil and CL7 controller						
		1000006681	-	11kV single phase 100A pole mount VR with 304SS tank and natural ester oil (multi phase controller is a separate material number)						
		1000006682	-	11kV single phase 200A pole mount VR with 304SS tank and natural ester oil (multi phase controller is a material number)						
		1000006683	-	CL7 multi phase VR controller						
Jointing and termination kits	450	-	-	JOINT KIT FOR 50mm SQ. NMSHVABC (1 PH ONLY)						
		1000007741	-	JOINT KIT FOR 150mm SQ. NMSHVABC (1 PH ONLY) ALSO SUITS 95mm SQ. MSHVABC						
	460	1000007740	-	TERM. KIT HEATSHRINK 50mm SQ.						
		1000004992	-	TERM. KIT HEATSHRINK 150mm SQ. 3PH ALSO SUITS 95mm SQ. MSHVABC						
	465	1000001902	-	JOINT KIT FOR 120mm SQ. CCT (MID SPAN JOINT KIT)						
	467	1000001959	-	TERMINATION LV 2 x 95mm TO 1 x 240mm GLOVE						
Heat shrink and cold applied hardware	470	1000007562	-	END CAP ROLL ON 16-150mm SQ. – SUITABLE FOR 95 AND 150mm LVABC						
		1000006105		END CAP ROLL ON 11.6-20.9mm UNLINED – SUITABLE FOR 95 AND 150mm LVABC						
	472				4-8mm	15-27mm 11kV CCT	28-50mm 22kV CCT	38-70mm	46-80mm	70-110mm
				H/SHRINK CAP LINED	1000000958	1000000156	1000000157	1000000954	1000007580	1000000158
	474	1000007966	-	H/SHRINK LV COLOURED TUBING R,W,B SET 50mm x 25mm						
	476	1000008218	-	H/SHRINK LV TUBING UNLINED EXP. DIA 38/20mm x 38M LG BLACK-THIN WALL						
	478	1000008145	-	H/SHRINK LV TUBING MASTIC LINED EXP. DIA 50/16mm x 300mm BLACK-MEDIUM WALL						
	480	1000008231	-	H/SHRINK NON-TRACKING TUBING EXP. DIA 42/19mm x 450mm LG RED-(NOT INSUL.)						
	482	1000007745	-	H/SHRINK LV ZIPPER SLEEVE EXP. DIA 75/22mm x 1.5M LG.						
				OTHER HEATSHRINK TUBING						
		1000005950	-	H/SHRINK LV TUBING UNLINED EXP. DIA 16/5mm x 40m ROLL Medium wall BLACK						
		1000008137	-	H/SHRINK LV TUBING UNLINED EXP. DIA 16mm/5mm x 50m ROLL						
		-	-	H/SHRINK LV TUBING UNLINED EXP. DIA 19mm/5mm x 1.2m LG-Medium wall						
		1000008139	-	H/SHRINK LV TUBING UNLINED EXP. DIA 35mm/12mm x 50m ROLL						
		1000000159	-	H/SHRINK LV TUBING MASTIC LINED EXP. DIA 50/16mm x 300mm LG						

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
		1000008135	-	H/SHRINK LV TUBING MASTIC LINED EXP. DIA 63mm/19mm x 300mm LG
		1000005951	-	H/SHRINK HV TUBING UNLINED EXP. DIA 15mm/6mm x 30m ROLL-RED-Medium wall
		1000005952	-	H/SHRINK HV TUBING UNLINED EXP. DIA 30mm/12mm x 30m ROLL-RED-Medium wall

					16mm	20mm	25mm	32mm	40mm	50mm
Misc. items	500			SADDLE GAL. CONDUIT	1000000243	1000000244	1000000245	1000000246	1000000247	1000000248
	502			CONDUIT FLEX. GREY	1000000232	1000000233	1000000234	1000000235	1000007499	1000007498
	504	1000000573	-	CLOUT STEEL GALV 2.8mm x 40mm LG						
	510	-	-	TIE CABLE UV STABILISED 380mm x 7.6mm BLACK HEAVY DUTY						
	515	1000007925	-	PIPE STEEL 20 NB GALV x LGTH TO SUIT						
	516	1000005972	-	CHAIN – SAFETY 10mm – 18 LINKS TO AS4177.4 COMPLETE WITH BOW SHACKLES						
	517	1000000974	279811	AERIAL OVERCROSSING WARNING MARKER DISC M500 YELLOW						
	518	1000007625	-	PHASE MARKER DISCS (SET OF 3 - RED, WHITE & BLUE)						
	520	1000006028		PALM TINNED Cu 2 HOLE 110 deg						

Earth rod-Cu + driving tip	600		348244	M15x2400LG		M15x1800LG		M15x1200LG		Driving tip	
				1000000527		1000005671		1000008012		1000008227	
				Coupling							
				-							
Earthing connection compression	605	1000001102	348243	CONNECTOR EARTH 'C' TYPE – 70 TO 95mm							
		1000001038		CONNECTOR EARTH '6' TYPE – 70mm							
				DIE-U997 or DU-1315							
				DIE UTILUX 38-142 (HEXAGONAL)							
Earthing connection Exothermic weld	605			TYPE	Material no.	TYPE	Material no.	TYPE	Material no.		
				GT	1000008477	XA	-	HS	-		
				TA	1000008478	LE	-	VS	-		
				GF	1000008480	LJ	-	CH	-		
Cadweld Plus charges	606			90G	115G	150G	200G				
				1000005555	1000005556	1000005557	-				
Earth mat portable	607	1000005426	-	EQUIPOTENTIAL MAT 1.5m x 1.5m WITH 1.5m BRAID & CLAMP							

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description
Earthing powder	610	1000000920	-	GOODEARTH 15KG BAG
Earth batten	615	-	348249	EARTH BATTEN 2.7M – WOOD
		1000005780		EARTH BATTEN 3M – PLASTIC
Earth Sign	616	-		EARTH CONNECTION WARNING LABEL
				WARNING LABEL CMEN
		1000006071		EPR DANGER SIGN
		1000006394		YELLOW/GREEN USEW DISC
Cable guard	620	1000005947		CABLE GUARD PLASTIC 2 PIECE - SINGLE CABLE
				CABLE GUARD PLASTIC 2 PIECE – MULTI CABLE
Anti- theft downlead	621	1000006374		CONCRETE POLE DOWNLEAD
		1000006375		WOOD POLE DOWNLEAD
LV Earth Bonds		1000006061		LV PERSONAL PROTECTIVE EARTH BONDS
Swivel		1000008516		S/STEEL CABLE GRIP WITH JOINING WIRE - SWIVEL RATING 0.5T, 220MM LG
		1000008507		S/STEEL CABLE GRIP - SWIVEL RATING 70kN SHORT
Cable pulling stockings		1000007719		STOCKING CABLE - 4 x 95mm ² LV ABC
		1000005260		STOCKING CABLE - 4 x 150mm ² LV ABC
		1000008505		STOCKING FOR CATENERY - 50mm ² NMSHVABC
		1000008506		STOCKING FOR CABLE CORES - 50mm ² NMSHVABC
		1000008503		STOCKING FOR CATENERY - 150mm ² NMSHVABC
		1000008504		STOCKING FOR CABLE CORES - 150mm ² NMSHVABC
Solvent		1000005791		SOLVENT WIPES IN A BUCKET
Cleaners		1000005792		SOLVENT LIQUID-1 LITRE BOTTLE (FOR HEAVY CLEANING)
		1000005781		ANTI-BACTERIAL WIPES IN A BUCKET
Cable stringing		1000005564	-	CLOSING TOOL - 95 & 150mm ² LV ABC SUSP CLAMPS
		1000001076	-	STRINGING ROLLER - 95 & 150mm ² LV ABC SUSP CLAMPS
		-		CCT ROLLERS

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description							
Joint compound		1000000875	-	ALMINOX – ALUMINIUM							
		-	-	ALMINIOX – COPPER							
Anti-seize		1000005724	-	ANTI-SEIZE AEROSOL SPRAY MOLYKOTE 1000 FOR S/STEEL							
		1000001838	-	ANTI-SEIZE AEROSOL SPRAY LOCTITE 767							
Scratch brush		1000000952	-	ALUMINIUM – WHITE BRUSH – SEMI CIRCULAR							
		1000000953	-	COPPER– BLACK BRUSH – SEMI CIRCULAR							
CCT tools		1000005100	-	COME-A-LONG FOR 120 & 180mm² CCT							
		-	-	CABLE STRIPPER – Hayco (Orange handle) - End cut and window cut – different blades							
		1000004955	-	CABLE STRIPPER – Dulmison (Chrome handle) - End cut and window cut – different blades							
		1000005980	-	TORQUE SCREW DRIVER 1-6Nm ¼” DRIVE							
Sign		-	064521	CONDEMED POLE DISC							
		1000005086	064521	NAIL POLE DISC							
Temp. Ind.		1000006073		TEMPERATURE INDICATING STRIP - STICK-ON 70º-110º (Thermax)							
Key LBS/ABS		1000006074	-	KEY TO UNLOCK MID POLE OPERATING MECHANISM ON LBS AND ABS							
Bandit tool		1000005744	-	TENSIONER-BANDIT TOOL, USE WITH 19mm STRAPPING BAND & BUCKLE							
Pole letters & numbers				BLACK ON YELLOW BACKGROUND 38mm x 25mm STICK-ON LABEL							
				No.		Alpha		Alpha		Alpha	
				1	1000005123	A	1000005147	K	1000005156	U	1000005165
				2	1000005124	B	1000005148	L	1000005157	V	1000005167
				3	1000005125	C	1000005149	M	1000005158	W	1000005166
				4	1000005126	D	1000005150	N	1000005159	X	1000005168
				5	1000005127	E	1000005151	O	Use 0	Y	1000005169
				6	1000005128	F	1000005152	P	1000005160	Z	1000005170
				7	1000005129	G	1000005153	Q	1000005161		
				8	1000005130	H	1000005154	R	1000005162		
				9	Use 6	I	Use 1	S	1000005163		

Overhead construction standards manual

Group	Item	Material no.	Drg no.	Description							
				0	1000005131	J	1000005155	T	1000005164		
Operational letters & numbers				BLACK ON SILVER BACKGROUND 64mm x 40mm TAGS							
				No's		Alpha		Alpha		Alpha	
				1	1000005355	A	1000005364	K	1000005620	U	1000005629
				2	1000005356	B	-	L	1000005621	V	1000005630
				3	1000005357	C	1000005365	M	1000005622	W	1000005631
				4	1000005358	D	1000005366	N	1000005623	X	1000005632
				5	1000005359	E	-	O	1000005624	Y	1000005633
				6	1000005360	F	1000005367	P	1000005625	Z	1000005634
				7	1000005361	G	1000005368	Q	-		
				8	1000005362	H	1000005369	R	1000005626		
				9	Use 6	I	Use 1	S	1000005627		
				0	1000005363	J	1000005619	T	1000005628		
Column numbers				BLACK ON WHITE BACKGROUND 64mm x 40mm STICK-ON LABELS							
				No's							
				1	1000007901						
				2	1000007902						
				3	1000007903						
				4	1000007909						
				5	1000007910						
				6	1000007911						
				7	1000007912						
				8	1000007913						
				0	1000007914						

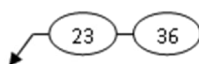
3.27 Assemblies

The following section contains drawings of parts and accessories that have been grouped together to form assemblies. This section must be used in conjunction with the parts and accessories list section where more details of parts is given.

Assemblies are shown on construction drawings but may be less detailed on the construction to facilitate a better view.

Where a part is numbered on an assembly the description and other details of that part can be found in the parts and accessories list section.

Legend



Indicates a specific part. The number can be found in the part and accessories list section.

When two (2) items are shown joined like this, it indicates that one part or the other may be used based on considerations such as voltage, conductor size or type.

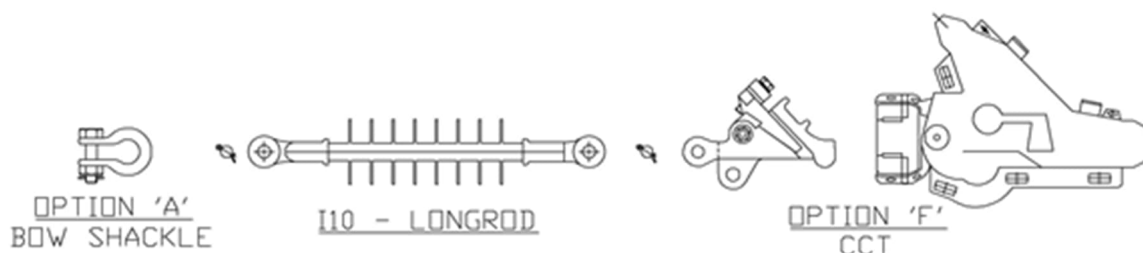
Legend



Indicates a group of items in a construction drawing that are used to form a common structure and is called an assembly. All assemblies are listed in this section.

When an assembly (such as XA020) is followed by a hyphen (-) with characters or numbers (such as XA020-A/B), this indicates there is one or more options in the assembly.

A typical assembly may be IA020-AI10F:



IA020 = insulator assembly 020

- = Option follows

A = Bow shackle connection

I10 = Insulator 10, which is a HV longrod

F = CCT termination connection

Another example could be MA100-B:

MA100 = LVABC suspension clamp

- = Option follows

B = Break away (if there is no option, non-break away would be used)

3.27.1 Assembly drawings

Drawing No.	Amend. No.	Subject
332000/1	D	Standard assemblies – Bolts-Eyebolts-Nuts-Washers-Hooks and Straps
332000/2	D	Standard assemblies – Bolts-Eyebolts-Nuts-Washers-Hooks and Straps
332001/1	D	Std assemblies – Insulators-Pins-Shackles-Surge diverters-Links-Fuses
332001/2	D	Std assemblies – Insulators-Pins-Shackles-Surge diverters-Links-Fuses
332001/3	D	Std assemblies – Insulators-Pins-Shackles-Surge diverters-Links-Fuses
332002/1	C	Standard assemblies – Miscellaneous items-Brackets-Connectors
332002/2	C	Standard assemblies – Miscellaneous items-Brackets-Connectors
332002/3	C	Standard assemblies – Miscellaneous items-Brackets-Connectors
332002/4	C	Standard assemblies – Miscellaneous items-Brackets-Connectors
332002/5	C	Standard assemblies – Miscellaneous items-Brackets-Connectors

4 Low voltage mains constructions

4.1 LV mains requirements and common constructions

4.1.1 General requirements

To use these constructions, it is necessary to refer to Section 3 clause **3.26– Assemblies**.

The assemblies contain all the details and parts used in each construction.

4.1.2 Special requirements

In order for live line work to be carried out safely on poles where a circuit of LV mains may cross a second circuit of LV mains, that is a four (4) way cross, either the upper or lower circuit, in both directions shall be installed as LVABC. Where there is a three (3) way cross, one of the circuits shall be installed as LVABC.

Additionally, where it is necessary to transpose phases on a pole incorporating bare conductor, one circuit shall be installed as LVABC. Bare, open wire transposition constructions are not permitted.

This requirement applies to all new work, augmentations and any pole replacement so affected by an existing bare conductor three (3) and four (4), way cross or a bare, open wire transposition.

4.1.3 Common constructions

The following constructions are formed from combinations of standard constructions and can be varied depending on the mains chosen.

Sample mains have been included in the constructions to help show transitions between different mains types which may or may not be the case in the actual construction.

4.1.4 Common LV construction drawings

Drawing No.	Amend. No.	Subject	Const. no.
332004	B	Termination to underground cable (UGOH)	LUGOH
332005	B	Termination to underslung link (USL)	LUSL

4.2 LV aerial services

4.2.1 General requirements

In order to improve the integrity of the overhead service neutral connection, a two (2) bolt neutral connection shall be used for all service installations. This requirement only applies to the neutral connection and all phase connections shall continue to be made with a single bolt insulation piercing connector.

All tightening bolt heads are shear-off, with a second bolt head provided for the removal of conductors. Clear inspection covers are incorporated to provide confirmation that the cables have been fully inserted.

As the integrity of the connection relies on the absence of water, the service conductor must remain sealed and therefore the insulation piercing connectors must not be removed or re-used.

Insulation piercing connectors have been developed for use with LVABC XLPE insulated cables however the use with existing PVC service conductor is acceptable provided the insulation is in good condition. Any service conductor found with defective insulation is to be replaced.



Fig 4.1 Two (2) bolt HSC insulating piercing neutral connector

Consumer mains smaller than 4mm² are to be twisted, double backed, and sealed with self amalgamating tape.

All LV network service neutral connections must incorporate two (2) bolt connector, as shown below.



Fig 4.2
ABC service to ABC main



Fig 4.3
ABC service to Al. main



Fig 4.4
ABC service to Cu main

4.3 Suspended overhead service (flying fox)

4.3.1 Mid span service connections

Mid-span service connections directly connected to open wire or LVABC distribution mains is not permitted.

Where an existing mid-span connected service is to be replaced or upgraded – it must be replaced with a flying fox arrangement. Refer to drawing no.: 332055.

Mid-span connections are not to be re-instated.

4.3.2 LV aerial services drawings – LVABC

Drawing No.	Amend. No.	Subject	Const. no.
011996	J	Consumers service mains method of service ties	-
059596	E	Service cable & strain clamp arrangement	-
078520	E	BBC cable installation near services	-
332055	C	OH service connections 100A and below	LS01

4.4 LV ABC mains constructions

4.4.1 LV ABC mains drawings – 95mm and 150mm LVABC

Drawing No.	Amend. No.	Subject	Const. no.
332006	A	Through suspension 0 - 25°	A01
332007	B	Through suspension 20° – 45°	A02
332008	A	Through strain 0 - 90°	A03
332009	A	Termination	A05
332010	A	Tee-off from bare mains	A01+A06
332011	B	3 way & 4 way tee-off LVABC	Various

4.5 LV bare mains constructions

4.5.1 LV bare mains drawings

Drawing No.	Amend. No.	Subject	Const. no.
332012	B	Pin insulators - single crossarm	B01
332013	B	Pin insulators - double crossarm	B02
332014	C	Through strain - single crossarm	B03
332015	B	Through strain - double crossarm	B04
332016	C	Termination - single crossarm	B05
332017	B	Termination - double crossarm	B06
332018	A	Tee-off from bare mains	B01+B05

5 11kV and 22kV mains constructions

5.1 HV mains general requirements and common constructions

5.1.1 General requirements

To use these constructions it is necessary to refer to Section 3 clause **3.26 – Assemblies**.

The assemblies contain all the details and parts used in each construction.

5.1.2 Common constructions

The following constructions are formed from combinations of standard constructions and can be varied depending on the mains chosen.

Sample mains have been included in the constructions to help show transitions between different mains types this may or may not be the case in the actual construction.

5.1.3 Common HV construction drawings

Drawing No.	Amend. No.	Subject	Const. no.
332020	D	Termination to air break switch (ABS)	HABS
332021/1	E	Termination to load break switch (LBS)	HLBS
332021/2	E	Termination to load break switch (LBS)	HLBS
332021/3	E	Termination to load break switch (LBS)	HLBS
332022/1	C	Termination to recloser	HREC
332022/2	C	Termination to recloser	HREC
332023/1	C	Termination to underground cable (UGOH)	HUGOH
332023/2	C	Termination to underground cable (UGOH)	HUGOH
332024/1	D	Termination to underslung link (USL)	HUSL
332024/2	D	Termination to underslung link (USL)	HUSL
332025	B	Railway crossing – special requirements	HRAIL
332060	B	Sectionaliser- DOF style	HSEC
332062	B	Fuse bypass - DOF style	HFBP

5.2 CCT mains constructions

5.2.1 Cable system description

5.2.1.1 Cable details and configuration

Covered conductor thick (CCT) is a single phase, AAAC 1120 alloy conductor mounted on insulators and preferably in a vertical formation.

5.2.1.2 Standard cable size

Endeavour Energy has standardised on grey insulation and the following sizes:

11kV - 80mm², 120mm² and 180mm²

22kV - 120mm²

However, other non-standard sizes may exist on the network.

5.2.1.3 Classification

CCT is classified as an insulated conductor however without an earthed screen as its outermost layer it is **NOT considered touch safe** (see AS3675:2002).

5.2.1.4 Precautions for work on or near CCT

Where work is to be carried out, the installation must be treated as bare conductor in accordance with the requirements of the Endeavour Energy Electrical Safety Rules.

As CCT does not have an earthed screen, contact while energised is not permissible.

The insulation thickness of the conductor, as specified in ETS-0060 – Covered Conductor Thick (CCT), makes possible a reduction in the normal distances specified for live exposed conductors, including:

- a) Phase to phase conductor separation.
- b) Conductor to tree clearances.

The insulation layer allows phase to phase clearances and clearances from trees to be less than for bare conductors, but personal safety clearances are the same as those for bare conductors.

5.2.1.5 Earthing requirements

As previously stated, CCT systems are similar to open wire systems but, due to the fact the conductor is covered with insulating material, special attention to lightning protection is required to prevent conductor burn down at support points.

This is achieved by the use of a current limiting arcing horn (CLAH), which consists of a surge diverter and arcing horn, installed on each phase and at regular intervals (refer to the earthing section of this manual for the earthing and construction details). Spacing of the CLAH units must be as specified on the project drawing. Effective mid-2022, CLAH will no longer be used and must be replaced with surge arrestors with disconnectors. (Material code: 11kV - 1000005440, 22kV – 1000005458)

5.2.1.6 Stringing

Stringing and terminating of CCT requires slightly different techniques to open wire and requires equipment such as stringing rollers, insulated end caps and vermin guards.

Care when handling the cable is of particular importance. To avoid possible cable failure, the following must be observed:

- a) Under no circumstances must the cable be dragged along the ground. This can result in abrasion leading to failure in the future.
- b) Care must be taken during installation not to cut or damage the cable insulation unless required for termination or at tee off locations.

Damage to the insulation could result in unnecessary outages.

5.2.1.7 Tree trimming

CCT must never be allowed to remain in contact with large tree branches for an extended period of time as this may cause electrical and mechanical breakdown of the insulating material. Heavy tree branches, if allowed permanent contact with the cable, may abrade the insulation. Trees must be trimmed in accordance with MMI 0013.

5.2.1.8 Hook separation

Separation between the bottom CCT insulator and the LVABC hook bolt (hook separation) must be as specified on the project drawing, typically this distance will be **1.365m**, refer to Drawing no. 012000 in Section 3 of this manual for details.

5.2.1.9 Non-tension bonding

All 11kV CCT to CCT tee-off connections for 40, 80 and 120mm² in non-tension situations shall be made with insulation piercing connectors. It must be noted that insulation piercing connectors are not suitable for the making or breaking of ANY load current.



Fig 5.1 IPC for CCT

These connectors are not suitable for 180mm² CCT or 22kV 120mm CCT, and for these conductors all bond connections shall continue to be parallel groove (PG) clamps.

In-line bond connections shall be made with non-tension sleeves covered with heat shrink tubing.

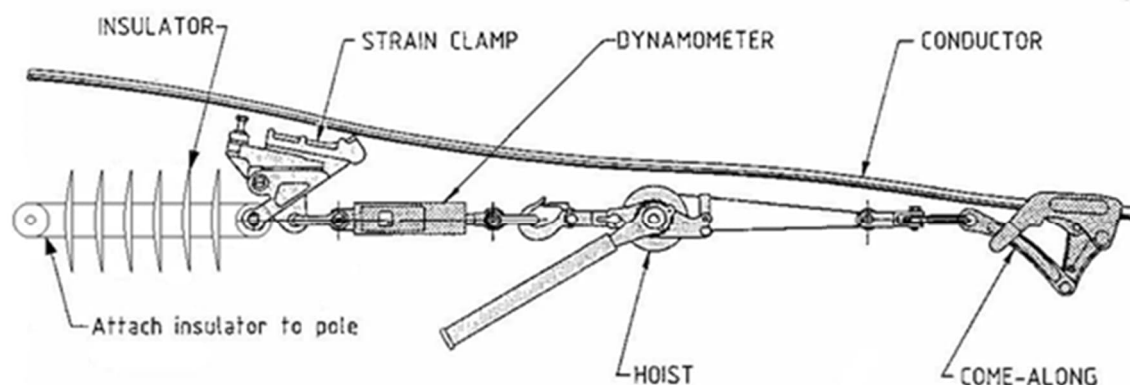
5.2.1.10 Mid span joints

A maximum of one mid-span joint is permitted on CCT conductors between shackle points. Joints must be constructed in accordance with Clause 3.3.1. All joints in mains under tension must be located at least 1.2 metres away from a conductor support point or termination.

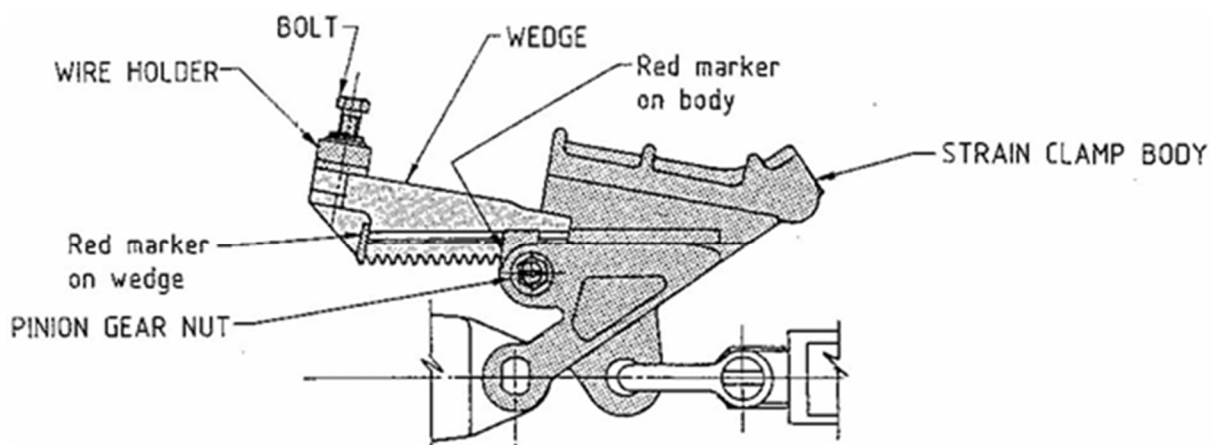
Full tension connector links must be used. A two-wrap band of red sealant mastic must be applied to the outer conductor layer, either side of the connector link. A suitable length of HVOT range red heat shrink insulation tubing must be installed over the connector link and mastic bands.

5.2.2 CCT installation of strain clamp cover

STEP 1: Assemble tension equipment to strain clamp and conductor; tension conductor to required value



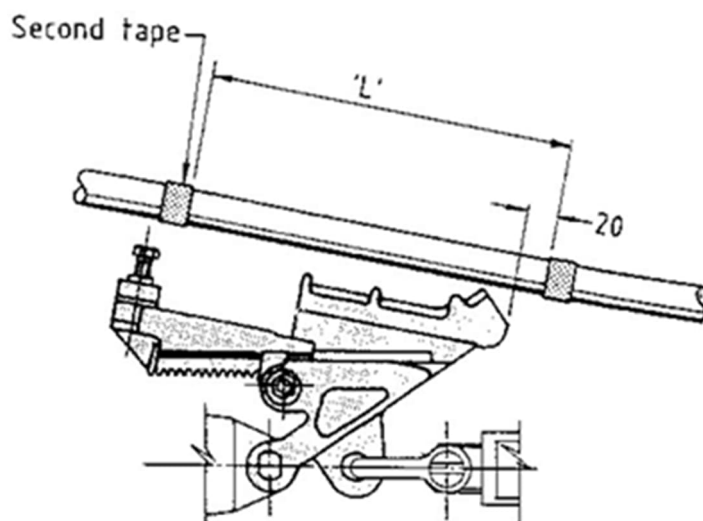
STEP 2: Wind out WEDGE on strain clamp by rotating PINION GEAR NUT and fully unscrew the bolt of the WIRE HOLDER.



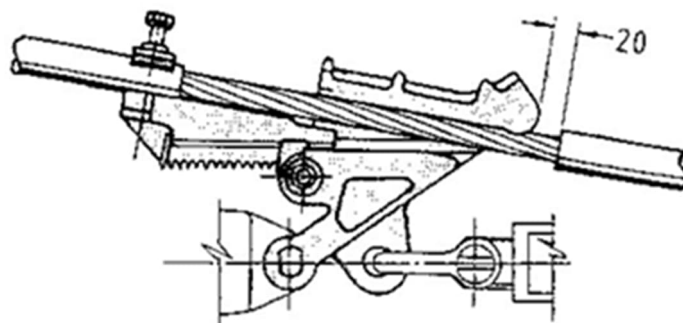
STEP 3: Remove any slack in conductor between COME-ALONG and STRAIN CLAMP. Tape conductor 50mm from end of clamp.

STEP 4: Increase tension in conductor until gap between clamp and tape is reduced to 20mm; add second tape to conductor.

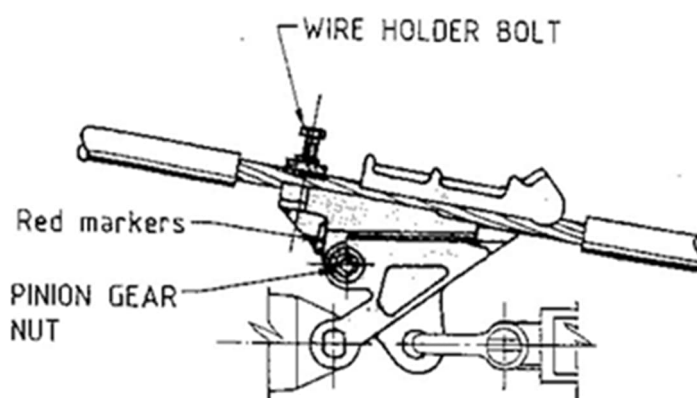
Conductor	Dim. 'L' (mm)
CCT 80	210 - 240
CCT 120	210 - 240
CCT 180	210 - 260



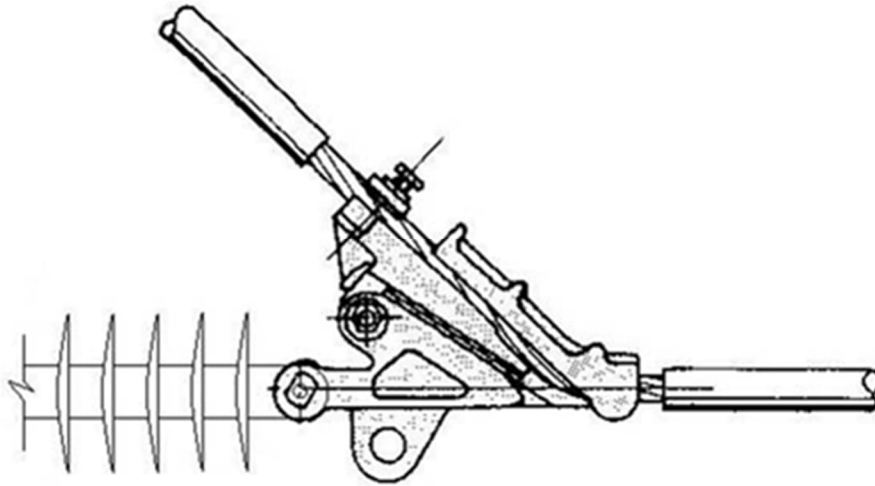
STEP 5: Strip conductor between tape markings, recheck the 20mm and 'L' dimensions. Remove tape and insert conductor into groove of clamp, including WIRE HOLDER. (Note: The insulation on the CCT conductor will not clear the end of the WIRE HOLDER, therefore some degree of force may be required to press conductor home. Check that washers on WIRE HOLDER BOLT are clear of bolt thread to prevent jamming).



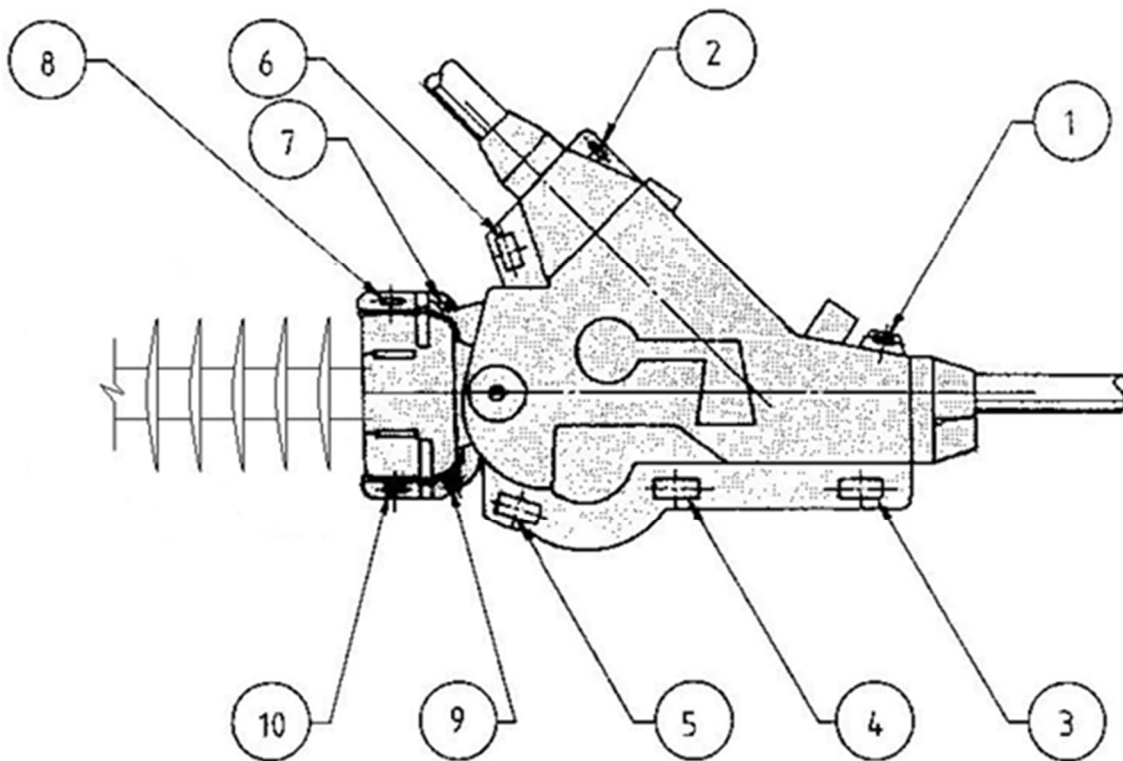
STEP 6: Rotate PINION GEAR NUT to tighten wedge onto conductor. Red marker on wedge must be adjacent to red marker on body. Tighten WIRE HOLDER BOLT.



STEP 7: Release tensioning equipment allowing the strain clamp to pivot on the insulator into its final position.



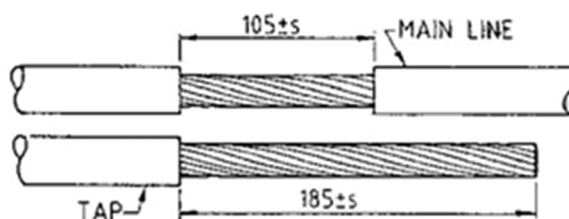
STEP 8: Place strain clamp cover over clamp and close tabs in numbered sequence from 1 to 10, as indicated.



5.2.3 CCT installation parallel groove connector and cover

Application 1

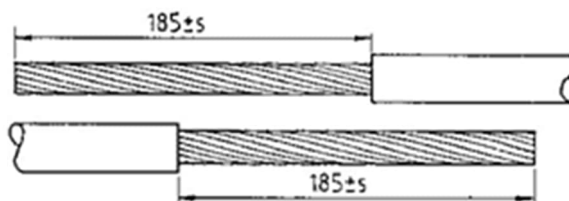
BRANCH CONNECTION



STEP 1: Strip insulation from conductors to dimensions shown, depending on application required.

Application 2

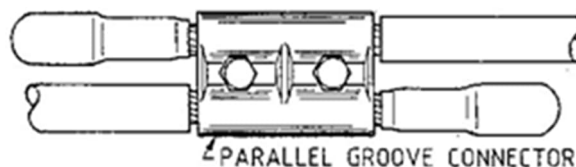
THROUGH CONNECTION



STEP 2: Fit and heatshrink 2 off End Caps onto all stripped conductor ends



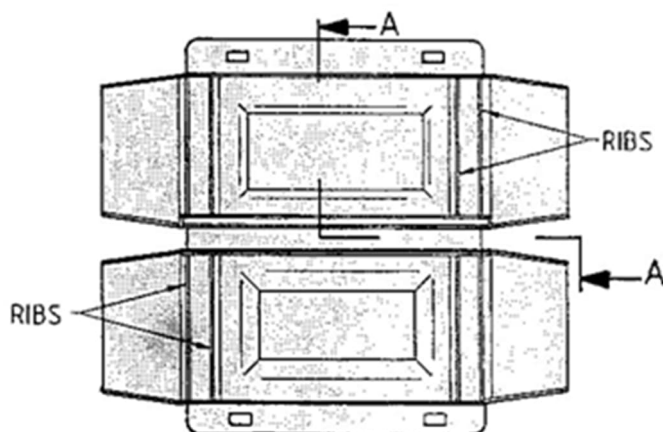
STEP 3: Wire brush and grease conductors. Fit PARALLEL GROOVE CONNECTOR and tighten bolts.



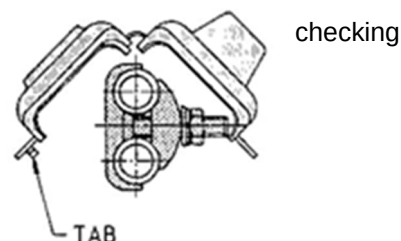
Trim ribs to clear conductors (required for 180mm CCT only).



STEP 4: If either or both of the conductors are 180mm CCT, the ribs on the internal face of the connector cover must be carefully removed with a knife. (Note: This is not required for 80mm CCT or 120mm CCT conductors.)

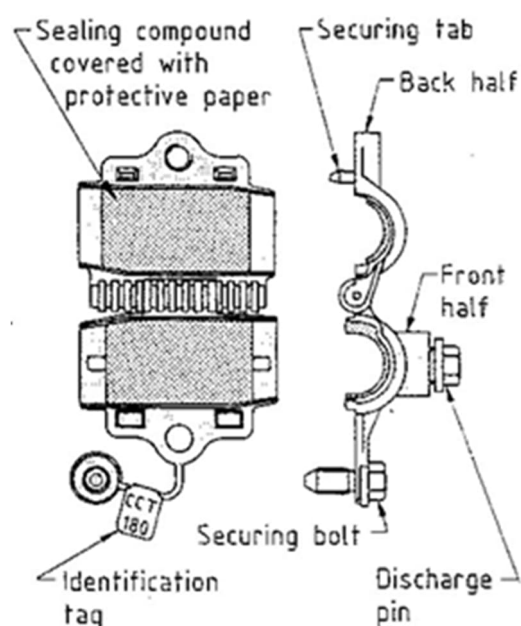


STEP 5: Place cover over parallel groove connector and close, that tabs are fully home.

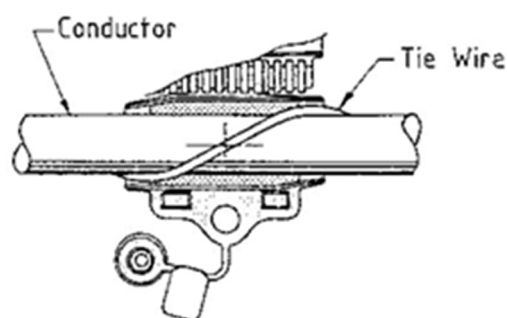


5.2.4 CCT installations of CLAH and discharge connector (For information only: CLAH not used in new installations)

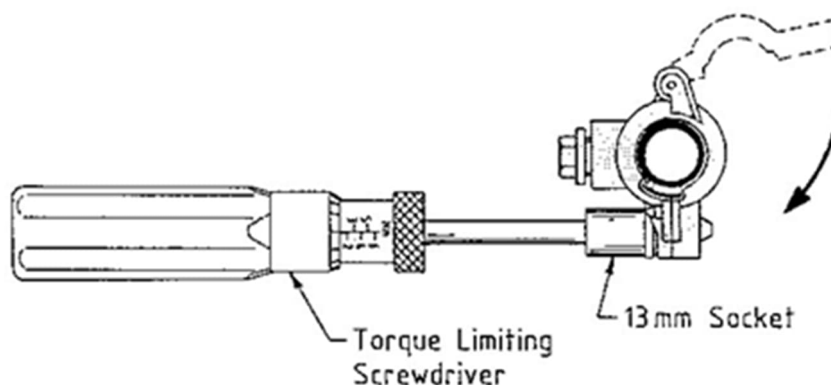
STEP 1: Check that identification tag on the discharge connector matches the conductor size. Establish location of discharge connector - the CLAH/DC assembly must be mounted according to ARRGT 1 – Preferred Option, except in dead end arrangements where the connector would foul the end cap, in which case, ARRGT 2 is used. Sit discharge connector loosely on conductor in selected location. Attach CLAH to the insulator's metal base, leaving clamp bolt finger tight, allowing CLAH to be pivoted around insulator to desired position. Check that CLAH spade will align with discharge connector



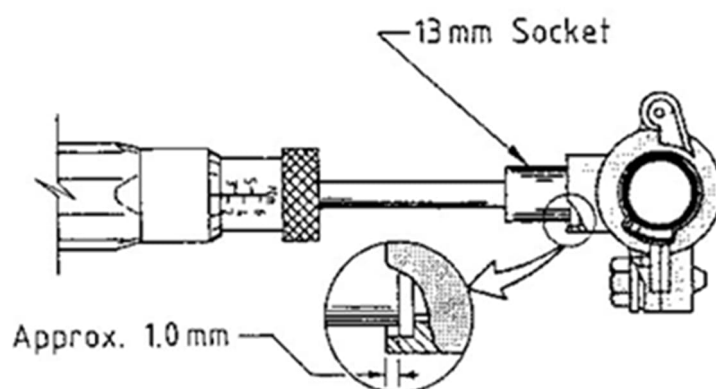
STEP 2: Pivot CLAH away from discharge connector. Remove protective paper from front half of the connector and place connector firmly onto conductor checking that tie wire is directly behind discharge pin.



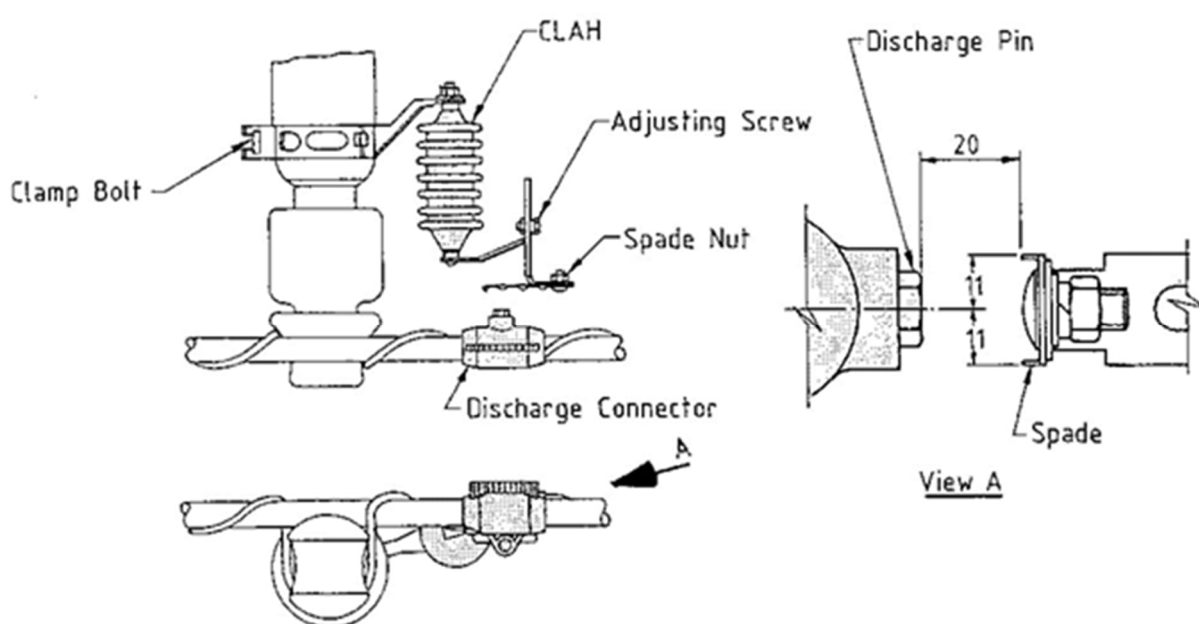
STEP 3: Remove protective paper from back half of connector and close over conductor, checking securing tabs are fully home. Check that setting on torque limiting screwdriver is 1.5 Nm and tighten securing bolt



STEP 4: Screw in discharge pin with torque limiting screwdriver still set at 1.5 Nm. Visually check that flange of discharge pin is recessed into body by approx. 1.0mm.



STEP 5: Pivot CLAH into position and tighten clamp bolt using adjustments provided. Align spade centrally with discharge pin on connector and check that the gap between connector and spade is 20mm. Reset torque limiting screwdriver to 3.5 Nm and tighten spade nut and adjusting screw

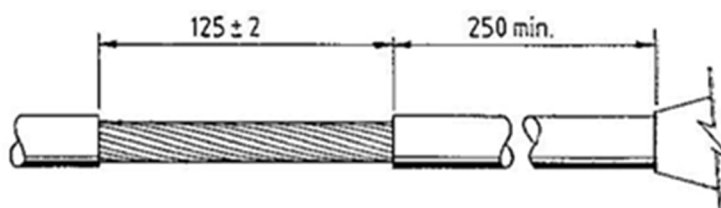


Notes:

1. The air gap for an 11kV CLAH is 20mm, as shown above.
2. The air gap for a 22kV CLAH must be set to 50mm

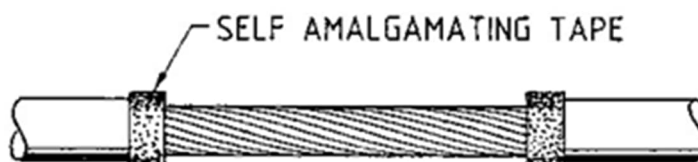
5.2.5 CCT installation of cover for earth locations

STEP 1: Check that the earth point is located at least 250mm from any other line component (such as tie wire and clamp covers) and in a position clear of any obstruction, so that cover can be placed or removed using the live line method. Remove 125mm of insulation.



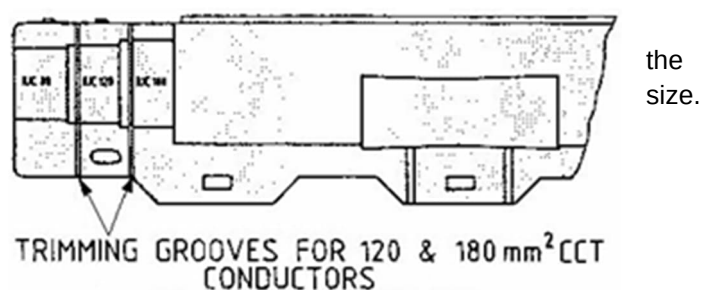
STEP 2: FOR 80mm² CCT ONLY

Wind three (3) layers of self-amalgamating tape onto insulation each side of stripped section.



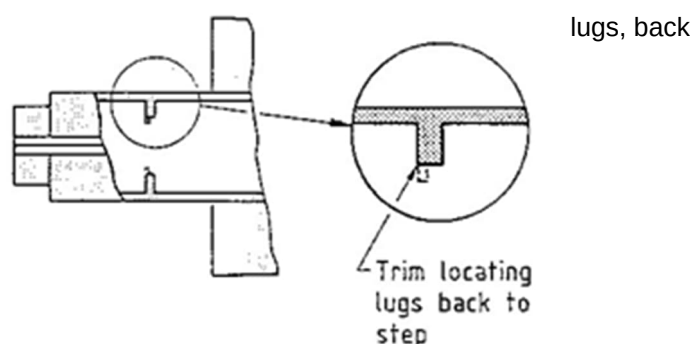
STEP 3: FOR 120 and 180mm² CCT ONLY

Using a knife, trim each end of the cover at grooves, related to the required conductor

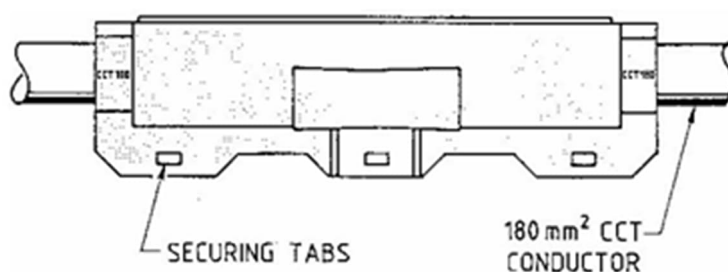


STEP 4: FOR CCT 120 and 180 mm² ONLY

Using a knife, carefully trim the four locating to the step

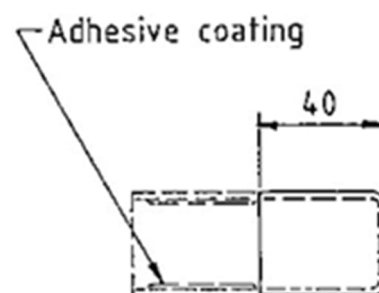


STEP 5: Close cover over the conductor checking that the locating lugs are adjacent to stripped section, preventing the cover from sliding along the conductor. Check that all securing tabs are fully closed



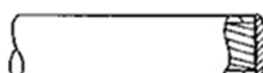
5.2.6 CCT installation of end seals

STEP 1: Cut one end seal to a length of 40mm, removing the adhesive coated section of the cap.

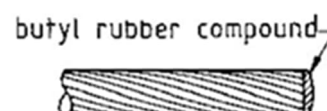


STEP 2: Mould a piece of butyl rubber compound onto the end of the conductor to smooth over any sharp edges

INSULATED END



STRIPPED END

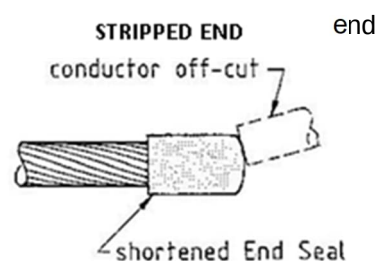


STEP 3: Heat shrink shortened end seal onto of conductor while applying slight pressure to the end of the seal with a piece of conductor off-cut, as seal will tend to slide off the conductor as it shrinks. (Note: For stripped CCT 80mm², the seal may still be loose after shrinking.)

INSULATED END



STRIPPED END

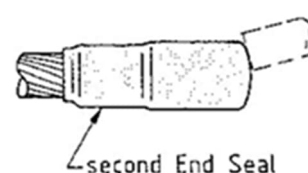


STEP 4: Place second end seal over the first, heat shrink while applying slight pressure to the end of the seal, as in Step 3

INSULATED END



STRIPPED END



5.2.7 HV CCT mains drawings

Drawing No.	Amend. No.	Subject	Const. no.
332026	C	Through suspension with CLAH/DC 1 Xarm (Delta)	C21
332027	C	Through suspension with CLAH/DC (Vertical)	C21-V
332028	C	Through suspension with CLAH/DC 2 Xarms (Delta)	C22
332029	C	Through strained angle argmnt 0-80° 1 Xarm (Delta)	C23
332030	B	Through strained angle argmnt 0-90° (Vertical)	C23-V
332031	C	Through strained angle argmnt 0-80° 2 Xarm (Delta)	C24
332032	B	Termination 1 Xarm with drop out fuse (Delta)	C25
332033	A	Termination (Vertical)	C25-V
332034	B	Termination 2 Xarm with drop out fuse (Delta)	C26
332035	C	Tee-off from bare mains (Delta)	B21+C25
332036	B	3 Way Tee-off from CCT mains (Vertical)	C23-V+C25-V
		4 Way Tee-off from CCT mains (Vertical)	C23-V+C23-V

5.3 11kV NMSHVABC mains construction

5.3.1 Cable system description

5.3.1.1 Cable details and configuration

Non-metallic screened high voltage aerial bundled cables (NMSHVABC) are cross-linked polyethylene (XLPE) insulated, non-metallic screened, three phase, aerial bundled cables (ABC) laid up around a support conductor.

The phase cable is an assembly comprising an aluminium conductor, semi-conducting inner conductor screen (XLPE), insulation (XLPE) and a dual semi-conducting outer insulation screen (XLPE + HDPE).

The support conductor or catenary is bare semi-compacted AAAC (1120 Alloy).

Effective March 2020, no new spans of NMSHVABC will be allowed to be installed in the network.

Electrical characteristics

NMSHVABC is an adaptation of an underground cable design that uses an outer SEMI-CONDUCTING screen, which is kept at earth potential by virtue of regular contact with the solidly earthed bare catenary to:

- a) Contain the electrical stresses within the cable's insulation and hence prevent insulation failure.
- b) Discharge any capacitive voltages to the earthed catenary thus establishing that the screen is at zero volts. Therefore, care must be taken to keep the bundled cable in as close a contact to the catenary as possible.

Extensive testing revealed that acceptable voltages on the semi-conducting screen of less than two (2) volts were measured when two (2) metres of phase conductor were moved one (1) metre away from the earthed catenary.

Therefore, at terminations (such as ABC to bare) where cable loops are required, the phase conductors must not be moved away from the catenary by more than is necessary so as to restrict any capacitive voltages that may appear on the conductor screen.

Testing by the former State Electricity Commission of Victoria (SECV) has shown that even a tree branch that has completely abraded the screen and some of the insulation, will carry leakage current, although at negligible levels.

- c) The semi-conducting screen also provides a path to earth (through the catenary) for an insulation failure. This is also applicable when the catenary is separated from the bundle at termination points. SECV testing has shown that a definitive path to earth exists at these points through the screen and that, even though the screen may burn while the fault current (at say a termination) finds a path to the earthed catenary, the burning ceases once the cable is de-energised.

5.3.1.2 Standard cable sizes

Endeavour Energy's standard 11kV NMSHVABC cable sizes are 50mm² and 150mm² and shall conform to ETS 0059 – Aerial Bundled Cable.

The semi-conducting outer screen is now manufactured using an inner screen consisting of 0.6mm of semi-conducting XLPE and an outer screen of 1.2mm of semi-conducting HDPE.

5.3.1.3 Classification

NMSHVABC has been classified as a screened cable with the screen at earth potential.

5.3.1.4 Precautions for work on or near NMSHVABC

Refer Electrical Safety Rules

5.3.1.5 Earthing requirements

As previously stated, NMSHVABC requires a solidly earthed catenary. This is achieved by using either a number of electrodes along the length of the cable with the catenary being electrically continuous throughout, or by bonding the catenary to the LV neutral. For specific details, refer to the earthing section of this manual.

5.3.1.6 Stringing

Stringing and terminating NMSHVABC requires different techniques to open wire and requires equipment such as stringing rollers, suspension clamps and heat shrink terminations.

Care when handling the cable is of particular importance. To avoid possible cable failure, the following must be observed:

- a) Under no circumstances must the cable be dragged along the ground. This can result in abrasion and/or stones being lodged within the bundled construction, leading to failure in the future.
- b) The catenary must be visually checked to establish that no burrs or sharp edges can penetrate the insulation screen.

Care must be taken during installation not to cut or damage the outer semi-conducting screen. Damage to the outer semi-conducting screen can result in the ultimate failure of the cable.

When stringing NMSHVABC, it must be remembered that the outer covering is SEMI-CONDUCTING and, if brought into contact with live exposed conductors (such as loose tails dangling down into bare LV mains), the outer surface will become live and dangerous.

It is recommended that before stringing NMSHVABC commences, the training DVD/videos As Easy As ABC and Now Screening ABC be viewed to refresh stringing techniques and to reinforce the fact that the outer layer is a semi-conductor.

5.3.1.7 Tree trimming

Non metallic screened high voltage ABC requires minimal tree trimming. Heavy tree branches, if allowed permanent contact with the cable, may abrade the insulation screen and the insulation. Therefore, trees must be trimmed to provide a minimum clearance as shown in MMI 0013 – Clearances to be Maintained Between Network Assets and Vegetation. Branches within this envelope may be trimmed with the cable in service, provided this can be achieved without subsequent damage to the cable from falling branches.

5.3.1.8 Hook separation

Separation between the NMSHVABC hook and the LVABC hook bolt (hook separation) must be as specified on the project drawing. Typically this distance will be from 1.365m to 2.73m (refer to Drawing no. 012000 in Section 3 of this manual for details).

5.3.2 11kV NMSHVABC drawings – 50 and 150mm²

Drawing No.	Amend. No.	Subject	Const. no.
332037	B	Through suspension 0 - 45° deviation plus in line joint	A21
332038	B	Strained through 0 - 90° deviation	A23
332039	B	Termination	A25
332040	A	Tee-off from bare mains	B21+A25
332041	A	3-Way tee-off from HVABC mains	A23-I+A25
		4 Way tee-off from HVABC mains	A23-I+A23-I

5.4 Bare mains constructions

5.4.1 HV bare mains drawings

Drawing No.	Amend. No.	Subject	Const. no.
332042	A	Pin insulator – single crossarm	B21
332043	A	Pin insulator – double crossarm	B22
332044	A	Through strain – single crossarm	B23
332045	A	Through strain – double crossarm	B24
332046	A	Termination – single crossarm	B25
332047	A	Termination – double crossarm	B26
332048	B	Tee-off from bare mains	B21+B25
332049	A	3-Way tee-off from bare mains	B23 +B25
		4-Way tee-off from bare mains	B23 +B23

5.5 12.7kV SWER mains constructions

5.5.1 12.7KV SWER mains drawings

Drawing No.	Amend. No.	Subject	Const. no.
332050	B	Pin insulators-single pin and double pin	SW21 & SW22
332051	A	Through strain	SW23
332052	A	Termination	SW25
332053	A	Angle strain 90° deviation	SW25+SW25
332054	A	Tee-off strain or pins	SW25+SW25+S W25

6 Transmission constructions

6.1 33kV and 66kV mains constructions

6.1.1 33kV and 66kV mains drawings

Drawing No.	Amend. No.	Subject	Const. no.
397999	B	Delta Line Post	61C
398011	B	Delta Line Post	61S
398023	B	Delta Line Post	61T
398000	B	Vertical Line Post	62C
398012	B	Vertical Line Post	62S
398024	B	Vertical Line Post	62T
398001	B	Vertical Through Strain - Deviation 0-60°	63C
398013	B	Vertical Through Strain - Deviation 0-60°	63S
398025	B	Vertical Through Strain - Deviation 0-60°	63T
398002	B	Vertical Through Strain - Deviation 60-90°	64C
398014	B	Vertical Through Strain - Deviation 60-90°	64S
398026	B	Vertical Through Strain - Deviation 60-90°	64T
398003	A	Vertical Angle Suspension	65C
398015	A	Vertical Angle Suspension	65S
398027	A	Vertical Angle Suspension	65T
398004	B	Delta Through Strain	66C
398016	B	Delta Through Strain	66S
398028	B	Delta Through Strain	66T
398005	B	Landing Structure - 2 Pole Concrete	-
398017	B	Landing Structure - 2 Pole Steel	-
398029	B	Landing Structure - 2 Pole Timber	-
398009	A	Auto Recloser - Concrete Pole	-
398021	A	Auto Recloser - Steel Pole	-
398033	A	Auto Recloser - Timber Pole	-
398006	B	Vertical Load Break Switch - Concrete Pole	-
398018	B	Vertical Load Break Switch - Steel Pole	-
398030	B	Vertical Load Break Switch - Timber Pole	-
398007	C	UG/OH Delta Termination	50C
398019	C	UG/OH Delta Termination	50S
398031	C	UG/OH Delta Termination	50T

Overhead construction standards manual

398008	C	UG/OH Vertical Termination	50VC
398020	C	UG/OH Vertical Termination	50VS
398032	C	UG/OH Vertical Termination	50VT
398010	B	UG/OH Delta Termination	60C
398022	B	UG/OH Delta Termination	60S
398034	B	UG/OH Delta Termination	60T

6.2 132kV mains constructions

6.2.1 132kV main drawings

Drawing no.	Amend no.	Subject	Const. no.*
397791	B	Delta Line Post	81C
397801	B	Delta Line Post	81S
397811	B	Delta Line Post	81T
537447	A	Delta Line Post	81XT
537921	A	Delta Line Post	81XC
537922	A	Delta Line Post	81XS
537448	A	Delta Horizontal Braced Post	
397792	B	Vertical Line Post	82C
397802	B	Vertical Line Post	82S
397812	B	Vertical Line Post	82T
537449	A	Vertical Horizontal Braced Post	
397793	B	Vertical Through Strain - Deviation 0-60°	83C
397803	B	Vertical Through Strain - Deviation 0-60°	83S
397813	B	Vertical Through Strain - Deviation 0-60°	83T
397794	B	Vertical Through Strain - Deviation 60-90°	84C
397804	B	Vertical Through Strain - Deviation 60-90°	84S
397814	B	Vertical Through Strain - Deviation 60-90°	84T
397795	A	Vertical Angle Suspension	85C
397805	A	Vertical Angle Suspension	85S
397815	A	Vertical Angle Suspension	85T
397797	B	Delta Through Strain	86C
397807	B	Delta Through Strain	86S
397817	B	Delta Through Strain	86T
397796	B	Vertical Termination	86VC
397806	B	Vertical Termination	86VS
397816	B	Vertical Termination	86VT
397798	B	Landing structure - 2 Pole Concrete	
397808	B	Landing structure - 2 Pole Steel	
397818	B	Landing structure - 2 Pole Timber	
397799	B	UG/OH Delta Termination	80C
397809	B	UG/OH Delta Termination	80S
397819	B	UG/OH Delta Termination	80T

Overhead construction standards manual

397800	B	UG/OH Vertical Termination	80VC
397810	B	UG/OH Vertical Termination	80VS
397820	B	UG/OH Vertical Termination	80VT

6.3 Earthing, OHEW and OPGW

6.3.1 Earthing, OHEW and OPGW drawings

Drawing No.	Amend. No.	Subject
051125	K	Earthing connection assemblies for concrete/steel poles
056814	K	Earthing installation detail - Concrete/steel poles
048340	M	Earthing installation detail - Timber poles
298799	B	Earthwire suspension/termination bracket
366177	D	Earthwire raiser bracket
502181	B	OHEW Assembly Type 1 - Suspension
502182	B	OHEW Assembly Type 2 - Through Strain
504728	B	OHEW Assembly Type 3 - Angle Suspension
502183	A	OHEW Assembly Type 4 - Termination
344471	B	OPGW Assembly Type 1 - Suspension
298176	D	OPGW Assembly Type 2 - Through Strain Without Splice
298166	D	OPGW Assembly Type 3 - Through Strain With Splice
298128	F	OPGW Assembly Type 4 - Termination

6.4 Assemblies and general requirements

6.4.1 Assemblies and general drawings

Drawing No.	Amend. No.	Subject
240600	D	Assembly details for concrete poles
398036	B	Assembly details for steel poles
054798	C	Assembly details for timber poles
309590	C	132kV long rod suspension assembly
398035	B	Line post insulator assembly
398038	B	Long rod insulator termination assembly
398037	B	Long rod insulator angle suspension assembly
048342	L	Pole stay assembly
048343	M	Ground stay assembly
367719	D	Pole foundation details
079985	C	Stay insulator
502043	C	132kV horizontal V string suspension bracket
537451	A	H2 steel channel modified crossarm
537452	A	RC pole base biscuit with lifting hook
537453	A	132kV 4.5m crossarm
537454	A	132kV 4.5m crossarm brace

6.5 Parts and fabrication drawings

6.5.1 Parts list and fabrication drawings

Drawing No.	Amend. No.	Subject
399844	C	Conductor fittings
061648	E	Crossarm for 132kV landing span
056304	D	Crossarm for 33/66kV landing span
052796	G	Crossarm type C3
048761	G	Pole band 125kN – 2 piece

7 Stringing tables

7.1 Bare mains

Note: All tensions are for NEW conductors. For previously tensioned conductor, ADD 10 °C to ambient temperature.

Example: Table 1 - If the ambient temperature is 20 °C, and the span to be erected is 40 metres, the following sag measurements apply:

- New conductor, sag = 540mm.
- Previously tensioned conductor, sag = 620mm.

7.1.1 Table selection guide

Cable type	%CBL @ 5 °C	Basic span (metres)				
		35	45	110	150	200
AAC	5	Table 5	-	-	-	-
	7	-	Table 1	-	-	-
	18	-	Table 6	-	-	-
	21	-	-	Table 2	-	-
AAAC	4.7	-	Table 1	-	-	-
	13.5	-	-	Table 2	-	-
	18	-	-	-	Table 3B	-
	20.5	-	-	-	Table 3	-
ACSR 6/1	20	-	-	-	Table 3	-
ACSR 6/7	22	-	-	-	-	Table 3A
Copper	7	-	Table 4	-	-	-

7.1.2 Table 1 – AAC and AAAC conductors – (by sag 30 to 60m) armour rods not required

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
30	220	250	280	300	330	350	370	390
35	300	340	380	410	450	480	510	540
40	400	450	490	540	580	620	660	700
45	500	570	630	680	740	790	840	890
50	620	700	770	840	910	970	1030	1090
55	750	840	930	1010	1100	1180	1250	1320
60	890	1000	1100	1200	1300	1400	1490	1570

7.1.3 Table 2 – AAC and AAAC conductors – (by sag 60 to 150m) armour rods must be fitted

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	320	350	390	430	460	500	540	570
70	430	480	530	580	630	680	730	780
80	560	630	700	760	820	890	960	1020
90	710	800	880	960	1040	1120	1210	1290
100	880	980	1090	1190	1290	1390	1500	1600
110	1060	1190	1320	1440	1560	1680	1810	1930
120	1260	1410	1560	1710	1850	2000	2150	2300
130	1480	1660	1840	2020	2190	2360	2540	2720
140	1720	1930	2140	2340	2530	2730	2930	3130
150	1970	2210	2460	2690	2910	3130	3360	3600

- Sags given are for initial conditions for use on all aluminium conductors up to and including 7/4.5, and AAAC conductors up to 7/3.75 (basic span = 110m).
- Tensions are based on 21% CBL at 5 °C AAC conductor, 13.5% CBL at 5 °C AAAC conductor.

7.1.4 Table 3 - ACSR/GZ (6/1 stranding) and AAAC conductors - (by sag 90 to 210m) armour rods must be fitted

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
90	500	530	580	630	670	710	760	800
100	620	660	720	780	840	890	950	1000
110	750	790	860	930	1000	1070	1140	1200
120	900	940	1030	1110	1190	1260	1350	1420
130	1050	1110	1200	1300	1400	1490	1580	1670
140	1220	1280	1410	1520	1620	1730	1840	1940
150	1400	1470	1610	1740	1860	1980	2110	2220
160	1590	1680	1830	1980	2120	2260	2400	2540
170	1800	1880	2050	2220	2380	2540	2700	2860
180	2020	2120	2310	2500	2680	2860	3030	3200
190	2250	2360	2570	2780	2980	3180	3380	3580
200	2490	2620	2850	3080	3310	3540	375 0	3960
210	2740	2880	3140	3400	3660	3920	4160	4360

- Sags given are for initial conditions (basic span = 150m).
- Tensions for Table 3 based on 20% CBL at 5 °C ACSR and 20.5% CBL at 5 °C AAAC.

7.1.5 Table 3A - ACSR/GZ (6/7 stranding - Cherry) conductors - (by sag 100 to 320m) armour rods must be fitted

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
100	610	650	680	720	760	800	840	870
110	740	790	830	870	910	960	1010	1060
120	880	940	980	1030	1090	1140	1200	1260
130	1040	1100	1150	1210	1280	1340	1410	1470
140	1200	1270	1340	1410	1480	1560	1640	1710
150	1380	1460	1540	1610	1700	1790	1880	1960
160	1570	1660	1750	1840	1930	2040	2140	2230
170	1770	1880	1970	2070	2180	2300	2410	2520
180	1980	2110	2210	2320	2450	2580	2710	2830
190	2210	2350	2460	2590	2730	2870	3010	3150
200	2450	2600	2730	2870	3020	3180	3340	3490
210	2700	2870	3010	3160	3330	3510	3680	3850
220	2960	3150	3300	3470	3650	3850	4040	4220
230	3240	3440	3610	3800	3990	4210	4420	4620
240	3530	3740	3930	4130	4350	4580	4810	5030
250	3830	4060	4270	4480	4720	4970	5220	5450
260	4140	4390	4610	4850	5100	5370	5640	5900
270	4470	4740	4980	5230	5500	5800	6090	6360
280	4800	5100	5350	5630	5920	6230	6550	6840
290	5150	5470	5740	6030	6350	6690	7020	7340
300	5510	5850	6140	6460	6800	7160	7520	7850
310	5890	6250	6560	6900	7260	7640	8020	8380
320	6270	6660	6990	7350	7730	8140	8550	8930

- Sags given are for initial conditions for use on Cherry conductors (basic span = 200m).
- Tensions are based on 22% CBL at 5 °C.
- Maximum span for standard 455mm delta construction is 180 metres.

7.1.6 Table 3B - AAAC conductors only - (by sag 90 to 210m) armour rods must be fitted

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
90	560	690	760	850	950	1060	1160	1260
100	700	780	850	930	1040	1150	1260	1370
110	860	950	1030	1130	1240	1360	1470	1590
120	1030	1140	1230	1330	1450	1580	1710	1830
130	1220	1340	1450	1560	1690	1820	1950	2080
140	1430	1560	1680	1800	1940	2070	2210	2350
150	1660	1800	1920	2050	2200	2350	2490	2630
160	1910	2060	2190	2330	2480	2630	2780	2930
170	2180	2330	2470	2620	2780	2930	3090	3240
180	2460	2620	2770	2920	3090	3250	3410	3570
190	2760	2940	3090	3250	3420	3590	3750	3920
200	3090	3260	3430	3590	3760	3940	4110	4270
210	3430	3610	3780	3940	4120	4300	4480	4650

- Sags given are for initial conditions (basic span = 150m)
- Tensions are based on 18% CBL at 5 °C.

7.1.7 Table 4 - Copper conductors only - (by sag 30 to 60m) armour rods not required

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
30	310	330	340	360	380	390	410	430
35	420	450	470	490	520	540	560	590
40	550	580	610	640	670	700	730	760
45	700	740	780	810	850	890	930	970
50	860	910	960	1000	1050	1090	1140	1190
55	1050	1100	1160	1210	1270	1320	1380	1440
60	1240	1310	1380	1450	1520	1580	1650	1720

- Sags given are for initial conditions (basic span = 45m).
- Tensions are based on 7% CBL at 5 °C

7.1.8 Table 5 - AAC conductors only - (by sag 20 to 45m) armour roads not required

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	150	160	170	190	200	210	220	240
25	230	250	270	290	310	330	350	370
30	330	360	390	420	440	470	500	530
35	450	490	530	570	600	640	680	720
40	590	640	670	740	790	840	890	940
45	740	810	870	940	1000	1060	1130	1190

- Sags given are for initial conditions (basic span = 35m).
- Tensions are based on 5% CBL at 5 °C
- This chart to be used for 7/4.5 to 19/3.75 all aluminium conductors erected on low voltage lines only, or as slack spans on high voltage lines.
- A slack span must not exceed 25m in length

7.1.9 Table 6 - AAC conductors only - (by sag 30 to 90m) armour rods must be fitted

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
30	80	90	110	140	160	190	220	250
35	100	120	150	190	220	260	310	350
40	130	160	190	240	290	340	400	450
45	170	200	250	310	370	430	500	570
50	210	240	300	380	460	530	620	710
55	250	290	360	460	550	640	750	860
60	300	350	430	550	660	770	900	1020
65	350	410	500	640	770	900	1050	1200
70	410	480	610	750	890	1040	1220	1390
75	470	550	670	860	1030	1200	1400	1590
80	540	620	760	970	1170	1360	1590	1810
85	610	700	860	1100	1320	1540	1800	2040
90	680	790	960	1230	1480	1720	2020	2290

- Sags given are for initial conditions for use on all aluminium conductors from 7/4.5 up to and including 19/3.75 (basic span = 45m).
- Tensions are based on 18% CBL at 5 °C.

7.2 Low voltage aerial bundled cable (LVABC)

Note: All tensions are for NEW conductors. For previously tensioned conductor, ADD 10°C to ambient temperature.

Example: Table LV8 – If the ambient temperature is 20°C and the span to be erected is 40 metres the following tensions apply:

- New conductor, tension = 3.111 kN.
- Previously tensioned conductor, tension = 2.866 kN

7.2.1 Table selection guide

Cable type	%CBL @ 5°C	Tension method		Sag method	
		20 - 60m span	60 - 100m span	20 - 60m span	60 - 100m span
2x25mm ²	6	Table LVS1	-	Table LVS3	-
4x25mm ²	6	Table LVS5	-	Table LVS7	-
	11	-	Table LVS6*	-	Table LVS8*
4x95mm ²	6	Table LV8	-	Table LV10	-
	11	-	Table LV9	-	Table LV11
4x150mm ²	6	Table LV19	-	Table LV21	-
	11	-	Table LV20	-	Table LV22

* Maximum 80m span for 4 x 25mm²

7.2.2 Table LVS1 - 2 x25mm² LVABC (service by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	-	0.49	0.42	0.37	0.34	0.31	0.29	0.27
25	-	0.46	0.42	0.39	0.36	0.34	0.32	0.30
30	-	0.45	0.42	0.40	0.37	0.36	0.34	0.33
35	-	0.44	0.42	0.40	0.38	0.37	0.36	0.34
40	-	0.44	0.42	0.41	0.39	0.38	0.37	0.36
45	-	0.43	0.42	0.41	0.40	0.39	0.38	0.37
50	-	0.43	0.42	0.41	0.40	0.39	0.38	0.38
55	-	0.43	0.42	0.41	0.40	0.40	0.39	0.38
60	-	0.43	0.42	0.41	0.41	0.40	0.39	0.39

- Tensions are based on 6% CBL at 5 °C

7.2.3 Table LVS3 – 2x25mm² LV ABC (service by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	-	200	230	260	290	320	340	370
25	-	330	370	400	430	460	480	510
30	-	490	530	560	590	620	650	680
35	-	680	720	750	780	810	850	870
40	-	900	930	970	1000	1040	1070	1100
45	-	1150	1180	1220	1250	1290	1320	1350
50	-	1430	1460	1500	1530	1570	1600	1630
55	-	1730	1770	1800	1840	1870	1910	1940
60	-	2070	2110	2140	2180	2210	2250	2280

- Tensions are based on 6% CBL at 5 °C

7.2.4 Table LVS5 - 4x25mm² LVABC (service by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	-	0.97	0.84	0.74	0.67	0.62	0.57	0.54
25	-	0.93	0.84	0.77	0.72	0.67	0.64	0.60
30	-	0.90	0.84	0.79	0.75	0.71	0.68	0.65
35	-	0.88	0.84	0.80	0.77	0.74	0.71	0.69
40	-	0.87	0.84	0.81	0.78	0.76	0.74	0.71
45	-	0.87	0.84	0.82	0.79	0.77	0.75	0.74
50	-	0.86	0.84	0.82	0.80	0.78	0.77	0.75
55	-	0.86	0.84	0.82	0.81	0.79	0.78	0.77
60	-	0.85	0.84	0.83	0.81	0.80	0.79	0.78

- Tensions are based on 6% CBL at 5 °C

7.2.5 Table LVS6 - 4x25mm² LV ABC (service by tension 60 to 80m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60	-	1.63	1.54	1.46	1.40	1.34	1.29	1.24
65	-	1.61	1.54	1.47	1.42	1.36	1.32	1.27
70	-	1.60	1.54	1.48	1.43	1.38	1.34	1.30
75	-	1.60	1.54	1.49	1.44	1.40	1.36	1.32
80	-	1.59	1.54	1.49	1.45	1.41	1.38	1.34

- Tensions are based on 11% CBL at 5 °C

7.2.6 Table LVS7 - 4x25mm² LV ABC (service by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	-	200	230	260	290	320	340	370
25	-	330	370	400	430	460	480	510
30	-	490	530	560	590	620	650	680
35	-	680	720	750	780	810	850	870
40	-	900	930	970	1000	1040	1070	1100
45	-	1150	1180	1220	1250	1290	1320	1350
50	-	1430	1460	1500	1530	1570	1600	1630
55	-	1730	1770	1800	1840	1870	1910	1940
60	-	2070	2110	2140	2180	2210	2250	2280

- Tensions are based on 6% CBL at 5 °C

7.2.7 Table LVS8 - 4x25mm² LV ABC (service by sag 60 to 80m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	-	1090	1150	1210	1260	1320	1370	1420
65	-	1280	1350	1410	1460	1520	1580	1630
70	-	1500	1560	1620	1680	1740	1800	1850
75	-	1730	1790	1850	1910	1970	2030	2090
80	-	1980	2040	2100	2160	2220	2280	2340

- Tensions are based on 11% CBL at 5 °C

7.2.8 Table LV8 - 4x95mm² LV ABC (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	3.913	3.259	3.192	3.127	2.721	2.429	2.208	2.035
25	3.749	3.303	3.192	3.089	2.807	2.585	2.405	2.257
30	3.616	3.303	3.192	3.090	2.880	2.705	2.557	2.430
35	3.520	3.292	3.192	3.100	2.936	2.796	2.673	2.564
40	3.451	3.279	3.192	3.111	2.981	2.866	2.763	2.670
45	3.401	3.267	3.192	3.121	3.016	2.920	2.833	2.753
50	3.364	3.257	3.192	3.130	3.043	2.963	2.888	2.819
55	3.335	3.248	3.192	3.138	3.065	2.997	2.932	2.872
60	3.313	3.240	3.192	3.145	3.083	3.024	2.968	2.915

- Tensions are based on 6% CBL at 5 °C

7.2.9 Table LV9 – 4x95 mm² LV ABC (by tension 60 to 100m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60	6.583	6.129	5.852	5.604	5.298	5.032	4.800	4.596
65	6.487	6.100	5.852	5.628	5.357	5.119	4.908	4.719
70	6.408	6.074	5.852	5.650	5.409	5.193	5.000	4.827
75	6.341	6.051	5.852	5.668	5.453	5.258	5.082	4.922
80	6.286	6.032	5.852	5.686	5.492	5.315	5.154	5.005
85	6.239	6.015	5.852	5.700	5.525	5.365	5.216	5.079
90	6.199	6.000	5.852	5.713	5.554	5.408	5.270	5.145
95	6.165	5.989	5.852	5.725	5.581	5.446	5.320	5.203
100	6.135	5.977	5.852	5.735	5.604	5.479	5.364	5.253

- Tensions are based on 11% CBL at 5 °C

7.2.10 Table LV10 - 4x95mm² LV ABC (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	170	200	210	210	240	270	300	330
25	280	310	320	340	370	400	430	460
30	410	450	470	480	520	550	580	620
35	580	620	640	660	690	730	760	790
40	770	810	830	850	890	930	960	1000
45	990	1030	1060	1080	1120	1150	1190	1230
50	1240	1280	1360	1330	1370	1410	1440	1480
55	1510	1550	1580	1610	1650	1690	1720	1760
60	1810	1850	1880	1910	1950	1990	2030	2070

- Tensions are based on 6% CBL at 5 °C

7.2.11 Table LV11 - 4x95mm² LV ABC (by sag 60 to 100m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	910	970	1020	1070	1130	1190	1250	1300
65	1080	1150	1200	1250	1310	1370	1430	1490
70	1270	1340	1390	1440	1510	1570	1630	1690
75	1470	1540	1600	1650	1720	1780	1840	1900
80	1690	1760	1820	1870	1940	2000	2070	2130
85	1930	2000	2050	2110	2180	2240	2310	2370
90	2170	2250	2300	2360	2430	2500	2560	2630
95	2440	2510	2570	2630	2700	2760	2830	2900
100	2720	2790	2850	2910	2980	3050	3110	3180

- Tensions are based on 11% CBL at 5 °C

7.2.12 Table LV19 - 4x150mm² LV ABC (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	6.23	5.60	5.04	4.56	4.14	3.79	3.50	3.25
25	5.99	5.48	5.04	4.66	4.32	4.03	3.79	3.57
30	5.79	5.39	5.04	4.73	4.46	4.22	4.01	3.82
35	5.64	5.32	5.04	4.79	4.56	4.36	4.18	4.02
40	5.52	5.27	5.04	4.83	4.64	4.47	4.32	4.17
45	5.44	5.23	5.04	4.87	4.71	4.56	4.43	4.30
50	5.37	5.20	5.04	4.89	4.76	4.63	4.51	4.40
55	5.32	5.17	5.04	4.92	4.80	4.69	4.58	4.49
60	5.28	5.15	5.04	4.93	4.83	4.73	4.64	4.56

- Tensions are based on 6% CBL at 5 °C

7.2.13 Table LV20 - 4x150mm² LV ABC (by tension 60 to 100m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60	10.17	9.69	9.24	8.83	8.45	8.09	7.77	7.47
65	10.08	9.65	9.24	8.86	8.51	8.19	7.89	7.62
70	10.01	9.61	9.24	8.90	8.58	8.28	8.00	7.75
75	9.94	9.58	9.24	8.92	8.63	8.36	8.10	7.86
80	9.88	9.55	9.24	8.95	8.68	8.43	8.19	7.97
85	9.83	9.52	9.24	8.97	8.72	8.49	8.27	8.06
90	9.78	9.50	9.24	8.99	8.76	8.55	8.34	8.15
95	9.73	9.48	9.24	9.01	8.80	8.60	8.40	8.22
100	9.70	9.46	9.24	9.03	8.83	8.64	8.46	8.29

- Tensions are based on 11% CBL at 5 °C

7.2.14 Table LV21 - 4x150mm² (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	160	180	200	220	240	260	280	300
25	260	280	310	330	360	380	410	430
30	390	410	440	470	500	530	560	580
35	540	570	600	630	670	700	730	760
40	720	750	790	820	850	890	920	950
45	920	960	1000	1030	1070	1100	1130	1170
50	1150	1190	1230	1270	1300	1340	1370	1410
55	1410	1450	1490	1530	1560	1600	1640	1670
60	1690	1730	1770	1810	1850	1890	1920	1960

- Tensions are based on 6% CBL at 5 °C

7.2.15 Table LV22 - 4x150mm² LV ABC (by sag 60 to 100m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	880	920	970	1010	1060	1100	1150	1190
65	1040	1090	1130	1180	1230	1280	1330	1370
70	1210	1260	1310	1370	1420	1470	1520	1570
75	1400	1460	1510	1560	1620	1670	1720	1770
80	1610	1660	1720	1770	1830	1880	1940	1990
85	1820	1880	1940	2000	2050	2110	2170	2220
90	2050	2110	2170	2230	2290	2350	2410	2470
95	2300	2360	2420	2480	2540	2600	2660	2720
100	2560	2620	2680	2750	2810	2870	2930	2990

- Tensions are based on 11% CBL at 5 °C

7.3 High voltage aerial bundled cable (NMSHVABC)

Note: All tensions are for NEW conductors. For previously tensioned conductor, ADD 10°C to ambient temperature.

Example Table HV8A – If the ambient temperature is 20°C, and the span to be erected is 40 metres the following tensions apply:

- New conductor, tension = 2.677 kN.
- Previously tensioned conductor, tension = 2.567 kN

7.3.1 Table selection guide

Cable type	%CBL @ 5°C	Tension method		Sag method	
		20 – 60m span	60 – 90m span	20 – 60m span	60 – 90m span
3X50mm ²	10	Table HV8A	-	Table HV10A	-
	15	-	Table HV9A	-	Table HV11A
3X150mm ²	10	Table HV8	-	Table HV10	-
	15	-	Table HV9	-	Table HV11

7.3.2 Table HV8A – 50mm² NMSHVABC (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	3.047	2.744	2.710	2.678	2.466	2.298	2.159	2.044
25	2.945	2.761	2.710	2.663	2.524	2.405	2.301	2.211
30	2.882	2.758	2.710	2.665	2.565	2.478	2.399	2.327
35	2.840	2.752	2.710	2.671	2.597	2.530	2.467	2.409
40	2.812	2.746	2.710	2.677	2.620	2.567	2.516	2.469
45	2.791	2.741	2.710	2.682	2.636	2.594	2.552	2.514
50	2.776	2.742	2.710	2.686	2.649	2.614	2.581	2.548
55	2.765	2.749	2.710	2.689	2.659	2.629	2.602	2.573
60	2.756	2.745	2.710	2.692	2.666	2.642	2.617	2.594

- Tensions are based on 10% CBL at 5 °C

7.3.3 Table HV9A - 50mm² NMSHVABC (by tension 60 to 100m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60	4.232	4.132	4.065	4.001	3.918	3.838	3.764	3.693
65	4.207	4.124	4.065	4.010	3.938	3.868	3.804	3.742
70	4.188	4.118	4.065	4.016	3.954	3.893	3.837	3.782
75	4.173	4.113	4.065	4.020	3.966	3.915	3.863	3.816
80	4.161	4.119	4.065	4.026	3.977	3.932	3.888	3.843
85	4.148	4.119	4.065	4.031	3.986	3.947	3.908	3.866
90	4.140	4.112	4.065	4.032	3.995	3.960	3.925	3.887
95	4.142	4.107	4.065	4.037	4.004	3.968	3.936	3.905
100	4.135	4.101	4.065	4.037	4.007	3.978	3.949	3.921

- Tensions are based on 15% CBL at 5 °C

7.3.4 Table HV10A - 50mm² NMSHABC (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	270	300	310	310	340	360	380	410
25	440	470	480	490	510	540	560	590
30	650	680	690	700	730	750	780	800
35	900	930	940	950	980	1010	1030	1060
40	1190	1210	1230	1250	1270	1300	1330	1350
45	1520	1540	1560	1580	1610	1630	1660	1690
50	1890	1910	1930	1950	1980	2010	2030	2060
55	2300	2310	2350	2360	2390	2420	2450	2480
60	2750	2760	2800	2820	2850	2880	2910	2930

- Tensions are based on 10% CBL at 5 °C

7.3.5 Table HV11A - 50mm² NMSHVABC (by sag 60 to 100m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	1770	1820	1850	1880	1920	1960	2000	2040
65	2100	2140	2170	2200	2240	2280	2320	2360
70	2450	2490	2520	2550	2590	2640	2670	2720
75	2820	2860	2900	2930	2970	3010	3060	3090
80	3230	3260	3300	3340	3380	3420	3460	3500
85	3660	3690	3740	3770	3820	3860	3900	3940
90	4120	4150	4200	4240	4280	4320	4360	4400
95	4600	4640	4690	4730	4770	4810	4850	4890
100	5120	5160	5210	5250	5290	5330	5370	5410

- Tensions are based on 15% CBL at 5 °C

7.3.6 Table HV8 - 150mm² NMSHVABC (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	4.433	4.199	4.170	4.142	3.944	3.768	3.611	3.470
25	4.374	4.216	4.170	4.126	3.990	3.866	3.751	3.646
30	4.328	4.216	4.170	4.127	4.029	3.936	3.850	3.768
35	4.293	4.211	4.170	4.131	4.057	3.987	3.920	3.856
40	4.268	4.216	4.170	4.137	4.079	4.024	3.971	3.919
45	4.250	4.228	4.170	4.140	4.095	4.050	4.008	3.966
50	4.241	4.223	4.170	4.144	4.108	4.071	4.037	4.000
55	4.242	4.212	4.170	4.147	4.118	4.089	4.057	4.029
60	4.229	4.205	4.170	4.150	4.125	4.101	4.077	4.053

- Tensions are based on 10% CBL at 5 °C

7.3.7 Table HV9 - 150mm² NMSHVABC (by tension 60 to 90m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60	6.412	6.323	6.255	6.194	6.108	6.026	5.951	5.873
65	6.394	6.335	6.255	6.197	6.129	6.058	5.987	5.923
70	6.373	6.338	6.255	6.204	6.144	6.081	6.024	5.967
75	6.362	6.326	6.255	6.211	6.153	6.101	6.050	6.000
80	6.366	6.312	6.255	6.212	6.165	6.119	6.074	6.029
85	6.350	6.309	6.255	6.218	6.176	6.135	6.095	6.055
90	6.338	6.299	6.255	6.223	6.186	6.150	6.113	6.078

- Tensions are based on 15% CBL at 5 °C

7.3.8 Table HV10 - 150mm² MNSHVABC (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	350	370	370	370	390	410	430	440
25	550	570	580	580	600	620	640	660
30	800	830	830	840	860	880	900	920
35	1100	1130	1140	1150	1170	1190	1210	1230
40	1460	1480	1490	1500	1530	1550	1570	1590
45	1860	1870	1890	1910	1930	1950	1970	2000
50	2310	2320	2350	2360	2380	2410	2430	2450
55	2800	2820	2850	2870	2890	2910	2940	2960
60	3360	3380	3410	3430	3450	3470	3500	3520

- Tensions are based on 10% CBL at 5 °C

7.3.9 Table HV11 - 150mm² NMSHVABC (by sag 60 to 90m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	2180	2210	2240	2260	2290	2320	2360	2390
65	2570	2600	2630	2660	2669	2720	2750	2780
70	3000	3020	3060	3090	3120	3150	31580	3210
75	3460	3480	3520	3550	3580	3620	3650	3680
80	3950	3980	4020	4050	4080	4110	4150	4180
85	4480	4510	4550	4580	4610	4650	4680	4710
90	5050	5080	5120	5150	5180	5210	5250	5280

- Tensions are based on 15% CBL at 5 °C

7.4 11kV covered conductor thick (CCT)

Note: All tensions are for NEW conductors. For previously tensioned conductor ADD 10 °C to ambient temperature.

Example: Table CCT11 – If the ambient temperature is 20 °C, and the span to be erected is 40 metres the following tensions apply:

- New conductor, tension = 0.85 kN.
- Previously tensioned conductor, tension = 0.80 kN

7.4.1 Table selection guide

Cable type	%CBL @ 5°C	Tension method			Sag method		
		20–60m span	60–130m span	100–180m span	20–60m span	60–130m span	100–180m span
80mm ²	5	CCT11	-	-	CCT14	-	-
	10	-	CCT12	-	-	CCT15	-
	15	-	-	CCT13	-	-	CCT16
120mm ²	5	CCT17	-	-	CCT20	-	-
	10	-	CCT18	-	-	CCT21	-
	15	-	-	CCT19	-	-	CCT22
180mm ²	5	CCT23	-	-	CCT25	-	-
	10	-	CCT24	-	-	CCT26	-

7.4.2 Table CCT11 - 11kV 80mm² CCT (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20		1.00	0.88	0.79	0.72	0.67	0.63	0.59
25		0.96	0.88	0.82	0.77	0.72	0.69	0.65
30		0.93	0.88	0.83	0.79	0.76	0.73	0.70
35		0.92	0.88	0.85	0.81	0.79	0.76	0.74
40		0.91	0.88	0.85	0.83	0.80	0.78	0.76
45		0.90	0.88	0.86	0.84	0.82	0.80	0.78
50		0.90	0.88	0.86	0.84	0.83	0.81	0.80
55		0.90	0.88	0.86	0.85	0.84	0.82	0.81
60		0.89	0.88	0.87	0.85	0.84	0.83	0.82

- Tensions are based on 5% CBL at 5 °C

7.4.3 Table CCT12 - 11kV 80mm² CCT (by tension 60 to 130m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60		1.86	1.76	1.67	1.60	1.53	1.47	1.42
65		1.84	1.76	1.69	1.62	1.56	1.50	1.45
70		1.83	1.76	1.69	1.63	1.58	1.53	1.48
75		1.82	1.76	1.70	1.65	1.60	1.55	1.51
80		1.82	1.76	1.71	1.66	1.61	1.57	1.53
85		1.81	1.76	1.71	1.67	1.63	1.59	1.55
90		1.81	1.76	1.72	1.68	1.64	1.60	1.57
95		1.80	1.76	1.72	1.68	1.65	1.62	1.59
100		1.80	1.76	1.72	1.69	1.66	1.63	1.60
105		1.79	1.76	1.73	1.70	1.67	1.64	1.61
110		1.79	1.76	1.73	1.70	1.67	1.65	1.62
115		1.79	1.76	1.73	1.71	1.68	1.66	1.63

Overhead construction standards manual

120		1.79	1.76	1.73	1.71	1.69	1.67	1.64
125		1.78	1.76	1.74	1.71	1.69	1.67	1.65
130		1.78	1.76	1.74	1.72	1.70	1.68	1.66

- Tensions are based on 10% CBL at 5 °C

7.4.4 Table CCT13 - 11kV 80mm² CCT (by tension 100 to 180m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
100		2.75	2.64	2.54	2.45	2.36	2.28	2.21
105		2.74	2.64	2.55	2.46	2.38	2.31	2.24
110		2.74	2.64	2.55	2.47	2.40	2.33	2.27
115		2.73	2.64	2.56	2.48	2.41	2.35	2.29
120		2.72	2.64	2.56	2.49	2.43	2.37	2.31
125		2.72	2.64	2.57	2.50	2.44	2.38	2.33
130		2.71	2.64	2.57	2.51	2.45	2.40	2.35
145		2.71	2.64	2.58	2.52	2.47	2.41	2.36
140		2.70	2.64	2.58	2.53	2.48	2.43	2.38
145		2.70	2.64	2.59	2.53	2.48	2.44	2.39
150		2.69	2.64	2.59	2.54	2.49	2.45	2.41
155		2.69	2.64	2.59	2.55	2.50	2.46	2.42
160		2.69	2.64	2.59	2.55	2.51	2.47	2.43
165		2.69	2.64	2.60	2.56	2.52	2.48	2.44
170		2.68	2.64	2.60	2.56	2.52	2.49	2.45
175		2.68	2.64	2.60	2.56	2.53	2.49	2.46
180		2.68	2.64	2.60	2.57	2.53	2.50	2.47

- Tensions are based on 15% CBL at 5 °C

7.4.5 Table CCT14 - 11kV 80mm² CCT (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20		220	250	280	300	330	350	380
25		360	390	420	450	480	500	530
30		530	560	600	630	650	600	710
35		740	770	800	830	860	890	920
40		970	1000	1040	1070	1100	1130	1160
45		1240	1270	1300	1340	1370	1400	1430
50		1540	1570	1600	1640	1670	1700	1730
55		1870	1900	1930	1970	2000	2030	2060
60		2230	2260	2300	2330	2360	2390	2430

- Tensions are based on 5% CBL at 5 °C

7.4.6 Table CCT15 - 11kV 80mm² CCT (by sag 60 to 130m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60		1070	1130	1190	1240	1300	1350	1400
65		1260	1330	1380	1440	1500	1550	1610
70		1480	1540	1600	1660	1710	1770	1820
75		1700	1760	1830	1890	1940	2000	2060

Overhead construction standards manual

80		1940	2010	2070	2130	2190	2250	2310
85		2200	2270	2330	2390	2450	2510	2570
90		2480	2540	2610	2670	2730	2790	2850
95		2770	2830	2900	2960	3020	3080	3140
100		3070	3140	3200	3270	3330	3390	3450
105		3400	3460	3530	3590	3650	3720	3780
110		3730	3800	3870	3930	3990	4060	4120
115		4090	4150	4220	4280	4350	4410	4470
120		4460	4520	4590	4650	4720	4780	4840
125		4840	4910	4980	5040	5110	5170	5230
130		5240	5310	5380	5440	5510	5570	5640

- Tensions are based on 10% CBL at 5 °C

7.4.7 Table CCT16 - 11kV 80mm² CCT (by sag 100 to 180m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
100		2010	2090	2180	2260	2340	2420	2500
105		2220	2310	2390	2480	2560	2640	2720
110		2440	2530	2620	2700	2790	2870	2950
115		2680	2770	2850	2940	3030	3110	3190
120		2920	3010	3100	3190	3270	3360	3440
125		3180	3270	3360	3450	3530	3620	3700
130		3440	3540	3630	3720	3800	3890	3980
145		3720	3810	3910	4000	4080	4170	4260
140		4010	4100	4190	4290	4370	4460	4550
145		4310	4400	4490	4590	4680	4760	4850
150		4610	4710	4800	4900	4990	5080	5170
155		4930	5030	5120	5220	5310	5400	5490
160		5260	5360	5450	5550	5640	5730	5820
165		5600	5700	5800	5890	5980	6070	6170
170		5950	6050	6150	6240	6340	6430	6520
175		6320	6410	6510	6600	6700	6790	6880
180		6690	6790	6880	6980	7070	7170	7260

- Tensions are based on 15% CBL at 5 °C

7.4.8 Table CCT17 - 11kV 120mm² CCT (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20		1.56	1.35	1.20	1.09	1.00	0.93	0.87
25		1.49	1.35	1.25	1.16	1.09	1.03	0.97
30		1.45	1.35	1.27	1.21	1.15	1.10	1.05
35		1.43	1.35	1.29	1.24	1.19	1.15	1.11
40		1.41	1.35	1.31	1.26	1.22	1.19	1.15
45		1.40	1.35	1.32	1.28	1.25	1.21	1.19
50		1.39	1.35	1.32	1.29	1.26	1.24	1.21
55		1.38	1.35	1.33	1.30	1.28	1.26	1.23
60		1.38	1.35	1.33	1.31	1.29	1.27	1.25

- Tensions are based on 5% CBL at 5°C

7.4.9 Table CCT18 - 11kV 120mm² CCT (by tension 60 to 130m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60		2.88	2.71	2.56	2.43	2.32	2.22	2.13
65		2.86	2.71	2.58	2.46	2.36	2.27	2.19
70		2.84	2.71	2.59	2.49	2.40	2.31	2.24
75		2.83	2.71	2.61	2.51	2.43	2.35	2.28
80		2.81	2.71	2.62	2.53	2.46	2.38	2.32
85		2.80	2.71	2.63	2.55	2.48	2.41	2.35
90		2.79	2.71	2.63	2.56	2.50	2.44	2.38
95		2.78	2.71	2.64	2.58	2.52	2.46	2.41
100		2.78	2.71	2.65	2.59	2.53	2.48	2.43
105		2.77	2.71	2.65	2.60	2.55	2.50	2.45
110		2.77	2.71	2.66	2.61	2.56	2.52	2.47
115		2.76	2.71	2.66	2.62	2.57	2.53	2.49
120		2.76	2.71	2.67	2.62	2.58	2.54	2.50
125		2.75	2.71	2.67	2.63	2.59	2.55	2.52
130		2.75	2.71	2.67	2.63	2.60	2.56	2.53

- Tensions are based on 10% CBL at 5 °C

7.4.10 Table CCT19 – 11kV 120mm² CCT (by tension 100 to 180m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
100		4.26	4.06	3.89	3.73	3.59	3.45	3.34
105		4.25	4.06	3.90	3.75	3.62	3.49	3.38
110		4.23	4.06	3.91	3.77	3.65	3.53	3.42
115		4.22	4.07	3.92	3.79	3.67	3.56	3.46
120		4.21	4.06	3.93	3.81	3.70	3.59	3.50
125		4.20	4.06	3.94	3.83	3.72	3.62	3.53
130		4.19	4.06	3.95	3.84	3.74	3.65	3.56
145		4.18	4.06	3.96	3.85	3.76	3.67	3.59
140		4.17	4.06	3.96	3.87	3.78	3.69	3.61
145		4.17	4.06	3.97	3.88	3.79	3.71	3.64
150		4.16	4.06	3.97	3.89	3.81	3.73	3.66
155		4.16	4.06	3.98	3.90	3.82	3.75	3.68
160		4.15	4.06	3.98	3.91	3.83	3.76	3.70
165		4.15	4.06	3.99	3.92	3.85	3.78	3.72
170		4.14	4.06	3.99	3.92	3.86	3.79	3.73
175		4.14	4.06	4.00	3.93	3.87	3.81	3.75
180		4.13	4.06	4.00	3.94	3.88	3.82	3.76

- Tensions are based on 15% CBL at 5 °C

7.4.11 Table CCT20 - 11kV 120mm² CCT (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20		200	230	260	290	310	340	360
25		330	360	390	420	450	480	500
30		490	520	550	590	620	650	670
35		670	710	740	780	810	840	870

Overhead construction standards manual

40		890	930	960	1000	1030	1060	1090
45		1140	1170	1210	1240	1280	1310	1340
50		1410	1450	1490	1520	1550	1590	1620
55		1720	1750	1790	1830	1860	1890	1930
60		2050	2090	2120	2160	2200	2230	2260

- Tensions are based on 5% CBL at 5 °C

7.4.12 Table CCT21 - 11kV 120mm² CCT (by sag 60 to 130m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60		980	1040	1100	1160	1220	1270	1330
65		1160	1220	1290	1350	1410	1460	1520
70		1350	1420	1480	1550	1610	1660	1720
75		1560	1630	1690	1760	1820	1880	1940
80		1790	1850	1920	1980	2050	2110	2170
85		2030	2090	2160	2230	2290	2350	2410
90		2280	2350	2420	2480	2550	2610	2670
95		2550	2620	2680	2750	2820	2880	2940
100		2830	2900	2970	3040	3100	3170	3230
105		3130	3200	3270	3330	3400	3470	3530
110		3440	3510	3580	3650	3710	3780	3850
115		3760	3840	3910	3970	4040	4110	4180
120		4110	4180	4250	4320	4390	4450	4520
125		4460	4530	4600	4670	4740	4810	4880
130		4830	4900	4970	5040	5110	5180	5250

- Tensions are based on 10% CBL at 5 °C

7.4.13 Table CCT22 - 11kV 120mm² CCT (by sag 100 to 180m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
100		1840	1930	2020	2110	2190	2270	2350
105		2040	2130	2220	2310	2390	2480	2560
110		2240	2340	2430	2520	2610	2690	2780
115		2460	2550	2650	2740	2830	2920	3000
120		2690	2780	2880	2970	3060	3150	3230
125		2920	3020	3110	3210	3300	3390	3480
130		3170	3270	3360	3460	3550	3640	3730
145		3420	3520	3620	3710	3810	3900	3990
140		3690	3790	3890	3980	4080	4170	4260
145		3960	4060	4160	4260	4360	4450	4540
150		4250	4350	4450	4550	4640	4740	4830
155		4540	4640	4740	4840	4940	5040	5130
160		4850	4950	5050	5150	5250	5340	5440
165		5160	5260	5360	5470	5560	5660	5760
170		5480	5590	5690	5790	5890	5990	6090
175		5820	5920	6020	6130	6230	6330	6420
180		6160	6270	6370	6470	6570	6670	6770

- Tensions are based on 15% CBL at 5 °C

7.4.14 Table CCT23 - 11kV 180mm² CCT (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20		2.48	2.08	1.81	1.61	1.46	1.34	1.25
25		2.35	2.08	1.88	1.73	1.60	1.50	1.41
30		2.27	2.08	1.93	1.81	1.70	1.61	1.54
35		2.22	2.08	1.97	1.87	1.78	1.70	1.63
40		2.19	2.08	1.99	1.91	1.84	1.77	1.71
45		2.17	2.08	2.01	1.94	1.88	1.82	1.77
50		2.15	2.08	2.02	1.96	1.91	1.86	1.82
55		2.14	2.08	2.03	1.98	1.94	1.90	1.86
60		2.13	2.08	2.04	2.00	1.96	1.92	1.89

- Tensions are based on 5% CBL at 5 °C

7.4.15 Table CCT24 - 11kV 180mm² CCT (by tension 60 to 130m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60		4.49	4.17	3.90	3.66	3.46	3.28	3.13
65		4.45	4.17	3.93	3.72	3.53	3.37	3.23
70		4.42	4.17	3.95	3.76	3.59	3.44	3.31
75		4.39	4.17	3.98	3.80	3.65	3.51	3.39
80		4.37	4.17	3.99	3.84	3.70	3.57	3.45
85		4.35	4.17	4.01	3.87	3.74	3.62	3.51
90		4.33	4.17	4.03	3.89	3.77	3.66	3.56
95		4.31	4.17	4.04	3.92	3.81	3.70	3.61
100		4.30	4.17	4.05	3.94	3.84	3.74	3.65
105		4.29	4.17	4.06	3.96	3.86	3.77	3.69
110		4.28	4.17	4.07	3.97	3.89	3.80	3.72
115		4.27	4.17	4.08	3.99	3.91	3.83	3.75
120		4.26	4.17	4.08	4.00	3.92	3.85	3.78
125		4.26	4.17	4.09	4.01	3.94	3.87	3.81
130		4.25	4.17	4.10	4.02	3.96	3.89	3.83

- Tensions are based on 10% CBL at 5 °C

7.4.16 Table CCT25 - 11kV 180mm² CCT (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20		170	200	240	270	290	320	340
25		280	320	350	390	420	450	470
30		420	460	500	530	560	600	630
35		590	630	660	700	730	770	800
40		780	820	860	890	930	970	1000
45		1000	1040	1080	1110	1150	1190	1220
50		1240	1280	1320	1360	1400	1430	1470
55		1510	1550	1590	1630	1670	1710	1740
60		1800	1840	1880	1920	1960	2000	2040

- Tensions are based on 5% CBL at 5 °C

7.4.17 Table CCT26 - 11kV 180mm² CCT (by sag 60 to 130m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60		850	920	990	1050	1110	1170	1230
65		1010	1080	1150	1210	1280	1340	1400
70		1180	1250	1320	1390	1460	1520	1580
75		1370	1440	1510	1580	1650	1710	1770
80		1560	1640	1710	1780	1850	1920	1980
85		1770	1850	1920	1990	2060	2130	2200
90		2000	2070	2150	2220	2290	2360	2430
95		2230	2310	2390	2460	2530	2600	2670
100		2480	2560	2640	2710	2780	2860	2930
105		2750	2820	2900	2980	3050	3120	3190
110		3020	3100	3180	3250	3330	3400	3470
115		3310	3390	3470	3540	3620	3690	3760
120		3610	3690	3770	3840	3920	3990	4070
125		3920	4000	4080	4160	4240	4310	4390
130		4250	4330	4410	4490	4560	4640	4720

- Tensions are based on 10% CBL at 5 °C

7.5 22kV covered conductor thick (CCT)

Note: All tensions are for NEW conductors. For previously tensioned conductor, ADD 10 °C to ambient temperature.

Example: Table CCT7 – If the ambient temperature is 20 °C, and the span to be erected is 40 metres the following tensions apply:

- New conductor, tension = 1.33 kN.
- Previously tensioned conductor, tension = 1.27 kN

7.5.1 Table selection guide

Cable type	%CBL @ 5 °C	Tension method		Sag method	
		20 – 60m span	60 – 130m span	20 – 60m span	60 – 130m span
120mm ²	5	CCT7	-	CCT9	-
	10	-	CCT8	-	CCT10

7.5.2 Table CCT7 - 22kV 120mm² CCT (by tension 20 to 60m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
20	1.63	1.48	1.35	1.26	1.17	1.11	1.05	1.00
25	1.53	1.43	1.35	1.29	1.23	1.17	1.13	1.09
30	1.47	1.41	1.35	1.31	1.26	1.22	1.18	1.15
35	1.44	1.40	1.35	1.32	1.28	1.25	1.22	1.19
40	1.42	1.39	1.35	1.33	1.30	1.27	1.25	1.22
45	1.41	1.38	1.35	1.33	1.31	1.29	1.27	1.25
50	1.40	1.38	1.35	1.34	1.32	1.30	1.28	1.27
55	1.39	1.37	1.35	1.34	1.32	1.31	1.29	1.28
60	1.38	1.37	1.35	1.34	1.33	1.32	1.30	1.29

- Tensions are based on 5% CBL at 5 °C

7.5.3 Table CCT8 - 22kV 120mm² CCT (by tension 60 to 130m)

Span in metres	Tension in kiloNewtons @ °C							
	5	10	15	20	25	30	35	40
60	2.93	2.81	2.71	2.62	2.53	2.45	2.38	2.31
65	2.90	2.80	2.71	2.63	2.55	2.48	2.42	2.36
70	2.87	2.79	2.71	2.64	2.57	2.51	2.45	2.40
75	2.85	2.78	2.71	2.65	2.59	2.53	2.48	2.43
80	2.83	2.77	2.71	2.65	2.60	2.55	2.50	2.46
85	2.82	2.76	2.71	2.66	2.61	2.57	2.52	2.48
90	2.81	2.76	2.71	2.66	2.62	2.58	2.54	2.50
95	2.80	2.75	2.71	2.67	2.63	2.59	2.55	2.52
100	2.79	2.75	2.71	2.67	2.64	2.60	2.57	2.54
105	2.78	2.75	2.71	2.68	2.64	2.61	2.58	2.55
110	2.78	2.74	2.71	2.68	2.65	2.62	2.59	2.56
115	2.77	2.74	2.71	2.68	2.65	2.63	2.60	2.57
120	2.77	2.74	2.71	2.68	2.66	2.63	2.61	2.58
125	2.76	2.74	2.71	2.69	2.66	2.64	2.62	2.59
130	2.76	2.73	2.71	2.69	2.66	2.64	2.62	2.60

- Tensions are based on 10% CBL at 5 °C

7.5.4 Table CCT9 - 22kV 120mm² CCT (by sag 20 to 60m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
20	250	280	310	330	350	380	400	420
25	420	450	480	500	530	550	570	600
30	630	660	690	710	740	770	790	810
35	880	910	940	960	990	1020	1040	1070
40	1170	1200	1230	1250	1280	1300	1330	1360
45	1490	1520	1550	1580	1610	1630	1660	1680
50	1860	1890	1920	1940	1970	2000	2020	2050
55	2260	2290	2320	2350	2370	2400	2430	2450
60	2700	2730	2760	2790	2820	2840	2870	2900

- Tensions are based on 5% CBL at 5 °C

7.5.5 Table CCT10 - 22kV 120mm² CCT (by sag 60 to 130m)

Span in metres	Sag in millimetres @ °C							
	5	10	15	20	25	30	35	40
60	1270	1330	1380	1430	1480	1520	1570	1610
65	1510	1570	1620	1670	1720	1770	1810	1860
70	1770	1820	1880	1930	1980	2030	2070	2120
75	2050	2100	2150	2210	2260	2310	2360	2400
80	2340	2400	2450	2500	2550	2610	2660	2700
85	2660	2710	2770	2820	2870	2920	2970	3020
90	2990	3050	3100	3160	3210	3260	3310	3360
95	3350	3400	3460	3510	3560	3620	3670	3720
100	3720	3780	3830	3890	3940	3990	4040	4100
105	4110	4170	4220	4280	4330	4390	4440	4490
110	4530	4580	4640	4690	4750	4800	4540	4910
115	4960	5010	5070	5120	5180	5230	5290	5340
120	5410	5470	5520	5580	5630	5690	5740	5790
125	5880	5940	5990	6050	6100	6160	6210	6260
130	6370	6430	6480	6540	6590	6650	6700	6760

- Tensions are based on 10% CBL at 5 °C

8 Substations, regulators, reclosers and other equipment

8.1 General construction requirements (all equipment)

8.1.1 Basic requirements

For general construction details, such as terminations, bolted connections, pole dressing, cable saddles, vermin guards and equipment breathers, refer to Section 3 of this manual.

8.1.2 Earthing

All equipment must be earthed in accordance with Section 10 and EDI 100 - Distribution Earthing Design.

8.1.3 Equipment numbering

Substations, regulators, reclosers, air break switches, load break switch and under slung link numbering must be clearly visible and mounted on the roadside of the pole at approximately 3700mm above ground level. Individual equipment numbering details must be in accordance with Section 3 of this manual.

8.1.4 Phase identification

All HV constructions must be identified with coloured phase identification discs. Discs must be coloured Red, White and Blue to correspond to A, B and C phases.

Cabling on three phase insulated switch fuses must be connected to the switch to achieve a phasing of R, W, B from the pole outwards (refer Section 3 of this manual).

8.1.5 HV protection equipment

Where any HV equipment is fitted with a protection system/s, these systems shall be tested and adjusted by Endeavour Energy protection employees only.

8.1.6 Pole tip loading calculation due to additional equipment

All designs for overhead line design shall include the tip loading imposed by any additional equipment mounted on the pole. This includes but is not limited to items such as transformers, regulators, LBSs, reclosers and the like.

As a guide only, the following loads need to be added for the listed equipment:

Table 8.1 Equipment loading

Plant/equipment	No wind (kN)	Wind (kN)
50kVA & SWER Transformer	0.2	0.9
Up to 400kVA transformer	1.4	3.2
SWER Isolating Trf	1.2	3.4
LBS or Recloser	0.2	0.5
Regulator 3 ph	1.4	8.9

8.1.7 Auxiliary power supplies

Where any equipment requires auxiliary power for control boxes, SCADA and the like, this supply shall meet the following requirements as a minimum:-

- Radio and SCADA = 50W
- LBS/recloser = 60W

Power can be provided by three (3) methods depending on the earthing design:

- From a HV VT (Typ. separate earthed)
- From a LV mains isolating transformer rated at 15kV for 1min (Typ. separate earthed)
- Directly from the local LV supply via a 60A LV ABC service fuse (Common earthed only)

8.2 Pole substation fuses

All requirements for the size and type of distribution fuses are set out in ETS 0071 - Distribution Fuse.

For the rural design, the fuses must be barrel service fuses.

Table 8.2 Fuse element selection chart

Transformer (kVA)	Max LV fuse (Amps)		Dropout fuse (Amps)	
	Single feeder / Single customer	Multiple feeders	11kV	22kV and SWER
Single phase	10	60	8 (Note 2)	3.15
	15	80		
	25	100		
	50	200		
	63	250		
Three phase & SWER Isol.	25	63	8	-
	63	100	8	3.15
	100	160 (Note 1)	16 (Note 1)	8
	160	200	20	8
	200	250	20	8
	250	400	20	8
	300	400 (Note 3)	40	20
	400	400 (Note 3)	40	20

Note 1: 100kVA pole subs in rural areas are to have 16A HV and 160A LV fuses

100kVA pole subs in urban areas are to have 20A HV and 200A LV fuses

100kVA SWER isolating transformer is to have 16A 11kV and 8A 22kV fuses.

Note 2: In some rural areas, where there is insufficient fault level to operate 8A fuses or where substation earthing is high and a small transformer is installed, a 3.15A Boric acid fuse may be used if approved by Endeavour Energy.

Note 3: For individual loads greater than 400A, a LV circuit breaker will be required.

Note 4: Multiple feeders means two sets of fuses sharing the load from one transformer.

Note 5: 250A normally, 400A only where mains size allows.

In all 22kV areas, SWER, and on 11kV networks where the fault current exceeds 8kA, the HV fuses shall be a Boric acid (or other approved HRC sealed fuses) drop out fuse unless approval to the contrary is given by Endeavour Energy.

Fire chokes must not be fitted to drop out fuses. Where fire chokes exist on existing substations they must be removed.

For LVABC switches, other than service switch fuses mentioned above, the suitable outdoor DIN blade fuses will be used.

LV fuses above 400A are not permitted. When an individual load above 350A is required, a pole mounted LV CB will be required (refer Drawing no. 078960).

Table 8.3 LVCB setting

Trf rating	LV CB derated to (A)	Max down-stream fuse (A)	LV CB type	LVCB setting	
300kVA (4.0%)	550	160	ABB XT7 1250	In=1250, 50Hz, I1=0.52 x In, t1 = 3s, I2 =2xIn, t2 = 0.2s, I3 = 7 x In, InN = OFF	Pickup= 650 A Short time = 2500A Instant. = 8750A
			Schneider NS1250N ML5.0	Ir=0.5, tr = 4, Isd = 4, tsd = 0.2, li = 6, I2t = OFF	Pickup= 625 A Short time = 2500A Instant. = 7500A
400kVA (4.0%)	550	180	ABB XT7 1250	In=1250, 50Hz, I1=0.65 x In, t1 = 3s, I2 =3 x In, t2 = 0.2s, I3 = 9 x In, InN = OFF	Pickup= 812.5 A Short time = 3750A Instant. = 11250A
			Schneider NS1250N ML5.0	Ir=0.7, tr = 4, Isd = 4, tsd = 0.2, li = 8, I2t = OFF	Pickup= 875 A Short time = 3500A Instant. = 10000A

8.3 Pole substation constructions

8.3.1 Transformer cable sizes

All transformer LV cabling must be copper, black, double insulated and UV resistant. The transformer LV cabling sizes must be a minimum as follows:

Table 8.4 Cable sizes

Size of substation	Phase cables	Neutral cable
Rural, Coastal and SWER substations no larger than 63kVA	1 x 70mm ² Cu	1 x 70mm ² Cu
All other substations with loads up to 250kVA	1 x 120mm ² Cu	1 x 120mm ² Cu
All other substations with loads above 250kVA	2 x 120mm ² Cu	1 x 120mm ² Cu
Note: All neutrals to be terminated onto the transformer palm using a two (2) hole lug		

8.3.2 Underground to overhead cables on substations

Only one (1) LV mains or service cable underground to overhead connection is allowed. Connection shall be to the LV outgoing side of fuse link palm (not the conductor) with the LV cable passing over the crossarm supporting the LV fuse links.

The LV cable shall not obstruct the operation of the LV transformer links and fuses, or the HV drop out fuses.

HV cables shall not be run up the substation pole under any circumstances.

8.3.3 Construction assemblies

Overhead construction standards manual

The table below shows the design drawings that need to be referred to when constructing an overhead substation.

Table 8.5 Construction design drawings

Drawing detail	Type of substation				
	Urban	Rural/semi-rural	Coastal and 33kV/415V	SWER sub.	SWER isol.
General arrangement	249489	240383	303376	251669	251671
HV assembly	240931	240931	332056	251669	251671
LV assembly	240933	240387	332057	251669	251671
Services	249488	240387	332057	251669	251671

It should be noted that design drawings could be combined to suit individual substations, for example, open wire HV and ABC LV.

Table 8.6 Typical substation usage chart

	Rural	Semi-rural	Single customer	Urban (standard)	Coastal
Transf. size	<= 63kVA	<= 250kVA	Max 400kVA	Max 400kVA	Max 400kVA
Max current	200A/ph 1ph 88A/ph 3ph	350A/ph	556A/ph	556A/ph	556A/ph
Sub location	Street	Street	Private	Street	Street/Priv.
Pole size min	12.5m/12kN	12.5m/12kN	12.5m/8kN	12.5m/12kN	12.5m/12kN
LV mains	No	Yes	No	Yes	Both
LV fuse*/CB options	100A service	400A LV ABC fuse switch	100A service / 400A LV ABC fuse switch / 630A links +CB, LV ABC	Trf Isol. + 2 x 400A Open style fuse links	1 or 2 x 400A Open style fuse links, 100A service, 400A LV ABC fuse switch, LV ABC + CB

* - Use appropriate fuse as in Table 8.2

8.3.4 Pole sub-station location

Pole sub-station can be located either on road reserve or customer property as stated in section 8.3.5 below. Pole sub- stations are not allowed on road intersection and bends.

8.3.5 Typical circuit diagrams

The circuit diagrams below show the typical layout for each of the substation configurations.

8.3.5.1 Urban sub-station

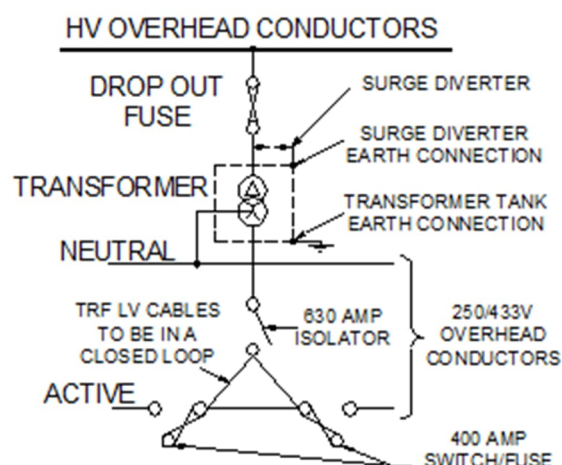
Urban substations are the preferred design for most areas and applications such as:

- Large loads generally greater than 63kVA.
- Multiple customers.
- Sub is located in the road reserve.
- Where LV crossarms are required.
- Open style LV fuses and links.
- Where an interconnected LV network is essential.
- 1000 m² (¼ acre or less) land block size is a standard or will be the standard developed in that area.

This design allows for transformers up to 400kVA and can have fusing of various ratings up to 400A in both lines leaving the substation.

The substation is generally used in built-up areas and provides greater flexibility in switching.

With the service box in arms, it allows multiple services to be strung at wide angles and with suitable clearance from any HV. Also allows good road crossing clearances to be maintained.



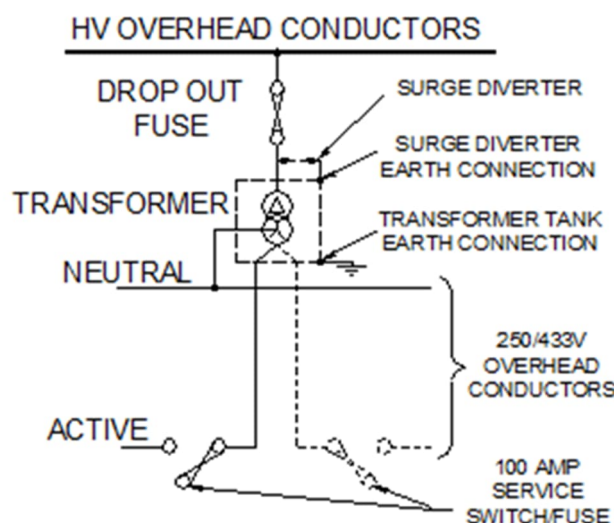
8.3.5.2 Rural sub-station

Rural substations are generally designed to the following type of load:

- Light loads, no larger than 63kVA.
- Generally, one (1) or two (2) individual customers supplied through pole-mounted 100A barrel service fuse.
- Substation is located in the road reserve.
- Rural areas with acreage blocks of land.
- No LV mains or network connection supply

Where two (2) customers are required, a second separate service switch/fuse shall be connected to the transformer LV cable by way of an IPC mounted on the opposite side of the pole to the first switch fuse.

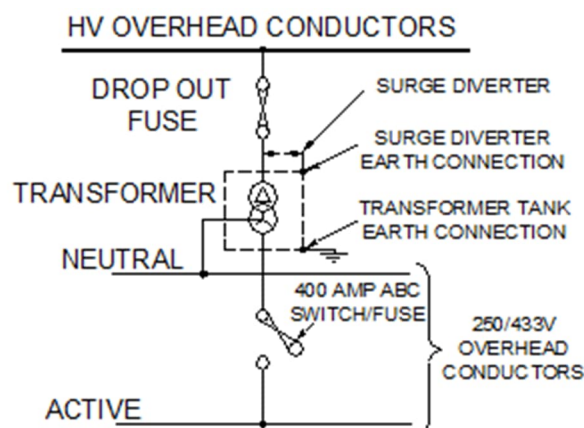
This is the preferred method of supply where customers are widely spaced and where LV backup is not economically possible, or voltage drop makes it technically unsuitable.



8.3.5.3 Semi rural sub-station

Semi-rural substations are generally designed to supply the following type of load:

- Medium loads no greater than 250kVA.
- More than two (2) customers fed from joint use LV mains.
- Insulated 400A LV ABC switch/fuse.
- Substation is located in road reserve.
- Houses fused separately at each property.
- Acreage type blocks of land.
- Possible limited LV network backup/interconnection.
- Not likely to be developed to an urban design for more than five (5) years.
- Generally, the transformer will connect straight to the LV mains through the LV fuse/switch.
- Typically, in new areas, the LV mains will be LVABC with no LV crossarms



8.3.6 Coastal sub-station

The use of the coastal substation for 33kV can only be made once specific approval has been obtained from the **Asset Engineering Manager**. Special earthing design will also need to be developed to the **Design Manager - Mains** requirements.

Coastal substations are designed to supply loads in areas of heavy salt pollution.

This design is to be used strictly within 2km of coastal or salt spray affected areas.

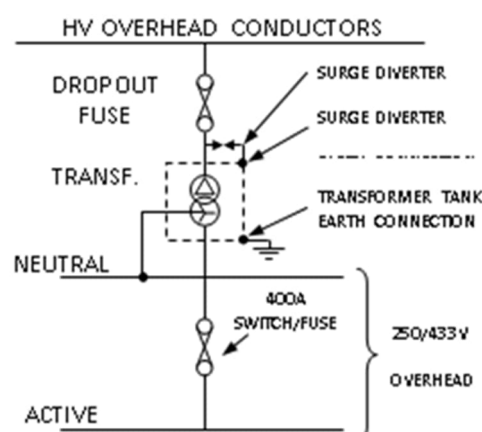
This design can be installed in the road reserve or on a customer's property. Both individual and multiple customers can be supplied from this design.

This design is more suited to open wire LV fuse link construction, but may be used with LV ABC where the salt pollution is less significant and single phase ABC fuse/links are used. (3 phase ABC links cannot be used in coastal areas).

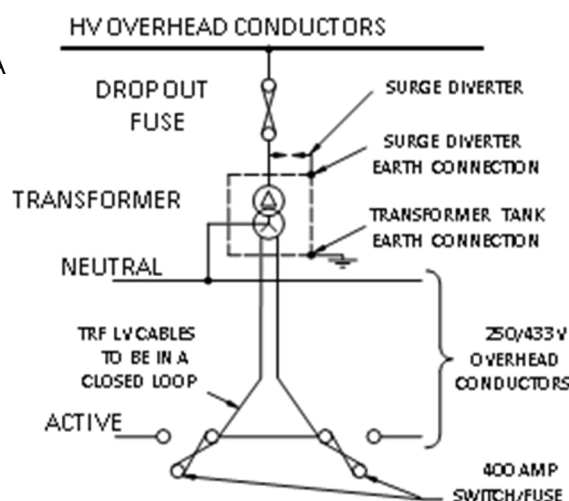
Due to the reduced LV mains height, long spans away from the substation cannot usually be achieved. Clearances over driveways and the like are also reduced and need to be considered during design.

The coastal substation design can be used with the following LV options:

Option 1 – Maximum continuous loads up to 350 amps or 250kVA (400 amps peak - short time) for each phase using fuses. 100A service fuses to be used for single customers. 400A LV open wire style switch/fuse links for loads greater than 100A or multiple customers. (3 phase ABC links cannot be used in coastal areas).



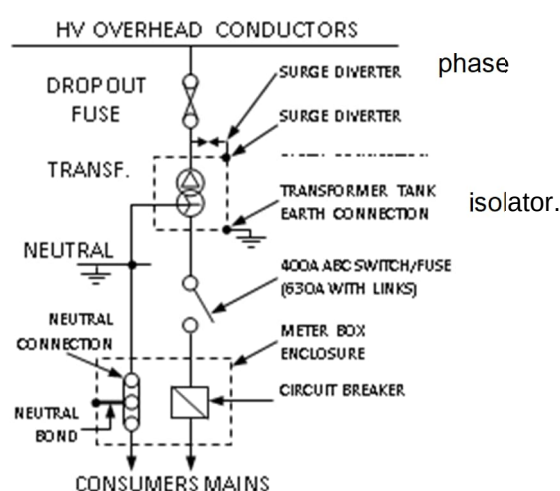
Option 2 – Twin LV fuse arrangement (up to 400A each). This is suitable for transformers up to 400kVA and allows isolation of each LV supply. If total load exceeds 250kVA, the transformer LV cabling will need to be doubled in a closed loop to achieve full load rating.



Option 3 – Single customer with maximum continuous loads greater than 350 amps up to 550 amps on each (400kVA) using a LV CB.

The 100A service fuse would be replaced with 3 x 1 phase 400A LV ABC switches fitted with links to achieve a 630A

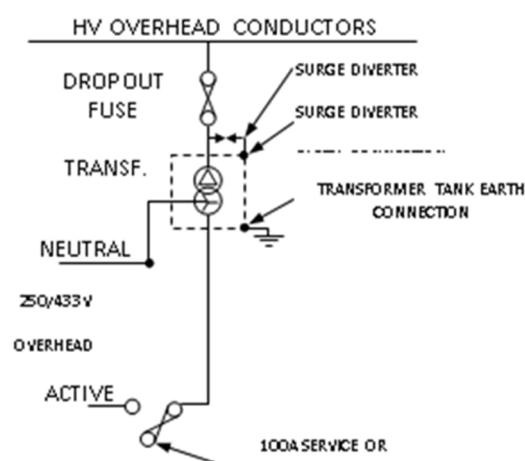
A 1250A LV CB and neutral isolation/test link would be installed on the pole as set out in Drawing no.078960



8.3.7 Single customer sub-station

Single customer substations are designed to supply the following type of load:

- Any loads, such as single phase 25kVA up to 400kVA three phase loads.
- One (1) customer only.
- Substation will be located in the customer's property but not in the road reserve.
- No LV mains, but a backup LV feed to the street may be installed, if required.
- Minimum 12.5m/8kN pole up to 63kVA. Loads greater than 63kVA - a minimum 12.5/12kN pole size.
- Normal loads, but where a more stable quality of supply is required



Option 1 or 2a - fused LV OH service

The basic rural substation design would be used, but with the following LV options:

Option 1 – Maximum loads up to 100A for each phase use the standard service fuse

Option 2a – Maximum continuous loads up to 350 amps or 250kVA (400 amps peak - short time) for each phase using fuses and an overhead service.

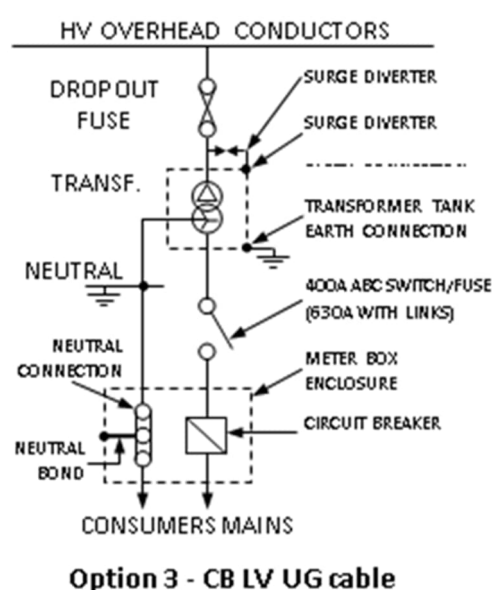
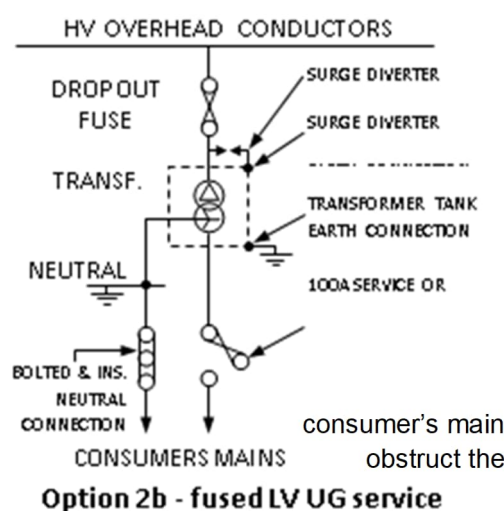
The 100A service switch/fuse would be replaced with a 400A ABC switch/fuse fitted with the appropriately rated DIN 2 fuses for the load.

Option 2b – Same as for 2a, but with underground connection on the pole. The LV cable shall not interfere or operation of the LV ABC switch when operated from the ground.

Option 3 – Maximum continuous loads greater than 350 amps up to 550 amps for each phase (400kVA) using a LV CB.

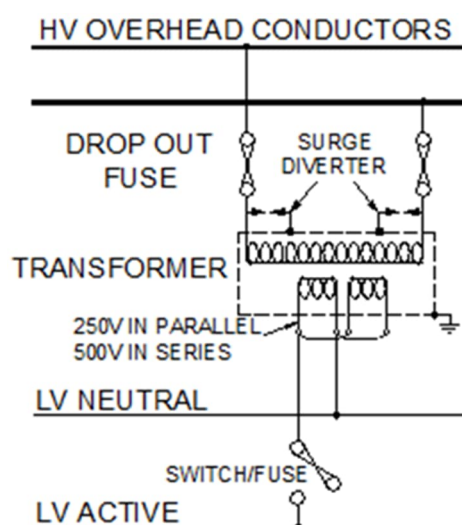
The 100A service fuse would be replaced with a 400A LV ABC switch fitted with links to achieve a 630A isolator.

A 1250A LV CB and neutral isolation/test link would be installed on the pole, as set out in Drawing no. 078960.



8.3.7.1 Single phase sub-stations

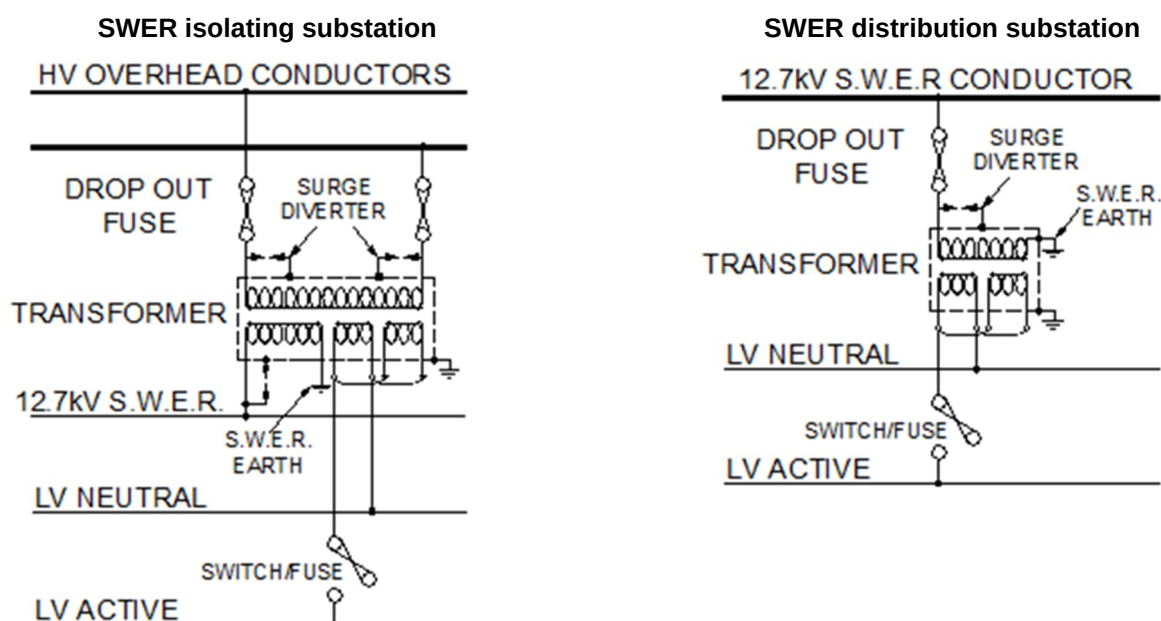
Single-phase substations must be built to the rural pole substation design. The centre phase dropper cable, drop out fuse, surge arrester and associated hardware are to be omitted from the construction. The transformer must be limited in size to 50kVA.



8.3.7.2 SWER sub-stations

SWER substations require that their earth grid is capable of continuously carrying load current in addition to providing safe protective earthing.

As with the single phase substations, generally the SWER substation's supply can be configured to supply 250V when the LV output windings are connected in parallel and 500V when they are connected in series.



8.3.8 Pole sizes

- Pole substation in the road alignment - 12.5m/12kN or bigger depending on mains
- Pole substation not in the road alignment - 12.5m/8kN or bigger depending on mains, plus a maximum transformer weight of 700kg and size of 63kVA.
- Refer to clause 8.1.6 for additional pole loading information.

8.3.9 Maximum demand indication (MDI)

Maximum demand indication is no longer required in three (3) phase transformers.

Existing MDIs can be removed when it is defective or during a transformer upgrade. Current transformers must be shorted after the removal of the MDI.

All new 3 phase pole transformers must be fitted with the following DSub monitor:

Material number	Supplier Part no.	Description
1000007339	EE-600-110	Dsub monitor for Pole mount, Padmount & indoor substation

The installation instructions are as follows:

- (i) Install the DSub monitor 455mm below the sub station LV crossarm. Preferred facing the property side but if there is other interference install opposite side of the crossarm bracket.
- (ii) For timber pole use coach screw and for concrete pole use the supplied pole bands.
- (iii) Where an external antenna is supplied install together with the bracket.
- (iv) Install the magnetic thermal sensor on the transformer body approximately 70mm from top of transformer.
- (v) Install the Rogowski CTs to the transformer low voltage conductors with the CT arrow towards the load.
- (vi) Cut the terminal lug of the voltage wires and terminate with appropriate insulated piercing connectors.
- (vii) Use cable ties to loop excess cable neatly and use saddle tap where required.

8.3.10 Transformer mounting

All new transformers must be mounted using a minimum 20mm grade A4 (316) class 70 stainless steel bolt through the top hole of the transformer mounting bracket. The bottom mounting can be either a bolt or threaded rod of the same grade. The nuts shall be grade 304-70. All stainless bolts shall have their threads lubricated with a nickel based solid lubricant (Molykote 1000 or equivalent). Oil based sprays are not suitable.

On units up to and including 63kVA they must be pole bolt mounted. If the unit will not sit flat and stable against the pole, a gain block must be used. In all cases, the top mounting bolt hole shall be used to secure the transformer to the pole and prevent movement. If the bottom hole does not line up with the mounting holes a mounting bracket shall be used which permits the correct mounting, refer to Drawing no. 078956.

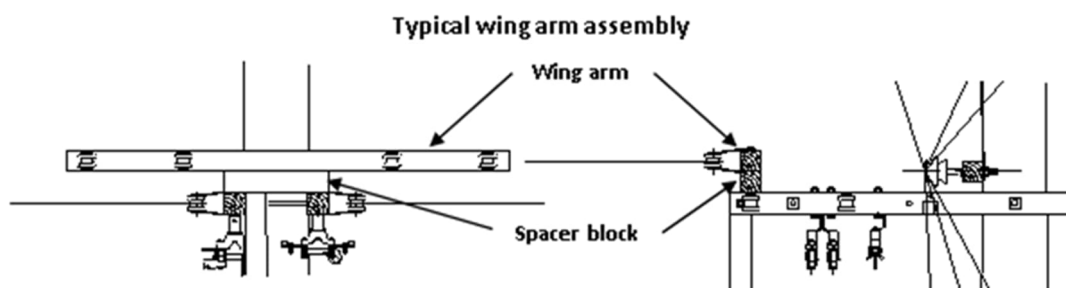
Units greater than 63kVA must be mounted on a transformer hanging bracket, which uses the same mounting holes as the 63kVA pole bolt style. This detail is covered on Drawing no. 078956.

Older transformers may be fitted with U-bolts that wrap around the pole and a hanging bracket. This arrangement can remain if it is not in the way or is suitable for the replacement transformer.

To aid in the mounting of transformers and equipment, a platform shall be used on all substations except the coastal design.

8.3.11 LV mains

The number of LV distributors at a substation is generally two, but three can be used if a design variation is submitted for approval. A typical submission that would require approval may be the use of a wing arm located on the top and at the end of the two (2) LV crossarms of the urban design. This will allow a 90° long span open wire LV tee at the substation.



8.3.12 Pole sub-station drawings

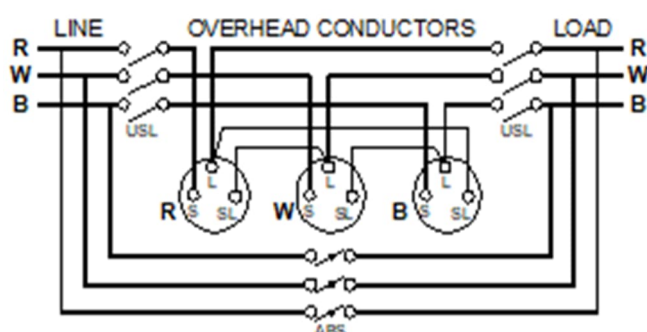
Table 8.7 Pole sub drawings

Drawing No.	Amend. No.	Subject
Urban substation		
249489	G	Urban pole sub GA
240931	F	Urban, rural & semi-rural pole sub HV assembly
240933	F	Urban pole sub LV assembly
249488	E	Urban pole sub service connection assembly
Rural substation		
240383	H	Rural/semi-rural pole sub GA
240387	J	Rural pole sub LV assembly
Coastal substation		
303376	D	Coastal pole sub GA
332056	C	Coastal pole sub HV assembly
332057	C	Coastal pole sub LV assembly
S.W.E.R. substation		
251671	B	S.W.E.R. isolating pole sub GA and assembly
251669	C	S.W.E.R. pole sub GA and assembly
Miscellaneous items		
078618	D	Overhead construction BCC cable mounting on pole substation
078960	F	Pole mounted 1250A CB for single customers, general arr't

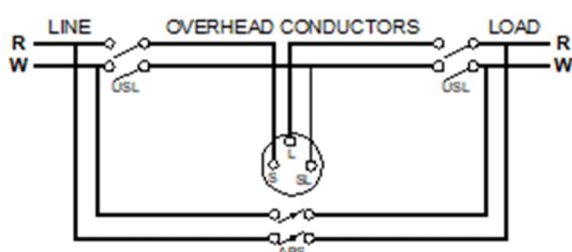
8.4 Pole mount voltage regulator construction (No new installations)

8.4.1 Typical circuit diagrams

The circuit diagrams below show the typical layout for each of the substation configurations.



3 x 1 phase regulators
(in closed delta formation)



1 x 1 phase regulators
(for phase to phase formation)



Fig. 8.1 Voltage regulator

8.4.2 Pole sizes

The voltage regulator substation must be constructed on a 14m/12kN concrete pole (steel and wood poles are not permitted).

Refer to clause 8.1.6 for additional pole loading information

The maximum voltage regulator weight (of the 3 phases) on any pole is 3700 kg. This pole design is suitable for regulators rating up to 4000kVA or 200A.

8.4.3 Phase sequence connections

The correct operation of a voltage regulator is highly dependent on the phase sequence of the mains at the point of installation. Before making connections, the phase sequence at the point of installation must be

verified with Endeavour Energy. Phase marking must be done on the crossarms in line with Drawing no. 332058.

8.4.4 Sequence of operation necessary to make regulator in/out service

To bring the regulator INTO SERVICE, the sequence of operation is as follows:

- Check that all connections are properly made.
- Check that the bypass air break switch is in closed position.
- Check that the regulator control is in local position.
- Set the tap position to the neutral position (confirmed by a lamp on control panel).
- Close source side and load side under slung isolating links.
- Open by pass air break switch.
- Set the regulators to automatic control.

To take the regulator OUT OF SERVICE, the sequence of operation is as follows:

- Check that the regulator control is in local position.
- Set the tap position to the neutral position (confirmed by a lamp on control panel).
- Close the bye pass air break switch.
- Open source side and load side under slung isolating links.

All operations are to be carried out by authorised personnel.

8.4.5 No new installations

No new voltage regulators are to be installed in the network. When an existing voltage regulator fails and is defected, refer to Strategic Planning & Forecasting section for guidance.

8.4.6 Voltage regulator drawings

Table 8.8 VR drawings

Drawing No.	Amend. No.	Subject
275182	F	Voltage regulator pole mount GA
316948	C	Voltage regulator pole mount steelwork fabrication
332058	B	Voltage regulator pole mount HV equipment assembly
332059	C	Voltage regulator pole mount LV equipment assembly
The following drawing is located in Section 3 – clause 3.25 Parts and accessories drawings		
316946	C	Voltage regulator pole mount concrete pole ferrule layout detail

8.5 Pole mount recloser and load break switch (LBS) construction

8.5.1 General

Refer to clause 8.1.7 for information on minimum auxiliary power requirements.

8.5.2 Typical recloser circuit diagrams

The circuit diagram shows the typical layout for a recloser installation.

8.5.3 Pole sizes

- 5m/8kN or bigger, depending on mains requirements
- refer to clause 8.1.6 for additional loading information
- Pole size must also meet the requirement of a minimum LV conductor attachment height or streetlight bracket mounting height (where fitted) of 6.3m above ground line to provide suitable clearance to recloser antenna.

8.5.4 Recloser mounting

The standard recloser mounting is to be as in Drawing no. 332022 which has the recloser mounted on the road side at 90° to the line.

All new reclosers must be mounted using 20mm stainless steel bolts through the pole.

8.5.5 Additional recloser protection

In some situations, temporary additional protection is required to be installed to protect a line when the recloser is bypassed or is out of service. This protection is provided by installing a drop out fuse in parallel with an USL before or after the recloser.

The full construction for this recloser protection is shown on Drawing no. 332062 - Const. No. HFBP.

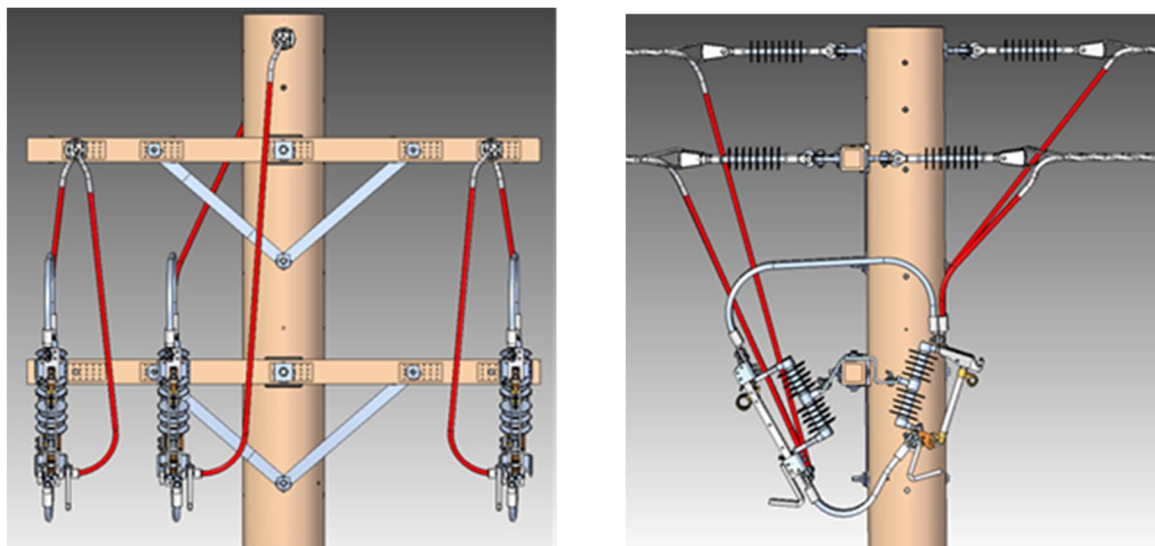


Fig. 8.2 Drop out fuse or USL

8.5.6 LBS Mounting

The standard LBS mounting is to be as shown in Drawing no. 332021.

All new manual LBSs shall be mounted at the pole top except on transmission poles or special circumstances where mid pole mounting is more appropriate.

All manual LBSs shall be fitted with a mid pole mounted operating mechanism.

All new LBS units must be mounted using 20mm stainless steel bolts through the pole.

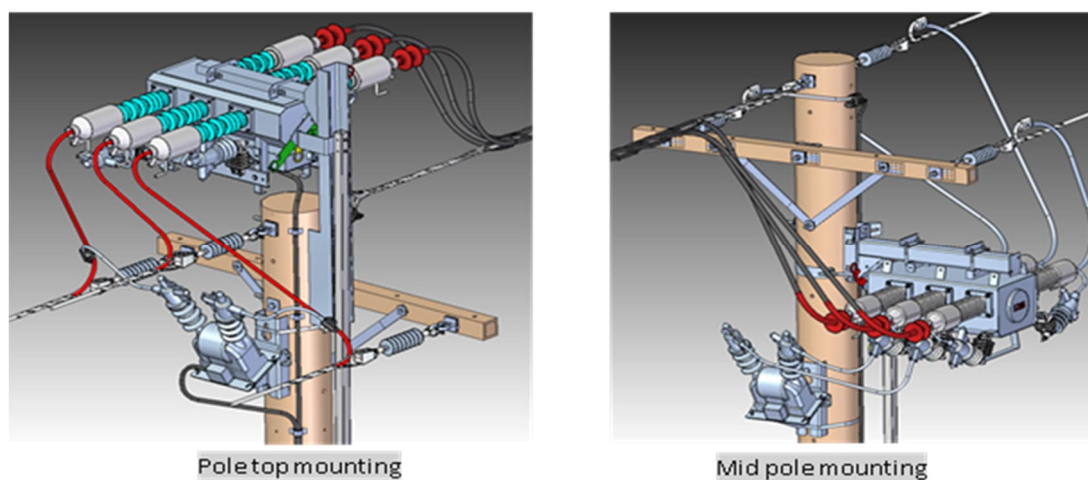


Fig. 8.3 Load break Switch

8.5.7 LBS and recloser drawings

These drawings can be found in Section 5.0 under common constructions.

Table 8.9 LBS and recloser drawings

Drawing No.	Amend. No.	Subject
Recloser drawings		
332022 1/2	C	HV recloser arrangement Const. No. HREC
332062	B	Fuse bypass - DOF style mounting arrangement Const. No. HFBP
Load Break Switch (LBS) drawings		
332021 1/2	E	HV load break switch arrangement Const. No. HLBS

8.6 Pole mount sectionaliser construction

8.6.1 General description of operation

A sectionaliser is a no load break device and should not be used for switching purposes.

To operate, the unit takes the following steps:

- a) Detect a fault current (by its setting) has passed through its circuit.
- b) Detect a loss of volts for a set time (generally about a 0.5 sec).
- c) Opens to isolate downstream load.

The units currently used need to be manually reset.

Endeavour Energy's current standard design for a sectionaliser is a single pole mounted unit, similar to that shown below.

The design uses a drop out fuse (DOF) style mount and where more than one (1) phase is required, the units are to be ganged together, as shown, on a special single steel mounting frame as a complete two (2) or three(3) phase unit.

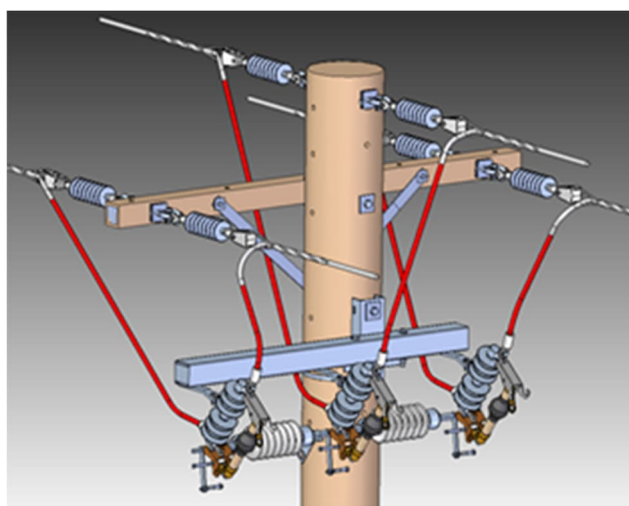
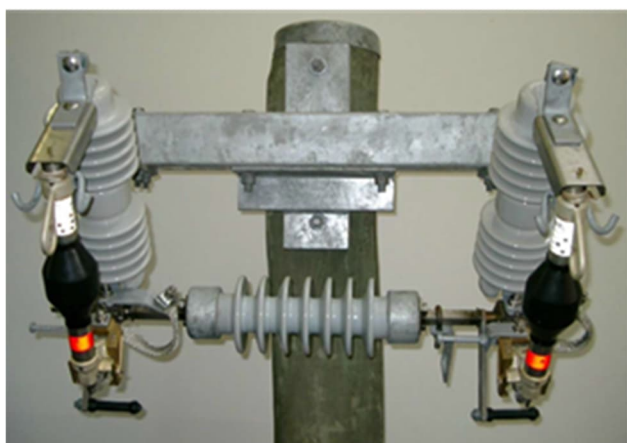


Figure 8.4 Typical two (2) and three (3) phase sectionaliser

Sectionalisers are no longer to be installed. Existing defected or faulty units must be replaced with a drop out fuse. Refer to Protection section for guidance.

8.7 Line fault indicator (LFI)

8.7.1 General description of operation

A line fault indicator is designed to operate (flash) when a fault current has passed through it to a downstream fault. This is detected by the line patrol crew to narrow down the fault location.

The specification for LFI's to be installed on the Endeavour Energy network is ETS 0062 - Line fault indicators, and all new units shall comply with this document.

They are generally self-resetting (after 2-4 hours) and clip onto the line using a live line insulated stick.

The LFI contains batteries that do need to be replaced after a specified period.

Some units communicate with a separate control/radio panel to give remote indication (refer to Drawing no. 284224 for details). **Note the remote indication LFIs are no longer in use.**

The material number for the LFIs used in EEs network are as follows:

Material number	Supplier Part no.	Description
1000006334	41-2004-131	Line fault indicator Navigator LM A

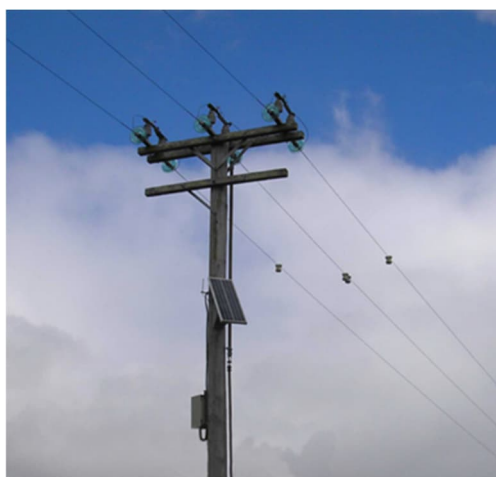


Fig. 8.5 Line fault indicator

8.7.2 Line indicator drawings

Drawing No.	Amend. No.	Subject
284224	E	Line Fault indicator

8.8 LV Statcom

8.8.1 General

A LV Static Compensator (STATCOM) is type of LV voltage regulator that is connected in shunt/parallel to overhead LV networks. This device continuously regulates the local LV voltage by absorbing or injecting reactive power autonomously based on locally measured voltage conditions.

The EcoVar is a power electronics based device with no moving parts besides a cooling fan. There is no mechanical tap changer or internal transformer.

8.8.2 Installation

There are 2 versions: EcoJoule EcoVAR v1 and EcoJoule EcoVAR v2.

The EcoVAR v1 is single phase unit that can be configured with three separate units to provide 3 phase LV compensation. The current version is EcoVAR v2 that combines three separate v1 units into a single, lighter, more compact and integrated 3 phase unit.

The material number for the LV Statcom used in EEs network is as follows:

Material number	Supplier Part no.	Description
TBA	90-02-017	Integrated 3 phase LV Statcom – EcoVAR V2 40kVAR

Refer to EcoJoule EcoVAR Low Voltage STATVOM manual for installation instructions.



Fig. 8.6 Statcom V1



Fig. 8.7 Statcom V2

8.8.3 LV Statcom drawings

Drawing No.	Amend. No.	Subject
533306	A	EcoJoule EcoVAR Statcom V1
533669	A	EcoJoule EcoVAR Statcom V2

8.9 Pole mount batteries

8.9.1 General

Low Voltage (LV) Pole Batteries are a grid connected battery energy storage system which is mounted onto a pole. LV Pole Batteries smooth out local LV network demand and generation. They can charge off excess solar generation and export this energy back into the network in periods of high demand (such as the evening period). This improves network utilisation, reliability and quality of supply for customers.

8.9.2 Installation

LV Pole Batteries are installed in existing network areas based on localised system voltage analysis. LV Pole Batteries are installed either on a stand alone pole or service pole at appropriate electrical clearances from other mains.

The LV Pole Battery can be electrically isolated from the network via a set of links at the tee off pole to the battery pole as well as the LV circuit breaker in the isolation panel on the battery pole.

Any new mains extensions or services are no longer permissible from the service mains that supply the LV Pole Battery.

The material number for the pole mount batteries used in EEs network is as follows:

Material number	Supplier Part no.	Description
TBA	90-2-018	EcoStore Gen 2 – 3 phase battery (CATL) cabinet + inverter cabinet

Refer to SDI 548 for further information.



Fig. 8.8 Gen 1



Fig 8.9 Gen 2

8.9.3 Drawings

Drawing No.	Amend. No.	Subject
531471	B	Ecojoule-Ecostore V2 Pole Battery Unit construction, electrical and earthing arrangement (non metered – Network Battery)
531472	B	Ecojoule-Ecostore V2 Pole Battery Unit construction, electrical and earthing arrangement (metered – Community Battery)

8.10 Early Fault Detection

8.10.1 General

Early Fault Detectors (EFDs) are a network monitoring technology designed to detect primary equipment defects prior to them resulting in a functional equipment failure. The system can be installed on any network voltage level, however, it is primarily employed on HV overhead distribution reticulation.

EFD continuously monitors the condition of network assets within its coverage area, allowing for detection of defects outside of our cyclic inspection programs. The EFD units are a passive device that draws power from the LV mains (where this type of unit is installed). The units contain a small internal backup battery which is charged via an AC/DC rectifier charger. Internal protection circuitry prevents these from back feeding into the LV network.

8.10.2 Installation

EFD installations consist of a pole mounted control box connected with sensors that mount on a separate crossarm (on custom brackets) beneath the associated phase conductor. There are two variants of the EFD control units: -

- A LV mains powered unit which is connected to a standard single phase LV supply (240 VAC); - and
- a solar powered unit with an internal battery for installation in locations where no LV mains supply is available.



Fig 8.10 EFD

8.10.3 Drawings

Drawing No.	Amend. No.	Subject
525545	B	Early Fault Detection EFD sensor standard drawing Generation 4

9 Street lighting

9.1 Street lighting standard – LCI 0001

The intention of a manual such as MCI 0005 is that all related material dealing with distribution construction is readily accessible for field staff in one (1) relatively easy to carry and read document.

This allows Authorised Persons to be able to work with assets from different areas (such as substations, mains, earthing and street lighting) such that they all combine to form a properly functioning network.

If there is a conflict between this document and LCI 0001 or it is considered that these Standards do not cover a particular situation, or they are impractical to follow, the Network Mains Manager shall be contacted in order that an approved solution can be developed.

LCI 0001 is available on the same Standards website where this document is located.

9.2 Streetlight construction drawings

This standard is available on the same standards website where this document is located.

10 Earthing

10.1 Earthing standards EDI 100

Due to the complex nature of earthing and the typical interface areas that exist between overhead and underground systems, EDI 100 is to be used as the main reference for all areas of earthing.

All the special requirements of each system (such as substations, CCT, and NMSHVABC) are included in this document, together with some details of how to carry out earthing design and testing.

EDI 100 forms part of this document and must be downloaded from the Standards website. However, relevant earthing drawings are listed herewith.

10.2 General earthing drawings

10.2.1 General earthing referred in EDI 100

Drawing No.	Amend. No.	Subject
348243	A	Cadweld Joints & Compression Connectors
348244	A	Driven Earth Electrode Assembly Detail
348245	A	Earth Connection Warning Label
348246	A	Deep Drilled Earthing System
348247	A	Driven Rod Earthing System.
348248	A	Earth bar and electrode connections
348249	A	Earth batten/Cable Guard installation on poles
358689	A	Format of Earthing information on Project Drawings (Sheets 1 and 2)
348251	A	Standard Earthing Symbols
332002	C	Standard Assemblies Miscellaneous items brackets-connections from MCI-0005
061674	D	Insulated Fence Posts and EPR Danger Sign

10.3 ABS earthing drawings

10.3.1 ABS earthing drawings referred in EDI 100

Drawing No.	Amend. No.	Subject
348252	A	Wood/ Concrete Pole ABS Earthing

10.4 UG/OH earthing drawings

10.4.1 UG/OH earthing drawings referred in EDI 100

Drawing No.	Amend. No.	Subject
348253	A	11/22kV UG/OH Earth Detail

10.5 Recloser/load break switch earthing drawings

10.5.1 Recloser/load break switch earthing drawings referred in EDI 100

Drawing No.	Amend. No.	Subject
348255	A	22 and 11kV Recloser/Load Break Switch on Wood / Concrete Pole Earth Detail
348256	A	DSA Recloser/Load Break Switch Control Box Earth Connections

10.6 Sub-station earthing drawings

10.6.1 Pole substation drawings referred in EDI 100

Drawing No.	Amend. No.	Subject
348257	A	Wood Pole 22 and 11kV Substation Common Earth Arrangement
348258	A	Wood Pole 22 and 11kV Substation Separate Earth Arrangement
348259	A	Concrete Pole Substation Common Earth Arrangement
348260	A	Concrete Pole Substation Separate Earth Arrangement
060514	E	12.7kV SWER Substation and Isolating substation Earthing Arrangement-Wood Pole
060970	E	12.7kV SWER Substation and Isolating Substation Earthing Arrangement-Concrete Pole

10.6.2 Padmount substation drawings referred in EDI 100

Drawing No.	Amend. No.	Subject
348261	A	Padmount Substation Common Earth Layout (Sheet 1 & 2)
348262	A	Padmount Substation Separate Earth Layout (Sheet 1 & 2)

10.6.3 Indoor substation drawing referred in EDI 100

Drawing No.	Amend. No.	Subject
348263	A	Indoor Substation Common Earth Layout

10.6.4 Switching stations drawing referred in EDI 100

Drawing No.	Amend. No.	Subject
348264	A	22&11kV Switching Station Separate Earthing Layout
348265	A	22&11kV Switching Station Common Earthing Layout

10.6.5 Padmount auto transformer earthing drawing referred in EDI 100

Drawing No.	Amend. No.	Subject
348266	A	Padmount Auto Transformer 11/22kV earthing layout

10.6.6 Streetlight earthing referred in EDI 100

Drawing No.	Amend. No.	Subject
010638	D	Streetlight column earthing arrangement

11 Testing

11.1 Testing standard – SDI 120

The intention of a manual such as MCI 0005 is that all related material dealing with distribution construction is readily accessible for field staff in one (1) relatively easy to carry and read document.

This allows Authorised Persons to be able to work with assets from different areas (such as substations, mains, earthing and street lighting) such that they all combine to form a properly functioning network.

If there is a conflict between this document and SDI 120 – Testing and Commissioning for Distribution Systems, or it is considered that these Standards do not cover a particular situation, or they are impractical to follow, the Network Mains Manager shall be contacted in order that an approved solution can be developed.

SDI 120 is available on the same Standards website where this document is located.

