SA Power Networks

Technical Standard - TS100

Electrical Design Standard for Underground Distribution Networks (up to and including 33kV)

Published: 01 May 2020

Revision Notice:

Date	Details	Author	Authorised
29 November 2018	**Section 6.15:** Enhanced 1000mm maximum buffer zone requirement **Section 6.16:** Updated Public Lighting Bollards requirement **Section 7.4:** Rural areas HV looping requirements enhanced **Section 7.5:** Clarified HV open points remote switching requirements **Section 8.1:** Updated LV cable detail to 240mm^2 4C XLPE/HDPE (Bundled, Termite Resistant), Al and Cu **Section 8.2:** ADMD value reduced from 8kVA to 6kVA per allotment **Section 8.7:** Clarified that 4 LV feeding (racks) points can accommodate maximum 8 LV cable connections. **Section 8.11.6** - Table 11: Introduced 'Double Cables 400A S/Pillar - Radial - 3 Phase'. **Section 8.14:** Clarified 'Double Cables 400A S/Pillar - Radial - 3 Phase' requirement. **Section 9.2.3:** Added new Figure 26 and new Tables 12 & 13 for clarifying separation requirements from 25KV Rail/Tram Lines **Section 9.2.4.1:** Added Figure 27 **Appendices:** A2 - Added New Table for Voltage Drop, A3 - ADMD values amended, B - Notes Updated and C - Updated Table 1	A Pradhan	J Ali
01 May 2020	• Added following Sections: ✓ 4. Grace Period ✓ 5. Intellectual Property ✓ 8.11.1. Spare Conduits and Vault Arrangement ✓ 9.4.1. Mandatory Requirement for Looped HV Networks > 9.4.1.1. Polymeric Cable Cover > 9.4.1.2. Cable Marker Tape ✓ 10.12.1. Access to Point of Supply • Updated: ✓ Section 8.3. Equipment Location ✓ Table 4 in Section 9.1. HV Cable Selection ✓ Tables 6, 7 and 8 in Section 10.1. LV Cable Selection ✓ Section 10.8. Connection to Padmount Transformers • Transferred information from NICC802 and Added: ✓ Appendix D. Connection of Consumers' Mains to Padmount Transformers > Appendix D.1. Mk7 Pad TF - 315kVA and 500kVA > Appendix D.2. Mk7 Pad TF - 750kVA and 1000kVA > Appendix D.3. Mk7 Pad TF - 1500kVA > Appendix D.4. Mk7 Pad TF - 2000kVA ✓ Appendix E. Typical Securing LV Cables	A Pradhan	M Napolitano

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Contents

1. Purpose

This technical standard is to be applied to any design involving the installation of underground cables of 33kV or less that will become a component of SA Power Networks' distribution network.

It sets out the design requirements for the installation of plant and equipment for the underground reticulation of the distribution network including:

- Underground residential developments (URD)
- Underground industrial developments (UID)
- Single customer and PLEC installations
- Public Lighting

2. Scope

The specification in this technical standard is applicable to **all parties,** whose activities are associated with design works for 33kV or less, and which will become a component of SA Power Networks' infrastructure.

This technical standard does not include the requirements for the installations within a substation boundary or 66kV underground sub-transmission networks (refer to TS110), or the application of sub-marine cables (ie project specific).

The electrical design work is principally governed by the Electricity (General) Regulations 2012, other statutory authorities, AS/NZS standards requirements and includes any specific design plans, drawings and documents that are part of the engineering design requirements.

3. Deviation from this Standard

Deviation from any specific requirement(s) of this Standard will only be permitted with the written approval of SA Power Networks' Manager Network Planning (MNP).

Contact via 'Standards and Equipment Hotline' on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

4. Grace Period

1. The maximum grace period acceptable by SA Power Networks for implementing this technical standard is 6 months from the date of publication.
2. All projects that are not in receipt of 'Specification Compliance' at the end of the grace period will need to incorporate the latest requirements.
3. The validity period following receipt of 'Specification Compliance' is 60 days; however, after 60 days 'Re-Specification Compliance' may be required at SA Power Networks' discretion.
4. Furthermore, on the expiry of 'Specification Compliance', any change to the technical specification (without a documented exemption) shall be incorporated into the design, construction and recording (eg drawings) for SA Power Networks' infrastructure.

5. Intellectual Property

Utilising SA Power Networks' specification for any installation other than an installation designed to be vested / connected to SA Power Networks' network without SA Power Networks' approval is an offence. We view such misuse seriously and may take legal action for any identified breach.

If anyone wishes to utilise SA Power Networks' specification for a design that is not being vested to SA Power Networks, then they shall request written approval from SA Power Networks' Manager Network Planning (MNP). A charge may apply for the use of SA Power Networks' drawings or templates for the design or construction of assets not intended to be vested to or constructed for SA Power Networks.

For organising access, please contact 'Standards and Equipment Team' via Hotline (08) 8404 4200, and or send an email to: networkstandards@sapowernetworks.com.au.

6. General Requirements

Where there is a mixture of contestable and non-contestable works, the design shall specify the extent of works that can be undertaken by a contractor (contestable) and the extent of works that can only be undertaken by SA Power Networks (non-contestable).

a) **Contestable Works**

SA Power Networks shall determine whether the work is contestable, define the scope of the project, detail the additional project specifications and stipulate engineering requirements. Refer to NICC400 for more detail.

b) **Design Stages**

There are three stages ie 'Preliminary', 'For Construction' and 'As Constructed', to a design, each serving a function as a project moves through from concept to completion. The design drawings format and details shall comply with the requirements stipulated in TS099.

c) **Clearances to Other Services**

The clearances to other services and trenching arrangements shall comply with the requirements specified in TS085.

d) **Network Access Permit**

Where a Network Access Permit (NAP) is required and works needs to be undertaken by SA Power Networks during the construction phase the design needs to be labelled with a unique identifier, refer to **Figure 1**.

NAP 1	NAP 2	NAP 3

Figure 1: NAP Unique Identifier

NAP 1, 2, 3 etc is the unique identifier for each specific access request location. For some projects (such as URD), there may be several NAPs required.

Each one shall detail the works to be carried out and who shall undertake the works. It is preferable that the information is linked and close to the identifier.

The designer also needs to highlight the works to be undertaken at the connection point(s) by SA Power Networks. This level of detail assists in scoping, costing and delineates responsibilities.

7. Design Areas

7.1 Underground Residential Development (URD)

A URD is a multi-lot 'Torrens Titled' development that can front a road reserve or be contained within a Greenfield site with created roads. The council approves that an area is an URD.

The URD design shall meet the SA Power Networks specifications including the 'After Diversity Maximum Demand (ADMD)', supply points and any other project specific requirements. It is advantageous from a costing perspective to incorporate the installation of cables and equipment into the overall URD layout.

Any industrial or commercial load, eg School, Shopping centre, Office complex etc; within the URD development, may be treated as a 'Single Customer'.

The relevant SA Power Networks Project Manager shall be consulted for URD design which has a mixture of residential and commercial allotments, including any proposed transformer installations in the areas where footpath verges are narrow (ie 1000mm or less) and or where back laneways do not have a footpath verge.

Where public lighting installation needs to be included within an URD design, then at the preliminary design phase the council must receive and accept the form attached within NICC402 and include TS101 requirements.

The URD design shall also consider the following requirements:

1. The width of the footpath verge as a part of the design.
2. Council's requirement for the provision of a Common Service Trench (CST) to reside under the concrete footpath and or CST to be the width of the footpath. This is to reduce subsidence issues with both the CST and the footpath.
3. When public lighting offsets are impacted by footpath placement, then council approval is required.
4. In a laneway where there is no defined kerb, a public lighting column may be best located off the boundary, and may require additional protective devices (ie bollards, kerbing). If such column is close to the boundary line, future building structure should also be met.

7.2 Underground Industrial Development (UID)

An underground industrial development (UID) is a multi-allotment Torrens-titled industrial or commercial subdivision that will be sold in the open market.

There are two types of UID installations (ie Serviced and Serviceable) that SA Power Networks considers. The designer needs to verify with the applicant the type of servicing that is required.

1. **Serviced UID**

   A design needs to encompass the agreed supply loads within the development.

   If the load requirements within the development are unknown, SA Power Networks may accept a design for the electrical infrastructure in a commercial and or light industrial area that provides the following:

   a) A minimum of an 80A (ampere) three phase service for each allotment;
   b) Installation of additional spare conduits to meet the capability of accepting a future supply upgrade to every allotment;
   c) Transformer(s) capable of handling the agreed load capacity; and
   d) Public lighting in accordance with council and the applicant's requirements.

2. **Serviceable UID**

   A serviceable development design will encompass the installation of a 'backbone' HV cable network within the subdivision, (but individual service points for each allotment are not provided) additional spare conduit installations for each property to assist in any future servicing arrangement and public lighting in accordance with council and the applicant's requirements.

   This design approach should be favored, if individual customer characteristics are unknown, or if individual customer loads have the potential to vary significantly.

   An applicant is required to inform purchasers that the blocks shall not be serviced but can be serviced at the purchaser's cost.

7.3 PLEC Projects

The Power Line Environment Committee (PLEC) is a committee that assists and operates under a PLEC Charter assigned by the Minister. The Essential Services Commission of SA (ESCOSA) is responsible for the administration of PLEC.

SA Power Networks is the part of PLEC committee, which assist local government with initiatives to enhance the aesthetics of a location by undergrounding power lines. Undergrounding can enable trees to be established and Streetscaping projects to be implemented thereby improving the appearance of a locality.

The Committee has developed Project Guidelines which define the roles and responsibilities for PLEC projects and provides guidance to the PLEC process.

7.4 Dual Fronted Properties

In dual fronted properties, the principal frontage area will be the face of the dwelling that has been designed as the main public access (ie the entry point at which a visitor would access the property), please refer to **Figures 2** and **3** for more detail.

There are specific requirements for the dual fronted properties which are stated in Service and Installation Rules.

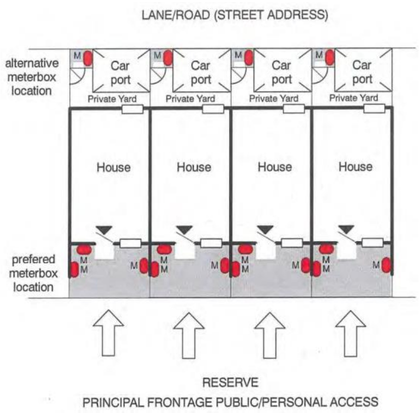


Figure 2:
Dual Fronted Properties Torrens Titles Allotments
Main Public Access via Reserve

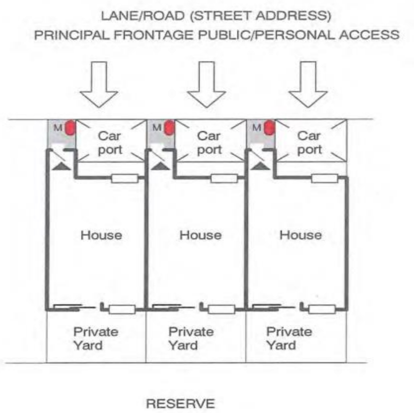


Figure 3:
Dual Fronted Properties Torrens Titled Allotments
Main Public Access via Lane

7.5 Redevelopments

A redevelopment (sometimes called a 'Brownfield' development) encompasses an area which has, or had, an existing electrical distribution infrastructure designed to supply power to a customer's metered supply point. The extent of a redevelopment will vary. Some examples:

1. A 'total redevelopment' site which will require the SA Power Networks existing infrastructure to be removed. An underground system will generally replace the old asset.
2. A 'partial redevelopment' with a mixture of old and new infrastructure.
3. Allotment layout changes only and the existing infrastructure remaining.

A redevelopment design shall include the extent of the works to be undertaken, particularly about the limitation of contestable works on existing assets.

8. Design Requirements

8.1 General

The design works shall address the following:

1. The designer shall be accredited prior to SA Power Networks issues specification compliance, refer to NICC401 for more detail.
2. The design shall comply with SA Power Networks technical standards, manufacturers' specifications, AS/NZS standards, and regulatory/obligatory requirements, those are relevant to the project. The applicant shall ensure that their designer have met such requirements.
3. Evaluate site plan details, locate all services and maintain specific clearance requirements as specified in TS085.
4. Acquire all necessary documents such as council acceptance, the SA Power Networks approval and other authority's approvals (eg DPTI).
5. SA Power Networks may request additional data, which shall include:
   (a) Engineering calculation sheets for pole strengths
   (b) Footing details
   (c) Cable-pull tensions for underground lines
6. For multistage URD/UID development, a proposed high voltage (HV) network design is required for all stages as a component of the preliminary design submission for the first stage.
7. Ensure that the HV equipment (eg Transformer, Switching Cubicle) load/cable rating does not exceed the values stated in the **Section 8.7**.
8. Establish the soil resistivity/earth resistance readings for any extension within MEN/CMEN areas, refer to TS109 for earthing requirements in more detail.
9. Design drawing format/changes shall comply with TS099, and equipment easement to comply with TS102.

8.2 Specifications

SA Power Networks will supply the project specifications and relevant information which will enable designer to undertake the design on behalf of the applicant. We reserve the right to refuse acceptance, when the design does not comply with the SA Power Networks' specifications.

The specifications provided by SA Power Networks will include:

1. Design after diversity maximum demand (ADMD)
2. Current earthing system (MEN or CMEN)
3. Any special conduit requirements (including spares)
4. Any special requirements for Bushfire Risk Areas
5. Feeder plans copies
6. GIS information
7. Existing drawings
8. SA Power Networks requested works that are associated with the applicant's works
9. Other requirements (eg provisions for the future development)
10. Any project specific requirements for the placement of the electrical works that will be vested to SA Power Networks will be notified to the designer

8.3 Equipment Location

The SA Power Networks' equipment (eg Transformer, Switching Cubicles) can be placed on:

- Reserves (ie Road Reserve, Council Parks and Parklands) only after acquiring written approval from the relevant authorities (eg DPTI, Council and or State Government)
- Very large building allotments likely to be developed as high-density residential sites
- Local shopping centres (this option has restrictions)
- And, at the rear and side of residential corner allotments

The following are the equipment location requirements:

1. Equipment location priority is to place it on a property boundary facing road reserve.
2. It shall be installed centrally within the easement as stated in TS102.
3. It shall not conflict with the requirements of other services (eg fire booster cabinets, water pipelines, sewer services, gas, telecom etc).
4. Customers' infrastructure shall not encroach on SA Power Networks' easement.
5. For a land development with multi customers, the location of equipment shall consider the LV feeder distribution network and be located as close practicable in the centre of the load.
6. Where the equipment is required to be located inside a building, then comply with TS108 requirements.
7. Avoid installing SA Power Networks' equipment location near water courses and or a storm water system. Evaluate equipment location site-plan and establish the following details near the equipment:
   a) Existing and proposed services
   b) Suitability of the terrain, watercourse impact, ground inclination
   c) Future accessibility to the equipment
   d) Indicate such assessments on the 'Preliminary Design' drawings
   e) Clear and safe access to the equipment, shall always be provided

   Note that SA Power Networks reserves all rights to request copy of equipment location site-plan, risk assessment and or evaluation report. At the 'Preliminary Design Stage', please consult and seek approval from the relevant SA Power Networks' Project Manager.

8.4 Clearances

For clearances to buildings, other utilities and third-party assets, please refer to TS085.

8.5 Determining Best Cable Route

The following are the general guidelines for achieving best cable route:

1. Use Pull-Planner™ 3000 computer program (or similar) to simulate cable/conduit route versus allowable cable pull tension, before finalising the actual design.
2. Minimise the number of bends per duct run and maintain straight-line cable route.
3. Utilise footpath reserve for cable trench and cable joints, to facilitate safer future access.
4. Allow jointing or pulling bays to avoid long duct runs.
5. Where HV multi-feeder cables are required to run, consider installing larger pit or manhole as appropriate to facilitate safer future access.
6. Allow locations for lubrication injection points, prior to bends. Apply Polywater® Lubricant J (stock item-OC8051) during cable pulling operation.
7. For reducing cable pulling tensions use appropriate conduit sweep bends to facilitate minimum cable pulling radius nominated by the cable supplier. Refer to **Appendix F** for more details.

8.6 Equipment Minimum Setbacks

The equipment installation location of above ground equipment in developments, car parks and or private roadways etc, shall meet following minimum setbacks requirements measured from the back of the footpath kerb:

1. **Public Lighting Column**

   The public lighting column minimum set back from the back of any kerb shall be 700mm and 1000mm at the road intersections. For more details, refer to TS101.

2. **Transformer/Switching Cubicle**

   For a Transformer/Switching Cubicle will require a minimum set back of 1000mm from the back of a kerb and the installation of bollards on any side exposed to vehicular traffic. Refer to **Section 8.16** for more details.

8.7 Padmount Transformer/Switching Cubicle - Design Consideration

In most residential development, 315kVA Mk7 type padmount transformer (stock item LC7309) is suitable, however, for new residential higher density load developments, the relevant SA Power Networks' Manager may approve to install 500kVA Mk7 type padmount transformer (stock item LC7310), where suitable HRC fuses are available.

8.7.1 Padmount Transformer Rating

The transformer rating shall meet the 'After Diversity Maximum Demand (ADMD)' for achieving continuous trouble-free operation when subjected to extreme heat wave conditions. Refer to **Appendix A** for ADMD values. The transformer load (ie specified kVA multiplied by the number of customers) shall not exceed:

1. For 500kVA Padmount Transformer - 90% of the name plate cyclic rating of the transformer, where the transformer installed supplies more than one customer.
2. For 315kVA Padmount Transformer - 85% of the name plate cyclic rating of the transformer, where the transformer installed supplies more than one customer.
3. For dedicated Padmount Transformer - 100% of the name plate cyclic rating of transformer, where the supply is via a dedicated transformer.
   (a) In such scenario, the use of a single main circuit breaker is mandatory, except where a load management system performs the function of the maximum demand control.
   (b) For more details, refer to Manual 32 'Service and Installation Rules' - Section Titled: 'Control of Customer Load (TIR)'.

Where a dedicated LV service is required to supply a spot load customer (eg shops, apartments, a school), then a larger transformer may be installed to service this requirement, however adequate fault current protection shall be provided by the customer.

Refer to **Appendix C** for more details.

8.7.2 Switching Cubicle (RMU) Rating

The switching cubicle (RMU) design rating shall not exceed **85%** of the rated current of the switching device, for achieving continuous trouble-free operation when subjected to extreme heat wave conditions (ie maximum demand loadings).

8.7.3 Operating Conditions

The following are the environmental operating conditions:

1. Installation: Outdoor/Indoor
2. Solar radiation: up to 1.1 kW/m^2
3. Maximum altitude/site elevation (above mean sea level): ≤ 1000m
4. Ambient air temperature from - 5°C to + 50°C and max. 24 hours avg. 40°C
5. Black body temperature in sunlight: 85°C
6. Max. temperature inside enclosure: 65°C
7. Dust: Concentrations up to 10g/m^3
8. Humidity: Maximum relative humidity up to 90% over 24 hours periods
9. Pollution: Areas of coastal spray and medium level industrial pollution with equivalent salt deposit density up to 30mg/m^2 per month

8.7.4 Transformer (Indoor) Minimum Separation

Refer to TS108 for more details.

8.7.5 Transformer (Outdoor) Minimum Separation

The installation design of an outdoor padmount transformer shall ensure that no part of the padmount transformer enclosure is within 1200mm of any part of a building or wall that has a fire rating less than three hour (ie FRL 180/180/180).

8.8 Cable Rating

For any given cable, relevant IEC and AS/NZS standards shall be referred to (eg IEC 60287, IEC 60853, AS 3865 and AS/NZS 3008) which explains the cable current rating related calculations/ methodologies.

The maximum operational ratings of any underground cables shall not be exceeded and provision for spare capacity is included for any foreseeable demand requirements.

In the CBD area, the cable rating critical location is considered at the nearest main substation feeder exits. In other areas, for most feeders, the cable rating critical location is considered at the smallest cable near the beginning of each feeder.

1. **Cyclic Rating**

   Cyclic rating factors for cables less than 66kV are to be determined in accordance with relevant IEC standards (eg IEC 60853.1).

   (a) The continuous cable ratings are increased by 10% to 15%, if the daily load profile is cyclical (eg average daily load is less than approx. 75% of the daily peak).
   (b) A cyclic rating factor of 1.12 can be applied to the continuous ratings of a cable, for typical residential and or commercial customers, operating at 1 shift/day.
   (c) For continuous 24 hours/day load profiles, no cyclic rating shall apply.

2. **Emergency Rating**

   (a) The 33kV bare lead cables more than 50 years of age are not assigned an emergency rating.
   (b) Recent 33kV cables in the CBD area, emergency ratings are applicable, which can be determined as per relevant IEC standards.

8.8.1 Parameters for Determining Cable Ratings

For any given cable in determining cable ratings, attention shall be given to 'Extended high loading during summer periods (ie Summer Emergency Continuous Rating)'.

The designer shall consider appropriate cable manufacturer's data, relevant IEC, AS/NZS standards, actual specific criteria and include the following parameters:

1. Nature of the soil (eg soil temperature and thermal resistivity). Where practicable, soil thermal resistivity tests shall be conducted for direct buried applications
2. Soil (Ground) temperatures
   25°C for summer and 12°C for winter
3. Soil thermal resistivity
   1.2°C m/W, for summer emergency continuous rating
   0.9°C m/W, for winter emergency continuous rating
4. The cable installation type (ie direct buried, in conduits and or exposed in air). Note that the underground cables when installed in air are limited to their steady state (sustained) 'in air' ratings
5. The cable configuration and spacing of the individual cable core
   Refer to TS085 for detailed information
6. Depth of cable (ie underground cable cover)
   Cables in conduits/spare conduits (min. depth) 750mm, below ground level to the top of conduit
   Buried cables, when necessary, to be laid below conduits with vertical separation of 50mm (min.). Refer to TS085 appendices for all typical arrangements
7. The method of bonding of the neutral screens to each other and or to earth
8. The heat dissipation due to single or multiple circuits installed nearby
   Cable XLPE insulation (maximum) temperature is 90°C for normal conditions and 120°C for emergency conditions

8.9 Trenching

The trench design shall incorporate the requirements of TS085. The cross-sectional details along the common service trench (CST) route shall be detailed on the design drawing.

The designer shall also ensure that SA Power Networks cables shall not be installed within the minimum safe clearance as prescribed in **Table 1**. Refer to Electricity (General) Regulations 2012 for further details.

Table 1
Minimum Safe Clearances for Underground Powerlines

Underground Powerline Voltage	Minimum Clearance Distance (Metres from the line)
275kV, 132kV, 66kV	3m
33kV or less	2m

8.10 Conduit System

The conduit system/arrangements shall comply with the requirements specified in TS085.

8.11 Spare Conduits Provision

All spare conduits provision shall comply with the requirements specified in TS085.

8.11.1 Spare Conduits and Vault Arrangement

Unless otherwise specified, all spare conduits shall be capped between 1.5m to 2.0m in front of the Padmount Transformer and Switching Cubicle vault (ie spare conduits do not need to be entered through the vault and shall be project specific). Refer to **Figure 4**, for more details.

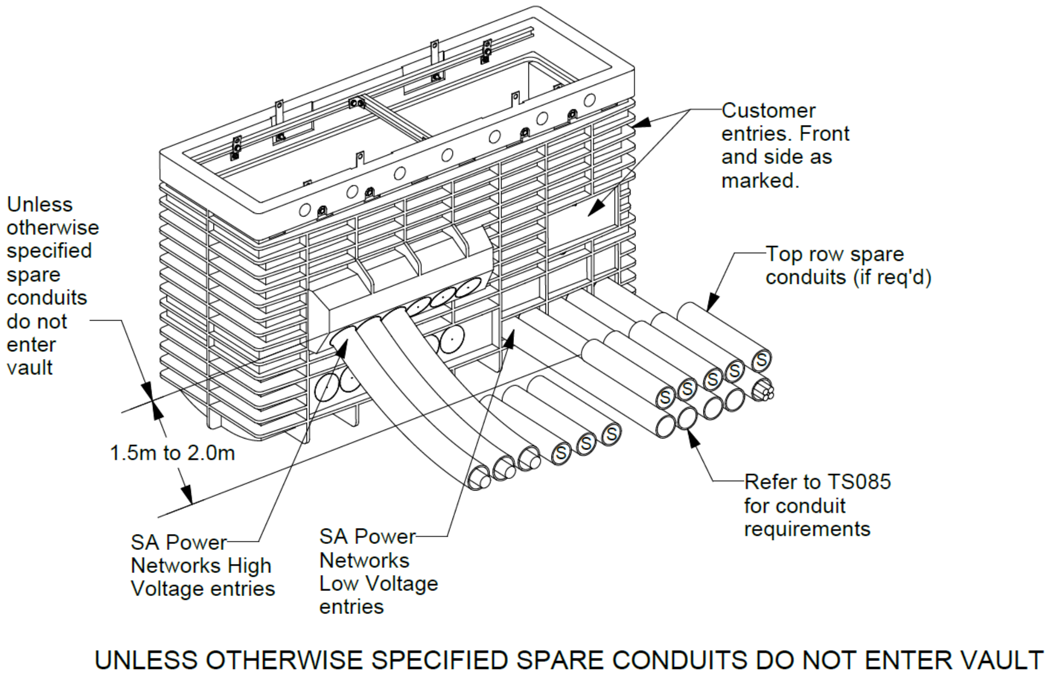


Figure 4: Spare Conduits and Vault Arrangement

8.12 Cable Destination and Numbering System

The design layout plan shall detail all equipment (eg switching cubicle/padmount transformer etc) HV and LV cable destinations labels/numbers, confirming to the correct position, designating each cable entry and exit.

The cable destination labels/numbering (eg refer to E drawings series E3019), shall be clearly visible, readable, durable, permanent and weatherproof. Refer to TS105, for more details.

8.13 Lubrication Injection Points (LIPs)

LIPs are positioned before bends and over long lengths where heavy cable hauling is expected and are installed according to the design drawing. Unless otherwise specified, LIPs installation is not required on a spare conduit.

8.13.1 Polywater® Lubricant J

Polywater® Lubricant J (stock item-OC8051) is a high performance, clean, slow drying and water-based gel lubricant. Lubricant J provides maximum tension reduction in all types of cable pulling.

It is especially recommended for long pulls; multiple bend pulls and pulls in a hot environment. Lubricant J dries to form a thin lubricating film which retains its lubricity for months after use. Polywater® Lubricant Pump with Conduit Adaptors (stock item-OC8052) will assist with easy operation. Refer to **Figure 5.**

Figure 5: Polywater® Lubricant J and Polywater® Lubricant Pump with Conduit Adaptors

8.14 Typical Easement

All easement requirements shall comply with the requirements specified in TS102. Refer to **Figures 6** and **7**, for typical easement examples, that indicates 3500mm x 3000mm as an operating area requirement in the front of the transformer.

Subject to the approval from the relevant SA Power Networks' Project Manager, the operating area may be provided via car parks, passageways, footpaths or private roadways, which will be an additional area, to the padmount transformer easement.

The requirements for distribution equipment and indoor transformer rooms are specified in TS108.

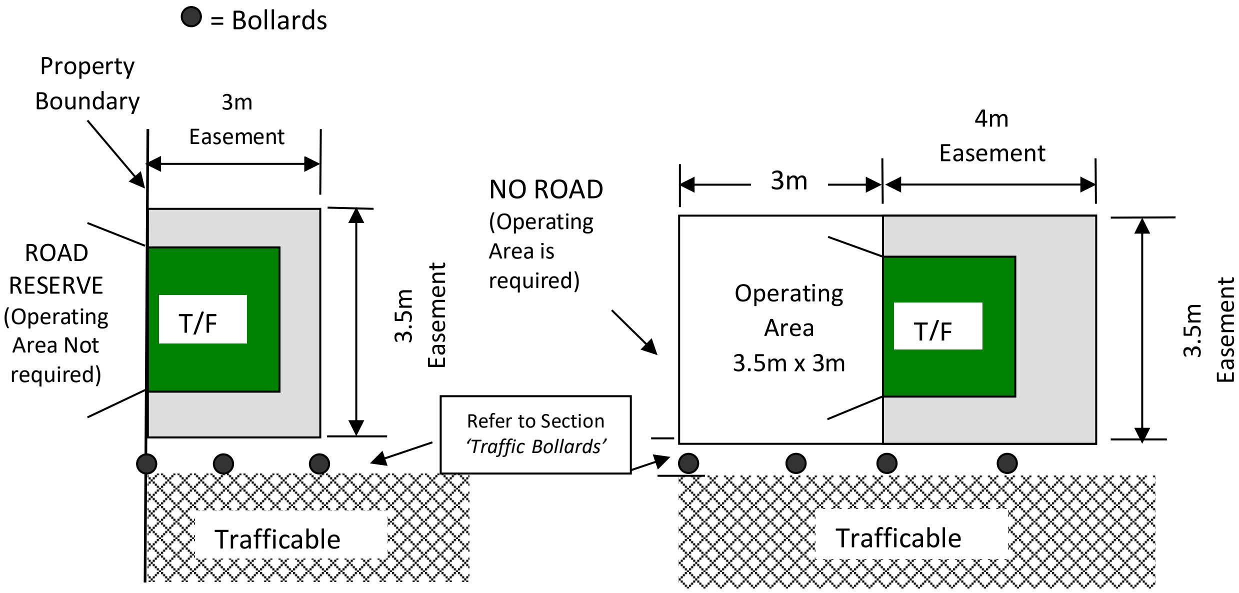


Figure 6
Typical Easement Dimensions (3.5m x 3m)
(Up to and including 1MVA Transformer)

Figure 7
Typical Easement Dimensions (3.5m x 4m)
(Greater than 1MVA Transformer)

8.15 Retaining Walls

Any cut or fill greater than 300mm in the area up to 2000mm from the easement boundary will require a retaining wall. Refer to **Figures 8, 9, 10**, and TS102 for easement requirements. Any fill above the natural ground profile (that in effect creates a raised island) on any site will not prevent the need for a retaining wall.

Where the retaining wall is placed beyond the standard easement, the easement shall be extended to include the area occupied by the retaining wall, ie retaining wall width + standard easement = full easement. Refer to **Figure 8** and TS102 for easement requirements. For any filled retaining wall, there shall be maximum buffer zone width up to 1000mm. The total easement shall be extended to include this buffer zone. Refer to **Figure 9**.

The buffer zone is equal to height of retaining wall up to 1000mm. Eg for a 500mm retaining wall, the easement shall be increased by 500mm, for a 1000mm retaining wall, the easement shall be increased by 1000mm. Where the retaining wall are more than 1000mm, the easement shall be increased up to 1000mm maximum, and will require:

1. design verification from a certified structural/civil engineer;
2. engineering calculations; and
3. council's approval, if the manufacturer's specification cannot be verified.

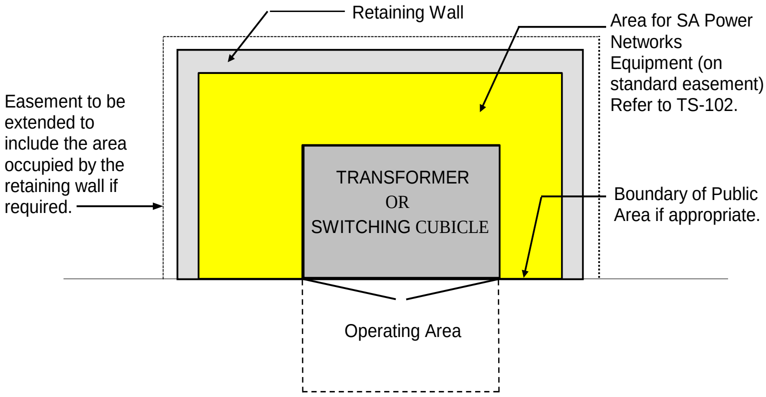


Figure 8 - Retaining Wall Area included in Extended (Overall) Easement

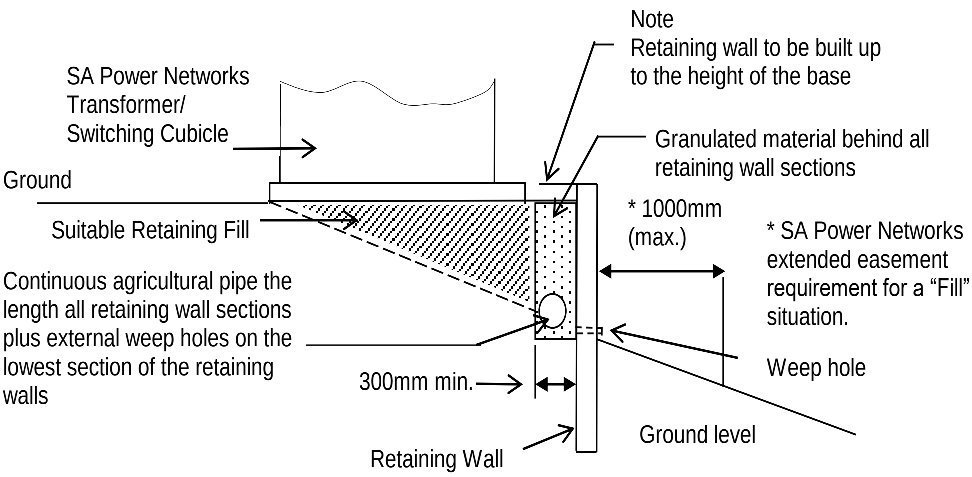


Figure 9 - Retaining Wall – Fill (1000mm Maximum Buffer Zone)

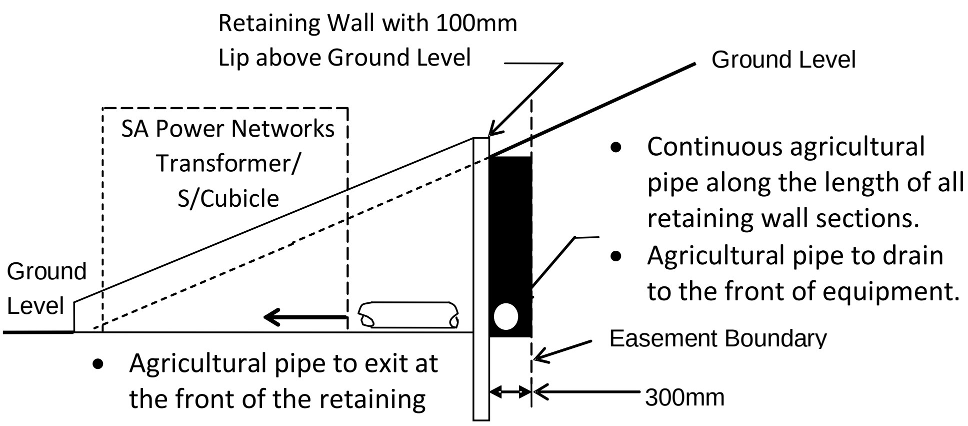


Figure 10 - Retaining Wall – Cut

8.16 Traffic Bollards

Traffic bollards are required where padmount transformers and or switching cubicle etc are adjacent to trafficable areas and are at a risk from any vehicular impact damaging SA Power Networks' Infrastructure.

The following are the general requirements for traffic bollards:

- The relevant SA Power Networks' Project Manager will assess the risk and bollard's suitability (including location) prior to its installation.
- Alternative barriers (instead of bollards) and their installation on the SA Power Networks' easement boundary are not acceptable.
- Traffic barriers for DPTI roads, shall be installed as per DPTI's requirements. Also refer to AS/NZS 3845, for road safety barrier systems requirement in detail.

1. **Fixed Bollards**

   As shown in **Figure 11**, the typical fixed round bollard heavy duty, is used for fixed installation around the SA Power Networks infrastructure exposed to the vehicular traffic. Maintain 1500mm bollard spacing (centre to centre) to act as vehicle barrier (average car width approx. 1800mm).

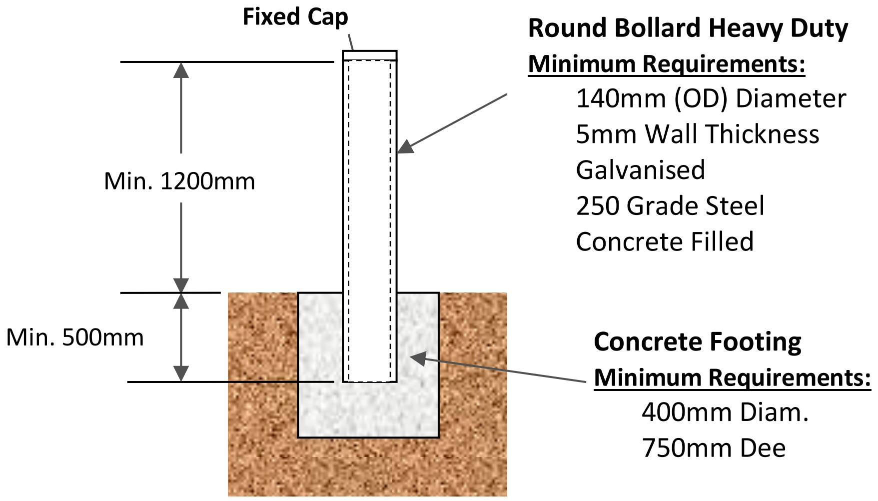


Figure 11: Typical Fixed Round Bollard Heavy Duty - (Not to Scale)

2. **Removable Bollards**

   As shown in **Figure 12**, the typical removable traffic round bollard heavy duty, is used for occasional operational access requirements around the SA Power Networks' infrastructure exposed to the vehicular traffic.

   The following are the requirements for removal bollards:

   (a) The relevant SA Power Networks' Project Manager will assess the risk and suitability of removable bollards prior to use.

   (b) Removable bollards for maintenance/operation vehicular access area require a minimum of 3000mm clear width (preferred 3500mm).

   (c) As per Service and Installation Rules, SA Power Networks will provide suitable pad locks when installed removable bollards are for the SA Power Networks.

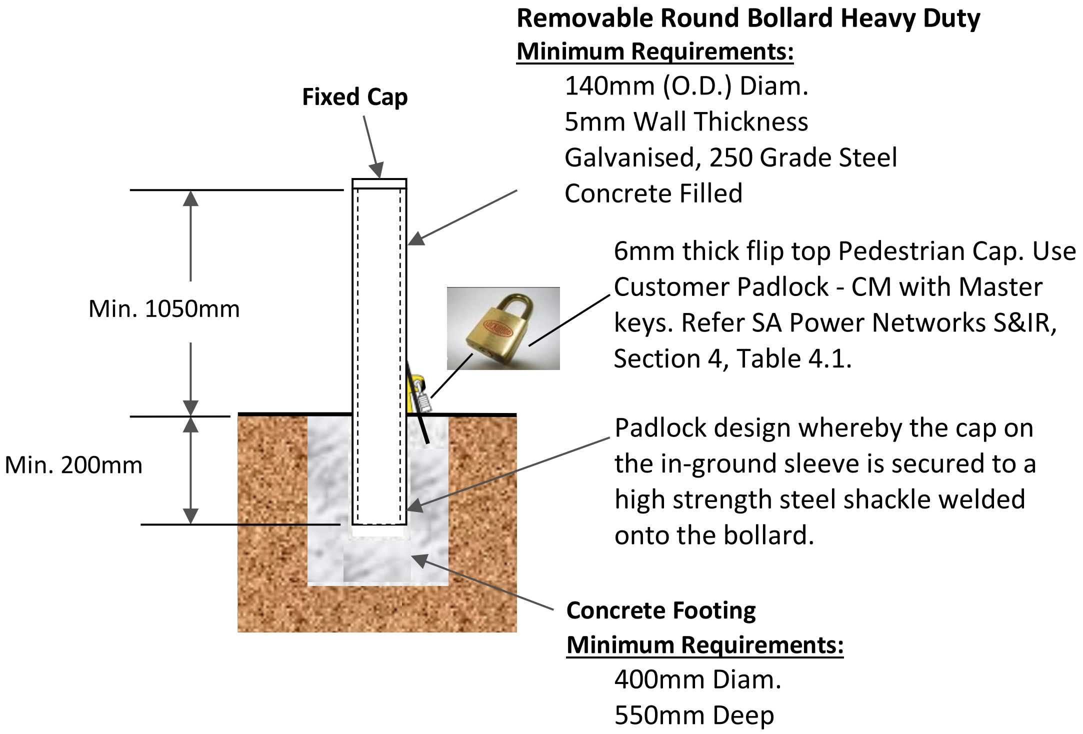


Figure 12: Typical Removable Traffic Round Bollard Heavy Duty - (Not to Scale)

3. **Public Lighting Bollards**

   Where there is no kerbing in the laneway, the protection of the public lighting column is required in a trafficable area to prevent vehicular impacts/damages.

   Mechanical protection, such as bollards or guard rails, are to be specified and approved by the customer (DPTI/council) and are required to allow operational access to the column and fuse panel. The bollards are to be maintained by the customer.

   Installation of two fixed bollards (minimum) placed 300mm in front of column with 600mm spacing between them. The distances are measured with the column placed centrally between the bollards. Refer to **Figure 13**.

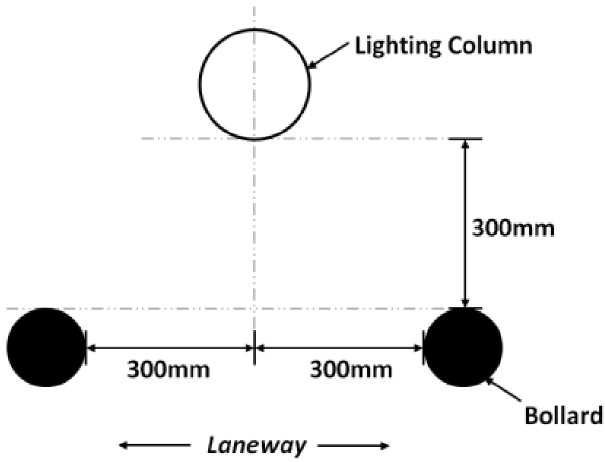


Figure 13: Typical Public Lighting Bollard Heavy Duty - (Not to Scale)

9. High Voltage Underground Network - Design

9.1 HV Cable Selection

Cable sizes will be based on the summation of the nameplate rating of individual padmount transformers in a loop system while also taking into consideration extended high loading during summer periods. If future expansion is expected, then 300mm^2 cable will be the minimum size.

Refer to the following **Tables 2, 3** and **4** for the HV cable selection and refer to **Appendix B** for more details.

Table 2
Cable Sizes for HV Mains

Purpose:	**Cable Description:**	SA Power Networks' **Supply Item Nos.**	
		Al. Cond.	**Cu. Cond.**
11 kV Substation Feeder Exits to the First Switching Cubicle	630mm^2, 1C, XLPE/HDPE, Cu Screen; OR	CK6039	--
	630mm^2, 1C, XLPE/HDPE, Cu Screen	--	CK6050
Main Feeders from the First Switching Cubicle	630mm^2, 1C, XLPE/HDPE, Cu Screen (Backbone); OR	CK6039	--
	300mm^2, 1C, XLPE/HDPE, Cu Screen (Not Backbone)	CK6025	--
Main Feeders Connecting Pad - Transformers	300mm^2, 1C, XLPE/HDPE, Cu Screen	CK6025	--
Substation Ties Between adjacent 11kV feeders (Start and End of Feeder)	630mm^2, 1C, XLPE/HDPE, Cu Screen	CK6039	--
Substation Ties Between adjacent 11kV feeders (at the Open Point)	630mm^2, 1C, XLPE/HDPE, Cu Screen; OR	CK6039	--
	300mm^2, 1C, XLPE/HDPE, Cu Screen	CK6025	--
Looped Cables within a Feeder	95mm^2, 1C, XLPE/HDPE, Cu Screen; OR	CK6005	--
	95mm^2, 3x1C, Bundled XLPE/HDPE, Cu Screen	CK6006 (Triplex)	--
11kV Feeders Backbone to End of Feeder	630mm^2, 1C, XLPE/HDPE, Cu Screen; OR	CK6039	--
	300mm^2, 1C, XLPE/HDPE, Cu Screen	CK6025	--
Laterals and Radials	95mm^2, 1C, XLPE/HDPE, Cu Screen, OR	CK6005	--
	95mm^2, 3x1C, Bundled XLPE/HDPE, Cu Screen	CK6006 (Triplex)	--

Note: Equivalent Copper (Cu) sized cable can be used.

Table 3
Cable Sizes for 6.35/11kV - For CBD and Approved Industrial Developments

Cable Description: 6.35/11kV	SA Power Networks' **Supply Item Nos.**	
	Al. Conductor	**Cu. Conductor**
240mm^2, 3C, XLPE/HDPE, Individual Cu Screens	--	CK3240
185mm^2, 3C, XLPE/HDPE, Individual Cu Screens	--	CK3185

Table 4
Cable Sizes for 19/33kV - For CBD and Approved Industrial Developments

Cable Description: 19/33kV	SA Power Networks' **Supply Item Nos.**	
	Al. Conductor	**Cu. Conductor**
50mm^2 1C AL XLPE/HDPE, Cu Screen	CK8090	--
70mm^2 1C Cu XLPE/HDPE, Cu Screen	--	CK8070
95mm^2 1C AL XLPE/HDPE, Cu Screen	CK8092	--
120mm^2 1C Cu XLPE/HDPE, Cu Screen	--	CK8120
240mm^2 1C Cu XLPE/HDPE, Cu Screen	--	CK8240
300mm^2 1C AL XLPE/HDPE, Cu Screen	CK8095	--

9.2 Surge Arrestors

Surge Arrestors shall be required for protecting electrical infrastructure against damage from lighting and switching overvoltage. Refer to AS/NZS 1768: 'Lighting Protection'.

For over to under cabling arrangement, surge arrestors shall be installed on over to under pole.

9.3 HV Straight Joints

The followings are the general requirements for HV straight joints:

1. Minimise the number of straight joints in the design.
2. When any conduit is damaged during any works, it shall be reinstated.
3. Avoid extending short lengths of HV cable to a development boundary. The preference shall be to install spare conduit to accommodate a longer length of cable in the future stage.
4. For any XLPE straight joint there shall be minimum allowance of 1000mm straight section of cable at both ends of the joint to reduce strain on the connector, tapes, heat shrink etc.
5. For more details, refer to E drawings series E1911 to E1918.

9.4 A Looped HV Network

On radial tee off installations where the sum of the transformer capacity exceeds 1 MVA, the extension is to become a looped HV network. In any multistage development that already has installed transformers and any future stage increases the sum of the transformer capacity to beyond 1 MVA, it shall be a looped network design. Refer to **Appendix B** for more details.

In rural areas where customer numbers per transformer may be low, approval may be provided by SA Power Networks' Customer Solutions Network Project Manager not to make a looped network.

Consideration should be given to a future looped system on the proviso there is a masterplan and staged construction proposal that has written agreement from the relevant SA Power Networks' Project Manager.

Any switching cubicle or transformer located in such a way that it unnecessarily deviates the high voltage cable route and requires additional lengths of high voltage cable will be deemed to be installed at the request of the developer and at the developers cost.

9.4.1 Mandatory Requirement for Looped HV Networks

Where looped HV cable networks deviate from the 'Common Service Trench (CST)' alignment, they must be protected by 'Polymeric Cable Cover' and 'Cable Marker Tapes'. The protective cover and marker tapes must be installed for the entirety of the deviated loop and extend at least 1 metre along the main CST also, as stated in Sections **9.4.1.1** and **9.4.1.2** respectively.

9.4.1.1 Polymeric Cable Cover

The polymeric cable cover (Stock Item No. RN0202), is 5mm thick, 15m long roll, 300mm wide, orange colour, inscribed ‘Danger - Electrical Cable’. Normally, the polymeric cable covers are only required when specified in a project.

However, where looped HV cable networks deviate from the ‘Common Service Trench (CST)’ alignment, the ‘Protective Cable Cover’ must be installed for the entirety of the deviated loop and extend at least 1 metre along the main CST.

The polymeric cover must be installed at 75mm above looped HV cable networks and overhanging sideways by minimum 40mm. Where, more than one polymeric cover slab is required, then they shall overlap each other by minimum 50mm.

9.4.1.2 Cable Marker Tape

Marker tape (Stock Item No. KS3765) is required mandatorily for all projects.

Where looped HV cable networks deviate from the ‘Common Service Trench (CST)’ alignment, the ‘Marker Tapes’ must be installed for the entirety of the deviated loop and extend at least 1 metre along the main CST.

The marker tapes must be installed measured halfway between the ground level and on the top of polymeric cable covers.

9.5 Switching Points

High voltage switching locations shall be determined such that the maximum load switched at a given point shall not exceed the capacity of the three-phase ganged switch. The maximum number of transformers between switching points shall be limited to the load breaking capabilities of the switching devices on the feeder.

In a HV looped system, when specified by SA Power Networks, the open point shall have a provision for remote switching capabilities (ie operable Ring Main Unit) within a transformer’s HV compartment or in a switching cubicle.

The following are the requirements for switching points:

1. All final HV open points using switches (as specified by SA Power Networks) shall be at a transformer with a Ring Main Unit (RMU) or a free-standing switching cubicle (RMU) with a Load Switch (LS);
2. When specified by SA Power Networks, all final feeder tie points shall have remote operation functionality ie switching cubicle (RMU);
3. The use of a circuit breaker (CB) within a switching cubicle as an open point of any feeder backbone is not permitted;
4. With a transformer, a transformer with RMU or a switching cubicle, the Circuit Breaker (CB), Fuse (F), and Load Switch Fuse (LSF) are not permitted as open points.
5. Refer to **Scenarios 1, 2** and **3** and **Appendix B** which provides more explanation.

Scenario 1: Looped Circuits on the same Feeder

If the looped circuits shall be on the same feeder, then there shall be an open point. At this open point, the switches shall be able to operate remotely. Cables shall be a minimum size of 95mm^2. To achieve this remote operating capability either:

(a) RMU shall be installed at the padmount transformer’s HV compartment; or
(b) Switching Cubicle (RMU) shall be installed nearby.

Scenario 2: Looped Circuits with an Open point separating two main Feeders

If the looped circuits with an open point separating two main feeders, then **Scenario 1** condition shall apply except that cables shall be a minimum size of 300mm^2.

Scenario 3: Radial Circuits

It shall be noted that for radial circuits, if any future extension/connection is required then it shall be to the same existing feeder. Where a radial circuit could become a looped circuit then **Scenario 1** applies. Cables shall be a minimum size of 95mm^2.

9.6 Significant Load Design

9.6.1 Customer Demand for Large Loads (From 1MVA and Less than 4MVA)

For the large customer demand loads (from 1MVA and less than 4MVA), the 'Main HV Supply Cable' and 'Alternative HV Supply Cable' are typically fed from the same feeder to the customers supply point. This is to enable SA Power Networks to switch to the alternative supply cable, when the main supply cable fails.

Additional design requirements for large loads (from 1MVA and less than 4MVA) that shall be adhered to are:

1. 'Main HV Supply Cable' and 'Alternative HV Supply Cable' shall be installed in a separate trench (or separate conduit system) to enable either cable to be repaired, while the other cable remains live.
2. 'Main HV Supply Cable' and 'Alternative HV Supply Cable' shall be physically separated until they reach the feeder backbone where multiple supply paths are available.
3. The customer's main switchboard (MSB) shall be located within 10m of the connection point but not within the SA Power Networks' easements (including statutory easements). The 4000mm minimum separation shall be maintained between the transformer's HV earthing and the MSB's LV earthing. Refer to Manual 32: 'Service and Installation Rules', for more details.

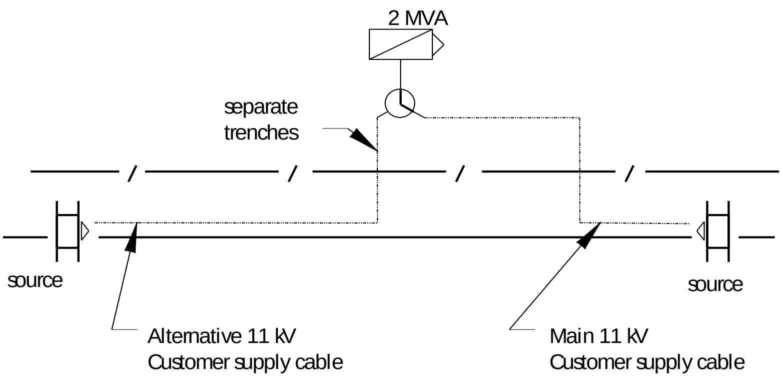


Figure 14: Typical Supply Arrangement for Max Demand from 1MVA and less than 4MVA

9.6.2 Customer Demand for Large Loads (4MVA and Above)

Very large customers, such as major shopping centres and hospitals, with a maximum demand 4MVA and above are to be supplied by a main and a backup feeder.

A load of 4MVA generally represents greater than 50% of feeder capacity and therefore SA Power Networks normal feeder design solution will not be adequate. A reserved capacity charge applies for this arrangement. Additional design requirements for large loads 4MVA and above that shall be adhered to are:

1. Install a main and a backup HV customer supply cable from two different feeders to the customer's supply points sized to carry the total customer load on either customer supply cable.
2. The customer may switch their load between either customer supply cables whenever either supply fails after agreement from SA Power Networks' Network Operations Centre. The requirement to seek approval can be removed by purchase of a backup supply arrangement.
3. If a customer has purchased a backup supply arrangement, then SA Power Networks will ensure the total agreed capacity is available at any time from either feeder.
4. The backup customer supply cable is to be installed in a separate trench or separate conduit system to enable either cable to be repaired while the other cable remains live.
5. At least two independent switching cubicles are to be supplied.
    (a) For LV customers, redundant transformer capacity is to be installed so that the total customer load can be supplied with one transformer out of service.
    (b) The customer shall contribute to the cost of this works in accordance with the Electricity Distribution Code.
6. The supply, protection, earthing and metering arrangements shall be:
    (a) Installed to the satisfaction of the SA Power Networks requirements and details to be provided on application.
    (b) Arranged to comply with the requirements of, the Electricity Distribution Code, Metering Code and National Electricity Rules in respect to interference to the SA Power Networks system.
    (c) Comply with all applicable Regulations, Codes of Practice and the S&I Rules.
7. Cables sizes shall satisfy the total customer load on either feeder.
8. The SA Power Networks preferred supply arrangement/connection, for the maximum demand load 4MVA and above is as per **Figure 15**.
    (a) If such, typical arrangement is practically not achievable and other alternative arrangement is to be considered then a written approval from MNSP is required.
    (b) Customers are encouraged to purchase a backup supply arrangement and thereby can transfer load by manual or automatic methods from one feeder to the other by internal switching.
    (c) This can be offered any time but is usually offered at the time of upgrade or connection.
    (d) A reserved capacity charge applies for this arrangement.

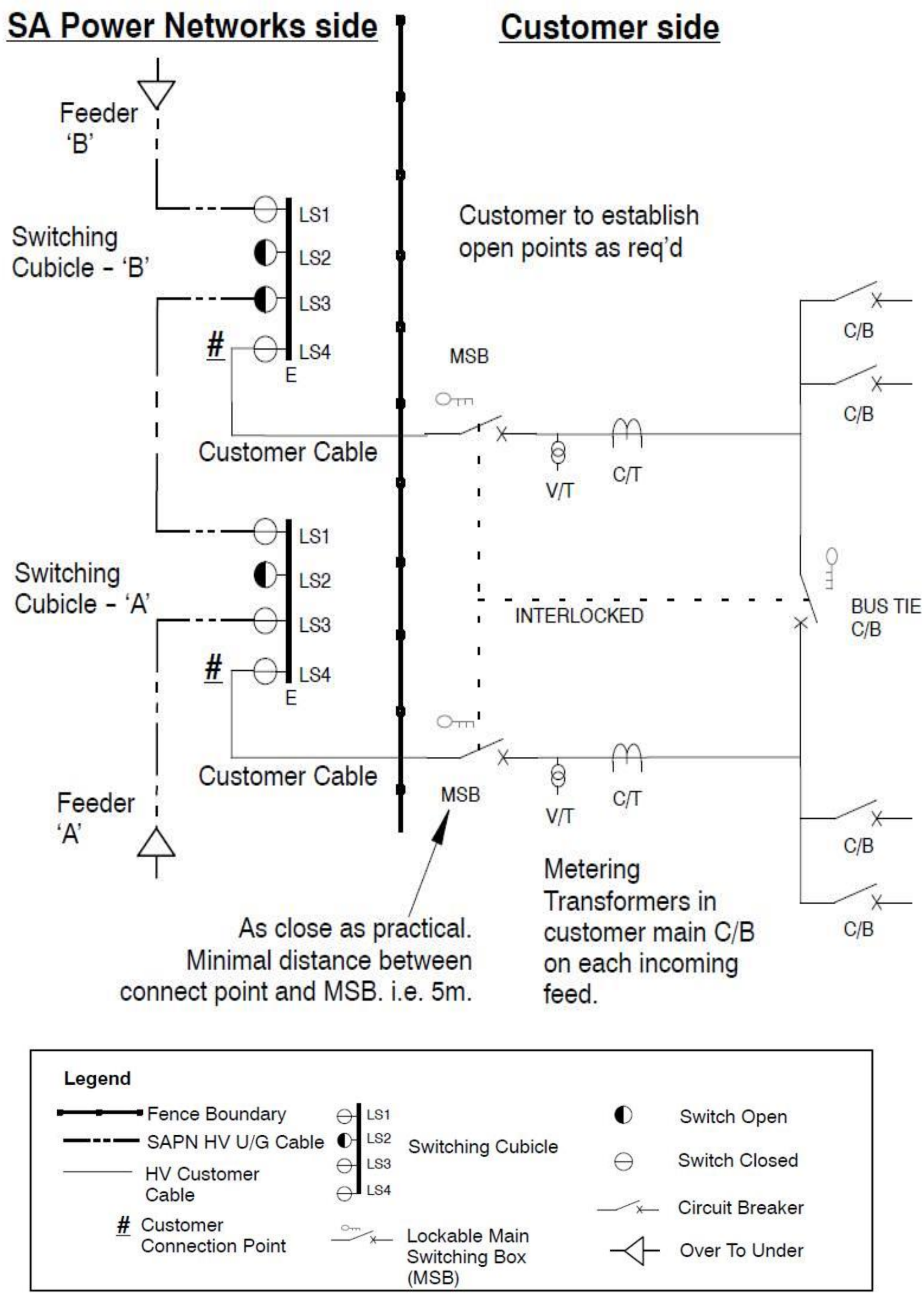


Figure 15 - Typical Supply Arrangement for Max Demand 4 MVA and Above

9.6.3 Backup Supply (Option for Improved Service)

The supply interruption sensitive customers (eg hospitals, high rise buildings, shopping centres, or large industrial customers), are encouraged to purchase a backup supply from SA Power Networks' alternative feeder. This can be offered any time but is usually offered at the time of upgrade or connection.

9.7 Ferroresonance

Ferroresonance is an electrical resonance phenomenon associated with single pole switching certain HV circuits which include inductive reactance (ie iron core TFs) and capacitive reactance (eg cable). It occurs commonly during single phase switching where lightly loaded transformers are connected through a long underground cable.

Under no load, or very light load conditions the capacitance of feeder is enough to precipitate ferroresonant behavior when single phase switching is carried out.

Ferroresonance can be prevented at the design stage by ensuring the cable does not exceed certain values and can be minimised by removing 1 of the 3 contributing causes:

1. Switch at the transformer (no capacitance); or
2. Ganged (three phase) switching of HV mains; or
3. Limiting cable length.

Note that Mk7 transformers are provided with ganged switching on the HV side, but this will not eliminate the occurrence of ferroresonance because this ganged switch may not always be used during (emergency) switching.

9.7.1 Three Phase Ganged Switch - Design Requirements

When designing a HV network, to eliminate the likelihood of ferroresonant over-voltages the following are the design requirements:

1. The three-phase ganged switching devices eg Load Switch (LS), shall be used at all the ‘Critical Switching Points’. **Note** that the term ‘Critical Switching Points’ refers to locations on the network where switching sections of the network is regularly undertaken (ie long sections of cable on feeder ‘Backbones’).
2. At over to under pole, install three phase ganged switch, where switching operations are required (eg feeder open point, operating multiple transformers etc).
3. Three phase ganged switch is not required, where radial transformers are being fed from relatively short lengths of underground cable.
4. At the critical switching points, where single or multiple radial transformers are fed from underground cable, a three-phase ganged switch shall be installed specifically for 33kV network which is at a higher risk of ferroresonance than the 11kV network.
5. Comply with the requirements stated in:
   - Switching Operators Handbook:
     Section 03; ‘01 Limitations Switching Devices E2805’
   - E drawings:
     E2805, E2806 and E2808 series
   - Operational Documents:
     Manuals No. 3: ‘Overhead E-Drawings Volume 1’
     Manuals No. 4: ‘Overhead E-Drawings Volume 2’

9.8 Fusing Requirements

Both HV and LV fusing are required for protecting the SA Power Networks equipment to prevent damage from excessive fault current, minimise customer supply interruptions and to avoid equipment replacement cost. The designer shall ensure that design complies with the SA Power Networks' HV and LV fuses requirements stated as below:

1. Ensure that the transformer used for network augmentation has built in HV/LV fuses. The Mk5, Mk6 and Mk7 transformers have built in HV and LV fuses for the protection.
2. If cable sizes are greater or equal to 95mm^2 and calculations for the cable fault current level and clearing time is determined to be less than the cable screen rating, then the installation of fuses on the underground cable section is not required.
3. Some types of transformers are supplied with underground cable sections that require fusing then install fuses prior to the cable. If this is not applicable, then ensure fuses are installed at the transformer.
4. Refer to **Table 5**.

Table 5
Summary of Fusing Requirements

Fuse Location HV	Fuse Requirements	Comments
General Locations (Applies to all Networks)		
Line Fuse	Do not fuse unless needed for protection	• Fuses operate for transient faults. • Circuit breakers and reclosers may operate for earth faults with fuses installed
Underground Cable Section (Fault level < Rating of cable)	Do not fuse	• Cable will not be damaged by fault current
Underground Cable Section (Fault level > Rating of cable)	Install fuses	• Cable may be damaged by fault current without fuse protection
Padmount Transformer	Install Fuses (at O/U pole if needed for cable protection, otherwise at TF)	• Transformer protection required due to large replacement cost

9.9 Line Fault Indicator (LFI)

The following are the line fault indicator (LFI) requirements:

1. Ideally supply to a transformer shall be a 'Ring Circuit' and HV cables do not cross over. This will assist SA Power Networks for conducting maintenance and switching activities safely.
2. If a radial transformer is required with cables supplying from the Left-hand side, then the cables shall be terminated on the LS1 side. This is to ensure that the line fault indicator (LFI) that is supplied with a fixed length connection can be placed around the cables.
3. If a radial transformer is required with cables supplying from the Right-hand side, then it is acceptable to terminate to LS2 where LFI is not required to be connected.
4. If the transformer becomes a loop feed, the additional cables will be connected to LS1 (where the LFI will be installed).

9.10 Standard Footing

A padmount transformer is installed on a concrete pad-footing, which incorporates a cable vault under the HV and LV compartments, refer to **Figure 16**.

Any floor supporting a transformer shall be capable of safely supporting the weight of the transformer. The height from the ground level to the top of the padmount transformer base shall be 75mm (E1982 sheet 3.3) and 150mm for a switching cubicle vault (E1981 sheet 3.0), this is to ensure the switchgear and fuses are positioned at the correct height for operational purposes and the vault is not compromised.

The standard footing and extended vault requirements are specified in E Drawings Group: 40 - Civil Construction.

The padmount transformer technical details are specified in **Appendix C**.

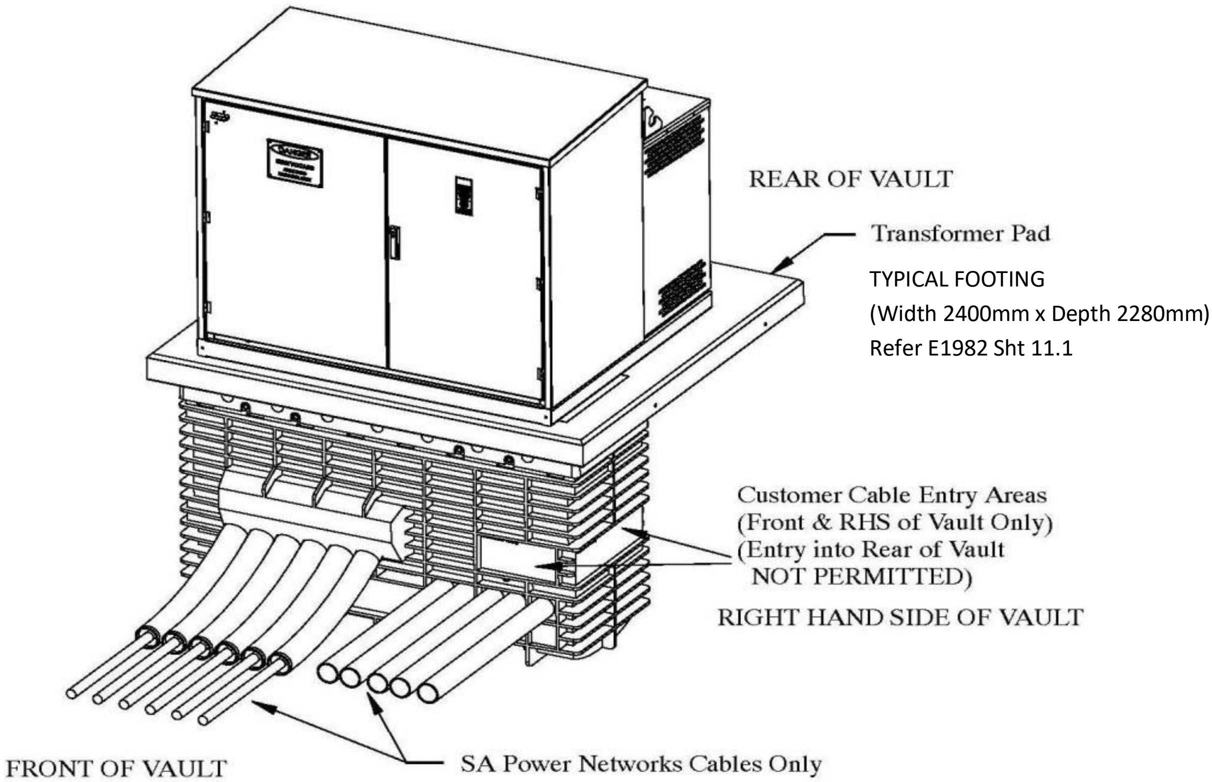


Figure 16 - Typical Footing Arrangement for the Mk7 Padmount Transformer

9.11 Extended Vault

Where standard footing and vault are not feasible due to the transformer location (eg in basements), the relevant SA Power Networks' Project Manager shall be consulted for alternative arrangement.

In CBD area, there may be an additional requirement for an extended vault in front of the padmount transformer. This extended vault will facilitate safe access to the cabling arrangements. The designer shall first seek approval from the relevant SA Power Networks' Project Manager before considering need for an extended vault.

10. Low Voltage Underground Network - Design

10.1 LV Cable Selection

Use following Tables 6 and 7 for making appropriate cable selection for LV network.

Table 6
Cable Sizes for LV Distribution Mains

Cable Description:	SA Power Networks' Supply Item Nos.	
600V/1.0 kV Low Voltage	**AL. Cond.**	**Cu. Cond.**
4x150mm² LV AL XLPE/HDPE UBC	CK5310	--
4x240mm² LV AL XLPE/HDPE UBC	CK5350	--
4x240mm² LV Cu XLPE/HDPE UBC**	--	CK5340

** 4x240mm² LV Cu XLPE/HDPE UBC (CK5340) is available for special projects requiring large current connection (eg 400A).

Table 7
Cable Sizes for LV Mains - CBD Applications

Cable Description:	SA Power Networks' Supply Item Nos.	
600V/1.0kV Low Voltage	**AL. Cond.**	**Cu. Cond.**
185mm² 3.5C LV Cu XLPE/PVC	--	CK1185
240mm² 3.5C LV Cu XLPE/PVC	--	CK1240
4x240mm² LV AL XLPE/HDPE UBC	CK5350	--
4x240mm² LV Cu XLPE/HDPE UBC**	--	CK5340

** 4x240mm² LV Cu XLPE/HDPE UBC (CK5340) is available for special projects requiring large current connection (eg 400A).

Table 8
Cable Sizes for LV Public Lighting Applications

Cable Description:	SA Power Networks' Supply Item Nos.
450V/750V Low Voltage	**Cu Cond.**
2.5mm², 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (100m Length)	CD7240
4.0mm², 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (100m Length)	CD7250
6.0mm², 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (100m Length)	CD7253
6.0mm², 2C, LV Cu PVC Insulated, Red/Black Cores, White Sheath (500m Length)	CD7254
6.0mm², 1C, LV Cu PVC Insulated, Green/Yellow Cores, Black Sheath (100m Length)	CD7061
6.0mm², 1C, LV Cu PVC Insulated, Green/Yellow Cores, Black Sheath (500m Length)	CD7062

10.2 After Diversity Maximum Demand (ADMD) Values

SA Power Networks specify the dwelling (ie new housing development) sizes from 'Medium to Large' range, refer to **Appendix A** for ADMD values.

The ADMD of a development should not be less than **6kVA** per allotment; however, the relevant SA Power Networks' Project Manager will specify the appropriate ADMD design value, as a part of the project specification.

The **Appendix A** specify ADMD values for the design purposes (allowing for future load growth) and do not make representation of the actual ADMD values expectation for a typical URD.

The projected dwelling sizes for a development shall be based on previous existing stages or the standard of housing in the vicinity. Any variation to the specified ADMD shall require approval from the relevant SA Power Networks' Project Manager.

The designer shall meet the following requirements for ADMD:

1. The existing and proposed customers supplied from an existing transformer.
2. The total proposed customers' load on a proposed transformer, LV cables, including customers within future stages, and any reinforcement of the SA Power Networks' existing assets as specified by SA Power Networks.
3. The ADMD values shall consider voltage drop calculations. Refer to **Appendix A**.
4. Transformer load (ie = specified ADMD x Nos. of customers) shall not exceed values stated in **Section 8.7**.
5. Cable ratings (specified in Amperes) shall not exceed the values stated in AS/NZS 3008.1.1 for a conductor temperature of 90°C. refer to **Section 8.8** for more details.
6. The expected load on a specific cable shall be determined from the specified ADMD multiplied by proposed numbers of customers connected to that specific cable.

10.3 Low Voltage Drop - Limit

The designer shall meet the following requirements for voltage drop:

1. For any underground LV feeder, the voltage drop shall not exceed 10 Volts, to the last (farthest) connection point and to the last (farthest) open point.
2. The voltage drop can be calculated using values supplied in **Appendix A**.
3. The voltage drop values for mains and services at the end of each LV circuit shall be indicated on the design drawings.
4. In some circumstances, LV parallel cables can be used for reduction of voltage drop. In such cases, parallel cable details shall be incorporated in the design.

10.4 Loads Balance

Single phase customers shall be evenly connected across all three phases with their phase connection identified (ie red (R), white (W) or blue (B)). The phase connections need to be 'Rolling' eg Sequential, Alternating etc.

Three phase customers shall have their loads evenly balanced across all three phases. For URD designs, unless final customer details are known, the design needs to take into consideration single phase connections.

10.5 LV Feeder Ties from Different Transformers

The designer shall meet the following requirements for LV feeder ties when they are fed from different transformer and come within 50m of each other:

1. Install LV feeder ties between different LV circuits with an open point as a mandatory requirement for all URD/UID networks. Such arrangements will ensure that there is an open point and LV switching capability is in place for future operating requirements.
2. All LV circuits shall be terminated in Pits/Pillars.
3. LV feeder ties can be established by terminating cables into a junction pit or by installing a LV cable between service pillars with a suitable open point within a service pillar.
4. In a high load area with a commercial component the installation of a LV switching cabinet as per E1927 series drawings shall be considered for feeder interconnection.
5. If a designer is unsure of the extent of ties needed, then consult the relevant SA Power Networks' Project Manager at the preliminary design stage. For an example, refer to **Figure 17**.

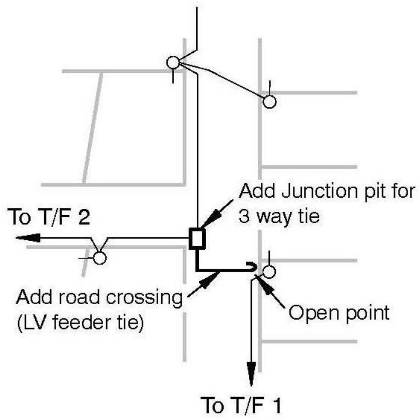


Figure 17: Example of a 3 Way LV Feeder Tie

10.6 LV Industrial Supply

There can be restraints on LV distribution capacity for a new supply to a commercial/industrial development and SA Power Networks may need to install a dedicated padmounted transformer.

The designer will need to discuss service arrangements in the first instance with the relevant SA Power Networks' Project Manager. If the existing distribution system has enough capacity, then the following service arrangements are on offer to be used:

1. Service Pits 200A to 400A (Refer to E drawings E1925 series)
2. Service Fuse Enclosure (Refer to E drawings E1160 series)

10.7 Number of LV Feeders per Transformer

A maximum of 4 LV feeders shall be provided from each padmount transformer. The arrangement of LV feeders will be dependent on the physical arrangements of the development. The number of customers (normally single phase) shall be balanced over the three phases of each feeder.

The open points between all LV feeders shall be clearly shown on the design drawing.

There are 4 LV feeding points (racks) available from a Padmounted Transformer. Each LV feeding rack can hold maximum 2 LV cable connections, provided the switch is not compromised and overloaded. The 4 LV feeding points can accommodate maximum 8 LV cable connections.

It is a mandatory requirement that each cable shall be clearly labelled to avoid confusion with 2 cable connections vs parallel cable connection. Refer to **Section 8.12** for more details.

10.8 Connection to Padmount Transformers

Where padmount transformer is required for LV and or HV consumers spot load supply, at the preliminary design stage, an approval from relevant SA Power Networks' Project Manager is required.

All LV circuits emanating from padmount transformers are via fuse switch disconnectors, a circuit breaker or isolator. For LV consumers' mains typical arrangements, please refer to **Appendix D**: 'Connection of Consumers' Mains to Padmount Transformers'.

10.9 LV Capped Cable Pillar - For Future Connection

1. The preferred option is to install spare conduit from last pillar to the future development stage boundary.
2. Cable pillar is to be used where LV cables are to be capped for connection to future development stages. Refer to **Figure 18** and E drawings E1926 series, for more details.

3. When joining future cables, access permit is required, prior to removing the pillar and undertaking straight joints.
4. Do not position cable pillar where driveway is likely to be installed, instead consider installing service and or junction pits as per **Sections 10.11.2** and **10.11.3**.

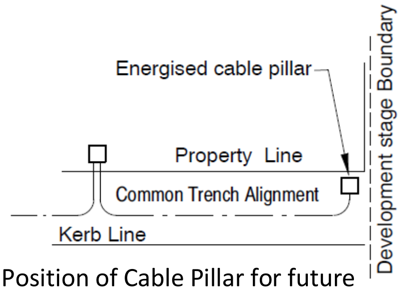


Figure 18: LV Capped Cable Pillar - Future Connection

10.10 Public Lighting

Public lighting design requirements are specified in TS101: 'Public Lighting - Design & Installation' and NICC402: 'Public Lighting - Ownership & Approval Process', which shall be adhered to.

10.11 LV Equipment - Design Consideration

The designer shall meet the following LV equipment design requirements:

1. The first LV equipment (eg service pillar, pits, cabinets) shall be located minimum 10m cable route length (as per S&IR Section 6.1.2) and 4000mm separation from the HV equipment (eg padmount transformer, switching cubicle). This separation is required to reduce the issues of voltage interference and excessive fault currents at the customer's supply point.
2. LV equipment earth to be installed a minimum of 4000mm from the HV equipment earth.
3. The footpath service/junction pits shall be located within the common (shared) service trench as detailed within TS085, unless otherwise approved.
4. In driveways and trafficable areas, install service and or junction pits as per **Sections 10.11.2** and **10.11.3**.
5. LV equipment shall be installed on flat levelled ground in a horizontal orientation.
6. LV equipment shall not be located behind sewer inspection points or adjacent to sewer 'Y' connections.
7. Where a development incorporates narrow fronted allotments with the potential for 'Villa Allotments' or when there are design issues, the applicant can make an application to the relevant SA Power Networks' Project Manager for an approval to ensure the appropriateness of the pit selection, which is assessed on case-by-case basis. Refer to **Tables 10** and **11** for pit/pillar selection.
8. LV equipment shall not interfere with the location of other services such as water mains and storm water pipes etc. The clearance to water pipelines infrastructure (eg SA Water) from the SA Power Networks' LV pit shall be 1000mm (ie the operating area) as specified in Service & Installation Rules.
9. Include consumer mains lead-ins to all properties in the design. The consumer mains lead-ins can be within the common service trench but shall be separated from the SA Power Networks cables.
10. The customer shall make provision for the SA Power Networks service pillar. The above ground service pillar has the SA Power Networks service fuses installed at an easily accessible height.

11. The installation of the service pillar inside the property allows other authorities better access in the verge area (ie Telstra, gas suppliers etc).

10.11.1 Standard Arrangement - LV Service Pillar

The SA Power Networks most preferred option is to install service pillar above-ground level as a standard service point.

The residential pillars are green in colour, vary in sizes depending on load capacities and are installed inside or on the property boundaries.

Refer to **Figure 19** and E drawings E1923 series, for more details.

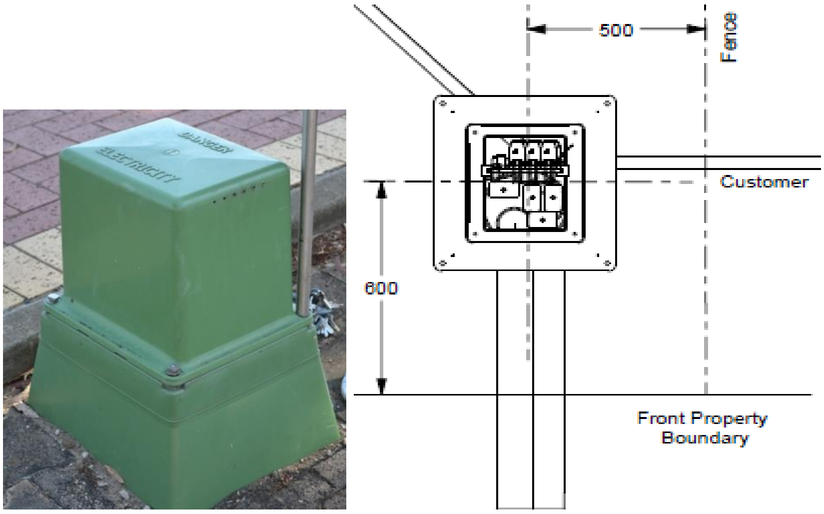


Figure 19: Standard Arrangement - LV Service Pillar (above ground level)

10.11.2 UD Pit Arrangement - Junction / Service Pit

When an installation of standard service pillar (above-ground) is not an appropriate option then alternatively the underground (UD) pit arrangement (below-ground) is considered. Refer to **Figure 20, Tables 10** and **11** for various pit types / applications and E drawing E1921 series, for more details.

For an example, a P7 pit that will allow up to 4 x 3 phase services in areas where councils have no objection to the installation of consumer mains in footpaths.

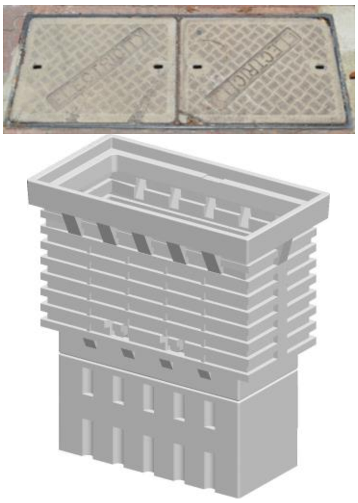


Figure 20: UD Pit Arrangement - Junction / Service Pit (below ground level)

10.11.1 LV Switching Cubicle

LV switching cubicle (above ground level) shall be used within the distribution system in high load areas such as industrial, commercial precincts and CBD areas.
Refer to **Figure 21** and E drawing E1927 series, for more details.

Figure 21: LV Switching Cubicle (above ground level)

10.11.2 Footpath Pit for Residential Driveway

If a service and or junction pit is in an area that will be subject to vehicular traffic on the footpath residential driveway, the design shall specify use of a pit with an appropriately reinforced concrete surround and steel lid or another strengthening device may be required. Refer to **Figure 22** and E drawings E1921 series, for more details.

Please note these pits are not suitable for installation on roads or laneways.

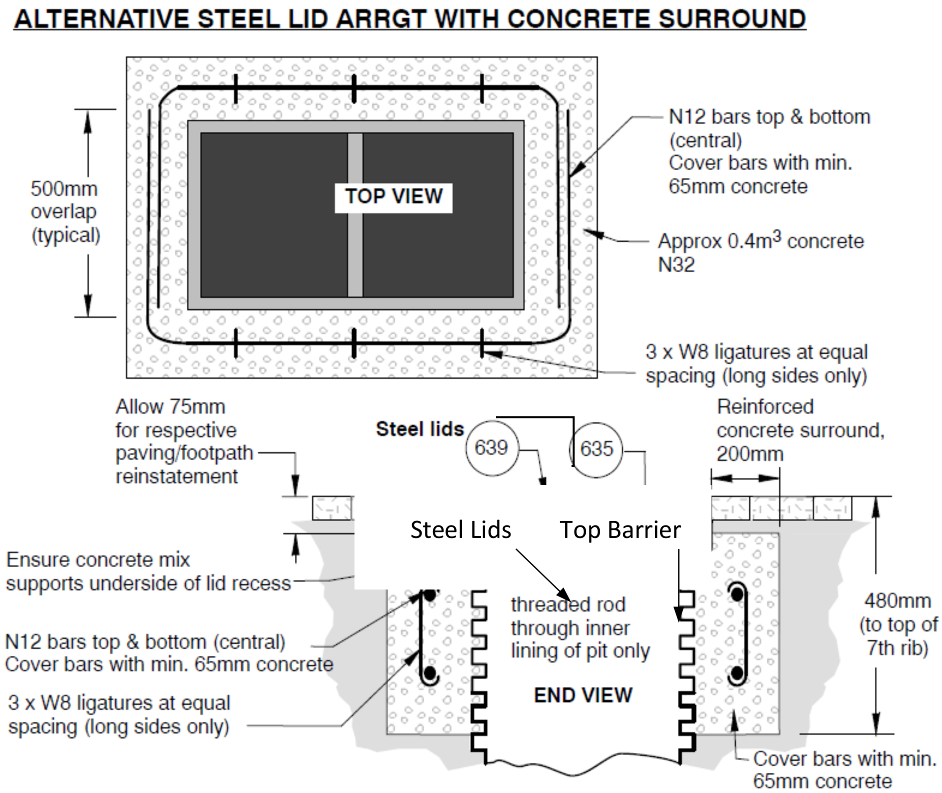
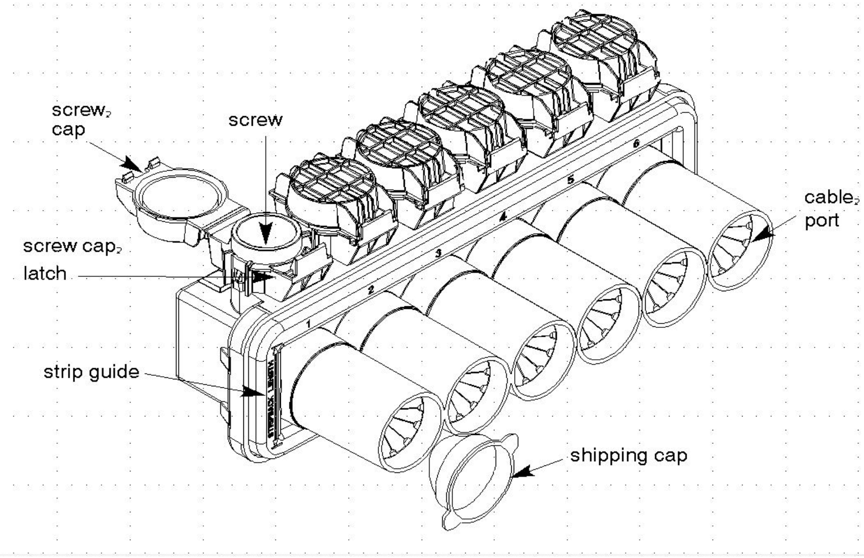


Figure 22: Footpath Pit for Residential Driveway

10.11.3 GelPorts Connector

To improve the safety and reliability of the LV network, for customer connections, installation of GelPorts Connector is a preferred option, instead of Cones Connection. Refer to **Figure 23**. The GelPorts Connectors are available for new designs/URDs. Refer to **Table 9** and E drawings E1921 series, for more details.



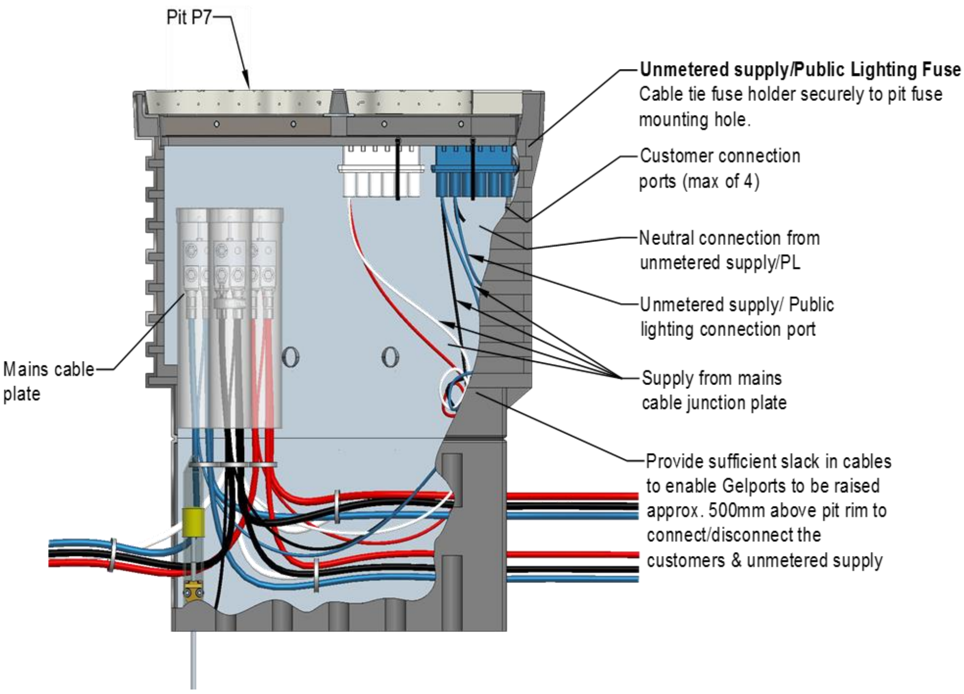


Figure 23: 6 Way GelPorts Connector

Table 9 - 6 Way GelPorts Connector

GelPorts Type	Colour	SA Power Networks' Stock Item Nos.
6 Way GelPorts Connector	Black	RA5410
	Red	RA5411
	White	RA5412
	Blue	RA5413

10.11.4 Pillar / Pit - Selection Priorities

The pit or pillar installations need to be positioned considering the terrain, electrical supply requirements, future equipment accessibility and suitability of the location, particularly the clearances to other authorities, and for above ground equipment, the likelihood of third-party damage etc.

Refer to **Tables 10** and **11** when selecting an applicable pit/pillar for any undergrounding project. When unable to make decision with appropriate pit/pillar selection then please consult the relevant SA Power Networks' Project Manager prior to the installation.

Table 10
Typical Applications of Residential Supply Pit/Pillar & Preferences

Preferences	Pit Types	Typical Application
First Option (Above Ground Level)	Service Pillar	Radial or loop-in/loop-out. (Refer to Note 1)
Second Option (Below Ground Level)	P7 Pit	Radial, 2, 3, 4-way and parallel cable applications.
		Footpath Residential Driveway Areas (Refer to Note 2)
Third Option (Below Ground Level)	P8 Pit	3 ways up to 6 ways, and parallel cable applications
Last Option (Below Ground Level)	P5 Pit (Non-Preferred)	Radial or 2 ways. (Refer to Note 3)

Notes:

1. Due to their above ground construction, a service pillar location could extend to a location inside a property's landscaped area or any other technically feasible position as agreed by the relevant SA Power Networks' Project Manager. Installation in a road reserve is not permitted without an approval from Manager Network Planning (MNP).
2. Where there would be the potential for exposure to residential vehicular traffic a pit with an appropriate reinforced concrete surround and steel lid or other strengthening device may be required; refer to Sections 10.11.2 and 10.11.3 and E drawings E1921 series, for more detail.
3. Due to operational and maintenance issues, the consideration of the non-preferred (last) option shall be in consultation with the relevant SA Power Networks' Project Manager.

The **Table 11** provides list of LV distribution enclosures that are commonly used:

Table 11
LV Distribution Enclosures

Description	Application	Refer
LV Service or Junction Pit	Various arrangements	E1921 series
	Footpath Residential Driveway Areas	E1921 Sheet 7.3
LV Service Pillar	up to 100A	E1923 series
	Single Cable 200A, 250A & 400A - Radial 3Ø	E1925 Sht 3.1
	Single Cable 200A, 250A - Radial 3Ø	E1925 Sht 3.2 Arrgt 1
	Double Cables 400A - Radial 3Ø	E1925 Sht 3.2 Arrgt 2
LV Capped Cable Pillar	For future connections at stage boundary	E1926
LV Switching Cubicle	Includes CBD application	E1927 series

10.12 LV Equipment Location

The designer shall meet the following LV equipment location requirements:

1. The conduit connection to an adjacent property shall be shown on the design drawing layout. This indicates the service point for that property.
2. A service pillar is normally located with its centre located 500mm (minimum) from the side property boundary and 600mm (minimum) from the front boundary of residential allotments. Refer to **Figure 24**.

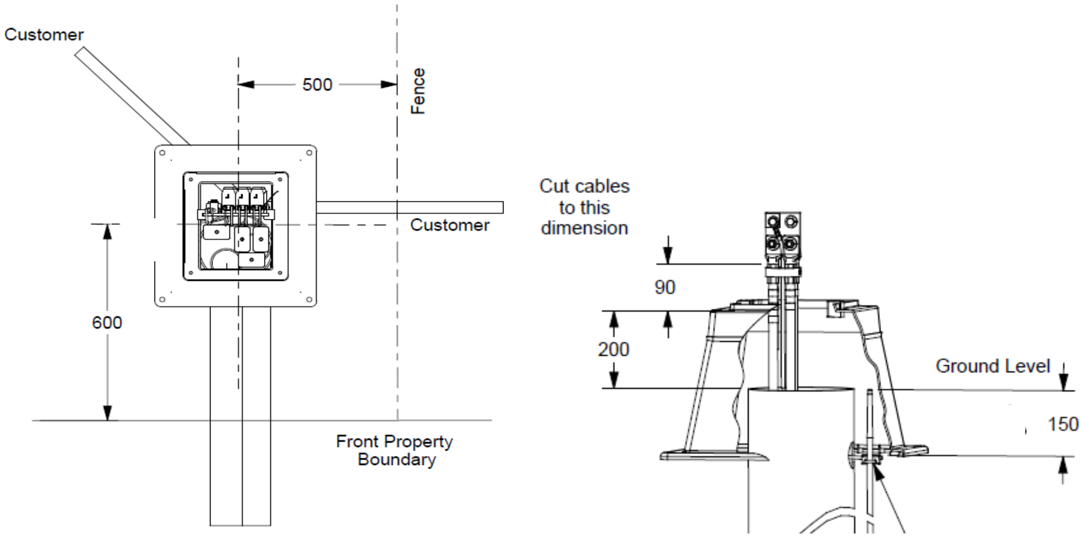


Figure 24: Service Pillar Installation Dimensions

3. In some cases, service pillars can be located 600mm in from cut off pegs on corner allotments.
4. Preferably each service pillar shall service two allotments.
5. Ensure that where fuse(s) is also required to be installed with service pillars then 1,000mm unrestricted operating area be met as per Service & Installation Rules for safe operation/ installation of fuse(s).
6. There shall be a minimum of 1200mm clearance for the full 360 degrees around the LV service pillar and any building/structure, refer to 'Service and Installations Rules' for more details.
7. The preferred location for LV switching cubicle is in the footpath adjacent to the building alignment to minimise the obstruction of the footpath reserve. It is important to locate other buried services before positioning such cubicles.
8. The placement of each LV switching cubicle shall require approval from the relevant local council. Forward council's approval copy to the relevant SA Power Networks' Project Manager.
9. Refer to appropriate E drawings series as stated below:
   (a) LV Service Pillar (Refer to E drawings E1923, E1925 and E1926 series)
   (b) LV Footpath/Junction Pit (Refer to E drawings E1921 series)
   (c) LV Switching Cubicle (Refer to E drawings E1927 series)

10.12.1 Access to Point of Supply

Customers are always required to provide unimpeded access to the point of supply. Refer to 'Service and Installation Rules - Section 7.3.5.4' for more details.

For access, a minimum one safe operating work zone clear of obstructions with minimum dimensions of 1m x 1m located immediately behind or adjacent and at the same ground level as at the pit/pillar is required.

The rear work zone is the direction that the fuse panel faces and is away from any fences. The side work zone position is also acceptable as an alternative.

Refer to **Figure 25**, for more details.

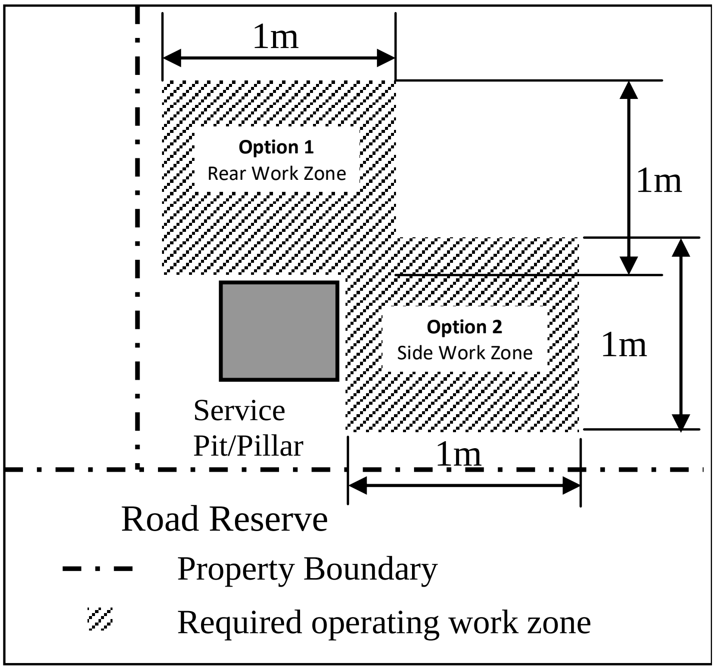


Figure 25: Safe Operating Work Zone

In a rare case, where the front work zone (ie access from roadside is not optional) is proposed and the pillar is required to be rotated 180° with fuse panel facing roadside with no fence, then approval is required from SA Power Networks' Project Manager.

Also note that, where the pillar is rotated, then it will need an appropriate E Drawing and may require a non-standard orientation label.

10.13 LV Straight Joints

The followings are the general requirements for LV straight joints:

1. Minimise the number of LV straight joints in the design.
2. Avoid extending short lengths of LV cable to a development boundary. The preference shall be to install spare conduit to accommodate a longer length of cable in the future stage.
3. When any conduit is damaged during any works, it shall be reinstated.
4. For more details, refer to E drawings E1901, E1902 and E1904 series.

10.14 LV Parallel Cable Termination

The LV parallel cables shall only be terminated in a Junction pit of P7 size (or larger). A service pillar is not a suitable for terminating parallel LV cables.

Where parallel cables are fed from transformers, then they shall be terminated at the first junction pit from the transformer of an appropriate size to suit the application and the circuit shall be clearly labelled 'Parallel Cables' as stated within E drawing E1921 series.

Where a LV 400A Service Pillar (to be installed as per E1925 Sht 3.2 Arrangement 2), which is for radial 3 phase single customer supply and LV supply is not continuing any further, then the need for terminating LV parallel cables into P7 or larger pit, prior to 400A Service Pillar, is not required.

11. Specific Design

11.1 Bridge Crossing Design

SA Power Networks shall only maintain their assets which are installed on the bridge ie cabling and conduit system. The owner of the bridge shall maintain bridge and its supporting structural elements (eg hangers, cable trays, pipes etc) used for holding conduits system.

The designer shall meet the following requirements:

1. Where steel pipes containing the SA Power Networks underground cables (eg 3xSingle core, or 1xTriplex, or communication etc) are attached to the railway line's and or tram line's bridge crossing structure and are bonded to the electrified rail and or tram network, then all single core cables for a given circuit shall be contained within the same (single) steel pipe. (Do not install 3 single core cables within 3 steel pipes).
2. Where cables pass through a structure containing steel reinforcing (eg building walls or foundations), then a single opening shall be created for all cables together to pass through the reinforced structure. (This is to prevent induction of circulating currents).
3. Where the medium or heavy seamless galvanised steel tubing are required, designer shall ensure that it complies with AS 1074 and the relevant SA Power Networks' Project Manager is notified.

11.1.1 Bridge Footpath Arrangement

The installation for underground cable and conduit system in the footpath on the bridge is permitted only where the minimum reduced cover trench requirements stipulated in TS085 standard is achievable.

Where such requirements are unachievable, then designer shall submit alternative proposal to the relevant SA Power Networks' Project Manager for seeking written approval from MNSP.

11.1.2 Service Bridge Arrangement

For the service bridge, installing SA Power Networks' infrastructure along with other utilities' services (eg APA gas, SA Water, third-party telecommunication etc) shall meet following specific requirements:

1. Electrical cable and conduit system shall be mechanically protected
2. Underground cables when installed in air are limited to their steady state 'in air' ratings, therefore shall be protected from sun's ultraviolet (UV) radiation
3. Install conduits and spare conduits as specified in TS085 standard
4. Maintain separation for other utilities' services as specified in TS085 standard

5. Where two or more feeders are to be installed parallel, 1000mm minimum separation between feeders is required. When such feeders are crossing perpendicular, the separation is negligible. For critical circuits, more detailed analysis may be required
6. Supports, clamps and hardware are to be 316 stainless steel

11.1.3 Bridge Cable Tray Arrangement

Before commencing any cable-tray arrangement works around bridge crossing, the designer shall meet the following requirements and shall seek approval from the relevant SA Power Networks' Project Manager:

1. Include mechanical, UV and vandalism protection criteria
2. Future repairs and durability criteria for the life of the infrastructure
3. Cable rating calculations
4. Engineering design calculations
5. Bridge structural drawings
6. Conduit and pipe support (eg cable trays, clamps etc) details including cable tray clamps

11.2 Railway and Tram Network Design

11.2.1 Access Permit Requirements

For seeking access permit for working in the vicinity of Adelaide Rail and Tram system, please contact DPTI rail network access team (0408 312 340) or email network.access@sa.gov.au and submit online form, at least 14 working days prior to commencing any works.

11.2.2 Design Requirements

The followings are the requirements for designing underground conduits and cables system within railway and or tram boundaries:

1. Submit enough information to the relevant SA Power Networks' Project Manager, which shall include section of 'Digital Cadastral Data Base' (DCDB) with street names, rail/tram lines information, any crossing point etc, clearly marked on the preliminary design drawing for the assessment.
2. Conduct risk assessment and consider additional factors such as rail and or tram safety, environmental criteria, any mandatory procedures etc.
4. The design live loads may be specified by rail/tram authority, else as minimum comply with AS 4799 and **Appendix A**.
5. Shall comply with requirements specified in AS 4799 and AS/NZS 3000.
6. Earth Potential Rise (EPR) design limits shall be as per AS 2067.
7. The metallic casing shall be protected against electrolysis, corrosion and induced currents in accordance with AS/NZS 2832.1 and statutory requirements. The steel bore casings shall be electrically isolated from any type of cable pits.
8. Cable joints/splices are not permitted for the entire cable length of the railway and or tram corridor's reserve crossing.
9. Consider de-rating factors as specified in **Section 8.8**.
10. The electrical and telecommunications conduits and spare conduits requirements are specified in TS085 standard.

11. Where multiple HV feeder circuits crosses under the railway and or tram network, a separate bore hole for each circuit is required.
12. SA Power Networks assume that CMEN system is in place. The continuity of any existing CMEN conductors shall be maintained at underground railway and or tram crossings.
13. Where existing HV overhead mains with CMEN conductor are to be undergrounded (no LV mains), the CMEN conductor shall be terminated at the over/under poles and bonded to the underground cable's screen wires at each end, to maintain CMEN continuity.

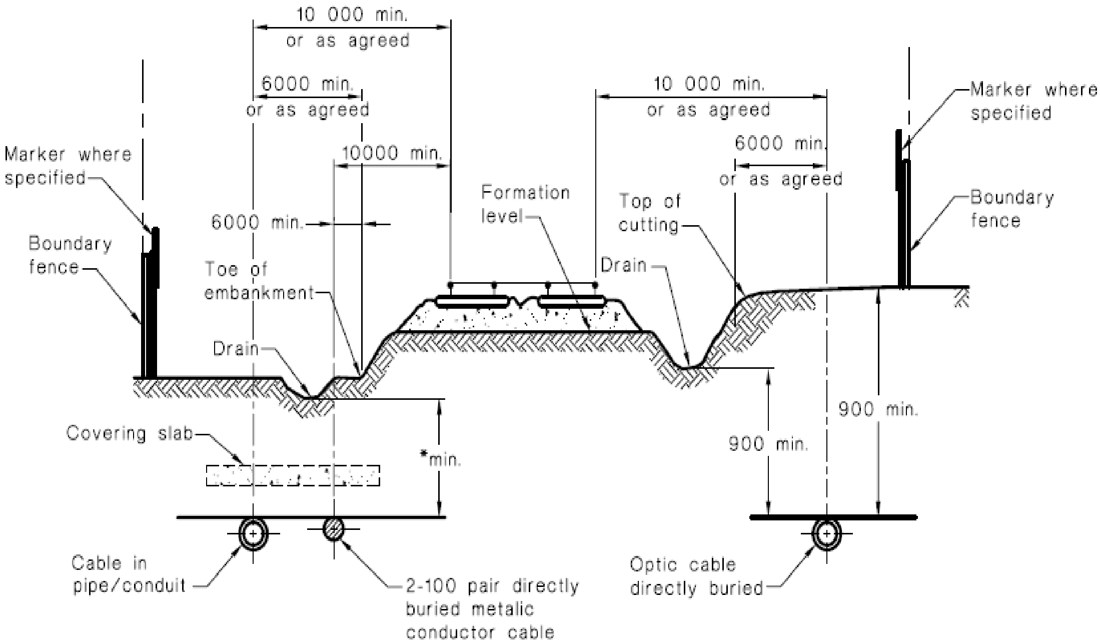
11.2.3 Separation Requirements

The minimum separation specified in the **Figures 26** and **27** are as per AS 4799.

In relation to rail/tram track and its formation, all services, pits and pipelines, shall not be located within 6m of the toe of banks or top of cuttings, or within 10m of the nearest rail.

To maintain enough clearance from railway facilities, all services, pits and pipelines shall be laid at least 3m clear of all railway structures, cattle pits and stops, drains, signaling equipment, overhead masts, poles, underground cables, buildings, points and crossings, bridges and culverts.

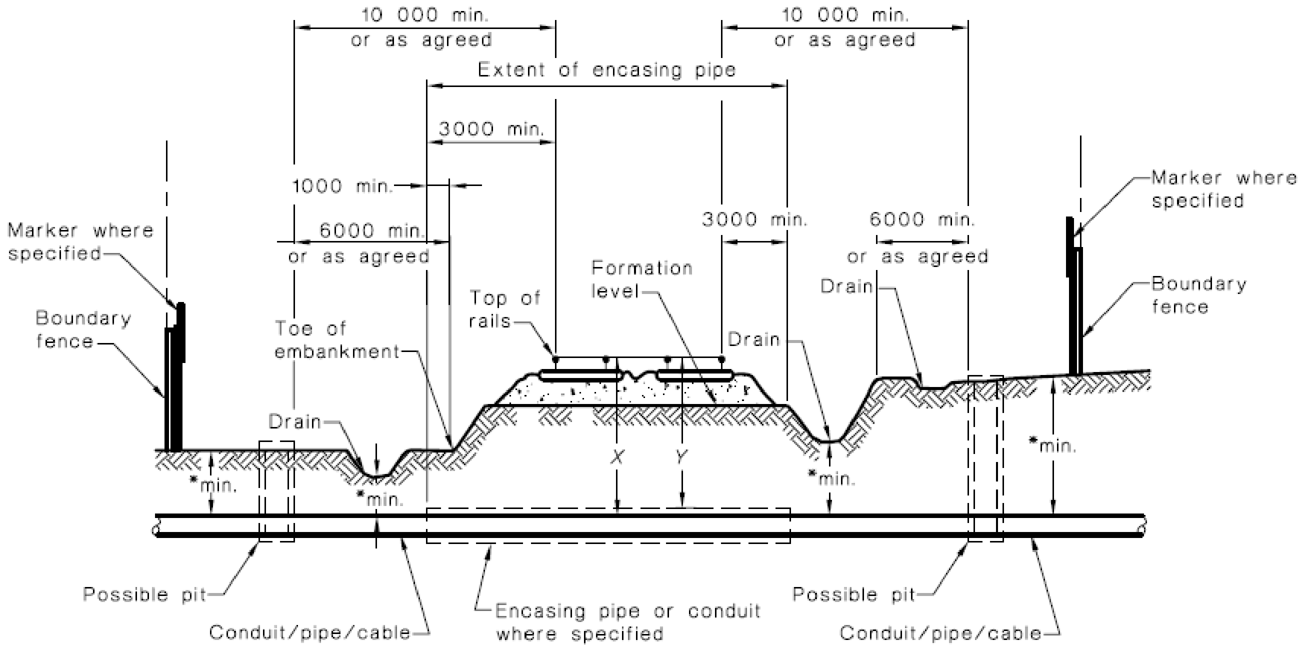
Pipeline routes, cable routes, carrier pipes and encasing pipes shall be separated by a clear spacing of at least 600mm in the horizontal plane from other pipelines and from power and communication cables, unless agreed to otherwise, in writing, by the parties.



Note: * = 600 min. Increase to 900 min. for directly buried optic cable

Figure 26: Conduit and Cables (Parallel) under the Railway/Tramline

(Reference: AS 4799, Section - 6)



Note: * = 600 min. Increase to 900 min. for directly buried optic cable

Figure 27: Conduit and Cables (Crossing) under the Railway/Tramline

(Reference: AS 4799, Section - 6)

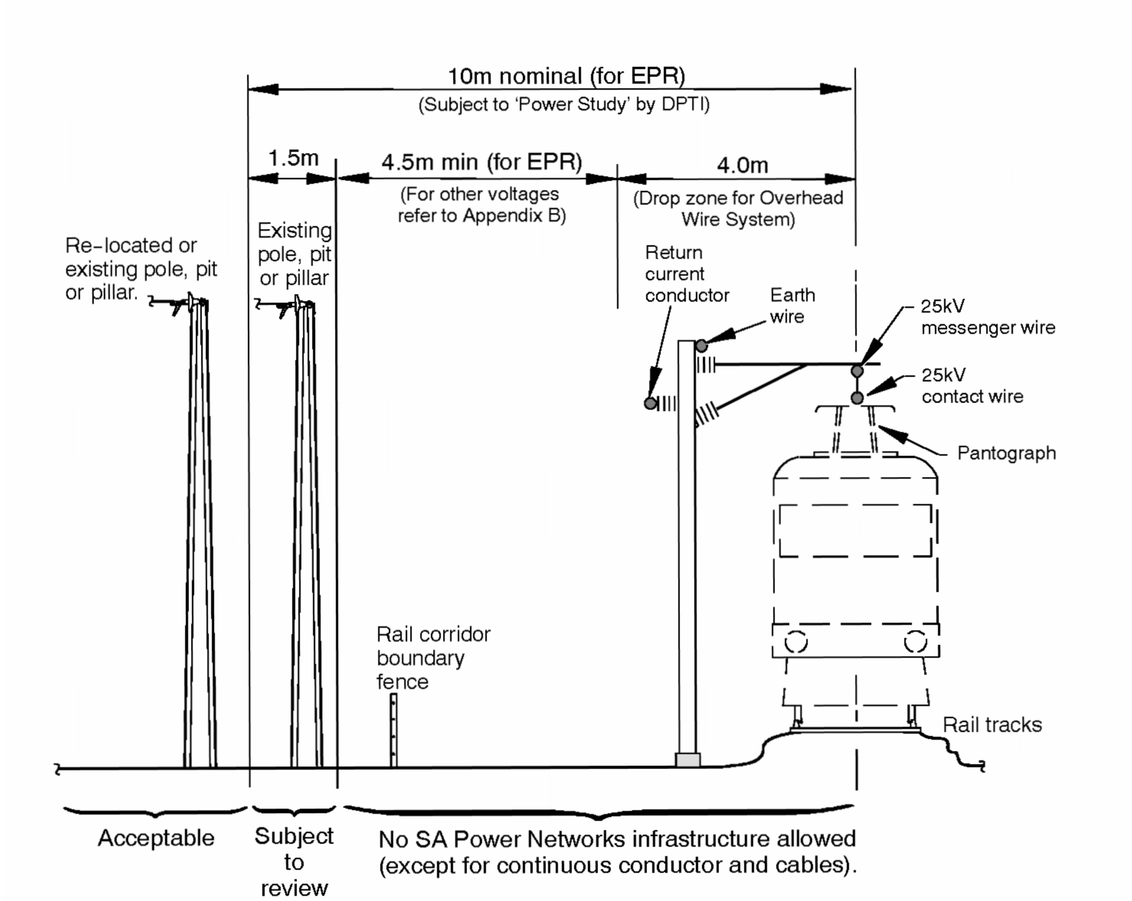


Figure 28: Guide - Separation from 25kV Railway/Tramline

Notes:

1. Any distribution lines voltage (eg LV, 7.6kV, 11kV) less than the 25kV railway networks and will be crossing 25kV lines shall be undergrounded. The clearance between OH 33kV and OH 25kV shall be minimum 3.7m, where this clearance is unachievable then consult SA Power Networks' Project Manager.
2. The minimum clearances requirements are to be from the highest point of the Overhead Contact Line Zone and Pantograph Zone (OCLPZ) or its supporting structure, whichever is the highest.
3. 3rd Party telecommunication carrier owners to be consulted in relation to their clearance requirements to the 25kV railway network.

11.2.4 Depth of Installation

11.2.4.1 Under Tracks

Where power cables pass under tracks, they shall be enclosed in an appropriate 'Category A' system in accordance with AS/NZS 3000.

The top of the encasing pipe or conduit shall be at a depth of not less than 2000mm below the top of rail (Refer to **Figure 29** and **Table 11**, for more details) and shall be maintained at this depth for not less 3000mm beyond the outer rails, when measured at right angles to the track.

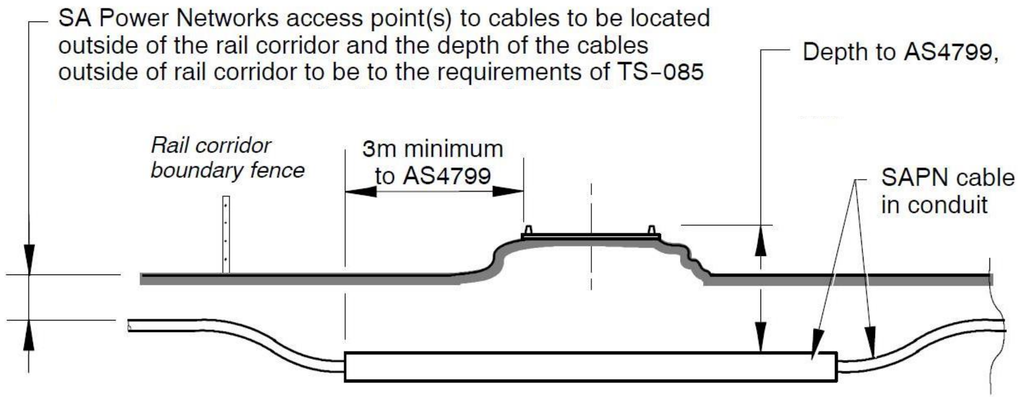


Figure 29: Conduit Extension (Crossing) under the Railway/Tramline

11.2.4.2 In Rail Corridor

Elsewhere in the rail/tram corridor, electrical power cables shall be laid at a depth of not less than 1000mm below ground level or at the same depth below the level of drain inverts that they may cross.

Where specified by the authorities, the cables shall also be enclosed or covered by protective slabs.

Table 12 - Minimum Depth of Conduits and Cables under Rail/Tram Tracks

Dimension	Description	Minimum Depth (mm)
X (Refer **Figure 25**)	Depth between top of rail/tram tracks and top of conduit/pipe/ or cable	1200/1500 (directly buried optic cable) 2000 (Electrical cables)
Y (Refer **Figure 25**)	Depth between top of rail/tram tracks and encasing pipe	1200/2000 (Electrical cables)

12. Provision for Future Stages

A master layout plan of proposed HV and LV distribution system must be prepared and submitted to the relevant SA Power Networks' Project Manager, which shall indicate current and future multi-staged development.

For multi-staged development, the provision shall be made by extending HV and LV cables, conduits and be capped at stage boundary, for the future connections.

Where a LV cable is installed to ultimately feed a future stage, the cable is to be shown on the 'For Construction' design as being connected and capped.

Finished ground levels at the subdivision boundary shall be provided, as this level is considered as the basis for the finished heights for service pits and pillars, lighting columns, transformer and switching cubicle installations.

With smaller building setbacks and allotments, the boundary shall be correctly levelled, as the cost to rectify levels for SA Power Networks' plant after installation can be very expensive, particularly if the project has been energised.

The designer shall ensure that none of the property gets missed out with future supply within current stage boundary. All properties within the project stage and future connecting stage boundaries shall be made supply ready by providing appropriate LV service and or junction pit, pillars, HV joints etc.

13. Who You Should Talk To?

For all General Enquiries:

In the first instance, please contact Builders and Electrical Contractors Service on 1300 650 014 (8am to 5pm, Mon to Fri) or send an Email: appointments@sapowernetworks.com.au

Dial Before You Dig Enquiries:

Call '1100' during business hours, and / or visit their internet website at www.1100.com.au

Customer Connections Information and Customer Solutions Managers:

SA Power Networks' Customer Connections Information and Customer Solutions Managers contact details are available on internet, click here:
https://www.sapowernetworks.com.au/public/download/?id=221664

For Documentation Access or For Approval of Non-Standard Special Purpose E Drawings:

For E-Drawings, Non-Standard Special Purpose E Drawings (E SP), AutoCAD standard templates and Instructional Manuals, please contact 'Standards and Equipment Team' via Hotline on (08) 8404 4200 or send an email to: networkstandards@sapowernetworks.com.au.

For 'Service & Installation Rules':

If your question relates to our 'Service & Installation Rules', you should contact our Network Connections Manager on (08) 8404 4898 or send an email to:
appointments@sapowernetworks.com.au

Appendices

A ADMD Tables

A.1 3 Phase Voltage Drop and ADMD Table - 4x150mm² LV AL XLPE/HDPE UBC

Number of Customers	Balanced 3 Phase Voltage Drop Table (V) based on 100m length of 4x150mm² LV AL XLPE/HDPE UBC (CK5310)					
	After Diversity Maximum Demand (ADMD) per Customer					
	3kVA	4kVA	5kVA	6kVA	8kVA	10kVA
1	2.74	2.92	3.10	3.28	3.64	4.00
2	2.51	2.79	3.07	3.35	3.91	4.47
3	2.53	2.89	3.25	3.61	4.33	5.05
4	2.62	3.05	3.49	3.93	4.81	5.69
5	2.74	3.24	3.75	4.26	5.28	6.30
6	2.87	3.44	4.01	4.58	5.72	6.86
7	3.01	3.64	4.28	4.92	6.20	7.48
8	3.15	3.85	4.55	5.25	6.65	8.05
9	3.30	4.06	4.82	5.58	7.10	8.62
10	3.45	4.27	5.09	5.91	7.55	9.19
11	3.59	4.47	5.35	6.23	7.99	9.75
12	3.74	4.68	5.61	6.54	8.40	10.26
13	3.89	4.88	5.88	6.88	8.88	10.88
14	4.04	5.09	6.14	7.19	9.29	11.39
15	4.19	5.29	6.39	7.49	9.69	11.89
16	4.34	5.49	6.65	7.81	10.13	12.45
17	4.49	5.70	6.91	8.12	10.54	12.96
18	4.63	5.90	7.16	8.42	10.94	13.46
19	4.78	6.10	7.41	8.72	11.34	13.96
20	4.93	6.29	7.66	9.03	11.77	14.51
21	5.07	6.49	7.91	9.33	12.17	15.01
22	5.22	6.69	8.16	9.63	12.57	15.51
23	5.36	6.88	8.41	9.94	13.00	16.06
24	5.51	7.08	8.65	10.22	13.36	16.50
25	5.65	7.27	8.90	10.53	13.79	17.05
26	5.79	7.47	9.14	10.81	14.15	17.49
27	5.94	7.66	9.38	11.10	14.54	17.98
28	6.08	7.85	9.62	11.39	14.93	18.47
29	6.22	8.04	9.87	11.70	15.36	19.02
30	6.36	8.23	10.11	11.99	15.75	19.51
31	6.50	8.42	10.34	12.26	16.10	19.94
32	6.64	8.61	10.58	12.55	16.49	10.43
33	6.79	8.80	10.82	12.84	16.88	20.92
34	6.93	8.99	11.06	13.13	17.27	21.41
35	7.07	9.18	11.29	13.40	17.62	21.84
36	7.20	9.37	11.53	13.69	18.01	22.33
37	7.34	9.55	11.76	13.97	18.39	22.81
38	7.48	9.74	12.00	14.26	18.78	23.30
39	7.62	9.92	12.23	14.54	19.16	23.78
40	7.76	10.11	12.46	14.81	19.51	24.21

A.2 3 Phase Voltage Drop and ADMD Table - 4x240mm² LV AL XLPE/HDPE UBC

Number of Customers	Balanced 3 Phase Voltage Drop Table (V) based on 100m length of 4x240mm² LV AL XLPE/HDPE UBC (CK5350)					
	After Diversity Maximum Demand (ADMD) per Customer					
	3kVA	4kVA	5kVA	6kVA	8kVA	10kVA
1	2.02	2.15	2.29	2.42	2.69	2.96
2	1.85	2.06	2.26	2.47	2.88	3.29
3	1.87	2.13	2.40	2.66	3.20	3.73
4	1.93	2.25	2.57	2.90	3.54	4.18
5	2.02	2.39	2.76	3.14	3.89	4.63
6	2.11	2.54	2.96	3.38	4.23	5.07
7	2.22	2.69	3.16	3.63	4.57	5.51
8	2.32	2.84	3.36	3.87	4.91	5.94
9	2.43	2.99	3.55	4.12	5.24	6.36
10	2.54	3.15	3.75	4.36	5.57	6.78
11	2.65	3.30	3.95	4.59	5.89	7.19
12	2.76	3.45	4.14	4.83	6.21	7.59
13	2.87	3.60	4.33	5.07	6.53	7.99
14	2.98	3.75	4.53	5.30	6.84	8.39
15	3.09	3.90	4.72	5.53	7.16	8.78
16	3.20	4.05	4.91	5.76	7.46	9.17
17	3.31	4.20	5.09	5.99	7.77	9.56
18	3.42	4.35	5.28	6.21	8.08	9.94
19	3.53	4.50	5.47	6.44	8.38	10.32
20	3.63	4.64	5.65	6.66	8.68	10.70
21	3.74	4.79	5.84	6.88	8.98	11.07
22	3.85	4.93	6.02	7.10	9.27	11.44
23	3.95	5.08	6.20	7.32	9.57	11.81
24	4.06	5.22	6.38	7.54	9.86	12.18
25	4.17	5.36	6.56	7.76	10.15	12.55
26	4.27	5.51	6.74	7.98	10.44	12.91
27	4.38	5.65	6.92	8.19	10.73	13.28
28	4.48	5.79	7.10	8.41	11.02	13.64
29	4.59	5.93	7.28	8.62	11.31	14.00
30	4.69	6.07	7.45	8.83	11.59	14.35
31	4.80	6.21	7.63	9.05	11.88	14.71
32	4.90	6.35	7.80	9.26	12.16	15.07
33	5.00	6.49	7.98	9.47	12.44	15.42
34	5.11	6.63	8.15	9.68	12.72	15.77
35	5.21	6.77	8.33	9.89	13.00	16.12
36	5.31	6.91	8.50	10.10	13.28	16.47
37	5.42	7.05	8.67	10.30	13.56	16.82
38	5.52	7.18	8.85	10.51	13.84	17.17
39	5.62	7.32	9.02	10.72	14.12	17.52
40	5.72	7.46	9.19	10.92	14.39	17.86

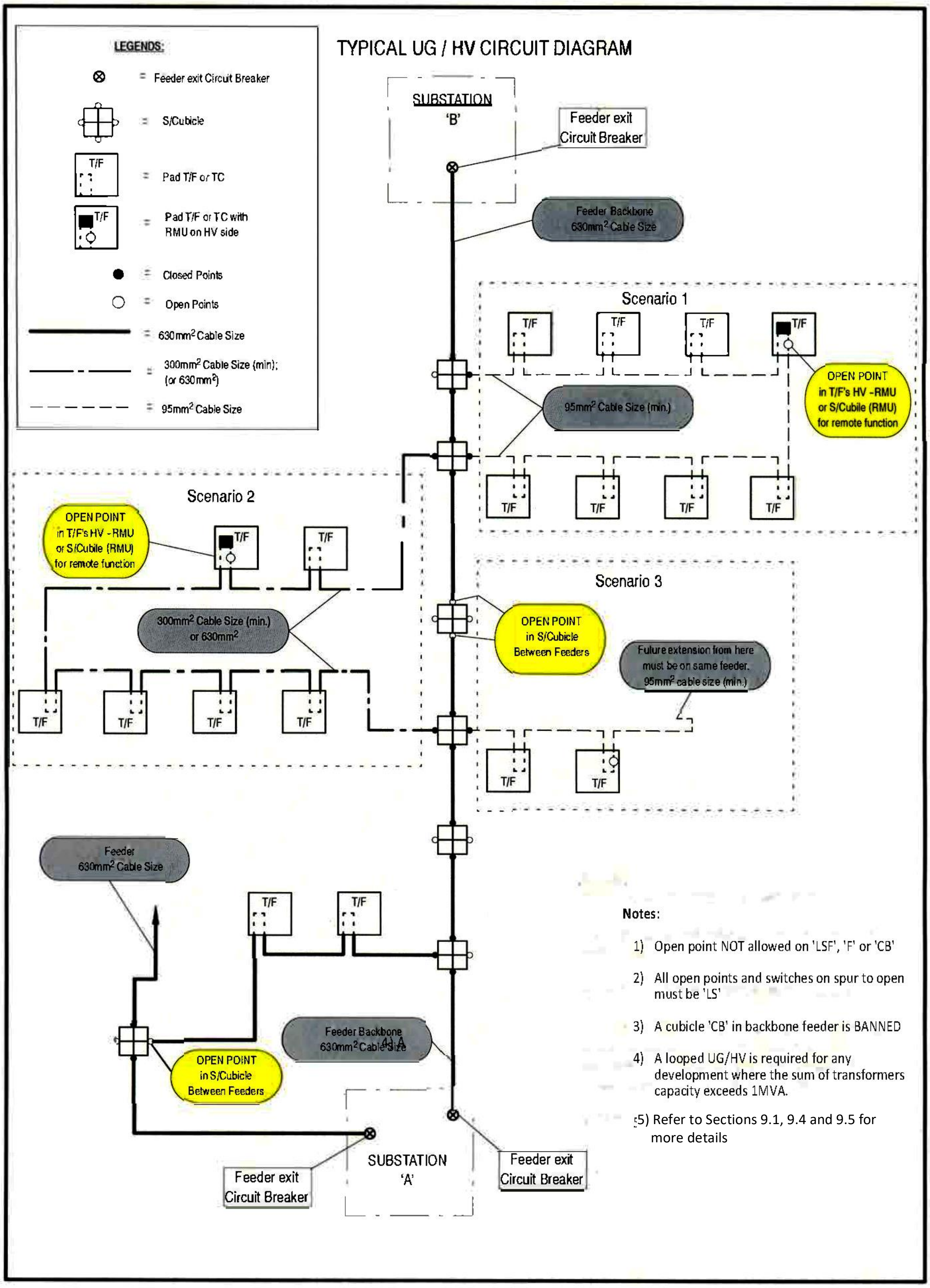
A.3 Table of ADMD for Average URD Dwelling Sizes

DESCRIPTION: Average URD Dwelling Sizes for the Development	ADMD (kVA)
Villas, Townhouses, Apartments (<12 squares/110 m^2)	4
Small to Medium (12 - 20 squares/110 – 185 m^2)	5
Medium to Large (20 – 30 squares/185 – 280 m^2)	6
Large (>30 squares/280 m^2)	* 8

Notes:

1. * = More extensive features/facilities in larger housing of some elite developments should proportionally increase the ADMD.
2. Refer to **Section 10.2** for the detailed explanation.
3. The ADMD of a development **should not be less than 6kVA per allotment**; however, relevant SA Power Networks' Project Manager will specify the appropriate ADMD design value, as a part of the project specification.
4. The ADMD values tabulated are used for design purposes (allowing for future load growth) and should not be representative of the customer ADMD expected in a typical URD.

B Typical UG HV Circuit Diagram



C Mk7 Padmount Transformer - General Details

Table C.1
Mk7 Padmount Transformer (11kV/400V) - General Details

Pad - T/F Nominal Rating (kVA)	Nominal Dimensions (Width x Depth x Height) (mm)	Weight (Tones)	Maximum SA Power Networks' LV 'NH' Fuse Link and/or Circuit Breaker Ratings (A)	Nominal Impedance (%)	Prospective Fault Current (kA) #
315	1950 x 1662 x 1627	2.6	400A (NH3 Type)	3.6	13.5
500	1950 x 1662 x 1627	3.0	400A (NH3 Type)	4.0	19.3
750	1950 x 2042 x 1677	4.1	400A (NH3 Type) and 2000A CB*	4.4	26.3
1000	1950 x 2042 x 1677	4.5	400A (NH3 Type) and 2000A CB*	4.4	35.1
1500	2200 x 2117 x 1797	6.1	2500A CB*	6.3	36.8
2000	2200 x 2117 x 1797	6.6	N/A	6.5	47.6

Note:
Nominal dimensions and weights of padmount transformers are subject to change by the transformer manufacturer without notice. The actual weight is stenciled on the Pad T/F nameplate.

Notations:
= Based on minimum transformer impedance
***** = Terasaki XS2000NE or XS2500NE LV Circuit Breaker with the following settings:

KVA Rating	I_n	I_o	I_1	T_1	I_2	T_2	I_3
750kVA	2000	0.8	0.85	5	2	0.1	5
1000kVA	2000	1	0.9	5	2	0.1	6
1500kVA	2500	1	1	30	2	0.1	6

Table C.2
Mk7 Padmount Transformers - 11kV/400V

Pad – T/F Nominal Rating (kVA)	Nominal Voltage (kV)	Pad – T/F Full Load Current (A)	Pad – T/F Losses (Watts)	HV Tapping Range (Tap Steps = 2.5%)
315	11/0.4	420	4994	-10% To +5%
500	11/0.4	667	6962	-10% To +5%
750	11/0.4	1000	10,188	-10% To +5%
1,000	11/0.4	1333	14,361	-10% To +5%
1,500	11/0.4	2000	21,834	-10% To +5%
2,000	11/0.4	2667	29,962	-10% To +5%

Table C.3
Mk7 Padmount Transformers - 11kV/7.6kV/400V (ie Dual Ratio)

Pad – T/F Nominal Rating (kVA)	Nominal Voltage (kV)	Pad – T/F Actual Rating (kVA)	Pad – T/F Full Load Current (A)	Pad – T/F Losses (Watts)	HV Tapping Range (Tap Steps = 2.5%)
315	11/0.4	315	420	4994	-10% To +5%
	7.6/0.4	268	357		
500	11/0.4	500	667	6962	-10% To +5%
	7.6/0.4	425	567		
750	11/0.4	750	1000	10,188	-10% To +5%
	7.6/0.4	638	850		
1000	11/0.4	1000	1333	14,361	-10% To +5%
	7.6/0.4	850	1133		
1500	11/0.4	1500	2000	21,834	-10% To +5%
	7.6/0.4	1275	1700		
2000	11/0.4	2000	2667	29,962	-10% To +5%
	7.6/0.4	1700	2267		

D Connection of Consumer’s Mains to Padmount Transformers

All low voltage circuits emanating from padmount transformers are via fuse switch disconnectors, a circuit breaker or isolator. Refer to TS100 and E drawings E1947 series. Refer to Figures D and D.1 to D.4, for various typical arrangements.

Note that where padmount transformer is required for LV and or HV consumers spot load supply, at the preliminary design stage, an approval from relevant SA Power Networks’ Project Manager is required.

STANDARD L.V. COMPARTMENT CONFIGURATIONS FOR Mk7 PADMOUNT TRANSFORMERS

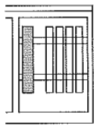
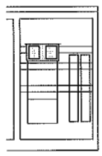
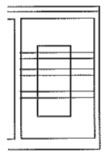
Transformer Rating (kVA)	L.V. Compartment Layout	
315 and 500kVA		1000A isolator with 4 x 630A size 3 fuse switch disconnectors (in-line type)
750 and 1000kVA		2000A Circuit Breaker & 2 x 630A size 3 fuse switch disconnectors (in-line type)
1500 and 2000kVA		**For 1500kVA - 2500A Isolator*** **For 2000kVA - 3000A Isolator*** ***Other variants should be discussed with SAPN Project Manager**

Figure D
Standard LV Compartment Configuration for 315kVA to 2000kVA Mk7 Padmount Transformers

Notes:

1. Where spare transformer capacity is available, we may include one or more supplies to our mains, or may supply another Customer. In this case the LV compartment will contain a fuse switch disconnector for each circuit and a main isolator. In emergencies this arrangement may be used to provide a limited supply to the Customer in the event of a HV failure at the transformer.
2. Generally, the terminals of the equipment (ie. fuse switch disconnects, isolators, circuit breakers and associated SA Power Networks’ parallel kits) used to connect the Customer’s cables are made of tinned plated copper and therefore suitable for copper or aluminium terminal lugs, which shall be supplied by the contractor. M12 bolts are supplied with the switchgear.
3. Where copper terminals or copper parallel kits or copper extensions are used as connection point for customers’ cables, only Bi-Metallic lugs should be used when connecting aluminium cables to these copper connections hardware.
4. The contractor or electrical worker shall clearly identify each phase and neutral of the Customers' mains.
5. When installing Customers' cables, allow 700mm above the top of the concrete pad footing for termination to switchgear.
6. In all cases we will supply appropriate shields for the Customer’s mains.
7. Offset brackets are fitted as standard with the Mk7 padmount transformer.

D.1 Mk7 Padmount Transformers - 315kVA and 500kVA

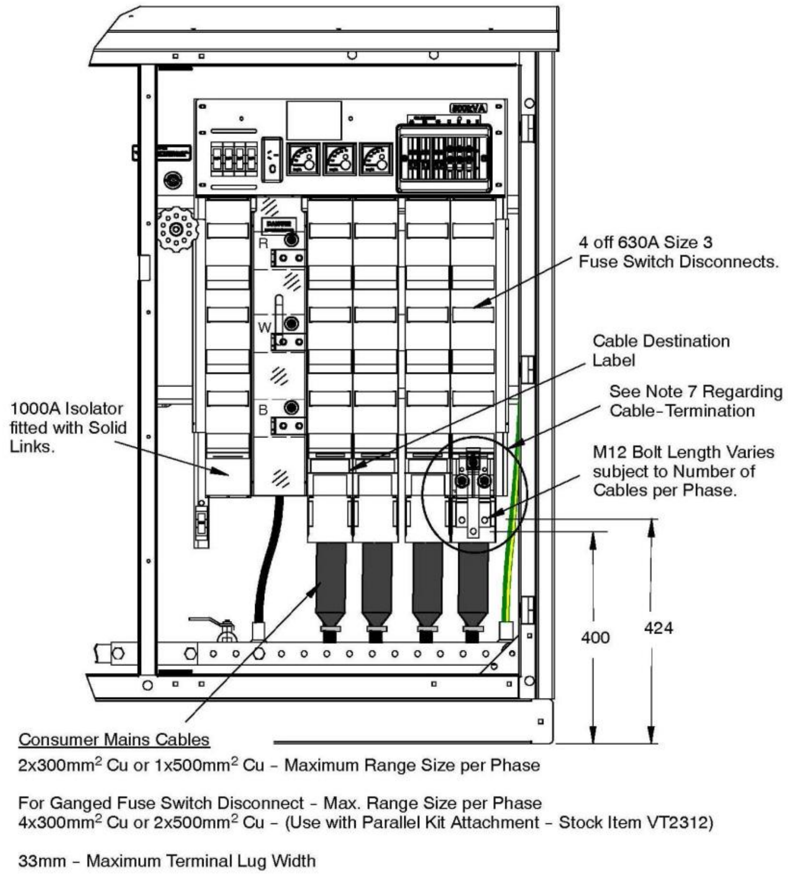


Figure D.1
Standard LV Compartment for
315kVA & 500 kVA Mk7 Padmount Transformers

Notes: The following notes are applicable to the Figures D.1 to D.4:

1. Where non-compliant conductors are installed, they shall be converted to compliant conductors prior to being connected to our equipment.
2. We shall be consulted where the suitability of proposed connection facilities is in doubt.
3. Ensure adequate phase to phase clearance is maintained using suitable shrouds or approved insulating materials.
4. Cables to be clamped in vault. For more details, refer to Appendix E 'Typical Securing LV Cables'.
5. If larger cables are required for voltage drop reasons, then these larger cables shall be terminated to allow for appropriate size cable at our connection point.
6. Offset brackets are fitted as standard to the Mk7 T/F.

D.2 Mk7 Padmount Transformers - 750kVA and 1000kVA

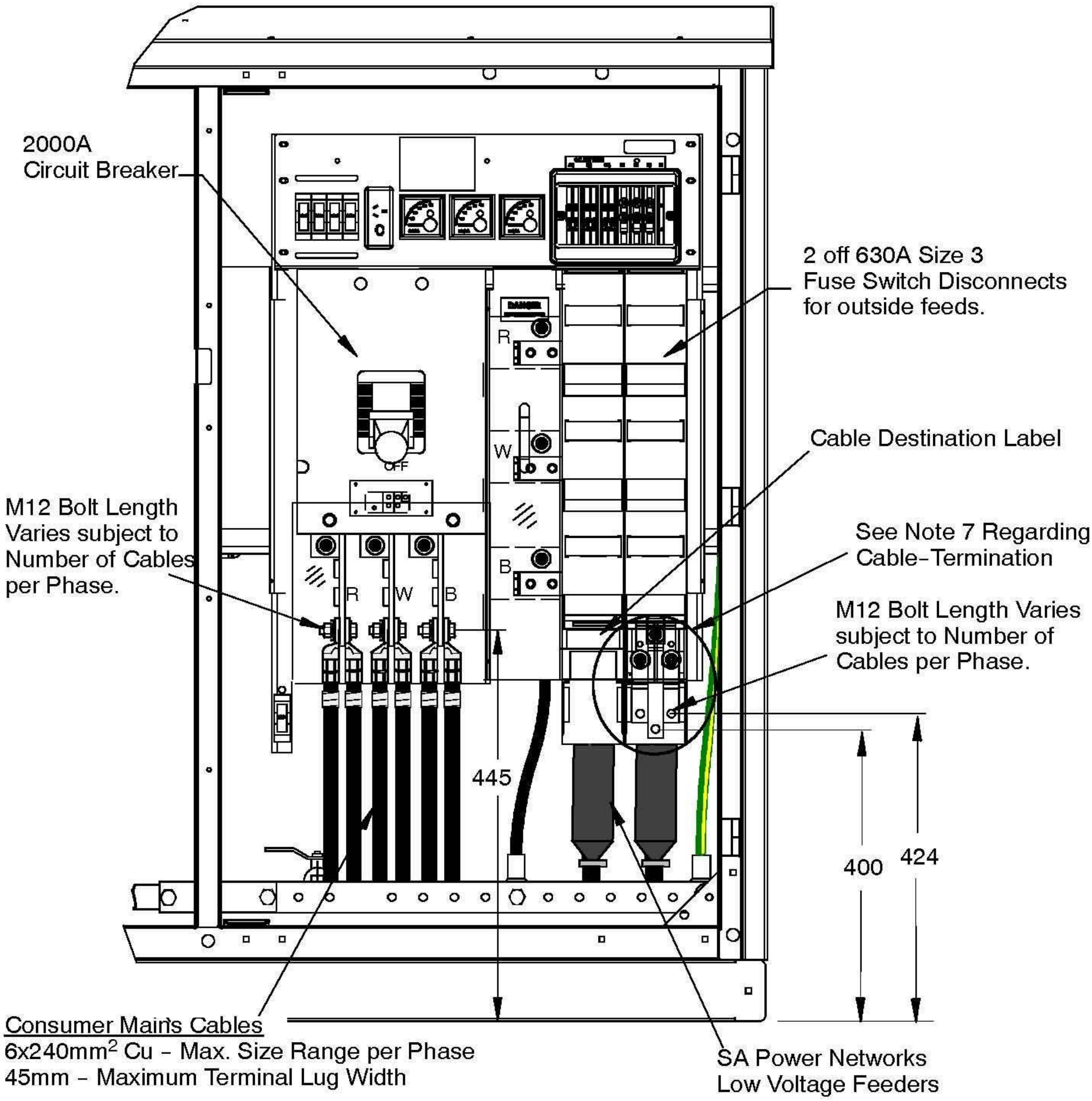


Figure D.2
Standard LV Compartment For
750kVA & 1000kVA Mk7 Padmount Transformers

D.3 Mk7 Padmount Transformers - 1500kVA

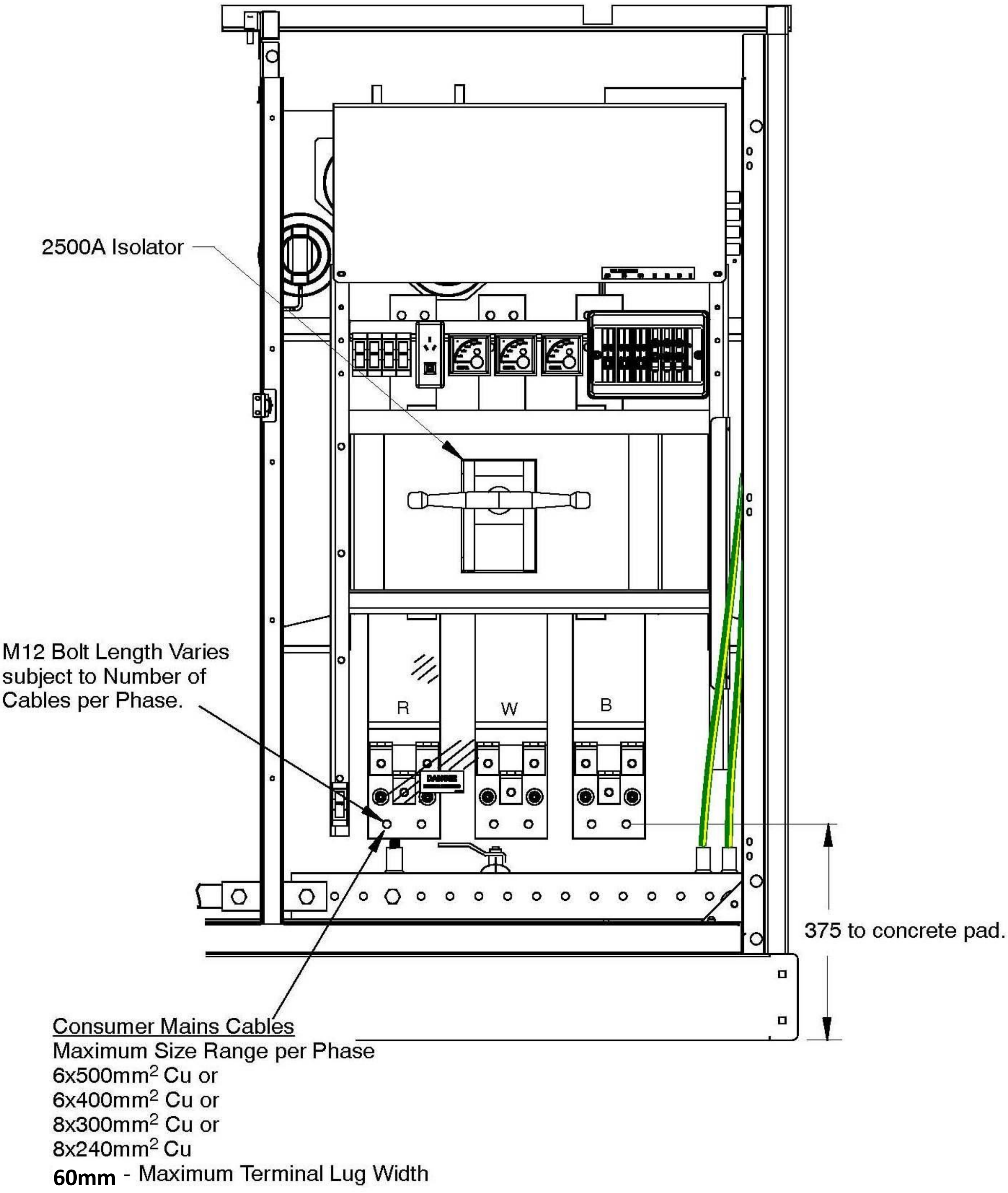


Figure D.3
Standard LV Compartment for
1500kVA Mk7 Padmount Transformer

D.4 Mk7 Padmount Transformers - 2000kVA

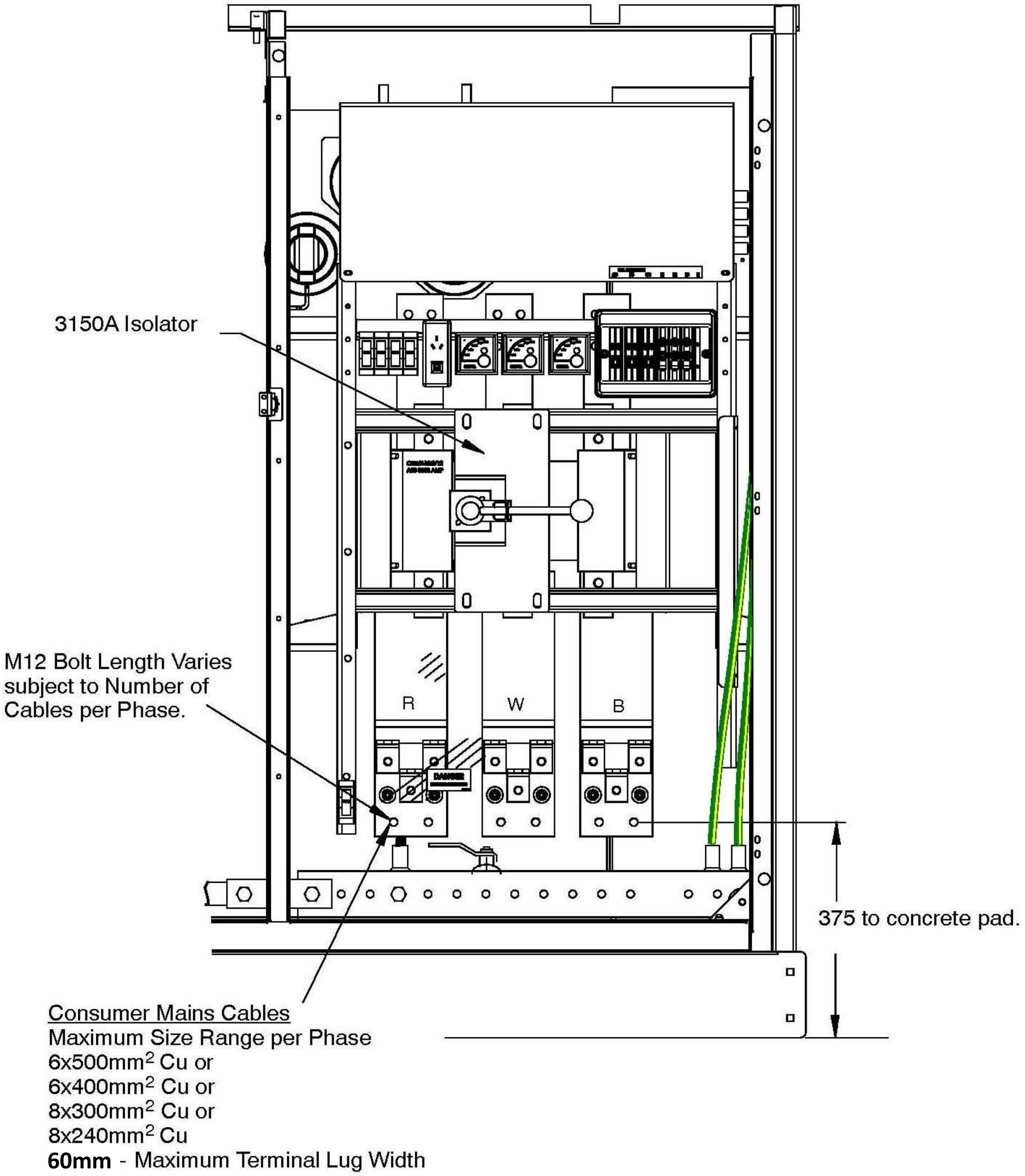


Figure D.4
Standard LV Compartment for
2000kVA Mk7 Padmount Transformer

E Typical Securing LV Cables

Customer's mains terminated in padmount transformers shall be secured. Support rails etc. will be supplied by us on request to our relevant Customer Solutions Manager/Network Project Officer. All cable vaults are pre-assembled with a centre cross member.

Customer to supply cable clamps (Unistrut P2024 series or equivalent) and shall ensure the clamps do not allow a continuous magnetic loop around the cable by using a brass screw, nut and spacer washer.

Refer to Figure E for 'Typical Securing LV Cables'.

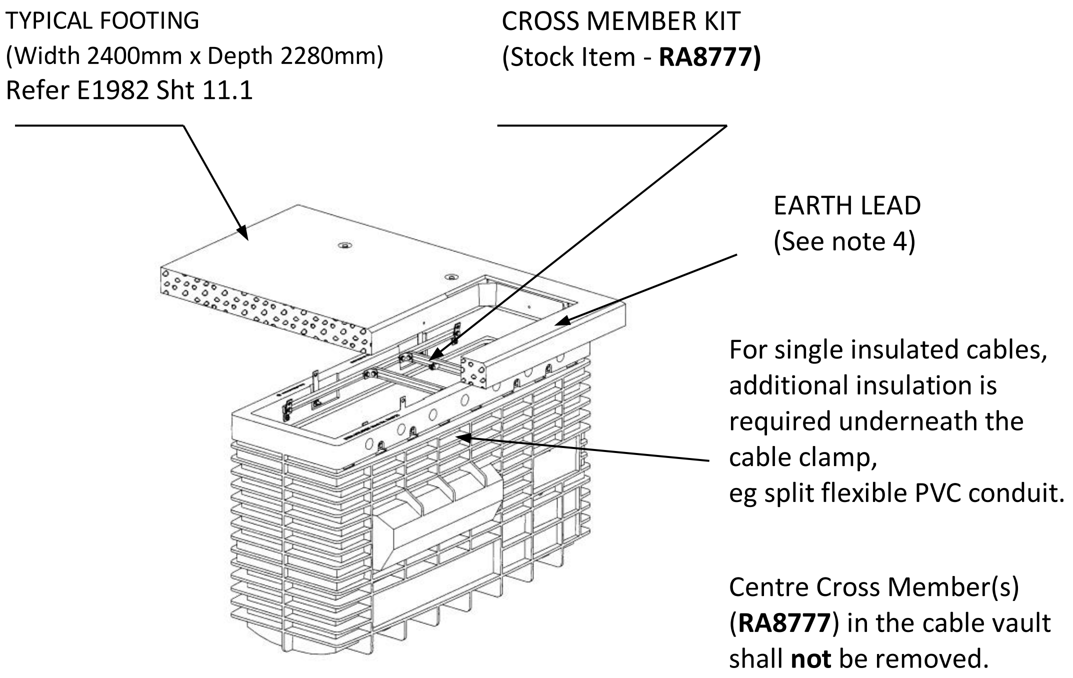


Figure E
Typical Securing LV Cables

Notes:

1. Where more than one cross member kit is used for securing cables, one steel angle bracket and one copper angle bracket (as supplied in the kit) shall be used to avoid magnetic loops around single core cables.
2. Channels, brackets, spring nuts and setscrews are Unistrut components or equivalent.
3. In CMEN areas bond framework to transformer LV earth bar using earth lead and in MEN areas bond framework to transformer case using an earth lead.

F An Example of Pull-Planner™ 3000 Tension Calculation

Pull-Planner™ 3000 Software

The cable Pull-Planner™ 3000 (for Windows™ computer program) calculates cable pulling tension and sidewall pressure around bends using pulling equations.

The tension estimates are useful in designing conduit systems and planning cable pulls. Such planning can save time and money by minimising splices, vaults, pulling set-ups etc while ensuring installation tensions that will not damage cable.

The Pull-Planner™ 3000 software is available for purchase from Adapt Australia; please visit their internet website at http://www.adaptaust.com.au/.

Data for Pull-Planner™ 3000

The cable pull tension shall not exceed the values stated in E drawings series E1900 to E1910; if unsure please consult the relevant SA Power Networks Project Manager. The cable pull tension calculations shall be incorporated in the design drawing.

For using Pull-Planner™ 3000 effectively, please implement the software supplier's guidelines/instructions and meet the data stated in Table A.

Table A - Data for Pull-Planner™ 3000 Software

Cable technical data (including cable weight):	Refer to E drawings E1900 to E1910 series
Conduit diameter:	Refer to TS085
Conduit bend radius:	Refer to TS085
Back tension:	500N
Coefficient of friction:	0.25

Pull-Planner™ 3000 - Pull Tension Calculations:

<table>
<tr><td colspan="3">Pull Area Identification:</td><td colspan="3">Demo (eg Gilbert Street Feeder)</td></tr>
<tr><td colspan="3">Conduit Inner Diameter:</td><td colspan="3">100mm</td></tr>
<tr><td colspan="3">Conduit Fill:</td><td colspan="3">25%</td></tr>
<tr><td colspan="6">Total of 1 Cable(s) of 1 different type being pulled. (ie nos. of cables per conduit)</td></tr>
<tr><td>Type # 1:</td><td>1 Cable</td><td>Type # 1:</td><td>1 Cable</td><td>Type # 1:</td><td>1 Cable</td></tr>
<tr><td>Type # 2:</td><td>--</td><td>Type # 2:</td><td>--</td><td>Type # 2:</td><td>--</td></tr>
<tr><td colspan="3">Total Cable Weight: (ie Sum of Type # 1 & 2)</td><td colspan="3">7.42kgs/m</td></tr>
<tr><td colspan="3">Calculated Weight Correction Factor:</td><td colspan="3">1</td></tr>
<tr><td colspan="3">Jam/Clearance Analysis:</td><td colspan="3">Jamming Not Possible</td></tr>
<tr><td colspan="3">Configuration:</td><td colspan="3">Single Cable</td></tr>
<tr><td colspan="3">Coefficient of Friction (COF):</td><td colspan="3">0.25</td></tr>
<tr><td colspan="3">Incoming Tension:</td><td colspan="3">500N</td></tr>
</table>

F.1 Calculations (continued)

	Straight Section Angle	Up Or Down	Straight Section Length (m)	Bend Type	Up Or Down	Bend Radius (m)	Bend Angle	Tension (N)	Sidewall Pressure (N/m)
SEG 1	--	--	25	H	--	0.8	25	1065	1331
SEG 2	--	--	2	H	--	0.8	25	1228	1535
SEG 3	--	--	15	H	--	0.8	25	1674	2092
SEG 4	--	--	2	H	--	0.8	25	1908	2385
SEG 5	--	--	130	N	--	--	--	4273	--
SEG 6	45	D	50	VU	D	0.8	15	2496	3120
SEG 7	--	--	5	N	--	--	--	2587	--
SEG 8	45	U	50	VU	U	0.8	15	6194	7742
SEG 9	--	--	75	N	--	--	--	7558	--

Bend Notation:
- N = No Bend
- H = Horizontal Bend
- VU = Vertical Concave Up Bend
- VD = Vertical Concave Down Bend
- R = Roller/Sheave
- PPD = Push/Pull Device

Directional Notation:
- U = Gravitationally Up
- D = Gravitationally Down

Note: The cable pull tension calculations/chart shall be incorporated in the design drawing.

G Definitions

Accredited Designer	Means a designer who has satisfied the SA Power Networks Terms and Conditions to undertake an electrical design.
ADMD	After Diversity Maximum Demand.
Applicant	Is the Person/Customer applying for access to the SA Power Networks infrastructure.
AS/NZS 3000	Means the Wiring Rules published by Standards Australia.
Bush Fire Risk Area	The SA Power Networks Bush Fire Risk Area is any area in South Australia so defined in the latest revision of the Regulations under the Electricity Amendment Act 1988.
Backbone Feeder	Is defined as the major HV circuit, which may have Tee offs, various overhead transformers, padmount transformers, switchgears and or a major customer connected, that is bearing the significant proportion of feeder load.
Brownfield	A brownfield is a property that has potential for expansion or site redevelopment, but that may be complicated by the presence of hazardous substances, pollutants or contaminants. Most brownfields are abandoned shopping centers located along a busy highway, industrial buildings or abandoned strip mines. Often brownfields have good locations and access to public transportation making ideal for site redevelopment. Brownfield is an ideal opportunity to revitalize a region.
Cable	Means an insulated conductor, or two or more such conductors, laid together, whether with or without fillings, reinforcements or protective coverings. (**Note:** Cable for this manual also means aerial bundled cables).
CMEN	Means Common Multiple Earthed Neutral Systems.
Conductor	Means a wire, cable or form of metal designed for carrying electric current.
Contractor	Includes but is not limited to licensed subcontractors, consultants and sub consultants and engaged by the Applicant.
Council	Means the local government authority for the site of the Development.
Connection Point	Has the meaning given to that term in the Electricity (General) Regulations 1997, namely a connection point to a transmission or distribution network. For this document connection point also has the same meaning as Point of Supply as defined in AS/NZS 3000.
CST	'Common Service Trench' also known as Shared Service Trench.

G.1 Definitions (continued)

Current Ratings Classification	Current ratings of conductors/cables may be classified as: • **Continuous Rating:** A fixed, non-varying load which can be sustained indefinitely by a conductor/cable with no degradation or loss of life. • **Cyclic Rating:** The peak value of a varying load, usually repeated every 24hrs which can be sustained indefinitely with no material degradation. • **Emergency Rating:** The peak value of a varying short time load more than the cyclic rating which can be sustained by a conductor/cable. The duration and repetition rate of the emergency loading will be specified and some loss of life of the conductor/cable may occur as a result. • **Short Circuit Rating:** The peak value of current flowing which can be sustained for a specified time by a conductor with no material degradation under fault conditions. The duration of the short circuit current flow is usually of the order of one second and will be specified as part of the short circuit rating.
Development	Means the development proposed by the Applicant on the Land and any land external to that land but included in the Applicant's proposal.
Distributor	Means a person who holds a Distribution License, or who is exempted from holding a licensee of the Electricity Industry Act. A 'Distributor' is also known as the Distribution Network Service Provider (DNSP). For this document SA Power Networks is the Distributor.
DCDB	Stands for Digital Cadastral Data Base.
DPTI	Stands for the Department of Planning, Transport and Infrastructure.
Dual Frontage Property	Means a property that has a frontage on two opposite boundaries, one of which is the street address and the other being another public area. For detailed explanation please refer to 'Service and Installation Rules'.
Earthed	Means connected to the general mass of earth by a conductor to ensure and maintain the effective dissipation of electrical energy.
Electrical Works	Includes: • All cable laying, cable jointing and street lighting required to service the applicant, and any works required to connect the applicant to the SA Power Networks distribution network but does not include LV electricity reticulation beyond the point of supply; • Padmount transformer and switching cubicle installation; and • Includes trenching, excavation, backfilling, conduits, pits, footings and restoration.

G.2 Definitions (continued)

Electrical Connection Works	Includes: • Those works required for the connection of the proposed extension to the SA Power Networks distribution network; and • Any works (electrical or non-electrical) that involve works on, around, under or above the existing network.
Greenfield	A greenfield site is an undeveloped land in a city or rural area either used for agriculture or landscape design or left to evolve naturally or forest land, or some other undeveloped site earmarked for commercial development, industrial projects or other urban development construction projects.
High Voltage or 'HV'	For this document means a nominal voltage exceeding 1,000 volts and up to 33,000 volts alternating current or exceeding 1,500 volts direct current.
Lands Titles Office (LTO)	The Lands Titles Office or Lands Titles Registration Office established by statute and continued in existence by the RPA to administer the provisions of that act. Also known as the LTO or LTRO.
Licensed Contractor	Means an individual who is registered as a Restricted Electrical Worker in accordance with The Plumbers, Gas Fitters and Electricians Act 1995, for the relevant endorsements of 'Limited to works on overhead lines' or 'Limited to cable jointing and underground distribution systems up to consumer terminals excluding (or including) lead'.
Low Voltage or 'LV'	Means a nominal voltage exceeding 50 volts alternating current or 120 volts direct current, but not exceeding 1000 volts alternating current or 1500 volts direct current.
Mains Side	The side of the street on which LV distributor cables are installed.
MEN	Means Multiple Earthed Neutral Systems.
NAP	Network Access Permit.
Point of Supply	Refer to Connection Point.
Plan of Division	Means the Applicant's Plan of the proposed division of the land into residential allotments, public roads, reserves and the like as varied from time to time.
PLEC	Stands for Power Line Environment Committee. They are responsible for the selection of sites where the SA Power Networks assets are to be undergrounded for the community benefit.
Principal Frontage Area	The principal frontage area is the face of the dwelling that has been designed as the main public access. (ie the entry point at which a visitor would access the property). For detailed explanation please refer to 'Service and Installation Rules'.

G.3 Definitions (continued)

Protection	An apparatus or combination of protective equipment designed to initiate, under predetermined abnormal conditions, the disconnection of an element of a power system.
Road Reserve	A road reserve is a legally described area within which facilities such as roads, footpaths, and associated features may be constructed for public travel. It is the total area between boundaries shown on a cadastral plan.
SA Power Networks' Project Manager	Means the SA Power Networks' Customer Solutions Area Project Manager who is ultimately responsible for the project management.
Service Side	Means the non-distributor side of the street.
Service Mains	The electricity cable connecting the Customer's first point of supply to the SA Power Networks connection point.
Shall	Is to be understood as mandatory.
Substation	The part of a power system concentrated in each place including mainly the terminations of transmission or distribution lines switchgear and housing which also include transformers. It generally includes facilities necessary for system security and control. (eg the protective devices).
Works	Means the term works as defined in the works Agreement.
Works Agreement	Means the Agreement for the Design, Construction and Testing of Electrical Services entered by SA Power Networks and the Applicant for the Development of the Land.

H References

The following listed documents are for additional information but may not be a conclusive list and other documentation may be required on a project specific basis. Refer to the following SA legislative acts and regulations, SA Electricity Code, the SA Power Networks publications, relevant AS/NZS and ENA standards for more detail.

Please note: It's your responsibility to ensure you have complied with all relevant standards and you have used the latest version. For civil contractors conducting regular civil works for any the SA Power Networks installations, there are E Drawings Group: 40 - Civil Construction available on request, which detail many project specific aspects of civil works that may not be detailed in this standard.

South Australian Legislations:

- Electricity Act 1996 and Electricity (General) Regulations 2012
- Electricity (Principles of Vegetation Clearance) Regulations 2010
- Environment Protection Act 1993 and Environment Protection Regulations 2009
- Development Act 1993 and Development Regulations 2008
- Telecommunications Act 1997 and Telecommunications Code of Practice 1997
- Work Health & Safety Act 2012 and Work Health & Safety Regulations 2012

Essential Services Commission of South Australia (ESCOSA) Codes:

- SA Electricity Distribution Code (EDC)
- SA Electricity Metering Code (EMTC)

Energy Networks Association (ENA) Publications:

- ENA NENS 03: National Guidelines for Safe Access to Electrical and Mechanical Apparatus
- ENA NENS 04: National Guidelines for Safe Approach Distances to Electrical and Mech. Apparatus

Australian Energy Market Commission (AEMC) Publications: National Electricity Rules (NER)

The Department of Planning Transport and Infrastructure (DPTI) Publications:

The Office of Technical Regulator (OTR) Publications:

Standards Australia Publications:

AS 1319	1994	Safety Signs for the Occupational Environment
AS 1428 (Set)	2010	Design for access and mobility set
AS 1824.1	1995	Insulation co-ordination – Definitions, principles and rules
AS 1931.1	1996	High voltage - Test techniques - General definition and test requirements
AS 2067	2016	Substations and high voltage installations exceeding 1 kV a.c.
AS 2467	2008	Maintenance of Electrical Switchgear
AS 4678 - 2002/ Amdt 2	2008	Earth-retaining structures
AS 4799	2000	Installation of underground utility services and pipelines within railway boundaries
AS 60038	2012	Standard voltages
AS 60068.1	2003	Environmental testing - General and Guidance
AS 60529	2004	Degrees of Protection Provided by Enclosures (IP Code)
AS/ACIF S009	2013	Installation requirements for customer cabling (Telecommunications Wiring Rules)
AS/NZS 1768	2007	Lightning protection
AS/NZS 2053.1	2016	Conduits and fittings for electrical installations Part 1: General requirements
AS/NZS 2648.1	1995	Underground marking tape - Non-detectable tape
AS/NZS 3000	2018	Electrical Installations (known as the wiring rules)

H.1 Standards Australia Publications:(continued):

AS/NZS 3008.1.1	2017	Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical Australian installation conditions
AS/NZS 3010	2017	Electrical Installations - Generating sets
AS/NZS 3017	2007	Electrical installations - Testing User Guides
AS/NZS 3100	2017	Approval and test specification - General requirements for electrical equipment
AS/NZS 3835.1 & AS/NZS 3835.2	2006	Earth Potential Rise - Protection of Telecommunications Network Users, Part 1: Personnel and Plant - Code of practice Part 2: Personnel and Plant - Application guide
AS/NZS 3845.1	2015	Road safety barrier systems and devices - Road safety barrier systems
AS/NZS 4026	2008	Electric cables - for underground residential distribution systems
AS/NZS 5033	2014	Installation and safety requirements for photovoltaic (PV) arrays
AS/NZS 5100 Series	2017	Bridge design
AS/NZS 61000.1.1	2016	Electromagnetic compatibility (EMC) - General - Application and interpretation of fundamental definitions and terms

International Standards:

ASTM STP1331	1998	The Design and Application of controlled low-strength materials (flowable fill)
IEC 60255.1	2009	Measuring Relays and Protection Equipment Part 1: Common requirements
IEC 60287.1.3	2002	Electric cables - Calculation of the current rating. Part 1-3: Current rating equations (100 % load factor) and calculation of losses - Current sharing between parallel single-core cables and calculation of circulating current losses
IEC 60853-2 - Amdt 1	2008	Calculation of the cyclic and emergency current rating of cables. Part 2: Cyclic rating of cables greater than 18/30 (36) kV and emergency ratings for cables of all voltages
IEEE C37.90.1	2012	Standard Surge Withstand Capability Tests for Relays and Relay Systems Associated with Electric Power Apparatus

SA Power Networks Documents:

Manuals (for Examples):

Manual 14	Safety, Reliability, Maintenance & Technical Management Plan
Manual 18	Network Tariff & Negotiated Services
Manual 32	Service and Installation Rules

Technical Standards & NICC Brochures (for Examples):

NICC400	Information for an applicant undertaking a contestable extension
NICC401	Information on Network Design and Installation by an External Contractor
NICC404	Working in the Vicinity of SA Power Networks Infrastructure - Network Access Permit Process
TS085	Trenching and Installation of Underground Conduits and Cables (up to and including 33kV)
TS102	Easement standard for distribution networks

Relevant E Drawing Series