

Technical Standard - TS100

Electrical Design Standards for Underground Distribution Network (up to and including 33 kV)

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SA Power Networks

Empowering South Australia

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1. Introduction

The purpose of this document is to establish SA Power Networks' electrical design standards for underground distribution assets operating at voltages up to and including 33 kV, that will become a part of SA Power Networks' distribution network.

SA Power Networks' underground distribution network includes:

- Underground residential developments (URD)
- Underground industrial developments (UID)
- Single Customers and PLEC Installations
- Public Lighting

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

2. Definitions and Abbreviations

2.1 Definitions

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 a significant proportion of feeder load.
Brownfield	A brownfield is a property with potential for expansion or site redevelopment but may be complicated by the presence of hazardous substances, pollutants, or contaminants. Most brownfields are abandoned shopping centres located along busy highways, industrial buildings, or abandoned strip mines. Brownfields often have good locations and access to public transportation, making them ideal sites for redevelopment. Brownfield land is an ideal opportunity to revitalise a region.
Bush Fire Risk Areas	SA Power Networks' bush fire risk area is any area in South Australia defined in the latest revision of the regulations under the Electricity Amendment Act 1988.
Cable Rating Critical Location	A specific point or section along a cable route where the cable's current-carrying capacity (or "rating") is most constrained due to environmental, installation, or operational conditions. This location determines the maximum allowable current the cable can safely carry without exceeding its thermal limits.
Cable System	The cable system includes components such as power cables, cable joints, cable terminations, cable accessories etc, which forms part of SA Power Networks' infrastructure in connection with the electrical transmission and distribution network, and in particular, will form the underground portion between the locations as specified.
Connection Point	As per Electricity (General) Regulations 2012: A connection point to a transmission or distribution network. The 'connection point' also has the same meaning as 'point of supply' defined in AS/NZS 3000. The point of supply established between the SA Power Networks and the customer.
Consumer Mains	The electrical cables/conductors, which are owned and maintained by the customer, connect the supply point to the main switchboard and form part of the customer installation.
Contractor	A contractor who is a suitably accredited installer (full or provisional) engaged by the customer and has satisfied SA Power Networks' terms and conditions (i.e. Construction Terms 3302) to undertake the civil and electrical installation works.
Customer	Is the customer as set out in the project-specific offer letter. A person who engages in the activity of purchasing electricity supplied through the distribution network to a connection point and is registered by AEMO as a customer under chapter 2 of the NER.
Customer's Agent	A contractor or designer engaged by the customer.
Designer	A person who is suitably accredited designer (full or provisional) engaged by the customer and has satisfied SA Power Networks' terms and conditions (i.e. Construction Terms 3302) to undertake the design work.
Development	The development proposed by the customer on the land and any land that is external to that land but is included in the customer's proposal.

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Distribution Network	The assets (e.g. poles, wires, underground cables, transformers, substations etc) operated by SA Power Networks, which transports electricity to and from a customer's connection point.
Distributor	A person who holds a distribution licence, 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). In this document, SA Power Networks is the Distributor.
Earth	Connection to the general mass of the earth by a conductor to ensure and maintain effective dissipation of electrical energy.
Earth Potential Rise	Earth Potential Rise (EPR), also called Ground Potential Rise (GPR), occurs when a large current flows to earth through an earth grid impedance. The potential relative to a distant point on Earth is highest at the point where the current enters the Earth and decreases with distance from the source.
Electrical Works	Includes: • all cable laying, cable jointing, testing, and streetlights needed to service the customer, and any works needed to connect the customer to SA Power Networks' distribution network, which excludes LV electricity reticulation beyond the supply point; • padmount transformer, switching cubicle, and pillars/pit installation; and • restoration works.
Excavation Depth	The vertical distance measured between the ground level and the deepest part of the excavation.
Greenfield	A greenfield site is an undeveloped land in a city or rural area that is either used for agriculture or landscape design, left to evolve naturally or forest land, or another undeveloped site earmarked for commercial development, industrial projects, or other urban development construction projects.
HV (High Voltage)	The HV is greater than 1000 Vac or 1500 Vdc, and up to 33,000 Vac.
Installation	Is an electrical installation unless the context is otherwise.
Inverter	Device that may form part of a generating system that uses semiconductor/power electronics devices to convert direct current to alternating current.
Inverter Energy System (IES)	A system consisting of one or more inverters that connect to the grid and operate by converting a direct current to an alternating current. In the context of system capacity, this definition includes the capacity of AC coupled energy storage systems.
Owner/Landowner	The owner/landowner is the person or entity that is the registered proprietor/owner of the land, as recorded at the Land Titles Office (LTO). All easement agreements shall be with the owner or landowner.
Licenced Contractor	Individual who is registered as a Restricted Electrical Worker in accordance with The Plumbers, Gas Fitters and Electricians Act 1995, for 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'.
Land Titles Office (LTO)	The 'Lands Titles Office' or the 'Lands Titles Registration Office' established by statute and continued in existence by the RPA to administer the provisions of that act. Also known as LTO or LTRO.
LV (Low Voltage)	The LV exceeds 50 Vac or 120 Vdc ripple-free but does not exceed 1000 Vac or 1500 Vdc.
Plan of Division	The customer's plan for the proposed division of the land into residential allotments, public roads, reserves, and the like varied from time to time.
National Construction Code (NCC)	The 'National Construction Code' specifies the technical requirements for the design, construction, and performance of buildings, plumbing and drainage systems. The NCC is made up of the Building Code of Australia (BCA) and the Plumbing Code of Australia (PCA).
Power Line Environment Committee (PLEC)	The 'Power Line Environment Committee' is responsible for selecting sites where SA Power Networks' assets are to be underground for the community benefit.

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Owner/Landowner	The owner/landowner is the person or an entity that is the registered proprietor/owner of the land, as recorded at the Land Titles Office. All easement agreements shall be with the owner/landowner.
Property	Either what is commonly described as a Torrens Title allotment, a Community Title Scheme or Land which is owned by the crown on which the owner/occupier has the right to the installation of the electricity supply. A property may include: • a single parcel of freehold, leasehold and/or public land, and/or land held underlease or license on which the customer or controlling body has the right to install their electrical installation; • any combination of contiguous land to which the customer or controlling body has the right to install their electrical installation; and • contiguous land and/or individual titles to which a corporate body, customer and/or controlling body has the right to install their electrical installation.
Public land	Land owned by the crown or an instrumentality or agent of the crown or by a council or other local government body, including any such land that is subject to native title.
Principal Frontage Area	The principal frontage area is the face of the dwelling, which was designed as the main public access. (ie the entry point at which a visitor would access the property). For a detailed explanation, please refer to 'Service and Installation Rules'.
Protection	A term referring to various devices (eg fuses, reclosers or circuit breakers) used to detect and initiate the isolation of faulty electrical equipment or installation overload.
Road Reserve	A road reserve is a legally defined area within which roads, footpaths and other related features may be constructed for public transport. It is the total area between boundaries shown on a cadastral plan.
Substation	Part of a power system concentrated in a given place, including the terminations of transmission or distribution lines, switchgear, and housing, which may also include transformers. It includes facilities necessary for system security and control (eg the protective devices).
Works Agreement	Agreement in accordance with SA Power Networks' construction terms (ie Construction Terms 3302 - Non-Contestable and Contestable).
Works	For the purposes of this document, "Works" refers to any activities associated with the design or construction requirements specified in this Standard. This definition is distinct from the term "Works" as defined in the Construction Terms 3302.
Watercourses	The Water Quality Policy defines watercourses as any of the following (regardless of whether its temporarily wet or temporarily dry): • river, creek, or other natural watercourse (whether modified or not); • a lake, wetland, swamp, dam, reservoir, or other body of water that collects water or flows through which water flows; this also includes groundwater; – the Coorong; – an artificial channel; – a public stormwater disposal system; and – includes part of a watercourse. Note that the kerbs and gutters are not considered water channels or water courses.

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2.2 Abbreviations

ADMD	After Diversity Maximum Demand
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator Limited (ACN 072 010 327)
AER	Australian Energy Regulators
AS/NZS	Jointly developed Australian and New Zealand Standard
BFRA	Bush fire risk areas
CB	Circuit Breaker
CGF	Customer Gelport Fuse
CMEN	Common Multiple Earthed Neutral Systems
CSP	Critical Switching Point
CST	Common Service Trench (also known as Shared Service Trench)
DCDB	Digital Cadastral Data Base
DIT	Department of Infrastructure and Transport
ESCOSA	Essential Services Commission of South Australia
E-Dwgs	SA Power Networks' Electronic Drawings
EPR	Earth Potential Rise
HBFRA	High-risk bush fire areas
HV	High Voltage exceeding
IEC	International Electrotechnical Commission
LCS	Life Cycle Safety
LFI	Line Fault Indicator
LIP	Lubrication Injection Point
LS	Load Switch
LSF	Load Switch Fuse
LTO or LTRO:	Land Titles Office or Land Titles Registration Office
LV	Low Voltage
MEN	Multiple Earthed Neutral Systems
NAP	Network Access Permit
NEM	National Electricity Market
NER	National Electricity Rules
NICC	SA Power Networks' publication 'Network Information for Contractors and Customers'
PFC	Parallel Flange Channel
TSM	SA Power Networks' Technical Standards Manager
NOC	SA Power Networks' Network Operations Centre,
OTR	The Office of Technical Regulators
PLEC	Power Line Environment Committee.
RMU	Ring Main Unit
SIR	SA Power Networks' Service and Installation Rules
TS	SA Power Networks' Technical Standard
UID	Underground Industrial Development
URD	Underground Residential development

2.3 Terminology

Shall	Indicates mandatory requirements.
May or Should	Indicates a recommendation that is not mandatory but can be imposed on the customer as deemed appropriate by SA Power Networks.
Suitable (or Suitably)	To the satisfaction of the relevant SA Power Networks Manager

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3. Relevant Rules, Regulations, Standards, and Codes

3.1 Standards and Codes

The following documents listed in this section provide additional information, however, this is not a conclusive list and other documentation may be required on a project-specific basis.

Please Note: It is the responsibility of the customer/customer's agent to ensure that you have complied with all applicable SA Legislative Regulations (under Acts), ESCOSA/ENA/AEMC/IEC documentations, relevant AS/NZS standards, and SA Power Networks' publications and have ensured their current publications before implementing them.

Australian Standards Publications

AS/CA S009	2020	Installation requirements for customer cabling (Telecommunications Wiring Rules)
AS 1074	1989	Steel tubes and tubular for ordinary service
AS/NZS 1170	-	Structural design actions (Series)
AS 1768	2021	Lightning protection
AS 1940	2017	The storage and handling of flammable and combustible liquids
AS 2067	2016	Substations and high-voltage installations exceeding 1 kV a. c.
AS 2312.1	2014	Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings
AS 2344	2016	Limits of electromagnetic interference from overhead a.c. powellises and high-voltage equipment installations in the frequency range from of 0.15 MHz to 3000 MHz
AS 2832.1	2015	Cathodic protection of metals: Pipes and cables
AS/NZS 2885.1	2018	Pipelines - gas and liquid petroleum: Design and construction
AS/NZS 3000	2018	Electrical installations (known as the Wiring Rules)
AS/NZS 3008.1.1	2025	Electrical installations: Selection of 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	2022	Electrical installations: Verification by inspection and testing
AS/NZS 3100	2022	Approval and test specification: General requirements for electrical equipment
AS/NZS 3835	2006	Earth potential rise: protection of telecommunications network users, personnel and plant (Series)
AS/NZS 3845.1	2015	Road safety barrier systems and devices: Road safety-barrier systems
AS/NZS 3845.2	2017	Road safety barrier systems and devices: Road safety devices
AS/NZS 4026	2008	Electric cables for underground residential distribution systems
AS 4100	2020	Steel structures
AS 4312	2019	Atmospheric corrosivity zones in Australia
AS/NZS 4645.2	2018	Gas distribution networks: Steel pipe systems
AS 4678	2002	Earth-retaining structures
AS/NZS 4853	2012	Electrical hazards on metallic pipelines
AS 5100	-	Bridge design (Series)
AS 5577	2013	Electricity network safety management systems
AS 60071	-	Insulation Co-ordination (Series)
AS 60529	2025	Degree of protection provided by enclosures (IP Code)
AS 60038	2022	Standard voltages
AS 60068.1	2023	Environmental testing: general and guidance
AS 62271.1	2019	High-Voltage switchgear and control gear: Common specifications for alternating current switchgear and control gears

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International Standards publications:

IEEE C37.90.1	2024	Standard surge withstands the capability tests of relays and relay systems associated with electric power apparatus
ASTM STP1331	1998	Design and application of controlled low-strength materials (flowable fill)
ISO 9223	2012	Corrosion of metals and alloys
IEC 60060.1	2026	High-voltage test techniques: General terminology and test requirements
IEC 60255.1	2025	Measuring relays and protection equipment, Part 1: Common requirements
IEC 60287.1.1	2023	Electric cables: calculation of current rating, Part 1: Current rating equations (100% load factor) and loss calculation
IEC 60287.1.3	2023	Electric cables: calculation of 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 60853.1	1985	Calculation of the cyclic and emergency current ratings of cables, Part 1: Cyclic rating factor for cables up to and including 18/30 (36) kV
IEC 60853.2	1989	Calculation of the cyclic and emergency current ratings of cables, Part 2: Cyclic rating of cables greater than 18/30 (36) kV and emergency ratings for all voltages
IEC 60865.1	2011	Short-circuit currents: Effect calculation, Part 1: Definitions and calculation methods
IEC 60949	1988	Calculation of thermally permissible short-circuit currents considering non-adiabatic heating effects

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SA Power Networks' publications

Manuals	
Manual 14	Safety, reliability, maintenance, and technical management plan
Manual 18	SA Power Networks' Connections and Ancillary Network Services
Manual 32	Service and Installation Rules (SIR)
Network Information for Customers and Contractors	
NICC401	Network Design and Installation by an External Contractor
NICC404	Working in the Vicinity of SA Power Networks' Infrastructure: Network Permit Process
NICC802	Padmount Transformers: General Information
Technical Standards	
TS085	Trenching and Installation of Underground Conduits and Cable Network (up to and including 33 kV)
TS099	Distribution and Transmission CAD Drafting Standards
TS101	Public Lighting Design and Installation
TS102	Easement Standards for SA Power Networks' Infrastructure
TS105	Testing Standards for the Underground and Overhead Distribution Powerline Network (up to and including 33 kV)
TS105A (Forms)	Standard Forms for SA Power Networks' Underground and Overhead Electricity Distribution and Transmission Cable Network
TS108	Technical Standards for indoor equipment
TS109	Earthing of SA Power Networks' Distribution Network
TS110	Electrical Design, Civil/Electrical works, and Testing for the 66 kV UG Network
TS116	Attachment of Third-Party Equipment to SA Power Networks' Infrastructure
TS117	Design and Construction near Railway and Tram Lines
TS129	Small EG connection: Capacity not exceeding 30 kW
TS130	Inverter Energy Systems (IES) above 30 kW and up to or equal to 200 kW
TS131	Inverter Energy Systems (IES) above 200 kW or Any-size Rotating Generating System
TS132	Low-voltage EG connections above 30 kVA Technical Requirements
TS133	High-voltage EG System Connection Technical Requirements
TS134	Communication Systems (Including SCADA) for Embedded Generation

3.2 Legislation and Regulations

This section provides a list of legislation and regulations applicable to the design, manufacture, installation, testing and commissioning, and operations and maintenance of all plant and equipment for distribution network.

In the event of any inconsistency between legislation and regulations and these technical requirements, the legislation and regulations shall prevail.

- Electricity Act 1996 and Electricity (General) Regulations 2012
- Work Health and Safety Act 2012 and Work Health and Safety Regulations 2012
- Environment Protection Act 1993 and Environment Protection Regulations 2009
- Electricity Corporations (Restructuring and Disposal) Act and Regulations of 1999

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4. Design Philosophies

4.1 General

The design of the underground distribution network requires that the entire system including electrical equipment (such as padmount transformers, switching cubicles, pits/pillars) and cables etc., operates safely for its intended design life and meets network reliability levels.

The underground design shall achieve several objectives. These include:

- Being designed in accordance with, and adhering to, the requirements outlined in Section 3;
- Ensuring security through minimal component failures;
- Safely maintaining supply under bushfire and flood danger conditions;
- Considering reliability, including potential outage considerations;
- Taking into account voltage drops and current carrying capacity;
- Meeting environmental requirements, such as those related to flora and fauna;
- Considering the whole of life cost;
- Ensuring the practicality of construction;
- Ensuring the design can be maintained;
- Satisfying power transfer rating requirements; and
- Considering surrounding third party assets.

Note that this standard is not exhaustive and relies on the expertise of trained and competent designers.

4.2 Design Working Life

The expected working life of an underground distribution network is 40 years. During this period, the network should function for its intended purpose with routine maintenance and without the need for significant repairs.

4.3 Protection Philosophy

Electrical protection, related control systems, and earthing systems shall be designed, installed, operated, and maintained to safely handle abnormal electrical network conditions. This will significantly minimise the risk of personal injury or substantial property damage.

4.4 Network Reliability and Resilience

SA Power Networks is required to operate a reliable and resilient network.

Therefore, the underground distribution network design should minimise:

- the frequency of power supply interruptions;
- the number of customers impacted by power supply interruption;
- the duration of power supply interruption; and
- the number of vegetation/animal related power supply interruptions.

4.5 High Corrosion Areas

The high corrosion areas are shown in the SA Atmospheric Corrosion Zone Map found in Appendix O. Note, the areas defined as ‘Very Severe Zones’ are regarded as SA Power Networks’ corrosion zone areas.

The effect of corrosion should be considered as part of the design phase and selection of E-dwgs.

4.6 Life Cycle Safety

Life Cycle Safety (LCS) shall be considered during design to ensure that the legislative design obligations are fulfilled as per the Workplace Health and Safety Act & Regulations 2012.

The designer shall ensure all-of-life hazards including construction, commissioning, operations, maintenance, decommissioning and demolition/removal are minimised 'So Far As Is Reasonably Practicable’.

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5. Design Requirements

5.1 Design scope

SA Power Networks will supply a site-specific scope (e.g. design requirements, current capacity, fault current, etc.) relating to the site-specific underground project. Existing drawings and any other information will be provided if available and suitable.

SA Power Networks reserves the right to request copies of the equipment location site-plan, risk assessment, or evaluation report.

5.2 Design Areas

5.2.1 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. A URD development needs to be approved by the local Council.

The URD design shall meet 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 (e.g. schools, shopping centres, office complexes, community titles for housing 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 have a mixture of residential and commercial allotments, including any proposed transformer installation in the areas where footpath verges are narrow (i.e. 1.0 m or less) and/or where back laneways do not have a footpath verge.

Where public lighting installation is to be included within an URD design, it shall be designed to the requirements of TS101. Then at the preliminary design phase the council shall receive and accept the 'Designer Authorisation Form" attached within NICC402.

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's approval is required.
(4) In a laneway where there is no defined kerb, a public lighting column may be located from the boundary, and may require additional protective measure (i.e. bollards).

5.2.2 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 that SA Power Networks considers, serviced and serviceable.

5.2.2.1 Serviced UID

A design needs to encompass the agreed supply loads within the serviced 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 minimum of an 80 A (ampere) three phase service for each allotment;
- installation of additional spare conduits to meet the capability of accepting a future supply upgrade to every allotment;
- transformer(s) capable of handling the agreed load capacity; and

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- public lighting in accordance with council and the customer's requirements.

5.2.2.2 Serviceable UID

A serviceable development design will encompass the installation of a 'backbone' HV cable network within the subdivision. Additional spare conduit shall be installed for each property to assist in any future servicing arrangements, and public lighting in accordance with council requirements. However, individual service points for each allotment are not provided.

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

Purchasers should be kept informed that their blocks shall not be serviced but can be serviced at their cost.

5.2.3 PLEC Projects

The Power Line Environment Committee (PLEC) is a committee that assists and operates under a PLEC Charter assigned by the Minister responsible for the Electricity Act 1996. Administration of PLEC is with the Office of Technical Regulators, Department for Energy and Mining.

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.

5.2.4 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 (i.e. the entry point at which a visitor would access the property).

There are specific requirements for the dual fronted properties which are stated in Manual 32: Service Installation Rules.

5.2.5 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 of redevelopments include:

- A 'total redevelopment' site which will require SA Power Networks' existing infrastructure to be removed. An underground system will generally replace the old assets.
- A 'partial redevelopment' with a mixture of old and new infrastructure.
- 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.

5.2.6 Contestable Work

The customer has the option to propose a network extension as 'contestable work' that meets the requirements of SA Power Networks. This can be designed either by SA Power Networks or by a customer's agent.

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.

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

For more details, refer to NICC401.

5.3 Design Stages

There are three stages to a design, each serving a function as a project moves through from concept to completion: 'Preliminary', 'For Construction', and 'As Constructed'.

5.4 Design Drawing Requirements

SA Power Networks drawings shall be in accordance with TS099. Underground design assemblies and arrangements shall be in accordance with SA Power Networks' TS085 and relevant E-dwgs.

Arrangements not identified in SA Power Networks' E-dwgs are considered non-standard and require approval from the SA Power Networks Technical Standards Manager (TSM). In some cases, project specific ESP-dwgs will be created.

Customers or their agents requiring access to E-dwgs should refer to NICC401 - Appendix A: 'New contractor or designer E-dwgs access registration process'.

5.5 Specifications

SA Power Networks will supply the necessary project specifications and information for the designer to carry out the design on behalf of the customer. SA Power Networks retains the authority to reject designs that do not meet its specifications.

The specifications provided by SA Power Networks include:

- Design after diversity maximum demand (ADMD);
- Current earthing system (MEN or CMEN);
- Any special conduit requirements (including spares);
- Any special requirements for bushfire risk/flood prone areas;
- Feeder plans copies;
- GIS information;
- Existing drawings;
- SA Power Networks requested works that are associated with the applicant's works; and
- Other requirements (e.g. provisions for the future development).

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.

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5.6 Parameters for Determining Cable Ratings

When determining cable ratings for any specific cable, consider the prolonged high load during summer periods, also known as the 'Summer Emergency Continuous Rating'.

The designer shall use relevant data from the cable manufacturer, applicable IEC and AS/NZS standards and the following parameters:

(1) The nature of the soil (e.g. soil temperature and thermal resistivity). Where practicable, soil thermal resistivity tests should 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 continuous summer emergency rating; and
- 0.9°C m/W for continuous winter emergency rating.

(4) The cable installation type (i.e. direct buried, in conduits and/or exposed in air). Note that underground cables located in air are limited to their steady state (i.e. sustained) 'in air' ratings.

(5) Depth of cable (i.e. underground cable cover) and cables in conduits shall be designed in accordance with TS085 requirements.

(6) The bonding of neutral screens to each other and/or to earth.

(7) Heat dissipation due to single or multiple circuits located nearby XLPE insulated cable (max) temperature is 90°C under normal conditions; and 120°C for emergency conditions.

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5.7 Environmental Considerations

The underground distribution network shall be designed, constructed and maintained to preserve or minimise the impact on native vegetation, significant and regulated trees, native flora, and fauna.

Preventative measures are also required to reduce potential harm to the environment, community, and economy from the entry of pest plants (weeds), pest animals (feral) and plant/animal diseases. These are required under the Environment Protection Regulations 2023.

An Environmental and cultural heritage impact assessment is required for all 33 kV and above sub-transmission lines and will require the approval of the State Commission Assessment Panel (SCAP) prior to design or construction. Distribution lines at 33 kV do not require this approval.

SA Power Networks' equipment shall avoid being located near water bodies, channels, courses, swale drains, or storm water ponds.

Designers and Project Managers must engage with the Environmental Branch to ensure that the appropriate enquires, assessments, notifications, and permit applications are made with the appropriate authorities. Contact our Environment and Sustainability Manager via email at res_environment_bran@sapowernetworks.com.au

5.7.1 Environmental Operating Conditions

The following environmental operating condition parameters to be incorporated in the design:

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

5.7.2 Oil Containment Requirements

AS 2067 states that transformers with an oil capacity of 1,000 litres or more shall require oil containment, therefore, any padmount transformer with a rating of 750 kVA or higher connected to SA Power Networks' distribution network shall have oil containment.

SA Power Networks requires any padmount transformer, regardless of size, to have full oil containment when the transformers are located within:

(1) 20 m or less of any water body, channel/watercourse, or stormwater retention pond, or
(2) 5 m or less from a side entry pit or any stormwater inlet point, whether upstream or downstream, and swale drains, or
(3) 2 m or less from groundwater depth measured as ‘Metres Below Ground Level (MBGL)’:

- For ‘Standing Water Level (SWL) data, refer to Groundwater Data Default from the WaterConnect website by the Department for Environment and Water.
- For advice, contact SA Power Networks’ Environment Team at res_environment_bran@sapowernetworks.com.au

Environmental protection legislation may impose additional requirements on the operator/owner regarding the containment of spilled insulating liquid and contaminated stormwater on-site. For more information, refer to clause 6.8.1 of AS 2067, clause 5.8, and Appendix H of AS 1940.

For padmount transformers of 315 kVA and 500 kVA, the requirement for oil containment shall be considered by the customer or customer’s agent as part of risk assessment during the design phase considering the rules set out in (1), (2) and (3) above.

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5.7.3 Corrosion Protection

Padmount transformers located in South Australia's severe and very severe corrosion zones (refer to Appendix O) shall be coated with corrosion resistant protective paint complaint to AS 2312.1. These transformers are available as a special-order item.

5.8 Separation Requirements

Refer to TS085 for separation requirements between underground services.

5.9 Easements

Refer to TS102 for easement requirements for distribution networks up to and including 33kV.

5.10 After Diversity Maximum Demand (ADMD) Values

SA Power Networks classifies dwellings by type and size. Refer to Appendix A for the ADMD value for each dwelling classification.

The ADMD values specified in Appendix A are for design purposes only (allowing for future load growth) and are not representative of the actual ADMD value expectations 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 number of customers supplied from an existing transformer.
(2) The total expected customer load on a proposed transformer, LV cables, customers within future stages, and any reinforcement of 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 (i.e. sum of ADMD values for each customer) shall not exceed values stated in Section 6.2.7.2.
(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 6.1 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.

5.11 Low Voltage Drop Limit

For any underground LV feeder, the 3-phase voltage drop shall not exceed 10 Volts, to the farthest connection point and to the farthest open point. The voltage drop shall be calculated using values supplied in Appendix A.

The voltage drop values for mains and services at the end of each LV circuit shall be indicated on the design drawings.

In some circumstances, LV parallel cables can be used to reduce voltage drop. In such cases, parallel cable details shall be incorporated in the design.

5.12 Load Balance

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

Three phase customers shall have their loads evenly balanced across all three phases. For URD designs, the design shall allow for each customer to accommodate three phase connections.

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5.13 Equipment Location

Project designs shall define equipment locations on site-plans and establish the following details near the equipment:

- Separation requirements from existing and proposed buildings, structures, and third-party utilities, are achieved as outlined in TS085. (**NOTE:** if metallic pipelines from third parties running parallel and extending 100 m or more are located near the underground distribution network, an engineering assessment is mandatory which shall be in accordance with AS/NZS 4853: 'Electrical hazards on metallic pipelines').
- Suitability of the terrain, watercourse impact, ground inclination. Refer to Section 5.7 for oil self-contained and/or corrosion-protected equipment requirements.
- Unhindered, safe, and 24/7 unrestricted access to the equipment.
- Future accessibility to the equipment.

SA Power Networks reserves the right to request copies of the equipment location site-plan, risk assessment, or evaluation report. When unsure on suitable equipment locations, consult with the relevant SA Power Networks' Project Manager.

5.13.1 HV Equipment - Unsuitable locations

The placement of high voltage (HV) equipment on uneven terrain, requiring steps and limiting personnel access is deemed unsuitable.

SA Power Networks' equipment shall avoid being located near water bodies, channels, courses, swale drains, or storm water ponds as per Section 5.7.

5.13.2 HV Equipment - Suitable locations

SA Power Networks' preference is to position HV equipment (e.g. padmount transformers and switching cubicles) on a property boundary facing a road reserve.

Additionally, SA Power Networks' HV equipment can be placed:

- On reserves, such as road reserves, council parks, and parklands, provided written approval is obtained from the relevant authorities, such as DIT, council, or state government.
- Large building allotments designated for high-density residential developments.
- At the front and sides of residential corner allotments.
- In local shopping centres (**NOTE:** restrictions apply to loading bays, basements, carparking etc. Speak with the relevant SA Power Networks project manager for clarification).

The HV equipment will require a minimum set back of 1.0 m from the back of a kerb and the installation of traffic bollards on any side exposed to vehicular traffic. The equipment shall be placed within the easement without disrupting existing third-party services.

For multi-customer land developments, the HV equipment location shall consider the LV feeder distribution network and be located as centrally to the load as practicable.

5.13.3 LV equipment - Unsuitable locations

The following locations are deemed unsuitable for placing SA Power Networks' LV equipment (e.g. LV pit/pillar) without prior approval from the SA Power Networks' Project Manager:

- behind sewer inspection points or adjacent to sewer 'Y' connections;
- within swale drains; and
- on a road reserve (with the exception of LV pits in footpaths as per Section 5.13.4 below).

5.13.4 LV equipment - Suitable locations

- The appropriate location for an LV pillar is on the customer's property, adjacent to dividing boundaries facing road reserve.
- An LV pit is located on a footpath on the same side of the street as the properties to be supplied. For more details, refer to Section 6.3.3. Note that a footpath forms part of a road reserve and therefore installation of an LV pit on a footpath shall be consulted with the relevant SA Power Networks' Project Manager.

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6. Electrical requirements

6.1 Cable Rating

For any given cable size, current carrying capacity methodologies and calculations shall refer to the relevant IEC and AS/NZS standards (e.g. IEC 60287, IEC 608503, AS 3865 and AS/NZS 3008).

The maximum operational ratings of any underground cables shall not be exceeded and provision for spare capacity shall include any foreseeable future 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 as the location of the smallest cable near the beginning of each feeder.

6.1.1 Cyclic Rating

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

(1) The continuous cable ratings are increased by 10% to 15%, if the daily load profile is cyclical (e.g. average daily load is less than approx. 75% of the daily peak).
(2) 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.
(3) For continuous 24 hours/day load profiles, no cyclic rating shall apply.

6.1.2 Emergency Rating

33 kV bare lead cables more than 50 years of age are not assigned an emergency rating.

However, emergency ratings are applicable to recent 33 kV cables in the CBD area, which can be determined as per the relevant IEC standards.

6.2 HV Requirements

6.2.1 HV Cable Sizes

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 the minimum cable size shall be selected in consultation with SA Power Networks.

For HV cable sizes, refer to Appendix L.

6.2.2 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. Refer to Section 8.1 for further details on significant load customers.

For any multi-stage development that already has transformers installed, which at any future stage increases the sum of the transformer capacity to beyond 1 MVA, the design shall be a looped network. Refer to Appendix K, for a typical UG HV circuit diagram.

In rural areas where customer numbers per transformer may be low, approval may be provided by the relevant SA Power Networks 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 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 developer's cost.

Refer to TS085 for mandatory trenching requirements for looped HV networks.

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6.2.3 Insulation Coordination

The insulation coordination requirements shall be adhered to as stipulated by Manual 32: Service Installation Rules, clause 3 of AS 2067 (IEC 60071.1) and AS 60071.

6.2.4 HV Switching Points

All HV switching points shall be equipped with a 3-phase ganged switch. The location of these switching points shall be such that the maximum load switched at any point does not exceed the capacity of the 3-phase ganged switch. The number of transformers between switching points should be limited by the load breaking capabilities of the feeder's switching devices.

In a HV looped system, if specified by SA Power Networks, the open point should have provisions for remote switching capabilities, such as an operable 'Ring Main Unit (RMU)', within the transformer's HV compartment or in a switching cubicle.

Referring to Appendix K, the requirements for switching points are as follows:

(1) All final HV open points using switches, as specified by SA Power Networks, should be in a transformer with an RMU or a free-standing switching cubicle with a 'Load Switch (LS)'.
(2) As specified by SA Power Networks, all final feeder tie points should have remote operation functionality, ideally in a switching cubicle.
(3) The use of a 'Circuit Breaker (CB)' within a switching cubicle as an open point for any feeder backbone is not permitted.
(4) For transformers with an RMU or a switching cubicle, the 'Circuit Breakers (CB)', 'Fuses (F)', and 'Load Switch Fuses (LSF)' are not permitted as open points.
(5) For further clarification, refer to Scenarios 1, 2, and 3 below in conjunction with Appendix K.

- **Scenario 1: Looped Circuits on the Same Feeder**

For looped circuits on the same feeder, an open point with remotely operable switches is required. The cables used shall be at least 95 mm^2 in size. This remote operation can be achieved by locating an RMU in the padmount transformer's HV compartment or by placing a switching cubicle nearby.

- **Scenario 2: Looped Circuits with an Open Point Separating Two Main Feeders**

In the case of operating looped circuits with an open point separating two main feeders, Scenario 1 applies, with the exception that the cables used shall have a minimum size of 300 mm^2.

- **Scenario 3: Radial Circuits**

For radial circuits, any future extension or connection shall be to the same existing feeder. If a radial circuit has the potential to become a looped circuit, Scenario 1 applies, and the cable size used shall be a minimum of 95 mm^2.

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6.2.5 Fusing Requirements

Both HV and LV fusing are essential to protect SA Power Networks' equipment from damage due to excessive fault current, minimise customer supply interruptions, and prevent equipment replacement costs. Refer to E-Dwgs series E 3241 and E 3244 for guidance on HV fuse selection using the 'Fuse Size Selection Table'.

Transformers used for network augmentation should be equipped with HV/LV fuses. Notably, Mk5 and Mk7 transformers include built-in HV and LV protection fuses.

For cable sizes 95 mm^2 or larger, where the calculated prospective cable fault current level and clearing time do not exceed the cable screen rating, fusing is not required for the underground cable section.

Certain transformers come with underground cable sections that require fusing prior to the location of fuses. If this is not the case, fuses should be located at the transformer.

During the commissioning phase, SA Power Networks will supply and install HV fuses for both padmount transformers and switching cubicles.

For a summary of the fusing requirements, refer to Table 1.

Table 1: Summary of Fusing Requirements

General locations (applies to all network)		
Fuse location HV	**Fuse requirements**	**Comments**
Line Fuse	Do not fuse unless needed for protection.	• Fuses are operated 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	Fault current does not exceed cable rating. Therefore cable will not be damaged by fault current.
Underground Cable Section (Fault level > Rating of cable)	Install fuses	Fault current exceeds cable rating. Therefore cable may be damaged by fault current if not protected with fuse.
Padmount Transformer	Install Fuses (at O/U pole if needed for cable protection, otherwise at TF)	Transformer protection is required due to high replacement costs.

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6.2.6 Ferroresonance

Ferroresonance is an electrical resonance phenomenon that often occurs during single-phase switching in certain HV circuits, which include inductive reactance (e.g. iron core transformers) and capacitive reactance (e.g. cables). This is common when lightly loaded transformers are connected through an underground cable of moderate length.

Under no load or very light loads, a feeder cable's capacitance can trigger ferroresonant behaviour during single-phase switching. This behaviour can cause dangerous overvoltage conditions on the feeder cable.

Ferroresonance can be prevented at the design stage by ensuring the cable length does not exceed certain values. It can also be minimised by eliminating one of the three contributing factors:

(1) Switch at the transformer (eliminating capacitance),
(2) Use ganged (three-phase) switching of the HV mains, and
(3) Limit the cable length.

Several Mk5 and Mk7 transformers have options for ganged switches. However, selection of these options will not completely eliminate the risk of ferroresonance, as a ganged switch may not always be used during emergency switching. Refer to Appendix I for further information.

6.2.6.1 Three Phase Ganged Switch Requirements

Three-phase ganged switching devices, such as ‘Load Switches (LS)’, shall be used at 'Critical Switching Point (CSP)'. The CSP refers to the network locations where regular switching of network section is undertaken, typically on long cable section of feeder 'Backbones'.

For over-to-under pole locations, a three-phase ganged switch should be located where switching operations are necessary, such as at feeder open points or when operating multiple transformers. However, these switches are not required for radial transformers fed from short lengths of underground cables.

At critical switching points, where single or multiple radial transformers are fed from underground cables, a three-phase ganged switch shall be located specifically for the 33 kV network due to its higher risk of ferroresonance compared to the 11 kV network.

The switching system shall comply with the following requirements:

- Switching Operators Handbook: Section 03: 01 Limitations of Device Switching
- E-Dwg E 2805
- E-Dwgs E 2806 and E 2808 series

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6.2.7 Padmount Transformers

Padmount transformers with capacities ranging from 50 kVA to 3000 kVA are available. Each has a supplier's nameplate rating and can provide customers with 250 V single-phase and 433 V three-phase power. For technical information on padmount transformers, refer to Appendices B to I and NICC802.

For specific transformer details, refer to the following E-Dwgs:

- Padmount Transformer: E 1944 to E 1947 series
- 33 kV Padmount Transformer: E 1948
- Rural Padmount Transformer: E 1952 to E 1957 series

6.2.7.1 Major Features

The padmount transformer facilitates several key features:

- Provides a neat and compact ground-level installation with a focus on safety, reliability and productivity.
- Finishing colour is Solver Colorbond River Gum Green.
- The transformers are designed with dual oil tanks; one for the HV switches and the other for the transformer windings, filled with mineral oil, with a flash point compliant with AS60296.
- Integrated earthing facilities in the HV switches simplify switching/isolation and accommodate dead break connectors as standard, enhancing connection security and eliminating the need for separate earth leads.
- Three flexible twist-lock earthing leads are provided in the LV compartment, enabling earthing by connection to the LV main bus or individual LV circuits, thus negating the need for separate earth leads.
- Cable clamping supports are now incorporated at the base of the HV compartment for added stability.
- A fault indicator on LS1 has been located to expedite the detection of underground HV faults, positioned at the upper left corner of the HV compartment.
- A transparent window on the HV door allows for distant visibility of the signal, removing the necessity to open the transformer door.

6.2.7.2 Padmount Transformer Rating

The padmount transformer rating shall align with the 'After Diversity Maximum Demand (ADMD)' to ensure uninterrupted operation during extreme heat conditions. Refer to Appendix A, for ADMD values.

In most residential developments, 315kVA Mk7 type padmount transformers are suitable, however, for new residential higher density load developments, the relevant SA Power Networks' project manager may approve the installation of a 500kVA Mk7 padmount transformer (subject to the availability of suitable HRC fuses and fault calculations).

The transformer load (specified ADMD x by the number of customers), shall not exceed:

(1) **For padmount transformers of 500 kVA and above:** 90% of the transformer's nameplate rating when supplying multiple customers.

(2) **For 315 kVA padmount transformers:** 85% of the transformer's nameplate rating when supplying multiple customers.

(3) **For dedicated padmount transformers:** 100% of the transformer's nameplate rating when supplied by a dedicated transformer. However, in such scenario, a single main circuit breaker is mandatory unless a load management system is in place to control maximum demand. For further information, refer to Manual 32: Service Installation Rules.

When a dedicated LV service is required to supply a spot load customer (e.g. shops, apartments, or a school), a larger transformer may be installed to service this requirement. However, the customer shall provide adequate fault current protection.

For designs involving large, significant customer loads, refer to Section 8.1, for more details.

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6.2.7.3 Padmount Transformer - HV Compartment Configurations

At the preliminary design stage, approval from an SA Power Networks' Project Manager is required if a padmount transformer is needed for a HV consumer's spot load supply.

For details on standard HV compartment configurations, refer to Appendix H and E-Dwgs E1945.

6.2.8 HV Switching Cubicle

For technical details on 11 kV HV switching cubicles, refer to Appendix J and E-Dwgs series E 1965 to E 1968.

For technical details on 33 kV HV switching cubicle, refer to E-Dwgs E 3087 series.

6.2.8.1 HV Switching Cubicle Rating

To ensure continuous, trouble-free operation under extreme heat wave conditions (i.e. maximum demand loadings), the design rating of the HV switching cubicle shall not exceed 85% of the switching device's rated current.

6.2.9 HV Straight Joints

The following are the HV straight joints requirements:

- Minimise the number of straight joints in the design.
- When any conduit is damaged during any works, it shall be reinstated.
- Avoid extending short lengths of HV cable to a development boundary. The preference shall be to install spare conduits to accommodate longer lengths of cable for future stages.
- For any XLPE straight joints, cables shall have a minimum straight section allowance of 1.0m at both ends of the joint to reduce strain on connectors, tape, heat shrink etc.
- For more details, refer to E-Dwgs series E 1911 to E 1918.

6.2.10 Surge Arresters

Surge arresters are required to protect electrical infrastructure from damage caused by lightning and switching overvoltage, in compliance with AS/NZS 1768: 'Lightning Protection'.

For over to under cabling arrangements, surge arresters shall be installed on over to under poles.

Refer to the E-drawings below for surge arrester arrangements:

- 11kV surge arrester arrangements: E-Dwg E 1207 series
- 33kV surge arrester arrangements: E-Dwg 1305 series

6.2.11 Line Fault Indicator (LFI)

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

- 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.
- 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.
- 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.
- If the transformer becomes a loop feed, the additional cables will be connected to LS1(where the LFI will be installed).

6.2.12 HV Earthing Design

The design of the high voltage earthing system shall be in accordance Refer to TS109 for SA Power Networks' technical standard for Earthing of the Distribution Network.

The design of the high voltage earthing systems shall be in accordance with the requirements SA Power Networks' project specifications, national and state codes, AS 2067, and Manual 32: Service Installation Rules.

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6.3 LV Design Requirements

6.3.1 LV Cable Selection

Refer to Appendix M, for low voltage (LV) cable sizes.

6.3.2 Padmount Transformer Requirements

6.3.2.1 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 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 padmount transformer. Each LV feeding rack can hold a maximum of 2 LV cable connections, provided the switch is not compromised and overloaded (to a total of 8 LV cables connections into a transformer).

Each cable shall be clearly labelled to avoid confusion with 2 separate cable connections vs parallel cable connection. Refer to TS085 for further details on cable labelling.

6.3.2.2 LV Feeder Ties From Different Transformers

The design shall meet the following requirements for LV feeder ties when they are fed from different transformer and come within 50 m 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 or 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 E-Dwgs E 1927 series shall be considered for feeder interconnection.
(5) If a designer is unsure of the extent of ties required, they shall consult with the relevant SA Power Networks' Project Manager at the preliminary design stage. Figure 1 provides an example of a 3-way LV feeder tie.

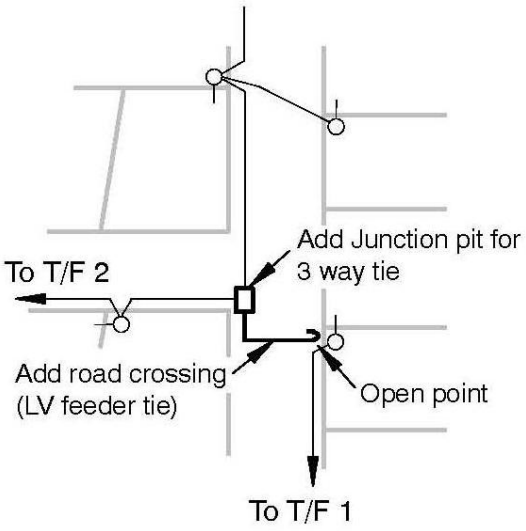


Figure 1: Example of a 3-way LV Feeder Tie

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6.3.2.3 LV Industrial Supply

When a new supply is required for a commercial/industrial development, there may be restraints to the existing LV distribution capacity. In those instances, SA Power Networks may need to install a dedicated padmount transformer.

For spot load supply to LV consumers requiring a dedicated padmount transformer, approval shall be obtained from SA Power Networks' Project Manager.

However, if the existing distribution system has sufficient capacity, then the following service arrangements may be offered:

(1) Fused service pillars 200 A to 400 A (Refer to E-Dwgs E 1923 Sheets 11.1 to 11.5)
(2) Service fuse enclosure (Refer to E-Dwgs E 1160 series)

6.3.2.4 Padmount Transformer LV Compartment Configurations

All LV circuits supplied from these transformers are connected through either a fuse switch disconnector, circuit breaker, or isolator.

Refer to Appendix I for standard LV compartment configurations. The main cable and terminal lug sizes for consumers are detailed in NICC802 and E-Dwgs E 1947 series. For details on the approved locations of consumer mains, refer to Manual 32: Service Installation Rules.

6.3.2.5 Padmount Transformer Circuit Breaker Settings

For the setting of the LV circuit breaker in the padmount transformer, Refer to Appendices D and E, and E-Dwgs E 1947 series.

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6.3.3 LV Service Pillar and Pits

6.3.3.1 LV Service Point Selection Priority

For new services up to and including 100 A, a fused connection point shall be provided, with the use of submersible fuse holders with a 100 A fuse cartridge within a P7 or P8 pit.

For appropriate LV pit/pillar selection for any undergrounding project, refer to Table 2 below. If there is any uncertainty regarding correct LV pit/pillar selection, consult with the relevant SA Power Networks' Project Manager during the preliminary design stage.

Table 2: Pit/Pillar Selection Priority for Residential LV Supply

Preferences	Installation Type (Pillar/Pit)	Typical Application	Maximum Number of Connections (Note 1)	Typical Location
First Preference (Above ground level)	**Option A** - Service Pillar (fused) w/ Standard Lid	Radial or loop-in/ loop-out	2 (With 2 x 3 phase fuse panel arrangement) (Note 2)	On a customer's property, adjacent to dividing boundaries.
	Option B - Service Pillar (fused) w/ Tall Lid		3 (With 3 x 3 phase fuse panel arrangement) (Note 2)	
Second Preference (Below ground level)	P8 pit (fused)	3 ways up to 6 ways, and parallel cable applications	4	Located on a footpath on the same side of the street as the properties to be supplied.
Third Preference (Below ground level) **TSM Approval Required**	P7 pit (fused)	Radial, 2, 3, 4-way, and parallel cable applications. Footpath areas	2	Located on a footpath on the same side of the street as the properties to be supplied.

Notes:

(1) Customer connections are planned with 3-phase provisions. Where a customer only requires a single phase supply, that will also be considered as a connection.

(2) Refer to E-Dwg E 1923 Sheet 7 for further details on LV service pillar fuse panel arrangements.

(3) Unfused P7 pits are an older installation type (i.e. not modern construction). Therefore they are not suitable for new installations and should only be used for retrofit scenarios by exception from the Technical Standards Manager (TSM).

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6.3.3.2 LV Fused Service Pillars

As per Table 2, the preferred standard service point is a green-coloured above-ground LV fused service pillar. These residential LV service pillars are typically located on or within property boundaries and their sizes vary based on load capacity.

The standard fused service pillar is typically positioned 500 mm from the side boundary and 600 mm from the front boundary of residential properties as per E-Dwg E 1923 sheet 5.3 (refer to Figure 2). In certain scenarios, these pillars can be placed 600 mm from corner allotment cut-off pegs, serving two allotments.

In accordance with Manual 32: Service Installation Rules, a service pillar shall have a minimum 1m x 1m safe operating work zone immediately behind or adjacent to it. Furthermore, a minimum distance of 1.2m shall be maintained from any structure or building surrounding the LV service pillar. An even level ground shall be provided around the service pillar to enable a safe working environment.

The design drawing layout shall indicate the conduit connection to an adjacent neighbouring property, indicating the service point. It shall include consumer main lead-ins for all properties, separate from SA Power Networks' cables, but potentially in the common service trench.

LV service pillars shall not be installed where residential driveway are likely to be installed. Where this cannot be achieved, consider installing a service and/or junction pit. Refer to Section 6.3.3.4 for additional details.

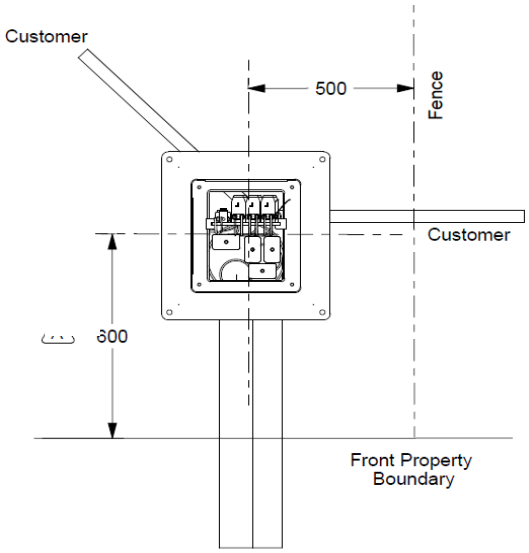


Figure 2: Service Pillar Positioning (Extract from E-Dwg E 1923)

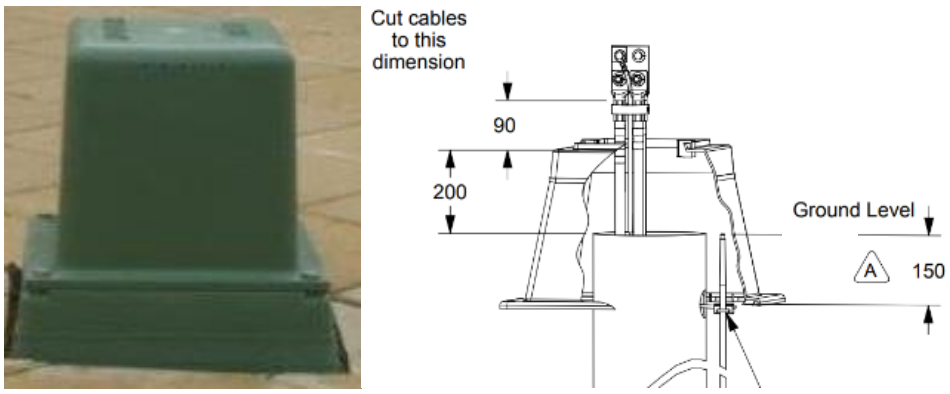


Figure 3: LV Service Pillar (Standard Lid Example)

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Table 3: Commonly Used LV Service Pillars

Description	Application	Reference Drawing
Fused LV Service Pillar	LV services up to 400 A	E 1923 series
LV Capped Cable Pillar	Future connections at stage boundaries	E 1926

Table 3 above is a list of commonly used LV service pillars and their respective E-drawing.

Customers or their agents can provide a tall fused service pillar, capable of housing 3-off fused connections (3-phase), to accommodate additional fused service arrangements in URD areas. Refer to E-Dwg E 1923 Sheet 7 for further details on standard and tall fuse panel arrangements.

Refer to E-Dwg E 1923 Sheet 8.2 for a more detailed list of components used in LV service pillars. Note, service pillar base, RA 5501, has been designed to be compatible with both standard tall panels. The service pillar base, identified as item number 671 in E-Dwg E 1923 Sheet 8.2, is designed for compatibility with both standard and tall panels.

6.3.3.3 LV Junction/Service Pit

When the location is not suitable for installing a standard service pillar (above-ground), the alternative option is to install a LV junction/service pit on a footpath. The pit structure and lids are not designed for regular traffic loads from council trucks, buses and heavy vehicles and therefore shall not be installed in carriageways or roadways.

The finished level of an LV pit shall be as per the surveyed finished ground level for a development.

Similarly to pillars, in accordance with Manual 32: Service Installation Rules, a LV pit shall have a minimum 1m x 1m safe operating work zone immediately behind or adjacent to it. Furthermore, a minimum distance of 1.2m shall be maintained from any structure or building surrounding the LV pit.

For 'Loop In/Loop Out' LV circuits, conduits and spare conduits should be positioned on the property side to directly enter the pit ends.

Where LV circuits bypass a pit, their conduits and spare conduits shall also bypass the pit. Third-party assets (e.g. Telstra, Optus, NBN, Private), including their associated spares, shall bypass SA Power Networks' pits.

Refer to E-Dwg E 1921 series for standard LV junction/service pit arrangements.

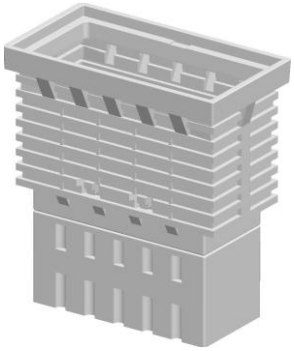


Figure 4: LV Junction/Service pit (below ground level)

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6.3.3.4 LV Pit for Residential Driveways

In areas where a service and/or junction pit will be subjected to vehicular traffic on a residential driveway, the design shall specify the use of a pit with a reinforced concrete surround and steel lid or another strengthening device, as shown in Figure 5.

For the P7 pit arrangements, refer to E-Dwgs E 1921 sheets 7.1, 7.2 and 7.3.

For the P8 pit arrangements, refer to E-Dwgs E 1921 sheets 8.5, 8.6, and 8.7.

Note that this type of pit shall not be placed on a carriageway, main road, or laneway.

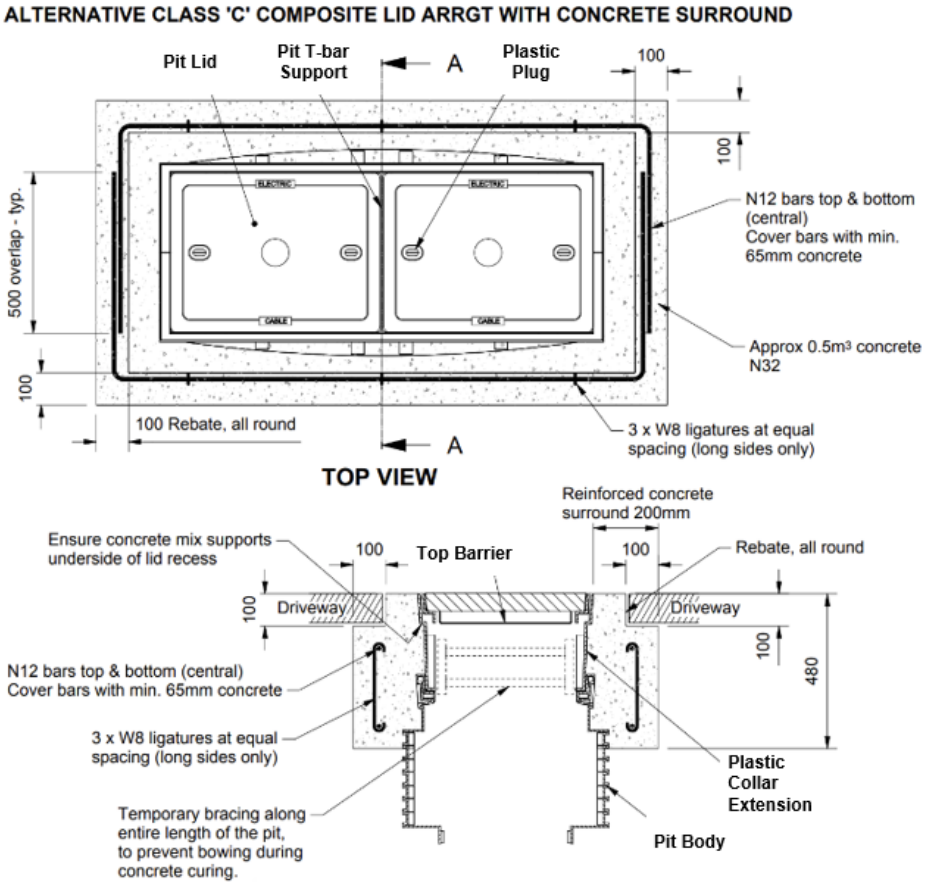


Figure 5: P8 Footpath for Residential Driveway

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6.3.4 Submersible Switchboards & Customer GelPort Fuses

Where submersible switchboards are used in pits, they shall be specified on design drawings. For mounting arrangements of 'Customer Gelport Fuses' (CGF) in submersible switchboards in pits, refer to the following drawings:

(1) P7 pit CGF mounting arrangement: E-Dwg E1921 Sheet 4.13
(2) P8 pit CGF mounting arrangement: E-Dwg E1921 Sheet 4.14

The selected mounting arrangement shall also be specified on design drawings.

For URDs and contestable work applications, the Customer or their agents are responsible for the supply and installation of submersible switchboard components inside fused P7 and P8 pits. Using red phase as an example, Figure 6 provides a summary of the main items to be supplied and installed by the Customer.

SA Power Networks will provide and install fuse links and terminate the customer's consumer mains to the fuse holder.

Refer to E-dwg E 1921 Sheet 4.12 for a comprehensive submersible switchboard parts list.

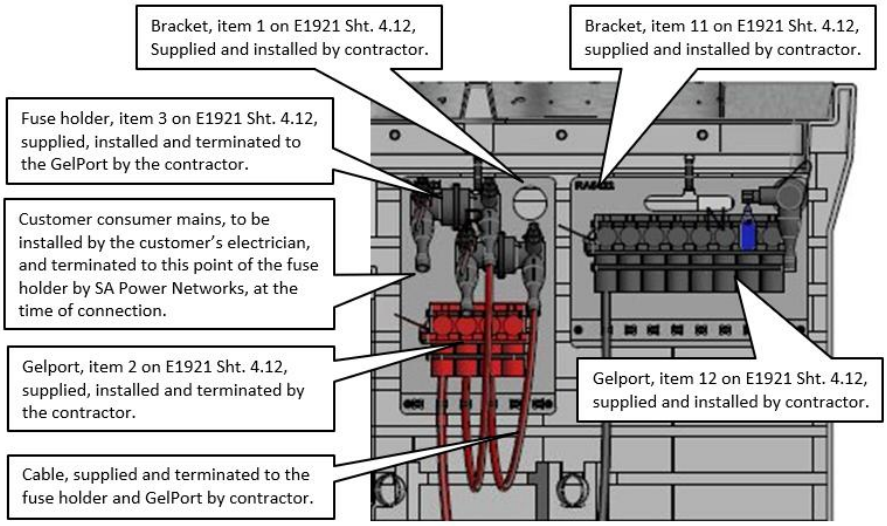


Figure 6: Supply and Installation for Submersible Switchboards

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6.3.5 LV Switching Cubicle

The LV switching cubicle should be positioned as outlined in the E-Dwgs E 1927 series, typically 600 mm behind the kerb and accessible from the footpath.

Relocation of the LV switching cubicle to 600 mm from the property boundary, with operation from a footpath, requires written council's approval.

LV switching cubicles (above-ground level) are recommended for use in high-load areas of the LV distribution system, such as industrial, commercial, and CBD areas. Figure 7 provides an example of a LV switching cubicle in the field. Refer to Table 4 for standard LV switching cubicles and reference drawings.



Figure 7: LV Switching Cubicle (above ground level)

Table 4: Standard LV Switching Cubicle Types

Stock Item	Description	Dimensions	Reference Drawings
RA 6316	4-way LV connections w/ generator connection	660 mm (W) x 425 mm (D) x 1310 mm (H)	E 1927 Series
RA 6317	5-way LV connections	660 mm (W) x 425 mm (D) x 1310 mm (H)	

6.3.6 LV Straight Joints

The following are the 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 longer lengths of cable in future stages.
(3) For more details, refer to E-Dwgs E 1901, E 1902 and E 1904 series.

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6.3.7 LV Parallel Cable Terminations

LV parallel cables can be terminated in LV service pillars and junction pits (P7 size or greater). However, where parallel cables are terminated into a LV service pillar, they shall be installed as per E-Dwg E 1923 Sheet 6.1 Arrangement 2A and are limited to a single outgoing circuit. This means parallel cables can only be terminated to the first LV service pillar and cannot be used for loop-in loop-out parallel cable arrangements.

Where parallel cables are fed from transformers, they shall be terminated at the first junction pit/LV service pillar from the transformer of an appropriate size to suit the application and the circuit shall be clearly labelled 'Parallel Cables' as stated within E-Dwgs E 1921 series.

Incoming parallel LV feeds to a 400 A service pillar shall be installed as per E-Dwg E 1925 Sheet 3.2 Arrangement 2.

6.3.8 Public Lighting Arrangements

Public lighting shall be designed in accordance with TS101 and NICC402.

6.3.9 LV Earthing Design

The design of LV earthing shall be in accordance with TS109 and Manual 32: Service Installation Rules.

6.3.10 LV Capped Cable Pillar - For Future Connection

A LV service pillar is to be used where LV cables are to be capped for connection to future development stages. Refer to Figure 8 and E-Dwgs E 1926, for more details.

When joining future cables, an Network Access Permit is required prior to removing the pillar and undertaking straight joints.

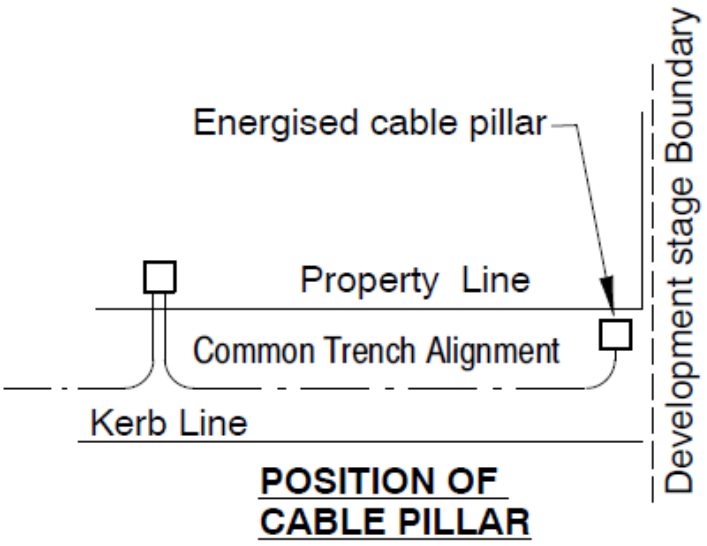


Figure 8: LV capped cable pillar: Future connection

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7. Civil Work Requirements

7.1 Determining Cable Routes

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

(1) Utilise the Pull-Planner™ 4.0 computer program (or similar) to simulate the cable/conduit route against the allowable cable pull tension and calculate required lubricant quantities before finalising the design. For more information, refer to Appendix N.
(2) Minimise the number of bends per duct run and maintain a straight-line cable route.
(3) To reduce cable pulling tensions, use appropriate conduit sweep bends to facilitate the minimum cable pulling radius as specified by the cable manufacturer.
(4) Use footpath reserves for cable trenches and cable joints to facilitate safer future access.
(5) Incorporate jointing or pulling bays to prevent long duct runs.
(6) Where HV multi-feeder cables are required to be run, it is recommended that a larger pit or manhole is installed to facilitate safer future access.
(7) Allow for lubrication injection points (LIPs) before bends and over long lengths where heavy cable hauling is anticipated. Unless specified otherwise, installation of LIPs is not necessary for spare conduits.
(8) In the design drawings, include a 'Cable Pull Tension Chart' and specify the required quantity of lubricant (e.g. Polywater® Lubricant J - stock item OC 8051 or similar) for cable pulling.

7.2 Trenching and Underground Network Design

Trenching and underground conduit/cable network designs shall adhere to the requirements of TS085.

7.3 Traffic Bollards

Traffic bollards are required where SA Power Networks' equipment (e.g. padmount transformers, switching cubicles, service pillars etc.) is installed adjacent to trafficable areas and at risk of vehicular impact.

They shall be installed as specified on the design drawing. Traffic bollards can be installed as fixed or removal types.

Traffic bollards shall be placed outside of equipment easement boundary and maintain a separation between bollards of 1.5 m (centre to centre). For equipment easement dimensions, refer to TS102. However, traffic barriers for DIT/council/private roads shall be installed according to their requirements.

Alternative barriers (other than bollards) and their installation within SA Power Networks' easement boundaries are not acceptable. It is the responsibility of the Customer/Landowner to maintain traffic bollards. Refer to AS/NZS 3845.1, for road safety barriers and road safety devices requirements.

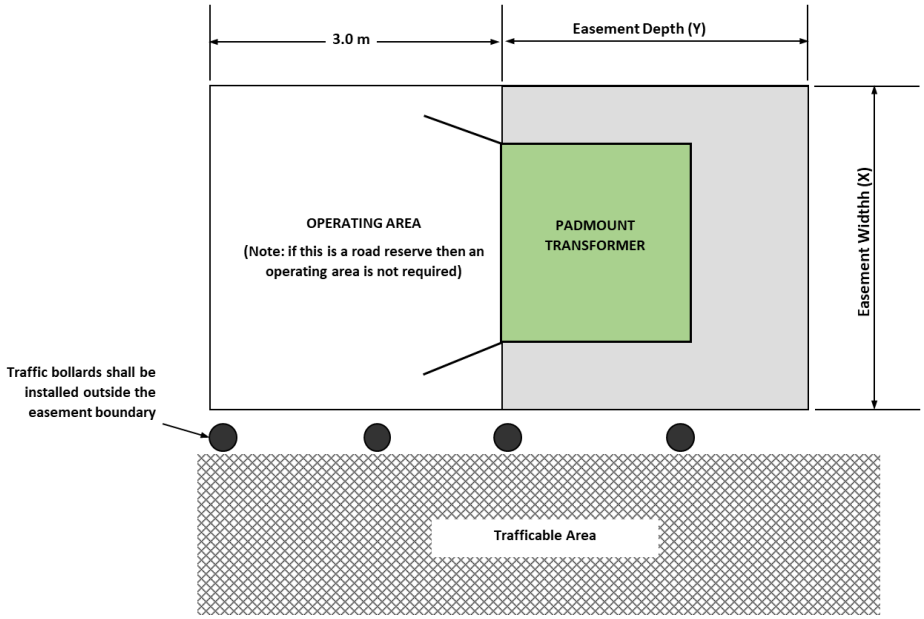


Figure 9: Traffic Bollard Arrangement Around Padmount Transformers

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7.3.1 Fixed Bollards

Fixed round heavy-duty bollards (refer to Figure 10) shall be installed around SA Power Networks' equipment exposed to vehicular traffic.

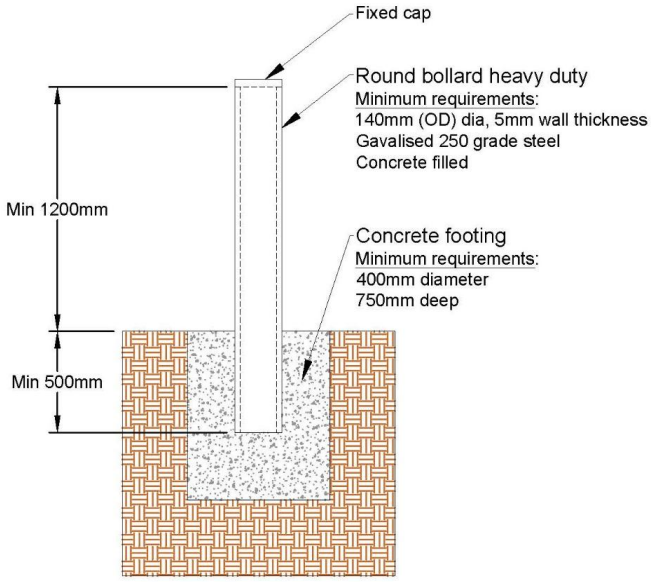


Figure 10: Typical fixed round bollard heavy duty - (Not to Scale)

7.3.2 Removable Bollards

Where occasional operational access is required around SA Power Networks' infrastructure that is exposed to vehicular traffic, removable heavy duty round bollards shall be installed as shown in Figure 11.

Removable bollards for maintenance/operational vehicular access areas require a minimum clearance width of 3.0 m (preferred 3.5 m).

Removable bollards shall be secured using SA Power Networks approved padlocks. Customers shall purchase and supply CM padlocks with master keys as specified in Manual 32: Service and Installation Rules.

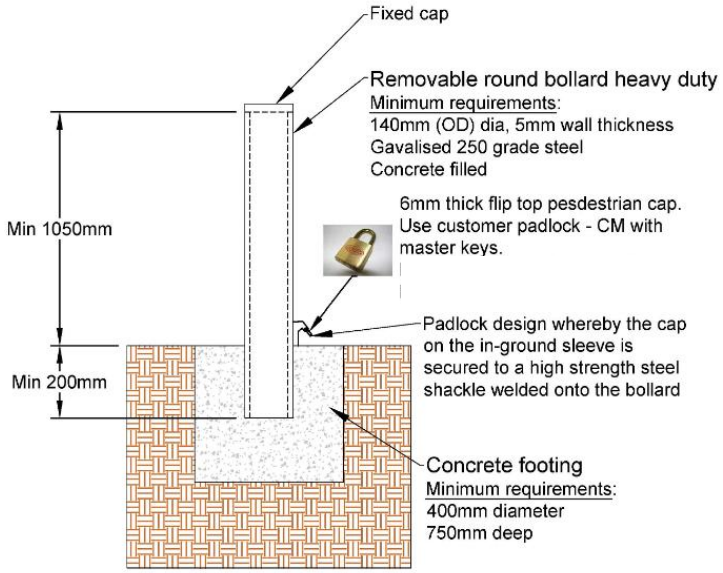


Figure 11: Typical removable traffic round bollard heavy-duty (Not to Scale)

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7.4 Retaining Walls

If there is any cut or fill exceeding 300 mm within 2.0 m of an easement boundary, a retaining wall is required. 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. Refer to Figure 12 for an example of this for a service pillar.

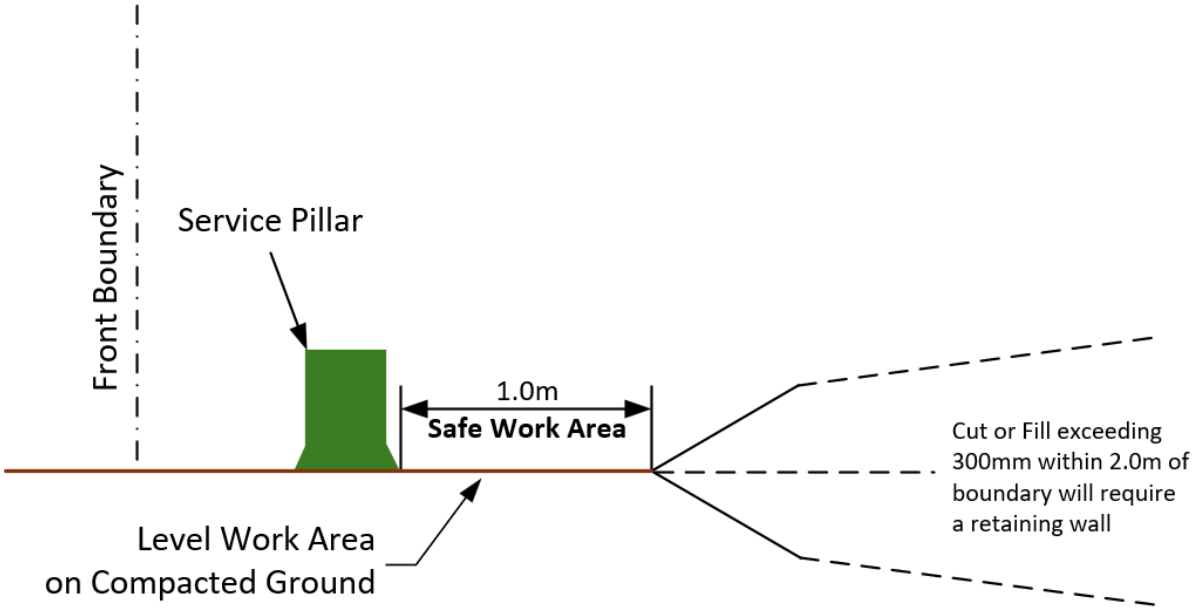


Figure 12: Service Pillar Example with Extents for Retaining Wall

Retaining wall construction specifications shall be submitted to the relevant SA Power Networks' Project Manager for approval.

Retaining wall shall meet the following requirements:

(1) Retaining walls shall be located as per the easement requirements specified in TS102.
(2) Allow for a 4-10 mm fall to achieve surface water runoff away from equipment footings.
(3) For "Fill" type retaining walls, a buffer zone equal to the wall's height, up to a maximum of 1.0 m with a tolerance of ± 100 mm shall be maintained. The buffer zone shall be treated as a 'No-Go-area to prevent accidental damage.
(4) Retaining walls over 1.0 m in height require the following:

- Design verification from a certified structural/civil engineer
- Engineering calculations
- Council approval where manufacturer specifications cannot be verified.

(5) The structure shall be constructed either of a combination of bricks/concrete masonry materials and/or concrete sleeper walls with galvanised steel posts that meet the required 60-year design life as per AS 4678.
(6) The use of precast concrete sleepers (refer to Figure 13) to retain SA Power Networks' equipment is acceptable but shall also comply with AS 4678 requirements.



Figure 13: Precast concrete sleepers

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(7) The following materials are not suitable for constructing retaining walls and are prohibited:

- Timber
- Rock-type Materials

(8) The Customer/landowner is responsible for maintaining the retaining wall. SA Power Networks will only conduct repairs/damages to the retaining wall that they have installed.

(9) SA Power Networks is not obligated to conduct repairs due to material defects or accidental damage by third parties.

(10) SA Power Networks reserve the right to refuse energisation, where non-compliances are identified, for example:

(a) The retaining wall was not designed according to the approved specifications indicated on the design drawing.
(b) A suitable foundation is not available for vertical block-type retaining walls.
(c) The area around the retaining wall and equipment has steps and not adequately compacted.
(d) The operating area has steps and is unsafe due to its location on an uneven ground surface.

(11) Observe that any non-conformance to the SA Power Networks requirements shall be rectified at the customer's expense.

(12) Drainage shall be provided along the length of the retaining wall sections with weep holes where required. This shall be shown in the design drawings.

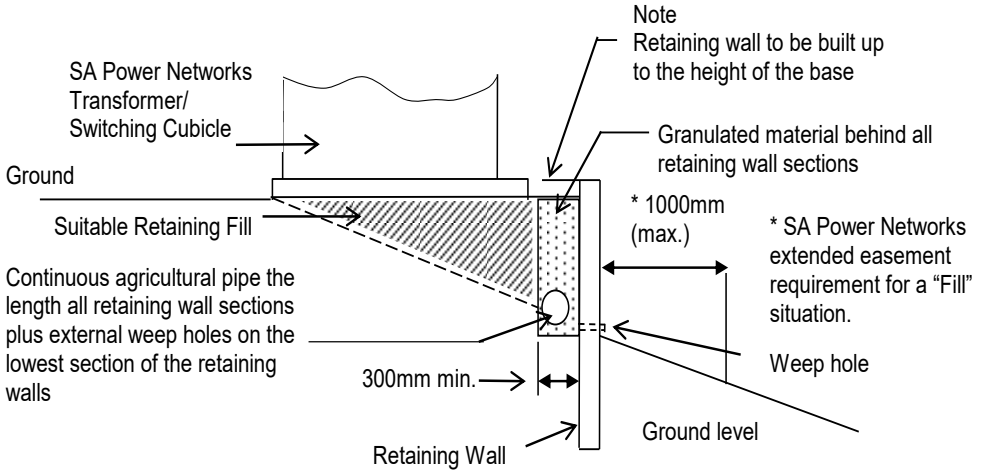


Figure 14: Retaining Wall – Fill (1000mm Maximum Buffer Zone)

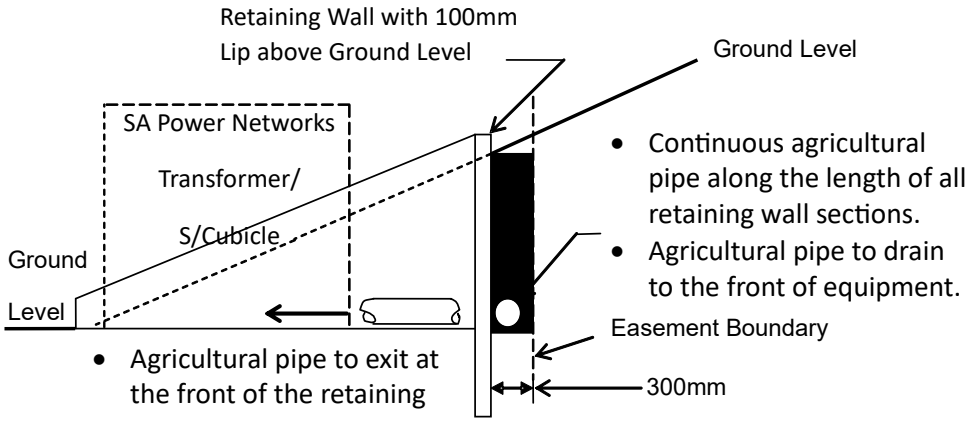


Figure 15: Retaining Wall – Cut

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7.5 Standard Footing Arrangements

Padmount transformers or switching cubicles shall be installed on concrete pad footings, which incorporate cable vaults under the HV and LV compartments. The type of standard footing arrangement used shall be indicated on design drawings.

Any floor supporting these padmount transformers or switching cubicles shall be capable of supporting the weight of the equipment.

7.5.1 Padmount Transformer Standard Footings

Standard footings for padmount transformers shall be constructed in accordance with E-Dwgs E 1982 series.

7.5.2 HV Switching Cubicle Standard Footings

Standard footings for HV switching cubicles shall be constructed in accordance with E-Dwgs E 1981 series.

7.6 Extended Vault Cover Arrangement

Where an extended vault cover arrangement is required, Approval is required from relevant SA Power Networks' Project Manager. Where required, the design drawing shall indicate the location of the extended vault.

If an extended vault cover arrangement is required, approval must be obtained prior from the relevant SA Power Networks' Project Manager. Additionally, when it is required, the design drawings shall specify the use and location of the extended vaults.

Refer to Figure 16, for a typical extended vault cover arrangement.

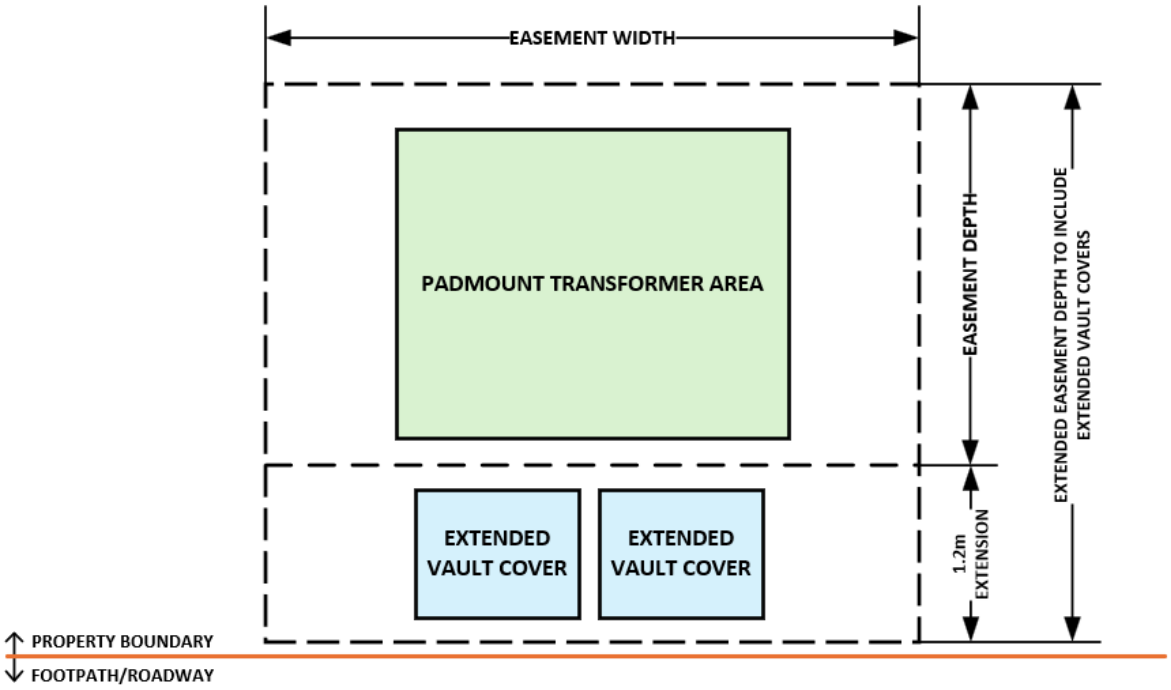


Figure 16: Typical Extended Vault Cover Arrangement (Not to scale)

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8. Specific Considerations

8.1 Significant Load Requirements

8.1.1 Customer Demand for Large Loads (from 1 MVA and less than 4 MVA)

For large customer demand loads ranging from 1 MVA to less than 4 MVA, both the 'Main HV Supply Cable' and 'Alternative HV Supply Cable' are typically sourced from the same feeder to the customer supply point. This arrangement allows SA Power Networks to switch to an alternative supply in case of a main supply failure.

The design requirements for these large loads are as follows:

(1) The 'Main HV Supply Cable' and 'Alternative HV Supply Cable' shall be situated in separate trenches (or separate conduit systems) to allow for repair of one cable, while the other remains live.

(2) The distance between two separate trenches should be ten times the diameter of the larger conduit from either trench. For example, if the largest pipe diameter is 100 mm, the separation between trenches should be 1.0 m.

(3) The 'Main HV Supply Cable' and 'Alternative HV Supply Cable' shall remain physically separate until they reach the feeder backbone, where multiple supply paths are available.

(4) The Customer's main switchboard (MSB) shall be located within 10 m (total cable route length) of the connection point but outside of SA Power Networks' easements (including statutory easements).

(5) In MEN areas, a minimum separation of 4.0 m shall be maintained between the transformer's HV earthing and the MSB's LV earthing. This distance can be reduced in CMEN areas, subject to consultation with SA Power Networks' Project Manager. For more details, refer to Manual 32: Service Installation Rules.

Max Demand 1 MVA - 4 MVA

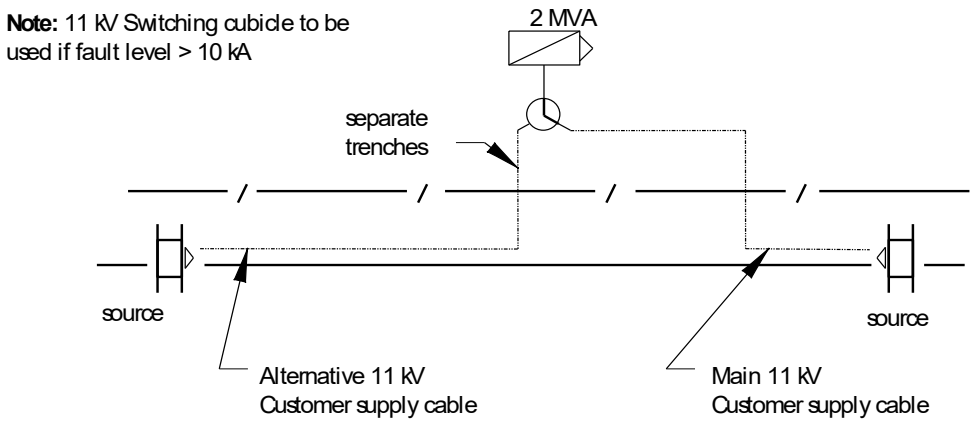


Figure 17: Typical Supply Arrangement for Max Demand from 1 MVA and less than 4 MVA

8.1.2 Customer Demand Loads of 4 MVA and Above

Customers with a maximum demand of 4 MVA and above, such as major shopping centres and hospitals, are to be supplied by both a main and a backup feeder. Given that a 4 MVA load typically represents over 50% of the feeder's capacity, a standard feeder design solutions from SA Power Networks will not suffice. Additional design requirements are required for loads of 4MVA and above and setup is subject to a reserved capacity fee.

The design requirements for large loads of 4 MVA and above include:

(1) A main and a backup HV customer supply cable shall be installed from two different feeders to the customer's connection points.

(2) The cable size of both the main and backup feeder shall be capable of carrying the total customer load on either feeder.

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(3) Provided approval is received from SA Power Network's Network Operations Centre (NOC), the Customer or their agent may switch their load between either of the customer supply cables in the event of a supply failure. The requirement to seek approval can be waived by purchasing a backup supply arrangement (for further details, refer to Section 8.1.3).

(4) If the Customer has purchased a backup supply arrangement, SA Power Networks will ensure the total agreed capacity is available at any time from either feeder.

(5) The backup customer supply cable shall be located in a separate trench or conduit system to allow for repair of one cable while the other remains live.

(6) At least two independent switching cubicles shall be supplied. For LV customers, transformer redundancy should be arranged such that the total customer load can be supplied with one transformer out of service. The Customer shall contribute to the cost of this work in accordance with the Electricity Distribution Code (EDC).

(7) The supply, protection, earthing, and metering arrangements shall comply with SA Power Network's requirements, with details provided upon application. These arrangements shall also comply with the EDC, Metering Code, and National Electricity Rules (NER) to prevent interference with SA Power Network's systems. They shall also comply with all applicable regulations, codes of practice, and Manual 32: Service Installation Rules.

(8) The preferred supply arrangement/connection for maximum demand loads of 4 MVA and above by SA Power Networks is depicted in Figure 18. If this typical arrangement is not feasible and alternative arrangements are considered, written approval from the Technical Standards Manager is required.

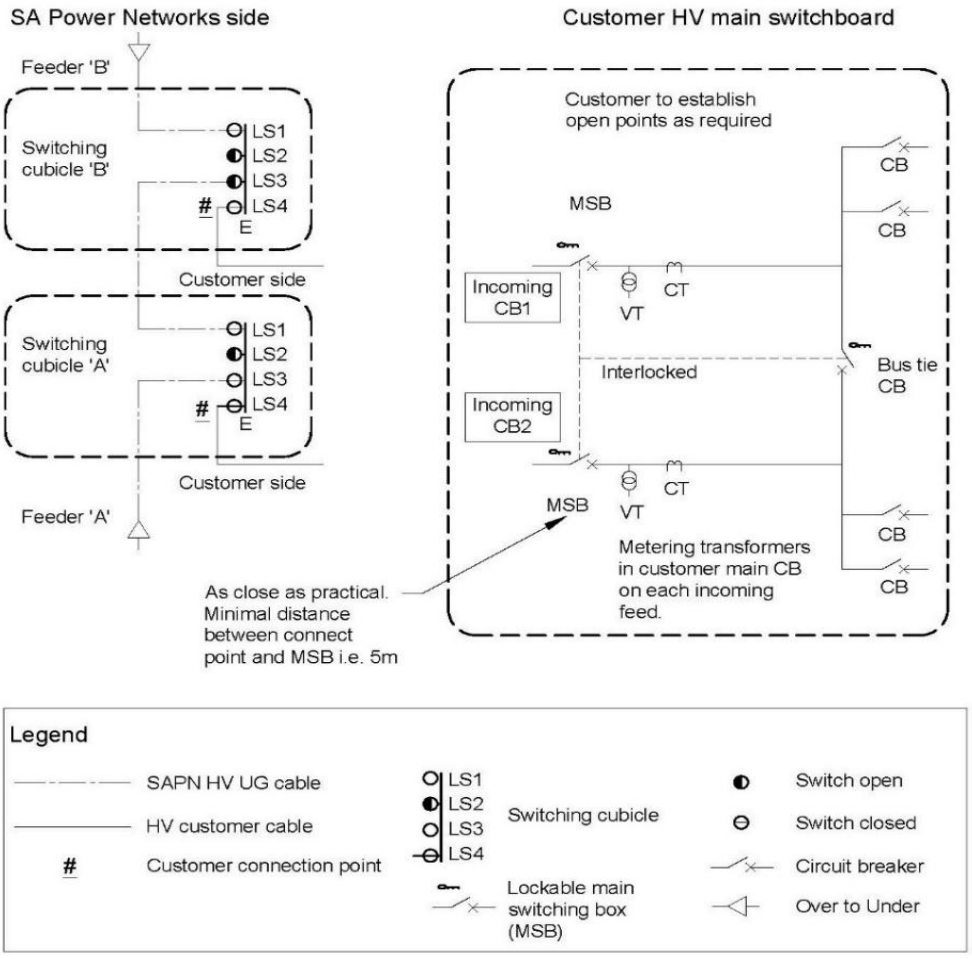


Figure 18: Typical supply arrangement for maximum demand 4 MVA and Above

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8.1.3 Backup Supply (Option for Improved Service)

Customers sensitive to supply interruptions (e.g. hospitals, high-rise buildings shopping centres, or large industrial) are advised to purchase a backup supply from an alternative SA Power Network's feeder. A backup supply allows Customer's the flexibility to manually or automatically transfer loads from one feeder to another via internal switching. This offer can be made at any time but is typically offered at the time of upgrade or connection. It shall be noted that this arrangement is subject to a reserved capacity fee.

8.2 Bridge Crossing Requirements

SA Power Networks will only maintain it's own assets located on the bridge, such as cabling and conduit systems. The bridge owner is responsible for maintaining the bridge and it's supporting structural elements, such as hangers, cable trays, and pipes used for holding the conduit systems.

The designer shall meet the following bridge crossing design requirements:

(1) The design shall be in accordance with AS 5100 standards.
(2) Where steel pipes containing SA Power Network's underground cables are attached to the railway and/or tramway 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 (e.g. 3 single core cables should be contained within a single steel pipe instead of 3 separate steel pipes).
(3) Where cables pass through a structure containing steel reinforcing (e.g. building walls or foundations), then a single opening shall be created for all cables together to pass through the reinforced structure to prevent induction of circulating currents.
(4) Where medium or heavy seamless galvanised steel tubing is required, the designer shall ensure it complies with AS 1074 and notify the relevant SA Power Networks' Project Manager.

8.2.1 Service Bridge Arrangement

Where SA Power Networks' infrastructure will be installed along a service bridge with other utilities' services, the design 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, and therefore shall be protected from the sun's ultraviolet (UV) radiation.
(3) Conduit installation and spare conduit requirements shall be as specified in TS085.
(4) For clearance requirements between SA Power Network's HV and LV Feeders or separations from other utilities, refer to TS085.
(5) Where two or more feeders are to be installed in parallel, 1.0 m minimum separation between feeders is required. When such feeders are crossing perpendicular, the separation is negligible.
(6) For critical circuits, more detailed analysis may be required.
(7) Supports, clamps and hardware are to be made of 316 stainless steel.

8.2.2 Reduced Cover in Service Bridge Footpath

The installation of an underground cable and conduit system on the footpath of a service bridge is only permissible when reduced cover trench requirements can be satisfied, as defined in TS085.

If these requirements cannot be achieved, the designer shall submit an alternative proposal to SA Power Networks' Technical Standards Manager for written approval.

8.2.3 Bridge Cable Tray Arrangement

Before commencing any cable tray arrangement works around a bridge crossing, the designer shall include the following requirements:

- Mechanical, UV and vandalism protection criteria;
- Future repair and durability criteria for the life of the infrastructure;
- Cable rating calculations;

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- Engineering design calculations;
- Bridge structural drawings; and
- Conduit/pipe support details, including cable tray clamps.

Approval shall be sought from the relevant SA Power Networks Project Manager before proceeding.

8.3 Railway and Tramway Network Requirements

Refer to TS117 for design and installation requirements of HV & LV conduits and cables within railway and tramway corridors.

8.4 Outdoor Distribution Equipment Enclosure Requirements

If outdoor distribution equipment is to be installed in an external locations surrounded by walls and no roof, it is not considered as an indoor equipment room. In this scenario, the arrangement is instead referred to as an outdoor equipment enclosure. Where this is required, the customer or their agent shall consult with SA Power Networks' Project Manager to address any site-specific requirements or constraints.

Where a building wall is intended to form part of an outdoor distribution enclosure, clearance shall be maintained between the wall and the distribution equipment. This clearance is dependent on the size of the padmount transformer in the enclosure and the fire rating of the building wall. The required horizontal clearance between building walls and oil contained transformers is as per Table 5 below.

Table 5: Outdoor equipment enclosures clearance requirements to walls

Padmount TF Size	Wall Fire Rating (FRL)	Minimum Horizontal Clearance from TF to Wall (Distance C)
Less than 750 kVA	3 hours (FRL 180/180/180)	1.0 m
	2 hours (FRL 120/120/120)	1.2 m
750 kVA and greater	2 hours (FRL 120/120/120)	1.5 m

The dimensions of the outdoor equipment enclosure should be width (A) x depth (B). Refer to Figure 19 for the layout requirements of an outdoor equipment enclosure for a Mk5 & Mk7 padmount transformers. It is worth noting that the total enclosure width may also increase based on clearance requirements to walls if any of the sides are building walls.

The outdoor distribution equipment should be set back at least 1.5m into the enclosure, ensuring there is clear access from the footpath. This is to maintain a minimum overall operating area of 3.0 m (with enclosure doors opened).

If fencing is provided for the sides of the enclosure not covered by walls, the fencing shall not obstruct the view of the equipment inside and its surrounding area within the enclosure.

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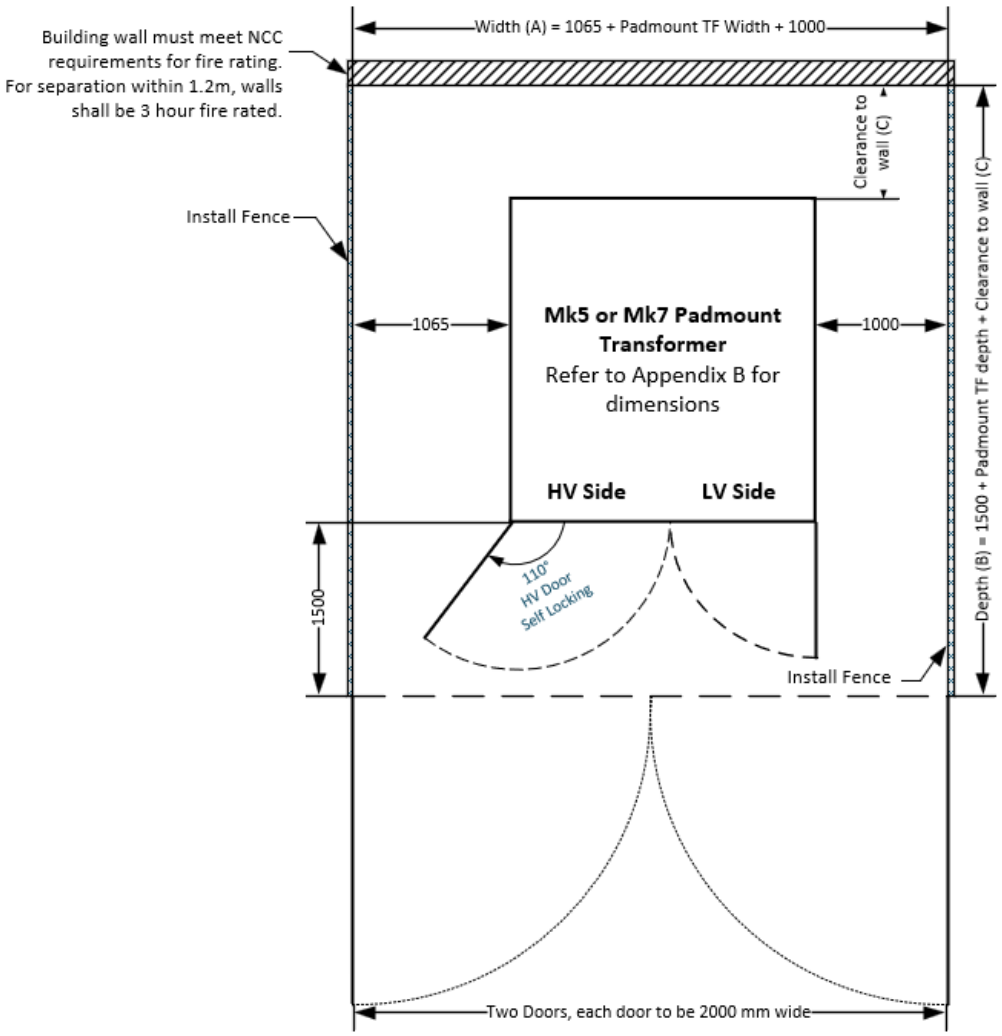


Figure 19: Outdoor Distribution Equipment Enclosure

Note: All dimensions are in 'mm' and are minimum requirements, and Drawing is 'Not to Scale'.

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9. Design Compliance

All works contained within this technical standard is subject to SA Power Networks design compliance and asset inspection processes. It is the responsibility of the customer/customer's agent to ensure that all design requirements are met.

Any changes required to the approved design shall be submitted and approved by the SA Power Networks' Project Manager, prior to work commencing.

SA Power Networks reserves the rights to refuse energisation, where on inspection, non-compliances are identified, for example but not limited to:

- The design does not meet specific requirements stipulated in this document and any other applicable standards.
- The design is not built to the approved specifications.

Any identified non-conformances to SA Power Networks requirements shall be rectified at the customer's expense.

To comply with SA Power Networks' design requirements, before receiving the 'Authority to Proceed-Connection and Energise', the customer or their agent shall provide all information required to complete test sheets in full. For further details, please refer to TS105A (Forms).

10. Provision for Future Stages

A comprehensive master layout plan for the proposed HV and LV distribution systems shall be prepared and submitted to the relevant SA Power Networks' Project Manager. This plan shall clearly illustrate both the current and future phases of multi-staged developments.

For developments with multiple stages, arrangements shall be made to extend the HV and LV cables and conduits, terminating them at stage boundaries with caps for future expansion. In cases where an LV cable is intended to eventually serve a subsequent stage, the 'For Construction' design should depict the cable as being connected and capped.

The finished ground levels at the subdivision boundary shall be provided, as these levels will determine the final installation heights for service pits and pillars, lighting columns, and transformer and switching cubicle installations.

In developments with smaller building setbacks and allotments, it is crucial to ensure the boundary is correctly levelled. Post-installation adjustments to SA Power Networks' infrastructure can be costly, especially if the project has already been energised.

The customer or their agent is responsible for ensuring that all properties within the current stage boundary are accounted for in terms of future supply. This includes making all properties within the project stage and adjacent future stages 'supply ready' by installing the necessary LV service and/or junction pits, pillars, HV joints, and other relevant infrastructure.

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11. Who Should You Talk To?

(1) SA Power Networks' Customer Solutions Managers:

- Website: https://www.sapowernetworks.com.au/public/download.jsp?id=315697

(2) General Enquiries:

Contact SA Power Networks' Customer Service Team:

- Website: https://www.sapowernetworks.com.au/contact-us
- Email: customerservice@sapowernetworks.com.au;
- Call: 13 12 61

(3) Network Access Permit Requests:

Contact SA Power Networks' Customer Solutions-Connection Central Team during business hours 8:00 am to 3:00 pm, Monday to Friday:

- Email: connectioncentral@sapowernetworks.com.au;
- Call: (08) 8404 5409

(4) Before You Dig Australia (BYDA) Enquiries:

- Website: https://www.byda.com.au/

(5) Service and Installation Rules Enquires:

Contact SA Power Networks' Network Connections Manager:

- Email: ConnectionsManager@sapowernetworks.com.au;

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Appendices

A. After Diversity Maximum Demand (ADMD) Tables

A.1 3 phase voltage drop and ADMD Table for 4 x 150 mm² LV AL XLPE/HDPE UBC

Table 6: 3 Phase voltage drop and ADMD Table for 4 x 150 mm² LV AL XLPE/HDPE UBC

Number of customers	Balanced 3 phase voltage drop table (V) Based on a 100 m length of 4 x 150 mm² LV AL XLPE/HDPE UBC					
	After diversity maximum demand (ADMD) per customer					
	3 kVA	4 kVA	5 kVA	6 kVA	8 kVA	10 kVA
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

Note: End of line voltage drop shall not exceed 10 V.

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A.2 ADMD for Average URD Dwelling Size

Table 7: ADMD for Average URD Dwelling Size

Average URD Dwelling Size for 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 (See Note 1)

Notes:

(1) In larger housing areas within premium developments, the presence of more extensive features or facilities should result in a proportional increase in the ADMD.

(2) The ADMD for a development **should not be less than 6 kVA** per allotment. The appropriate ADMD design value will be specified by SA Power Networks' Project Manager as part of a project specification.

(3) The ADMD values listed in Tables 9, 10 and 11 are intended for design purposes only (accommodating future load growth), and should not be considered as representative of the customer ADMD typically expected in an Underground Residential Distribution (URD) system.

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B. Padmount Transformers Without Oil Containment: Technical Data

Table 8: Padmount Transformers (without Oil Containment) Selection Table

Padmount Transformers (without Oil Containment)				Actual Manuf. Dimensions (includes tie down lugs) Width x Depth x Height (mm)	Actual Manuf. Weight (Tones)	Prospective Fault Current (kA)	Maximum SA Power Networks' LV 'NH' Fuse Link
Type	Voltage Ratio (kV)	Capacity Rating (kVA)	Stock Item Number				
Rural Pad 1Φ	11 / 0.250	50	LC 5101	1450 x 1184 x 1254 (Lifting lugs removable / not included)	1.23	13	LC 5101H - 250 A (NH3) LC 5101G - 100 A (NH2)
Rural Pad 3Φ	11 / 0.433	63	LC 5330	1450 x 1185 x 1255 (Lifting lugs removable / not included)	1.26	13	100 A (NH2)
		100	LC 5331	1450 x 1185 x 1255 (Lifting lugs removable / not included)	1.32	13	200 A (NH2)
Mk7 Oil RMU & 600 A DB Bush	11 / 0.433	315	LC 7309	2090 x 1662 x 1627	2.45	13.0	400 A (NH3)
		500	LC 7310	2090 x 1662 x 1627	2.85	18.5	400 A (NH3)
		750**	LC 7311	2090 x 2042 x 1677	3.90	25.3	2000 A CB and 400 A (NH3)
		1000**	LC 7312	2090 x 2042 x 1677	4.35	33.7	2000 A CB and 400 A (NH3)
		1500**	LC 7313	2340 x 2112 x 1797	5.90	35.3	2500 A CB and 400 A (NH3)
		2000**	LC 7314	2340 x 2112 x 1797	6.60	45.6	3200 A CB and 400 A (NH3)
	11 / 7.6 / 0.433 Dual Ratio	315	LC 7433	2090 x 1662 x 1627	2.45	13.0	400 A (NH3)
		500	LC 7434	2090 x 1662 x 1627	2.85	18.5	400 A (NH3)
		750**	LC 7435	2090 x 2042 x 1677	3.90	25.3	2000 A CB and 400 A (NH3)
		1000**	LC 7436	2090 x 2042 x 1677	4.35	33.7	2000 A CB and 400 A (NH3)
		2000**	LC 7438	2340 x 2112 x 1797	6.45	45.6	3200 A CB and 400 A (NH3)
Mk5 SF6 RMU	11 / 0.433	500	LC 5315	2240 x 1850 x 2025 (Lifting lugs removable / not included)	4.82	19.9	400 A (NH3)
		750**	LC 5316	2240 x 2025 x 2025 (Lifting lugs removable / not included)	5.10	27.8	2000 A CB and 400 A (NH3)
		1000**	LC 5317	2240 x 2025 x 2025 (Lifting lugs removable / not included)	5.35	37.0	2000 A CB and 400 A (NH3)
		1500**	LC 5318	2590 x 2343 x 1950	6.29	37.0	2500 A CB and 400 A (NH3)
		2000**	LC 5319	2250 x 2250 x 2025	7.16	47.4	3200 A CB and 400 A (NH3)
Mk5 SF6 RMU	33 / 0.443	1000**	LC 5443	2400 x 2625 x 2225	6.32	TBA	TBA
		2000**	LC 5445	2605 x 3305 x TBA	8.30	TBA	TBA

Notes for Tables 10 and 11:

1. ** = Mk5 and Mk7 type padmount transformers from 750 kVA up to and including 2000 kVA without oil containment are for maintenance replacement only. Approval will be required from the Technical Standards Manager prior to its use.
2. The nominal dimensions and weights of padmount transformers are subject to change without notice by the transformer manufacturer. The actual weight and voltage ratings are specified on the padmount transformer drawings, and their nameplate is stencilled on the nameplates of the padmount transformers.

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Table 9: Padmount Transformers (without Oil Containment) Selection Table - Continued

Padmount Transformers (without Oil Containment)				Nominal Impedance (%)	Pad T/F Actual Rating (kVA)	Pad T/F Full Load Current (A)	Pad T/F Losses (W)	
Type	Voltage Ratio (kV)	Capacity Rating (kVA)	Stock Item Number				No Load	On Load
Rural Pad 1Φ	11 / 0.250	50	LC 5101	TBA	50	100-200	111	652
Rural Pad 3Φ	11 / 0.433	63	LC 5330	TBA	63	84	180	875
		100	LC 5331	TBA	100	133	260	1403
Mk7 Oil RMU & 600 A DB Bush	11 / 0.433	315	LC 7309	3.6	315	420	580	2770
		500	LC 7310	4.0	500	667	720	4104
		750**	LC 7311	4.4	750	1000	960	5490
		1000**	LC 7312	4.4	1000	1333	1215	7938
		1500**	LC 7313	6.3	1500	2000	1591	12484
		2000**	LC 7314	6.5	2000	2667	1921	16870
	11 / 7.6 / 0.433 Dual Ratio	315	LC 7433	3.6	11 / 0.433 (315)	11 / 0.433 (420)	580	2740
					7.6 / 0.433 (268)	7.6 / 0.433 (357)		
		500	LC 7434	4.0	11 / 0.433 (500)	11 / 0.433 (667)	750	3940
					7.6 / 0.433 (425)	7.6 / 0.433 (567)		
		750**	LC 7435	4.4	11 / 0.433 (750)	11 / 0.433 (1000)	978	5623
					7.6 / 0.433 (425)	7.6/.433 (850)		
		1000**	LC 7436	4.4	11 / 0.433 (1000)	11 / 0.433 (1333)	1310	8140
					7.6 / 0.433 (850)	7.6 / 0.433 (1133)		
		1500**	LC 7437	6.3	11 / 0.433 (1500)	11 / 0.433 (2000)	1670	12430
					7.6 / 0.433 (1275)	7.6 / 0.433 (1700)		
		2000**	LC 7438	6.5	11 / 0.433 (2000)	11 / 0.433 (2667)	1920	16870
					7.6 / 0.433 (1700)	7.6 / 0.433 (2267)		
Mk5 SF6 RMU	11 / 0.433	500	LC 5315	3.73	500	667	750	3925
		750**	LC 5316	4.0	750	1000	980	6050
		1000**	LC 5317	4.0	1000	1333	1335	7725
		1500**	LC 5318	6.0	1500	2000	1500	11960
		2000**	LC 5319	6.25	2000	2667	2064	15469
Mk5 SF6 RMU	33 / 0.443	1000**	LC 5443	TBA	TBA	TBA	1500	7640
		2000**	LC 5445	TBA	TBA	TBA	2100	17806

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C. Padmount Transformer Technical Data: With Oil Containment

Table 10: Padmount transformers (with oil containment) Selection table

New Installations Padmount Transformers (with Oil Containment)				Actual Manuf. Dimensions Width x Depth x Height (mm)	Actual Manuf Weight (Tones)	Prospect Fault Current (kA)	Maximum SA Power Networks' LV 'NH' Fuse Link
Type	Voltage Ratio (kV)	Capacity Rating (kVA)	Stock Item Nos.				
Mk7 (Oil Contained) Oil RMU, 600 A DB Bushings	11/ 7.6 / 0.433 (Dual Ratio)	1000	TBA	TBA	TBA	TBA	TBA
	11/0.433	315	LC 7509	1950 x 1890 x 1677 (not including lifting lugs)	3.23	12.0	400 A (NH3 Type)
		500	LC 7510		3.05	19.0	400 A (NH3 Type)
		750	LC 7511	2113 x 2357 x 1677	4.77	27.3	2000 A CB and 400 A (NH3)
		1000	LC 7512		4.73	34.0	2000 A CB and 400 A (NH3)
		1500	LC 7513	2450 x 2343 x 1950	6.30	36.0	2500 A CB and 400 A (NH3)
		2000	LC 7514	2450 x 2343 x 2250	7.85	47.0	3200 A CB and 400 A (NH3)
Mk5 (Oil Contained) SF6 RMU	11/0.433	500	LC 5715	TBA	TBA	TBA	400 A (NH3)
		750	LC 5716	TBA	TBA	TBA	2000 A CB and 400 A (NH3
		1000	LC 5717	TBA	TBA	TBA	2000 A CB and 400 A (NH3)
		1500	LC 5718	2590 x 2343 x 1950	6.29	35.3	2500 A CB and 400 A (NH3)
		2000	LC 5719	2590 x 2343 x 2250	7.70	45.6	3200 A CB and 400 A (NH3)
Mk5 SF6 RMU	33/0.443	1000	LC5453	2450 x 2450 x 2317	TBA	TBA	TBA
		2000	LC5455	TBA	TBA	TBA	TBA
Zone Substation Pad Unfused Radial	(Mk 6) 33 / 11	3000	LD 6787	2090 X 2755 X 2184	8.60	TBA	TBA
	33 / 11 / 7.6 (Dual Ratio)	3000	LD 6797	2170 x 2755 x 2184	8.62	TBA	TBA

Note: The nominal dimensions and weights of padmount transformers are subject to change without notice by the transformer manufacturer. The actual weight and voltage ratings are specified on the padmount transformer drawings, and their nameplate is stencilled on the nameplates of the padmount transformers.

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Table 11: Padmount transformers (with oil containment) Selection table - Continues

New Installations Padmount Transformers (with Oil Containment)				Nom. Impedance (%)	Pad T/F Actual Rating (kVA)	Pad T/F Full Load Current (A)	Pad T/F Losses (W)	
Type	Voltage Ratio (kV)	Capacity Rating (kVA)	Stock Item Nos.				No Load	On Load
Mk7 (Oil Contained) Oil RMU, 600 A DB Bushings	11/ 7.6 / 0.433 (Dual Ratio)	1000	TBA	TBA	TBA	TBA	N/A	N/A
	11/.433	315	LC 7509	4.0	315	420	537	2674
		500	LC 7510	4.0	500	667	694	4072
		750	LC 7511	4.4	750	1000	931	5065
		1000	LC 7512	4.4	1000	1333	1128	7693
		1500	LC 7513	6.3	1500	2000	1591	12484
		2000	LC 7514	6.5	2000	TBA	1920	16870
Mk5 (Oil Contained) SF6 RMU	11/.433	500	LC 5715	TBA	500	TBA	N/A	N/A
		750	LC 5716	TBA	750	TBA	N/A	N/A
		1000	LC 5717	TBA	1000	TBA	1215	8048
		1500	LC 5718	6.3	1500	2000	1620	12477
		2000	LC 5719	6.5	2000	2667	1920	16870
Mk5 SF6 RMU	33/.443	1000	TBA	TBA	TBA	TBA	1426	7277
		2000	TBA	TBA	TBA	TBA	2100	17806
Zone Substation Pad Unfused Radial	(Mk 6) 33 / 11	3000	LD 6787	TBA	TBA	TBA	N/A	N/A
	33 / 11 / 7.6 (Dual Ratio)	3000	LD 6797	TBA	TBA	TBA	N/A	N/A

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D. Mk5 & Mk7 LV circuit breaker settings - (without oil containment)

Table 12: Mk5 and Mk7 (11 kV/433 V) LV circuit breaker settings - (without oil containment)

Pad T/F Nominal rating (kVA)	CB Model/maker	In	Io	I1	T1	I2	T2	I3
750**	Terasaki XS2000NE	2000 A	0.8	0.85	5	2	0.1	5
1000**	Terasaki XS2000NE	2000 A	1	0.9	5	2	0.1	6
1500**	Terasaki XS2500NE	2500 A	1	1	30	2	0.1	6
2000**	Terasaki XS3200NE	3200 A	1	1	30	2	0.1	6

E. Mk5 & Mk7 LV circuit breaker settings - (with oil containment)

Table 13: Mk5 and Mk7 (11 kV/433 V) LV circuit breaker settings - (with oil containment)

Pad T/F Nominal Rating (kVA)	CB Model/Maker	In	Io	I1	T1	I2	T2	I3
750	Terasaki XS2000NE	2000 A	0.8	0.85	5	2	0.1	5
1000	Terasaki XS2000NE	2000 A	1	0.9	5	2	0.1	6
1500	Terasaki XS2500NE	2500 A	1	1	30	2	0.1	6
2000	Terasaki XS3200NE	3200 A	1	1	30	2	0.1	6

F. Mk7 11/7.6/0.433 - Full load current/losses - (without oil containment)

Table 14: Mk7 (11 kV/7.6 kV/433 V) - Full load current/tapping ranges (without oil containment)

Pad T/F nominal rating (kVA)	Voltage (kV)	Pad T/F actual rating (kVA)	Pad T/F full load current (A)	Pad T/F losses, Watts (W)	HV tapping range (tap steps = 2.5%)
315	11/0.433	315	420	4994	5% to +10%
	7.6/0.433	268	357		
500	11/0.433	500	667	6962	5% to +10%
	7.6/0.433	425	567		
750**	11/0.433	750	1000	10,188	5% to +10%
	7.6/0.433	638	850		
1000**	11/0.433	1000	1333	14,361	5% to +10%
	7.6/0.433	850	1133		
1500**	11/0.433	1500	2000	21,834	5% to +10%
	7.6/0.433	1275	1700		
2000**	11/0.433	2000	2667	29,962	5% to +10%
	7.6/0.433	1700	2267		

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G. Mk5 full load current/tapping ranges - (with oil containment)

Table 15: Mk5 (11 kV/433 V) - Full load current/tapping ranges - (with oil containment)

Pad T/F nominal rating (kVA)	Voltage (kV)	Pad T/F actual rating (kVA)	Pad T/F full load current (A)	Pad T/F losses, Watts (W)	HV tapping range (tap steps = 2.5%)
500	11/0.433	500	TBA	TBA	5% to +10%
750	11/0.433	750	TBA	TBA	5% to +10%
1000	11/0.433	1000	TBA	TBA	5% to +10%
1500	11/0.433	1500	2000	14,175	5% to +10%
2000	11/0.433	2000	2667	19,119	5% to +10%

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H. Standard HV Compartment Configurations

Please be aware that when a padmount transformer is necessary for the spot load supply of high voltage (HV) consumers, the customer or their agent shall obtain approval from SA Power Networks' Project Manager during the preliminary design stage.

Table 16: Mk7 (11 kV/433 V) with or without oil containing - HV compartment

Pad T/F nominal rating (kVA)	Primary HV compartment			
315	630 A LS1	630 A LS2	400 A LS3 (For T/F)	Bay-O-Net Fuses (For T/F)
500				
750				
1000				
1500				
2000				

Table 17: Mk5 (11 kV/433 V) - without oil containment - HV compartment

Pad T/F nominal rating (kVA)	Primary HV compartment							
	Standard safe CCCV (C)				Non-preferred option Safer CCVV (D)			
500	630 A LS1	630 A LS2	630 A LS3	200 A CB4 (For T/F)	630 A LS1	630 A LS2	200 A CB3	200 A CB4 (For T/F)
750								
1000								
1500								
2000								

Table 18: Mk5 (11 kV/433 V) with oil containing - HV compartment

Pad T/F nominal rating (kVA)	Primary HV compartment			
	Standard safe CCCV (C)			
500	630 A LS1	630 A LS2	630 A LS3	200 A CB4 (For T/F)
750				
1000				
1500				
2000				

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I. Standard LV Compartment Configurations

Please note that if a padmount transformer is needed for low voltage (LV) consumers' spot load supply, the customer or their agent shall seek approval from SA Power Networks' Project Manager during the preliminary design stage.

Table 19: Mk7 (11 kV/433 V) with or without oil containing LV compartment

<table>
<tr><th>Pad T/F nominal rating (kVA)</th><th colspan="5">Secondary LV compartment</th></tr>
<tr><td rowspan="2">315</td><td colspan="2">Standard (A)</td><td colspan="3">Non-Preferred Option (F)</td></tr>
<tr><td rowspan="2">1250 A Isolator</td><td rowspan="2">4 x 630 A FSDs</td><td rowspan="2">1250 A Bus Isolator</td><td rowspan="2">2 x 630 A FSDs</td><td rowspan="2">2 x 630 A Gang FSDs</td></tr>
<tr><td>500</td></tr>
<tr><td rowspan="5">750</td><td colspan="2">Standard (B)</td><td colspan="3">Non-Preferred Option (A)</td></tr>
<tr><td rowspan="4">2000 A CB</td><td rowspan="4">2 x 630 A FSDs</td><td colspan="2">1250 A Bus Isolator</td><td>4 x 630 A FSDs</td></tr>
<tr><td colspan="3">Non-Preferred Option (F)</td></tr>
<tr><td>1250 A Bus Isolator</td><td>2 x 630 A FSDs</td><td>2 x 630 A Gang FSDs</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>1000</td><td colspan="5">Standard (B)</td></tr>
<tr><td colspan="2">2000 A CB</td><td colspan="3">2 x 630 A FSDs</td></tr>
<tr><td>1500</td><td colspan="5">Standard (E)</td></tr>
<tr><td colspan="2">2500 A CB</td><td colspan="3">2 x 630 A FSDs</td></tr>
<tr><td>2000</td><td colspan="5">Standard (J)</td></tr>
<tr><td colspan="2">3200 A CB</td><td colspan="3">2 x 630 A FSDs</td></tr>
</table>

Table 20: Mk5 (11 kV/433 V) with or without oil containing LV compartment

<table>
<tr><th>Pad T/F nominal rating (kVA)</th><th colspan="5">Secondary LV compartment</th></tr>
<tr><td rowspan="2">500</td><td colspan="2">Standard (A)</td><td colspan="3">Non-preferred option (F)</td></tr>
<tr><td>1250 A Isolator</td><td>4 x 630 A FSDs</td><td>1250 A Bus Isolator</td><td>2 x 630 A FSDs</td><td>2 x 630 A Gang FSDs</td></tr>
<tr><td rowspan="5">750</td><td colspan="2">Standard (B)</td><td colspan="3">Non-Preferred Option (A)</td></tr>
<tr><td rowspan="4">2000 A CB</td><td rowspan="4">2 x 630 A FSDs</td><td colspan="2">1250 A Bus Isolator</td><td>4 x 630 A FSDs</td></tr>
<tr><td colspan="3">Non-Preferred Option (F)</td></tr>
<tr><td>1250 A Bus Isolator</td><td>2 x 630 A FSDs</td><td>2 x 630 A Gang FSDs</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>1000</td><td colspan="5">Standard (B)</td></tr>
<tr><td colspan="2">2000 A CB</td><td colspan="3">2 x 630 A FSDs</td></tr>
<tr><td>1500</td><td colspan="5">Standard (E)</td></tr>
<tr><td colspan="2">2500 A CB</td><td colspan="3">2 x 630 A FSDs</td></tr>
<tr><td>2000</td><td colspan="5">Standard (J)</td></tr>
<tr><td colspan="2">3200 A CB</td><td colspan="3">2 x 630 A FSDs</td></tr>
</table>

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J. 11kV Switching Cubicles: Dimensions/Weight

Switchgear in an electric power system includes electrical disconnect switches, fuses, or circuit breakers that control, protect, and isolate electrical equipment. It is essential for de-energising equipment to facilitate maintenance and for clearing downstream faults, playing a crucial role in the reliability of the electricity supply. For detailed specifications, please refer to Table 21 and Figure 20.

Table 21: Switching cubicles dimensions and weight

Switching cubicle	Stock item number	Factory fitted Switchgear factory fitting in outdoor enclosure	Nominal Dimensions W x D x H (mm)	Weight (Tones)
(Manually Operated) 630 A RM6 Type 2 Downward Arc Venting	RA 7200	3 Load Switches and 1 Fuse Switch (LS1, LS2, FS, LS4)	1809 x 1067 x 1945	1.0
	RA 7201	3 Load Switches and 1 Circuit Breaker (LS1, LS2, CB3, LS4)		
	RA 7202	2 Load Switches and 2 Circuit Breakers (CB1, LS2, CB3, LS4)		
	RA 7203	4 x Load Switches (LS1, LS2, LS3, LS4)		
(Automated) 630 A RM6 AUTO2 Type 2 Downward Arc Venting	RA 7205	4 Load Switches (LS1, LS2, LS3 LS4)	1809 x 1067 x 1945	1.2
	RA 7206	3 Load Switches and Circuit Breaker (LS1, LS2, CB3, LS4)		



Figure 20: Typical switching cubicle 630 A RM6 Type 2 downward arc venting inside outdoor enclosure

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K. Typical UG HV circuit diagram

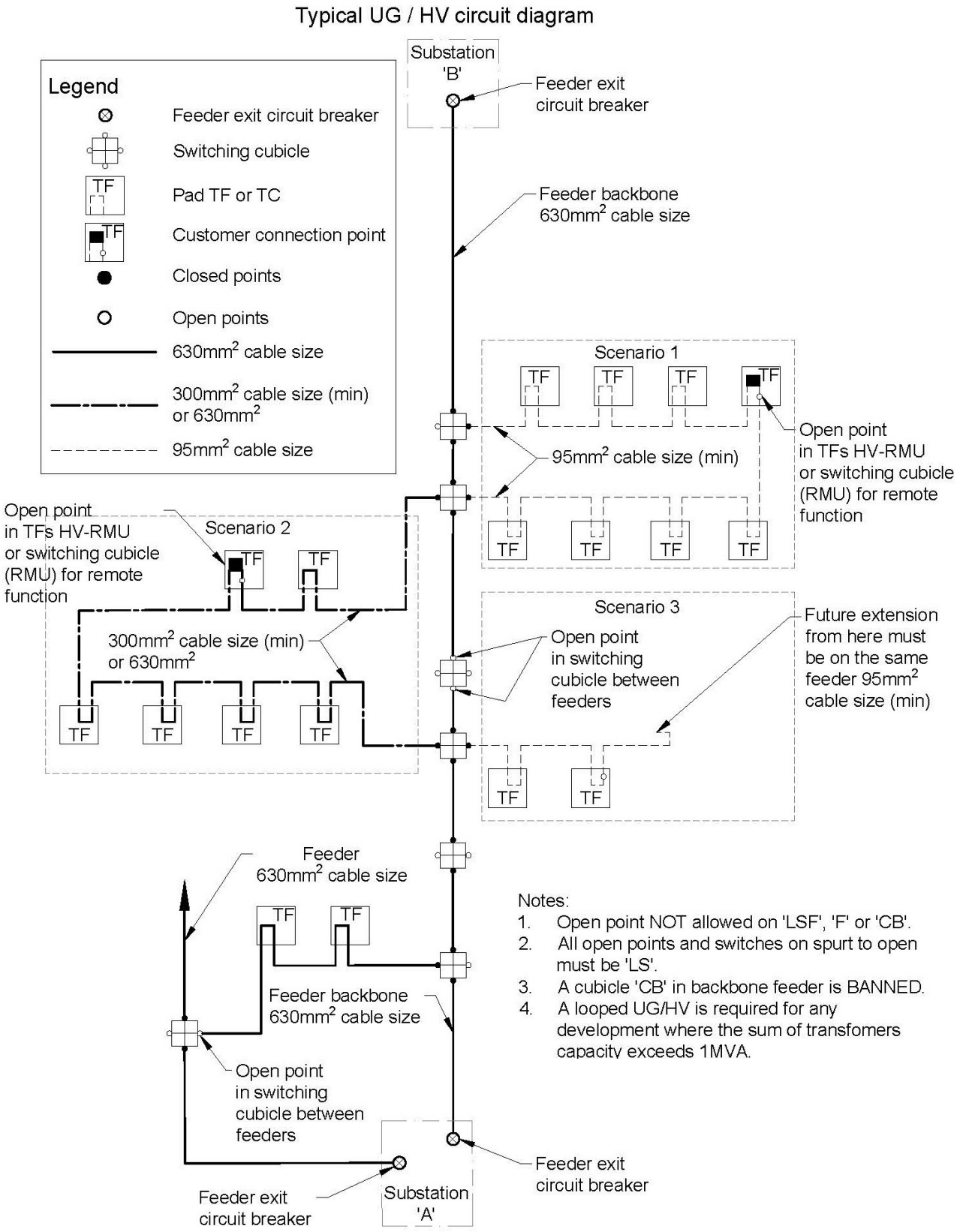


Figure 21: Typical UG HV circuit diagram

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L. HV Cable Selection

Refer to Tables L.1 to L.3 to determine the suitable high voltage (HV) cable selection.

L.1 HV Main Scenarios and Cable Size Selection

Table 22: HV Main Scenarios vs Cable Size Selection

HV mains scenarios	Cable description	SA Power Networks' supply item number	
		Al. Cond.	Cu. Cond.
11 kV substation feeder exit to the first switching cubicle	630 mm^2, 1C, XLPE/HDPE, Cu Screen	CK 6019	CK 6060
Main feeders from the first switching cubicle	630 mm^2, 1C, XLPE/HDPE, Cu Screen (Backbone); OR	CK 6019	CK 6060
	300 mm^2, 1C, XLPE/HDPE, Cu Screen (Not Backbone)	CK 6025	--
Main feeders connecting pad transformers	300 mm^2, 1C, XLPE/HDPE, Cu Screen	CK 6025	--
Substation ties between adjacent 11 kV feeders (start and end of Feeder)	630 mm^2, 1C, XLPE/HDPE, Cu Screen	CK 6019	CK 6060
Substation ties between adjacent 11 kV feeders (at the open point)	630 mm2, 1C, XLPE/HDPE, Cu Screen; OR	CK 6019	CK 6060
	300 mm^2, 1C, XLPE/HDPE, Cu Screen	CK 6025	--
Looped cables within a Feeder	95 mm^2, 1C, XLPE/HDPE, Cu Screen; OR	CK 6005	--
	95 mm^2, 3 x 1C, Bundled XLPE/HDPE Cu Screen	CK 6006 (Triplex)	--
11 kV backbone to the end of the feeder	630 mm^2, 1C, XLPE/HDPE, Cu Screen; OR	CK 6019	CK 6060
	300 mm^2, 1C, XLPE/HDPE, Cu Screen	CK 6025	--
Laterals and radials	95 mm^2, 1C, XLPE/HDPE, Cu Screen, OR	CK 6005	--
	95 mm^2, 3 x 1C, Bundled XLPE/HDPE Triplex, Cu Screen	CK 6006	--

Please note that an equivalent-sized copper (Cu) cable may be used as an alternative.

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L.2 HV Cable Sizes for Distribution Mains

Table 23: HV Cable Sizes for Distribution Mains

Voltage	Underground cable sizes	Screen type	SA Power Networks' supply item number	
			AL Cond.	Cu Cond.
HV 6.35/11 kV	95 mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 35 mm^2	CK 6005	--
	95 mm^2 3 x 1C AL Bundled XLPE/HDPE Triplex, Cu Screen	Screen Cu 35 mm^2	CK 6006	--
	300 mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 70 mm^2	CK 6025	--
	630 mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 95 mm^2	CK 6019	CK 6060

Note: Al = Aluminium; Cu = copper.

L.3 HV cable sizes for CBD approved industrial developments

Table 24: HV cable sizes for CBD and Approved Industrial Developments

Voltage	Underground cable sizes	Screen type	SA Power Networks' supply item number	
			AL Cond.	Cu Cond.
HV 6.35/11 kV	185 mm^2 3C Cu XLPE/HDPE, Cu Screen	Individually screened Cu 90 mm^2 Total	--	CK 3185
	240 mm^2 3C Cu XLPE/HDPE, Cu Screen	Individually screened Cu 90 mm^2 Total	--	CK 3240
HV 19/33 kV	50 mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 25 mm^2	CK 8090	--
	70 mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 65 mm^2	--	CK 8070
	95 mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 65 mm^2	CK 8092	--
	120 mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 65 mm^2	--	CK 8120
	240 mm^2 1C Cu XLPE/HDPE, Cu Screen	Screen Cu 65 mm^2	--	CK 8240
	300 mm^2 1C AL XLPE/HDPE, Cu Screen	Screen Cu 95 mm^2	CK 8095	--

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M. LV Cable Selection

Refer to Tables M.1 to M.3, for making appropriate LV cable selection.

Notes:

(1) Al = Aluminium; Cu = Copper; and N/A = Not Applicable
(2) Confirm the suitability of the selected cables with your SA Power Networks Project Manager

M.1 LV Cable Sizes for Distribution Mains

Table 25: LV cable sizes for distribution mains

Voltage	Underground cable sizes	Screen type	SA Power Networks' supply item number	
			AL Cond.	Cu Cond.
LV 0.6/1 kV	4 x 150 mm^2 LV AL XLPE/HDPE UBC	N/A	CK 5310	--

M.2 LV Cable sizes for CBD Approved Industrial Developments

Table 26: LV cable sizes for CBD approved industrial developments

Voltage	Underground cable sizes	Screen type	SA Power Networks' supply item number	
			AL Cond.	Cu Cond.
LV 0.6/1 kV	185 mm^2 3.5 C LV Cu XLPE/PVC	N/A	--	CK 1185
	240 mm^2 3.5 C LV Cu XLPE/PVC	N/A	--	CK 1240

M.3 LV Cable Sizes for Public Lighting Applications

Table 27: LV cable sizes for public lighting applications

Cable description		SA Power Networks' supply item number
450 V and 750 V (LV)	2.5 mm^2, Flat, 2 C, Cu, PVC Insulated Red/Black inner core and white outer sheath (100 m Length)	CD 7240
	6 mm^2, Flat, 2 C, Cu, PVC Insulated Red/Black inner core and white outer sheath (100 m Length)	CD 7253
	6 mm^2, Flat, 2 C, Cu, PVC Insulated Red/Black inner cores and white outer sheath (500 m Length)	CK 7254
	6 mm^2, 1 C, Cu, PVC-insulated, Green/Yellow inner cores and black outer sheath (100 m Length)	CD 7061
	6 mm^2, 1 C, Cu, PVC-insulated, Green/Yellow inner cores and black outer sheath (500 m Length)	CK 7062
	2.5 mm^2, Flat, 2 C + E, Cu, PVC-insulated, Red/Black inner core and white outer sheath (100 m Length)	CD 7340

M.4 Earthing cable sizes

Refer to TS109 for earthing cable sizes of 33 kV and less network and TS110 for a 66 kV network.

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N. Pull-planner™ 4.0 Tension Calculation Example

Pull-Planner™ 4.0 Software:

The cable Pull-Planner™ 4.0(for Windows™ computer programme) calculates the cable pulling tension and sidewall pressure around bends using pulling equations.

The tension estimates are useful for designing conduit systems and for planning cable pulls. Such planning can save time and money by minimising splices, vaults, and pulling setups while ensuring installation tensions that do not damage the cable.

The Pull-Planner™ 4.0 software is available for purchase from Adapt Australia; please visit their website at http://www.adaptaust.com.au/

Data for Pull-Planner™ 4.0

The cable pull tension shall not exceed the values stated in E-Dwgs series E 1900 to E 1910; if unsure, please consult SA Power Networks' Project Manager. The cable pull-tension calculations shall be incorporated in the design drawing.

For effective use of Pull-Planner™ 4.0 effectively, please implement the software supplier's guidelines/instructions and meet the data stated in Table 31.

Table 28: Data for Pull-Planner™ 4.0 Software

Cable technical data (including cable weight):	Refer to the E-Dwgs E 1900 - E 1910 series
Conduit diameter:	Refer to TS085
The conduit bend radius:	Refer to TS085
Back tension:	500 N
Coefficient of friction:	0.25

Table 29: Pull-Planner™ 4.0 Pull Tension Calculations

Pull Area Identification:			Demo (eg Gilbert Street Feeder)		
Conduit Inner Diameter:			100 mm		
Conduit Fill:			25%		
Total of 1 Cable(s) of 1 different type being pulled. (ie numbers of cables per conduit)					
Type 1:	1 Cable	Type 1:	1 Cable	Type 1:	1 Cable
Type 2:	--	Type 2:	--	Type 2:	--
Total Cable Weight: (ie Sum of Type # 1 & 2)			7.42 kgs/m		
Calculated Weight Correction Factor:			1		
Jam/Clearance Analysis:			Jamming is not possible		
Configuration:			Single Cable		
Coefficient of Friction (COF):			0.25		
Incoming Tension:			500 N		

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N.1 Calculations (continued)

Table 30: Pull-Planner™ 4.0 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 bending
- VU = vertical concave up bend.
- VD = Vertically concave down bend.
- R = Roller/Sheave
- PPD = Push/Pull Device

Directional Notation:

- U = Gravitationally Up
- D = Gravitationally Down

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

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O. SA Atmospheric Corrosion Zones

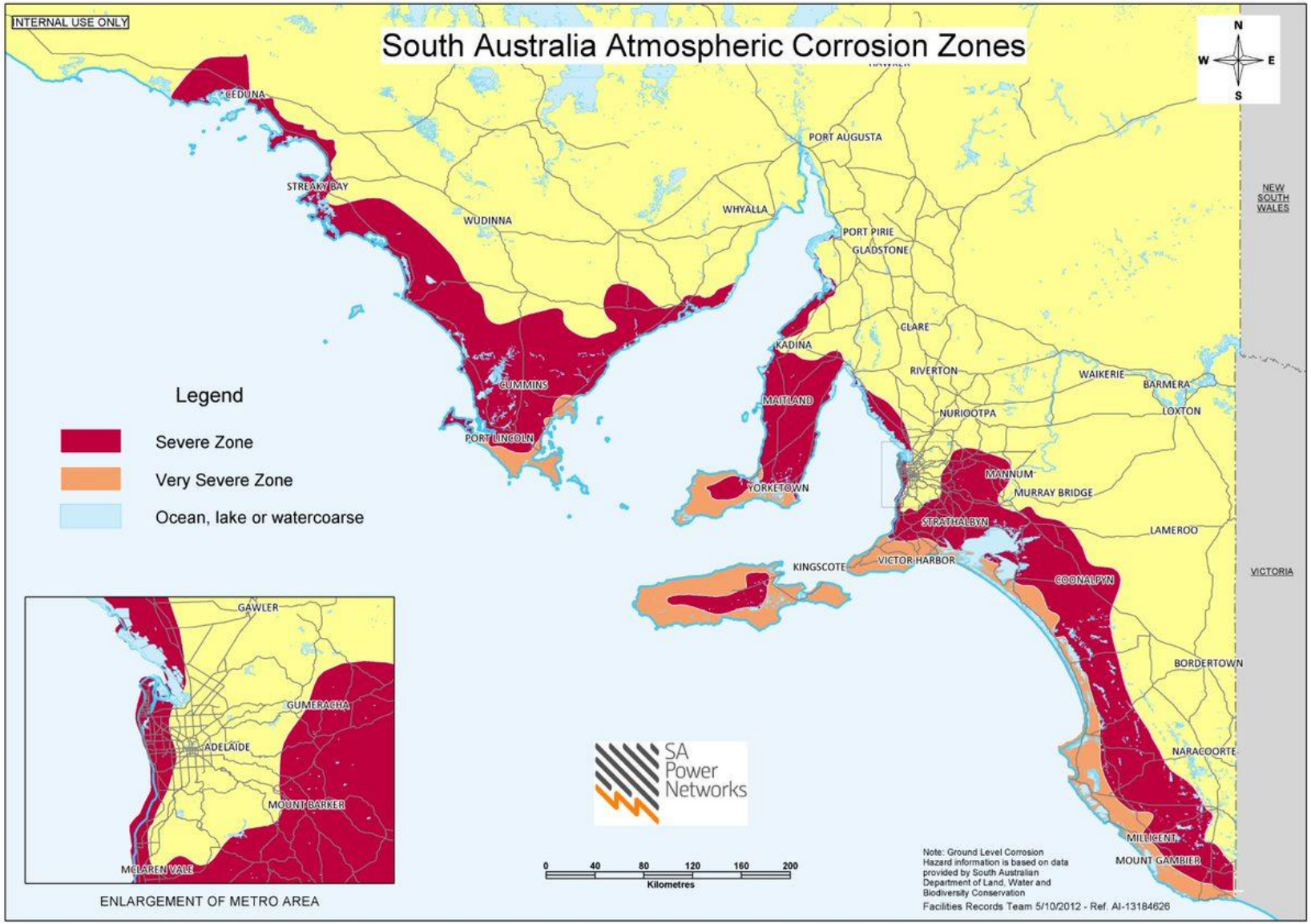


Figure 22: SA atmospheric corrosion zones

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