

Mains Design Instruction

Underground distribution network design

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MAINS DESIGN INSTRUCTION

ASSET STANDARDS AND DESIGN

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MDI 0028 Underground distribution network design

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SECTION 1 - INTRODUCTION

1.1 PURPOSE

To specify the standard design practices to be used for the design of Endeavour Energy's underground distribution electricity reticulation network.

1.2 SCOPE

This document applies to all designs of the underground distribution network in all new subdivisions, residential, commercial and industrial installations. Older installations may have been reticulated using different materials and methods. Where possible, modification of older installations must be to the new.

This instruction covers the design of the underground distribution network including high and low voltage mains, service mains and padmount substations.

The standard must be followed and any dispensation request must be approved by Asset Standards and Design. If it is considered that this standard does not cover a particular situation or the directions are impractical to follow, or there is confusion in the interpretation of any directions, Asset Standards and Design must be consulted in order to clarify and develop an acceptable solution.

This instruction is to be used in conjunction with the distribution construction manual MCI 0006.

1.3 REFERENCES

Internal

- Company Policy (Network) 9.2.1 – Network Planning
- Company Policy (Network) 9.2.5 – Network Asset Design
- Company Procedure (Governance) GRM 0003 – Risk Management
- Earthing Design Instruction EDI 100 - Distribution earthing design, construction and test
- Environmental Management Standard EMS 0001 - Environmental impact assessment / management plans
- Equipment Technical Specification ETS 0054 - High voltage polymeric insulated underground distribution cables
- Equipment Technical Specification ETS 0055 - Low voltage polymeric insulated underground distribution cables
- Equipment Technical Specification ETS 0068 - Distribution indoor and padmount substation 12-24kV switchgear
- Equipment Technical Specification ETS 0069 – Distribution indoor and pad mount substation low voltage switchgear
- Equipment Technical Specification ETS 0070 – 11kV and 22kV pad mount and indoor distribution transformers
- Equipment Technical Specification ETS 0071 – Distribution fuses
- Equipment Technical Specification ETS 0072 – Pad mount substation plinth and culvert
- Equipment Technical Specification ETS 0073 – 11/22kV pad mount auto transformer
- Equipment Technical Specification ETS 0077 – Pad mount substation cubicles

- Equipment Technical Specification ETS 0079 – 11kV and 22kV dry-type distribution transformers
- Equipment Technical Specification ETS 0081 – Installation of conduits using trenchless techniques
- Lighting Design Instruction LDI 0001 - Public lighting design
- Mains Construction Instruction MCI 0005 - Overhead distribution construction standards manual
- Mains Construction Instruction MCI 0006 - Underground distribution construction standards manual
- Mains Design Instruction MDI 0011 – Underground distribution cables – continuous current ratings
- Mains Design Instruction MDI 0026 – Location of isolation points on the high voltage network
- Mains Design Instruction MDI 0030 - Method of calculating voltage drop in low voltage mains
- Mains Design Instruction MDI 0043 – Grid connection of embedded generation through inverters
- Mains Design Instruction MDI 0044 – Easements
- EDI 100 - Distribution earthing design, construction and test
- Standard Asset Data SAD 0001 – Project drawing standard
- Standard Asset Data SAD 0002 – GISCAD design
- Substation Design Instruction SDI 120 – Testing and commissioning of distribution systems
- Substation Maintenance Instruction SMI 116 - MDI readings and identification of overloaded transformers
- Network Management Plan December 2013 Review
- Public lighting Management Plan (2016)

External

- *Environmental Planning and Assessment Act 1979*
- ENA National Electricity Network Safety Code (Doc 01-2008)
- Service and Installation Rules of New South Wales
- Street opening conference Guide to codes and practices for street opening (2009)
- Australian Standard AS 2067 (2016) – Substations and high voltage installations exceeding 1Kv a.c.
- Australian Standard AS 3996 (2006) – Access covers and grates
- Australian Standard AS 4198 (1994) – Precast concrete access chambers for sewerage applications
- Australian Standard AS 60079.10 (2009) – Explosive atmospheres – classification of areas – explosive gas atmospheres
- Australian Standard AS 62271.1 (2012) – High voltage switchgear and controlgear – common specifications
- T HR EL 10003 ST *Underground Installation Configurations for High Voltage and 1500 V dc Cables*

1.4 DEFINITIONS AND ABBREVIATIONS

1.4.1 Abbreviations

ADMD

After diversity maximum demand

AML

Approved Material List

ASP

Accredited Service Provider

CBD

Central Business District (designated by local council, not as designated for Licence compliance criteria)

CCT

Covered conductor thick

CT

Current Transformer

CMEN

Common Multiple Earth Neutral –a system of earthing where the combined high voltage and low voltage earthing systems of a distribution substation are connected to a sub-transmission or transmission voltage earthing system.

CWO/E

Contestable Works Officer/Engineer

EDI

Earthing Design Instruction

ETS

Equipment Technical Specification

HV

high voltage (11kV, 22 kV and 12.7 kV SWER)

LV

low voltage (400 volts 3 phase and 230 volts single phase)

NMSHVABC

Non-metallic screen high voltage aerial bundled cable

MCI

Mains Construction Instruction

MDI

Mains Design Instruction

PVC

poly-vinyl chloride

SWER

single wire earth return

UCD

underground commercial distribution

UID

underground industrial distribution

UML

Urban multi residential load

URD

underground residential distribution

XLPE

cross linked polyethylene

1.4.2 Definitions

Connection point

The junction of the electricity distribution system and the consumer mains.

Consumers' mains

The conductors between the connection point (within the customer's property) and the main switchboard and forming a part of an electrical installation.

Distribution network/system

Collection of assets (distribution lines, cables, substations and associated equipment) whose purpose is to distribute power from zone substation to distribution substations, which feeds the low voltage network.

Hub System

A backup feeder system where spare capacity is provided by means of dedicated feeders via the use of switching hubs.

Indoor substation

An electrical substation housed in a building designed in accordance with the Building Regulations of NSW. They are generally of brick and concrete construction with gutters and drainage, or a room that is part of a larger building.

Non-urban

An area where the majority of available land is zoned for rural and/or rural residential use. A non-urban area may include some industrial or commercial land, but does not form large adjacent areas of development with other towns or cities. This includes rural townships. Endeavour Energy will determine those areas considered to be non-urban.

Point of supply

Now replaced by Connection point.

Public land

For the purpose of this instruction, public land is defined as public roads and associated foot paths. A public road is defined under the Roads Act 1993.

Padmount substation

An electrical substation housed in an outdoor enclosure that is designed to prevent the ingress of moisture from rain and storms but is subject to water rise at ground level and high levels of humidity. The enclosure can be made from fibreglass, stainless steel or aluminium.

Property tenure

A broad term covering the rights of Endeavour Energy to retain, maintain and operate all network assets on that land not owned by Endeavour Energy. The method used to achieve this must be through an easement or a legally equivalent document.

Service cable/mains

The service cable extends between the electricity distribution mains and the connection point. This may be from:

- a mains pillar to a service pillar:
- a distribution pillar (outside the customer's property) directly to the main switchboard or:
- a distribution pillar (outside the customer's property) to a private pillar within the customer's property.

Urban

Area where the majority of available land is zoned for residential (including medium and high density), commercial or industrial use. A town or city area that is adjacent to other similar town or city areas. Endeavour Energy will determine those areas considered to be urban.

1.5 ACTIONS

The design, construction and commissioning of assets must be carried out in accordance with Endeavour Energy's Health and Safety Management Systems.

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

1.6 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management must have the authority and responsibility for:

- approving this Standard, including any variations;
- making all decisions concerning compliance in respect of this Standard and;
- delegating any of these authorities and responsibilities to the **Manager Asset Standards and Design**.

Manager Asset Standards and Design must have the authority and responsibility for:

- approving and endorsing this Standard, including any variations;
- reviewing this Standard and making recommendations to the General Manager Asset Management and;
- making recommendations concerning compliance in respect to this Standard.

Mains Assets Manager/Substation Assets Manager jointly have the authority and responsibility for:

- clarifying all the technical aspects of this Standard with stakeholders;
- updating the relevant actions required and outlined in this Standard and;
- issuing Technical Bulletins on issues that arise between amendments to this instruction.

Regional Services Managers must be responsible for confirming that designs of the distribution network by their staff fully comply with the requirements of this instruction.

Manager Network Connections and their delegates must be responsible for confirming that all designs by Accredited Service Providers (ASPs) are assessed and fully comply with the requirements of this instruction and are certified before they are issued.

Contractor Operations Manager must be responsible for confirming that installations are in accordance with compliant and certified designs.

All **Designers** are responsible for:

- obtaining and use the latest issue of any Standards, technical bulletins or drawings relevant to or referred to in this instruction and;
- producing designs that comply with this standard.

1.7 DOCUMENT CONTROL

Documentation Content Coordinator : **Manager Asset Standards and Design**.

Documentation Distribution Coordinator : Branch Process Coordinator

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SECTION 2 – BASIC REQUIREMENTS

2.1 GENERAL

Design of the underground distribution system must take into consideration the practical aspects of installing new distribution cables and equipment along with existing services, such as electricity, gas, water and sewerage. It must comply with the following:

- The requirements of this document.
- The requirements of other utilities and organisations.
- The requirements of local councils, (also refer to clause 2.5).
- Public safety and liability requirements.

2.1.1 Use of railway corridors

Railway property crossings must be designed in accordance with Transport for NSW standard - T HR EL 10003 ST. Contestable works projects require prior approval from Endeavour Energy's Manager Network Connections before being agreed or committed to.

Where new and/or additional assets are proposed to be installed within property owned/ managed by the railway, the following documentation must be submitted to the Manager Network Connections for review/endorsement:

- A list of all alternative options considered;
- Justification that the rail property crossing is the only feasible/practical option;
- Overhead line/underground bore profile of both new and existing assets;
- Details of the construction/location of poles/conduits either side of the crossing;
- Details of any future stages/propose use of the crossing.

In the event that assets are permitted to be installed in the rail corridor, all poles, joints and the ends of conduits are to be installed outside of the corridor to facilitate ease of future access.

2.2 UNDERGROUND SERVICES SEARCH

Existing underground assets owned by Endeavour Energy and other utilities must be taken into consideration while undertaking design work.

An underground record search must be undertaken to establish the location of the assets.

2.3 DRAWINGS FOR PROJECTS/WORKS

Engineering proposals must include drawings showing appropriate detail of conductor/cable routes, poles and any other equipment, together with road crossings, other services and easements.

Electricity network construction drawings must be in accordance with SAD 0001, SAD 0002 and must be certified by Endeavour Energy's Network Connections Branch. These drawings (at a minimum) must show the following details:

- Subdivision lay out, including lots and lot numbers.
- Location of public reserves.
- Location of service pillars.
- Location of proposed straight through joints.
- Location of public lighting.
- Location of substations and switching stations, both existing and proposed.
- Location of underground electricity cables, both existing and proposed.
- Location, number and size of ducts to be installed, including road crossings and footpaths.
- Location of easements for underground cables, overhead electricity lines and padmount substations, both existing and proposed.
- Types and size of HV and LV cables to be installed, including the LV open points.
- Details of trenching arrangements with other utility service providers
- Details of the earthing requirements.
- Details of operational limitations, including the requirements of Construction and Installation work.
- Location of pole positions, including cross road service poles, both existing and proposed.
- Pole schedule showing type of pole (wood or concrete), length and kN loading, depth and diameter of the hole, type of foundation, type of HV and LV construction.
- Where development includes transmission works and/or supplies to HV customers, a single line diagram clearly identifying the Endeavour Energy and customer interface is required.
- Final circuit diagrams (geographic) for HV, LV, substations, street lighting and earthing, including isolation points.

2.4 PROPERTY TENURE ARRANGEMENTS AND EASEMENTS

Network assets are to be installed within public land. In situations where network assets need to be installed in any location other than public land, an easement benefiting Endeavour Energy, or legally equivalent status (as described in MDI 0044), must be granted to Endeavour Energy to retain, maintain and operate all network assets installed in that land, without any restrictions.

Any network assets (e.g. padmount substations, indoor substations, cables etc.) proposed to be located within or under a building or structure, must be approved in writing by either the Substation Assets Manager or Mains Assets Manager.

2.5 ENVIRONMENTAL ASSESSMENT

Irrespective of whom carries out the design work, Endeavour Energy, as the determining authority, must confirm the requirements of the *Environmental Planning and Assessment Act 1979* are satisfied. The proponent of the works must submit an Environmental Impact Assessment and any impacts must be approved by the Business Systems/Environment Manager or delegates, as set out in EMS 0001.

For all contestable works projects, Endeavour Energy is the determining authority for all electricity works under part 5 of the Environmental Planning and Assessment Act. All other ancillary or supporting structures or features such as fire-walls, retaining walls, architectural screening, gardening and the like, that are required to allow the electricity works to be located at a site, are to be determined as part of the Development Application under part 4 of the Environmental Planning and Assessment Act by the local council.

ASPs will be required to provide evidence of approval for any such structures prior to certification of designs.

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SECTION 3 – GENERAL DESIGN REQUIREMENTS

3.1 REGULATIONS

All standards and requirements are based on the relevant regulations applicable to the industry and associated guidelines, including the ENA National Electricity Network Safety Code, Service and Installation Rules of New South Wales, and Endeavour Energy policies and procedures.

3.2 CONSTRUCTION REQUIREMENTS

For complete details of construction requirements, including all construction drawings, refer to the appropriate distribution construction Standards manuals – MCI 0006 (for underground) or MCI – 0005 (for overhead).

The number of LV and HV joints must be minimised in all new developments. Where staged subdivisions are proposed, considerations must be made to remove short sections of cables and existing joints to minimise the installation of additional joints. Smaller staging practices that significantly increase the number of joints must not be conducted. Joints must not be installed within 15m of all road intersections.

If redevelopment is proposed in an area currently supplied by paper insulated cables, any affected bays must be replaced by XLPE cables.

Additionally designs in existing brownfield sites must consider the removal, replacement or utilisation of existing assets to reduce additional street hardware, improve switching ability and improve network reliability.

3.3 URBAN AREAS

Reticulation of all new and redeveloped residential, commercial, industrial and town centre developments are to be underground. Where this new reticulation is located within a nominated development precinct plan and the surrounding network is proposed to be progressively undergrounded, all existing distribution overhead assets are to be removed.

Where conduits are required, adequate spare conduits and suitable easements must be provided at the outset to cover the final load requirements of the entire development precinct plan.

Extensions to the existing 11kV/22kV network must be underground. Bare overhead wire construction may be used for conductor replacements and augmentations except in heavily treed areas where CCT or NMSHVABC must be used.

Extensions to the existing overhead LV network and augmentations must either be underground or ABC.

In non-bushfire prone areas, new lines within existing overhead areas can be overhead, unless underground lines are cost or environmentally justified or required by the local council.

Where all existing overhead electrical assets are to be removed and there are overhead communications assets attached to Endeavour Energy poles, the developer must advise the communications provider and underground the assets where directed to do so through the Request to Connect process and development application for the subdivision.

3.4 NON-URBAN AREAS

Subdivisions and extensions may be overhead or underground. Extensions to the existing overhead HV network, conductor replacements and augmentations are to be either underground or covered conductor.

Bare conductor may be used only in circumstances where covered conductor is not practicable, such as long gully crossings, SWER, or areas where shielding from trees is insufficient.

Extensions to the existing overhead LV network must either be underground or aerial bundled cable.

Overhead LV conductor replacements greater than 100m in route length must utilise aerial bundled cable; like for like replacement is acceptable for smaller route lengths.

3.5 URD DEVELOPMENT WHERE EXISTING OVERHEAD MAINS WILL REMAIN

Where residential development takes place where overhead mains are currently installed, these mains will be removed and replaced with underground assets where required.

Approval may be given by the Manager Network Connections for the existing overhead mains to remain as part of the project after full details of the proposal have been evaluated and if the following circumstances exist:

- an existing overhead transmission feeder;
- underground development on one side of the road only where the existing established dwellings are supplied from the overhead system or;
- when an overhead system is planned to be removed in conjunction with future development work.

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

- Streetlight columns must not be erected on the side of the road occupied by any remaining aerial mains (transmission, HV or LV) after the installation of underground mains.
- Where a property is subdivided to form new residential lots, and the existing overhead low voltage mains exist and will remain, the method of supplying the new lots must be determined by the Manager Network Connections. Where an overhead sub-transmission line only will remain after construction, the lots developed will be supplied as a normal underground development.
- In laying out the distribution system where existing overhead mains will remain, easements must be acquired for padmount substation sites for future development. These easements must be acquired in the normal manner for URD areas. The layout of the development must cater for the removal of pole mounted substations at a later date.

3.6 COMMUNITY TITLE DEVELOPMENTS

The electrical assets and internal roads within a community title development may be owned and maintained entirely by the community group. However, Endeavour Energy may choose to accept ownership of the electrical reticulation assets within a community title development providing all of the following conditions are met:

- The electrical network supplying into and within the development has been designed and constructed using only Endeavour Energy approved equipment in accordance with the relevant Endeavour Energy standards;
- 24 hour unimpeded access, in accordance with the requirements detailed in MDI 0044 and MCI 0006, is available at the entry and within the entire development to allow suitable vehicle access for future maintenance and repair of electrical assets;
- Easements are created within the development in favour of Endeavour Energy, where all network electrical assets are located, in accordance with the requirements detailed in MDI 0044;
- All network pillars and cables must be installed within the footpath electrical allocation according to the trench alignment directions and drawings in MCI 0006, with no other utility assets or services within the same alignment and;
- Street lights within the development are metered and owned by the community title in accordance with the current Public Lighting Management Plan.

Where a community title development borders on public roads, the network electrical assets must be installed within the standard footpath electrical alignment and Endeavour Energy will seek an agreement with the local Council regarding the lighting charges in accordance with the current Public Lighting Management Plan.

3.7 LOCATION AND INSTALLATION HEIGHTS OF ASSETS

When positioning assets such as padmount substations, pillars or street light columns steps must be taken to minimise street hardware and the risk of motor vehicles colliding with them. On new project work this requirement is considered as a function of the design.

Installation heights are determined by the finished ground level around the asset. The level, degree or direction of the fall of the surrounding landscaping and footpaths must be considered when determining the finished ground level. All assets must be set high enough to allow for a fall so that water flows away and does not pool around the asset. No assets are permitted to be positioned within 1 metre of any form of proposed or existing drainage culvert.

3.8 SUPPLY TO COUNCIL FACILITIES

The connection of a metered supply to facilities within council parks is classified as a special small service. A 16 amp single phase supply can be taken from an auxiliary fuse strip within a padmount substation to a securely mounted meter board enclosure. For larger supply, connection is taken from a 400 amp fuse strip. If supply is taken from a mains pillar via a private pillar within the park, any additional pillars must be located in areas not susceptible to accidental damage or vandalism.

3.9 FOOTPATH ALLOCATION FOR ENDEAVOUR ENERGY ASSETS

Underground reticulation in new developments must comply with the requirements of Section 4 – Trenching, conduits and cable installation of MCI 0006.

3.10 STREET HARDWARE

All designs must look to minimise street hardware (electrical supply assets). The locations of the assets must be carefully considered to minimise the risk of vandalism, vehicle damage or interfering with pedestrian access.

In a CBD and areas where the electrical asset is likely or proposed to be surrounded by concrete, paving or bitumen footpath, a completely separable section or block of concrete must be installed directly around the column, pillar, cabinet or pole base, to permit clear excavation access to the electrical infrastructure. When this section is removed, there must be a minimum clearance of 400mm on each side and at the front of the asset, to allow clear access for activities such as excavation, fault and emergency repairs, additional cable installation or replacement. Expansion strips must be installed between the section of concrete and both the asset and the footpath. The concrete section re-enforcing must be separated from the footpath to allow removal of the block (without damage to the surrounding pavement) if required.

3.11 TRENCHING ARRANGEMENT WITH OTHER UTILITIES

Endeavour Energy will not share the same trench with other utilities such as telecommunication and gas service providers. The trenching configuration must comply with the requirements given in Section 4 of MCI 0006 – Trenching, conduits and cable installations. Endeavour Energy will not accept designs where assets of other utilities are installed above Endeavour Energy assets, except at crossovers.

3.12 CONDUITS

All conduits are to be continuous unless otherwise detailed in the design.

For the minimum number of conduits required in residential, industrial, commercial distribution and redeveloped areas, refer to Section 4 and 5 of this standard.

A draw line with a breaking strain of not less than 160kg must be installed in all conduits. The string line must be of non-electrical conducting material and capable of being left in contact with ground water for a number of years without deterioration.

3.13 CONDUIT ALIGNMENT AND DEPTH

The length of cable to be pulled through the conduits at any one time must not exceed 500 metres.

The number and angles of deviations in the conduit route are limited by the following not being exceeded for the cable to be installed:

- 80% of the maximum pulling tension and;
- the side wall bearing pressure of the cable being installed within.

If multiple conduits are installed, the orientation of conduits must remain the same along the entire length. Any twist in the orientation must be limited to 22.5° clockwise or anticlockwise.

The conduits must not cross over each other.

3.13.1 Road crossing conduits

Endeavour Energy will not share the same road crossing trench or bore hole with other utilities. The trenching configuration and clearances between utility assets detailed in Section 4 of MCI 0006, also applies to road crossings. Endeavour Energy will not accept designs where assets of other utilities are installed above Endeavour Energy assets.

Endeavour Energy and RMS have a Memorandum of Understanding (MOU) in place regarding road crossings under roads that are the responsibility of RMS. All new road crossings must be undertaken by underboring unless the following necessitate a road opening:

- There is insufficient land available for entry and exit pits;

- There are obstructions or utility assets in the underbore path;
- Where the cost of underboring is excessive compared to its community benefit;
- There are significant safety or environmental risks associated with underboring;
- Ground conditions and geotechnical data indicate that boring is not practicable;
- Where cable ratings may be compromised.

Refer to Table 1 and Drawing no. 060786 for the required depth of cover.

Table 1 - Summary of required depth of cover for road crossings

Road classification	Scenario		Minimum depth of cover above conduits	
			Standard Trench Profile	Concrete encased conduits (100mm spacing required around conduits)
RMS classified roads	Existing road		1200mm	1000mm
	Proposed road – assets energised before road construction completion		1800mm	1500mm
	Proposed road – assets energised after road construction completion		1500mm	1200mm
URD roads	Existing and proposed roads		750mm	Not applicable
Underbore road crossings (as per ETS 0081)	Existing	RMS Roads	1500mm	-
		Non RMS Roads	750mm	
	Proposed	RMS Roads	2100mm	
		Non RMS Roads	750mm	

Road crossing conduits are required to run between electrical alignments (1100mm from the property boundary)

Road crossing conduits must be installed at right angles to the kerb. However, deviations up to 15° may be allowed where prior approval has been obtained from Endeavour Energy's **Manager Network Connections**

3.13.2 Road crossing service conduits

Service conduits that cross a road, must be installed across the road in a direct line from property boundary to property boundary provided this does not create an angle less than 45° to the front property line. Where this is not possible, the conduit must cross the road in a line from the property boundary opposite the mains cable trench at an angle 90° to the property line (refer to Drawing 060786).

3.13.3 Easement conduits

Easement conduits are required to run from the front property line in one street, directly through the easement to another front property line in a second street, to complete LV circuits. They are to be installed parallel with side property boundaries. HV cables in easements through or between properties are to be avoided unless approved by Asset Strategy and Planning, Refer to Drawing no. 060862 for easement alignment and depth requirements. Bends are only permitted within these

conduits where it can be shown the cable(s) installed within will not exceed 80% of the calculated maximum pulling tension and side wall bending pressure during installation. The width of the required easement must be as specified in MDI 0044.

3.14 CABLE INSTALLATIONS AT BRIDGE CROSSINGS

Cables proposed to be installed at existing bridge crossings must either be installed in conduits under the existing bridge using trenchless techniques (for example under boring the bridge) or within conduits in the bridge. The installation of new conduits within an existing bridge must only be proposed if the access to the cables is not negatively impacted, no maintenance of the conduits will be required and the bridge is mechanically suitable for the installation of conduits.

Cables installed in new bridges must be installed in conduits. The minimum cover over the conduits (excluding the depth of the footpath) is to be in accordance with Section 4 of MCI 0006.

For concrete and steel bridges the degree of any expansion/contraction must be considered and included in designs submitted to the Mains Assets Manager for approval. The design must include a suitable provision to prevent damage to the cables.

Under no circumstances must cables be installed on trays or in conduits suspended from the bridge.

Cables or conduits must not be laid on railway bridges.

3.15 EARTHING

It is the responsibility of the designers that all their designs contain adequate information to enable construction staff to install the necessary earthing in accordance with the requirements of EDI 100.

Design information to be provided must include, as a minimum:

- The site soil resistivity measurements;
- The number of electrodes and their spacing and length and;
- Earth layout design and the design values.

3.16 EMBEDDED GENERATION

The customer is responsible for arranging the design, installation and maintenance of private generation facilities in accordance with MDI 0043. Applications for connection of embedded generation to the distribution system will be assessed on an individual basis. Issues to be considered when connecting embedded generation may include, but are not limited to:

- confirming network and customer assets can be protected under normal and fault conditions;
- confirming network assets are operated within their thermal capacity; and,
- confirming Endeavour Energy maintains control over system voltage levels and the transient stability of the network is maintained under all operating conditions.

MAINS DESIGN INSTRUCTION

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SECTION 4 – UNDERGROUND LOW VOLTAGE NETWORK

4.1 LOW VOLTAGE CABLES

4.1.1 Cable sizes

The following LV insulated cables (as specified in ETS 0055) must be used for the low voltage network:

Mains cable and feeder ties	4 core 240 mm ² aluminium conductor, stranded sector shaped, XLPE insulated, PVC sheathed.
Service cables	4 core 16, 25 or 50 mm ² copper conductor, XLPE insulated, PVC sheathed; or, or Single core 16 or 25 mm ² copper conductor, XLPE insulated, PVC sheathed (Red XLPE/Black PVC and Black XLPE/Black PVC).
Service cable supplying private pillars	Single core 120mm ² copper conductor, XLPE insulated, Orange PVC sheathed.
Road crossing service cable and/or cable from main pillar to service pillar or column	4 core 50mm ² copper conductors, XLPE insulated and PVC sheathed.
Street light cables	Refer to LDI 0001
Consumers' mains	As a minimum, 16mm ² copper conductor cables installed in accordance with the Service and Installation Rules of New South Wales.

No cables other than those listed above must be installed as part of Endeavour Energy's distribution network.

4.1.2 Current ratings of LV mains

For continuous and short circuit current ratings, refer to MDI 0011.

4.1.3 Underground LV reticulation

- **URD**

The design must include the reticulation of the LV mains, connection assets and services to individual lots in the development along with substations and HV reticulation to the substations.

- **UID and UCD**

Where the final load details are known at the time the subdivision is developed, the design must include LV mains reticulation through the subdivision, connection assets for individual lots, along with HV reticulation and substations.

Where the final load details are not known at the time the subdivision is developed and the lot sizes are:

- (i) Less than 3500 m², the design must include underground HV reticulation, substations (including transformers) and LV mains through the subdivision and connection assets for individual lots to make supply equivalent to 40 VA per square metre of lot size available to each lot.
- (ii) Equal or greater than 3500 m², the design must include the HV reticulation through the subdivision, footpath conduits, road crossing conduits and easements (in favour of Endeavour Energy) to enable the installation of substations as required.

4.1.4 Method of laying

Developments involving underground residential, commercial and industrial distribution of electricity must be direct buried systems, with one spare conduit for LV and one spare conduit for HV cables. Additional spare conduits are not required for street light circuits.

All cables installed in road crossings and easements and all service cables and streetlight cables must be installed in conduits.

Additional spare conduit requirements will be determined by the Asset Strategy and Planning Capacity Planning Manager.

Conduits installed between the property boundary to a customer substation, within UCD or UID development and road crossings must have a minimum of 6 x 125mm and 2 x 50mm conduits installed.

There may also be a requirement to install additional spare conduits across driveways, future landscaped or inaccessible areas for LV and HV cables to cater for future network requirements. These will be considered on a case by case basis by the Asset Strategy and Planning Capacity Planning Manager.

LV and HV Cables may also be installed in a fully conduited system in the following circumstances:

- the installation of direct buried cables would pose an unacceptable risk to the public (e.g. during an asset relocation along a public road or in a CBD area where it is not practical to fence of the entire work site / trench);
- Between two or more stages of a development where the cabling may not be installed until a later stage;
- Between two or more stages of a development where short, temporary sections of cable will be replaced by continuous lengths during the next development;
- In brownfield sections of projects where existing driveways already exist.

Other situations may arise where a direct burying cable(s) is not practical and details of such situations must be submitted to the Contestable Network Manager for review and endorsement prior to certification of the design drawings.

4.1.5 Low voltage isolation points

LV isolation points include link pillars and the LV fuse/switchgear within indoor or pad mount substations. Links in the pillars must be rated at have a continuous current rating of 400 amperes.

4.1.6 LV backup

- **URD**

The distribution network must be designed to allow transfer of the load of any one transformer to neighbouring transformers under abnormal supply conditions without overloading the associated switchgear and cables, until the supply is normalised.

In order to minimise disruption of supply to consumers under abnormal supply conditions, backup cross connections to LV feeders from adjacent distribution substations must be installed as stated in clause 4.8 of this instruction.

In new URDs, all low voltage spur cable circuits (including cul-de-sacs) must (where practically feasible) be provided with an alternate supply from another feeder.

The layout of the LV network must be arranged so as to allow the offloading of each LV feeder of a distribution substation to adjacent substations without exceeding conductor voltage drop of 15 Volts, assuming the prevailing consumer demand is 60% of the design ADMD. Refer to clause 4.8 in relation to requirements at the periphery of the network.

All such LV cross connections must include a neutral conductor permanently connected through (not switched) and is at least equally rated to its associated phase conductor/s.

- **UCD and UID**

New developments must be supplied by their own dedicated distribution substation, unless the existing network is capable of supplying the new load. LV reticulation must not be used in CBD areas for the above purpose, except for the LV ring mains supplying the existing LV consumers. However, where customers wish to fund additional parallel capability, approval must be granted for additional supply by the Manager Network Connections.

4.2 AFTER DIVERSITY MAXIMUM DEMAND

4.2.1 Residential development

The after diversity maximum demand (ADMD) for the design of the LV distribution network in all residential developments (including apartments), will be calculated in accordance with MDI 0030.

4.2.2 Industrial and commercial developments

ADMD in industrial and commercial areas must be calculated on the basis of actual demand (if known at the time of development). If actual demand is not known it must be assessed as set out in the requirements of clause 4.1.3.

4.3 VOLTAGE DROP

The voltage drop must be calculated on the basis of the demand of all consumers being 100% of their design ADMD. Refer to MDI 0030 for the method of calculating voltage drop in low voltage mains.

The low voltage network is to be designed so the voltage drop between the substation low voltage bus and any customer connection point calculated using the design ADMD (as specified in clause 4.2) must not exceed:

1. 4.35% of the nominal phase voltage of 230 Volts (10 Volts) in residential, industrial and commercial areas.
2. 4.35% of the nominal phase voltage of 230 Volts (10 Volts) in non-urban areas within 5km route length of the HV network from the zone substation or regulator; and 2.17% of the standard phase voltage of 230 Volts (5 Volts) in non-urban areas outside 5km route length of the HV network from the zone substation or regulator.
3. The load on a distribution substation is offloaded onto adjacent substations so the calculated conductor voltage drop at any connection point does not exceed 15 Volts when calculated using 60% of the design ADMD.

Parallel cables for reduction of voltage drop are not be used.

Where an existing LV reticulation needs to be redesigned, and the voltage drop criteria cannot be met, the proposed new design must as a minimum maintain the existing voltage drop calculations to all existing connection points.

4.4 SUBSTATIONS FOR URD

Substations in URD's must be padmounts, 500 kVA must be the standard size for transformers. 315 kVA transformers must be installed where the capacity of a 500 kVA transformer cannot be adequately utilised by this and adjacent developments and the deferment of expenditure is economical.

Under normal supply conditions, the total number of (single) dwellings for each substation must not exceed the following limits:

$$N = \frac{TX \text{ Rating} \times 90\%}{ADMD}$$

Where:

N	is the total number of approved single residential dwelling
TX rating	is the transformer capacity (kVA)
ADMD	is the design after diversity maximum demand for a single dwelling as specified in Clause 4.3 of this document (kVA).

The total number of consumers must, as far as possible, be equally divided among the number of LV mains, taking into consideration the rating of the fuse protecting the mains and the maximum allowable voltage drop limit(s) allowed for the mains.

4.5 MAXIMUM NUMBER OF CONSUMERS FOR EACH SERVICE CABLE

For the maximum number of consumer service connections, refer to Section 5 – LV mains and services jointing and termination in MCI 0006.

4.6 SUPPLIES TO MULTI-DWELLING STRATA DEVELOPMENTS (IN URBAN AREAS)

For multi-dwelling developments in urban areas, for loads of 150 Amps per phase or greater (as assessed by Endeavour Energy) a padmount substation may be required on site, unless an existing adjacent padmount substation is capable of supplying the new load.

An easement (in favour of Endeavour Energy) must be created over the substation site as described in Clause 2.5 of this document.

4.7 NUMBER OF LOW VOLTAGE FEEDERS FROM EACH DISTRIBUTION SUBSTATION

Up to four (4) low voltage feeders are generally to be provided from each distribution substation in URD's. However in UCDs, UMLs and UIDs, this will depend on the physical arrangements of the development. The number of consumers must be balanced over the three phases of each feeder.

4.8 LOW VOLTAGE PARALLELING POINTS FOR ALTERNATIVE SUPPLY

In residential developments, provision for alternative supply for LV feeders of a substation from adjacent substations must be provided by installing paralleling (normally open) points between the feeders.

Every feeder must have an alternative feed from a different substation except at the periphery of the network and where this is impracticable to achieve.

4.9 PILLARS FOR JOINTING LOW VOLTAGE CABLES

Only mains, link and service pillars approved by Endeavour Energy must be used. For details refer to Section 5 – LV mains and services jointing and termination in MCI 0006.

If redevelopment is proposed in an area currently supplied by paper insulated cables, any affected bays must be replaced by XLPE cables.

In URD, low voltage pillars may be required on every second property boundary. Pillars must not be located in the centre of double driveways and the edge of the base must be a minimum of 300mm from any driveway. The pillar may only be located closer to the driveway if it is protected

by a minimum 300mm high brick, concrete or steel wall/fence which extends wider than the pillar base and is installed on the customers' front boundary behind the pillar.

The first pillar on each LV mains cable from the padmount substation must contain a switch or insulated link termination to allow for substation maintenance and repairs without customer interruption. The location of the pillars and open points will be determined by the services fed from them. Only one pillar and/or streetlight column must be installed adjacent to the substation easement to allow clear access to the padmount.

Mains or link pillars for jointing low voltage mains must be installed on the side of the street where the low voltage mains are installed. Mains cables are jointed and three phase supply is made available to lots on the same side of the street in the same pillar.

A service pillar must be used to make three phase supply available to lots and/or street lighting on the opposite side of the street.

Supply to the service pillar (or street light column) must be through a service cable from the mains/link pillar.

Cascading of service pillars / cables is not permitted.

In commercial developments, the mains and services may be terminated in a distribution fuse panel (DFP) in a cubicle (refer to Section 5 – LV mains and services jointing and termination in MCI 0006) in order to supply and fuse a number of individual small lots/loads. The cubicle can be free-standing or mounted against a wall.

For typical UID layouts, refer to Section 4 – Trenching, conduits and cable installation in MCI 0006.

4.10 CABLES IN STREET LIGHT COLUMNS

The termination of mains cables in streetlight columns is no longer permitted. However, some older installations may contain mains, panels and services mains in the column.

The termination of a single 50mm² 4 core Cu cable (including the connection of associated streetlight and service mains cables) is permitted in enlarged base streetlight columns with full access doors only. Slimline columns are not suitable for these installations.

An approved insulating sheet must be installed in all columns containing these cables. These columns are to be treated in the same manner as service pillars and therefore cascading is not permitted.

In brownfield sites existing service mains from the street light columns do not need be relocated even if they have to be upgraded (from single phase to three phase supply). If an existing dwelling is rebuilt or the land subdivided into two lots, the service mains of both these affects lots may be fed from the existing supply column, providing there is sufficient capacity and no additional negative impact to safety. If there is insufficient capacity in the street light column or the existing lot is subdivided into more than two new lots the installation of service pillar(s) is required.

4.11 EARTHING OF MAINS AND LINK PILLARS

Refer to Section 5 of MCI0006 for earthing of mains and link pillars requirements.

Locations of pillars where earthing is to be provided must be clearly shown on the project drawing.

For padmount substation earthing requirement details, refer to Clause 3.15 and EDI 100.

4.12 LOTS WITH 20 METRES OR LESS FRONTAGE

Where lots have a street frontage of 20 metres or less, mains pillars and service pillars may be spaced so as to supply up to four (4) lots from each low voltage jointing enclosure.

In a *small lot* subdivision, this could result in pillars generally being installed only on every fourth property boundary.

4.13 RESIDENTIAL CONSUMER UNDERGROUND SERVICE

Installation of the consumers' underground service must be the responsibility of the consumers/consumers' electrical contractor and must be installed in accordance with the *Service and Installations Rules of New South Wales*.

Three phase supply will generally be made available to the service fuses on the consumer's point of supply. Single-phase customers must be connected to the following phase arrangement:

- (a) Reconnect existing service cable to the same phase as previously connected, or
- (b) Connect the new underground service cables to lot or street numbers 1, 2, and 3 to A phase, B phase and C phase respectively and repeating this sequence for the rest of the lots or street numbers.

Consumers' service cables must be connected to Endeavour Energy's network using the service cable terminal blocks provided in each pillars. Only one (1) consumer must be connected into each terminal of a service cable terminal block. This allows consumer connection/disconnection without interference to other consumers. Six (6) hole terminal blocks must be used for this purpose.

If the size of the consumer's service is larger than that which can be connected to the terminal block in the mains/service pillar, they must be terminated in a private pillar, positioned within the property and directly behind the mains pillar, fed via an approved bridging cable (max size of 120mm² compacted Cu) from the mains pillar.

4.14 INDUSTRIAL CONSUMER UNDERGROUND SERVICE

A maximum of three (3) mains cables (max 240mm² 4 core cables) only, can be terminated on the rear of the UID 3 way double link pillar termination.

Each pillar is to be fitted with a switchboard containing a minimum of two (2) 400 amp links per phase for sectionalising purposes.

Insulated covers are provided for the neutral link and exposed open live links.

There is provision for the termination of a service cable (up to 1 x 120mm² compacted Cu) onto the front dropper cable and also provision for up to, two (2) 50mm² Cu (street light or service cables) to be terminated directly onto the front of the main switching module.

When a customer is connected to the centre connectors (at the rear of the panel), the only cable permitted to be used is 240mm² Al, sector shaped, XLPE, LV cable.

No other service / consumer cables may be used in the UID mains pillar.

Where larger or alternate Cu service / consumer cables are required to be used to compensate for voltage drop, they must be terminated in a private pillar, positioned within the property and directly behind the mains pillar, fed via an approved bridging cable (max size of 120mm² compacted Cu) from the mains pillar.

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SECTION 5 – UNDERGROUND HIGH VOLTAGE NETWORK

5.1 GENERAL

The high voltage network (including cable routes, switching points and the like) must be designed in accordance with Company Policy 9.2.1 and 9.2.5.

5.2 HIGH VOLTAGE CABLES

5.2.1 Cable sizes

In accordance with ETS 0054, the following lists the currently approved high voltage underground cables:

- 11kV 3 core 240 mm² Al, XLPE
- 11kV 3 core 240 mm² Cu, XLPE
- 11kV 3 core 300 mm² Cu, XLPE
- 22kV 3 core 240 mm² Al, XLPE
- 22kV 3 core 240 mm² Cu, XLPE

5.2.2 Method of laying

Cables and conduits must be installed in accordance with the requirements detailed in Section 4 of MCI 0006.

For more information, including spare conduit requirements also refer to Section 4 of this instruction.

5.3 VOLTAGE DROP

The maximum design limit of voltage drop in the HV distribution network with respect to its automatically regulated HV source, under normal operating conditions and without line drop compensation, must be 3.5% in URD, UCD and UID and 6% in non-urban areas.

The voltage drop must be calculated on the basis of the installed capacity of the transformer(s) along the feeder.

5.4 HIGH VOLTAGE FEEDERS

High voltage feeders must be designed to carry not more than 80% of their continuous rating under system normal conditions to allow offloading onto the adjacent feeders through cross-feeder ties or cross-zone ties.

Where areas are rezoned industrial or commercial and redeveloped, provision must be made for the establishment of a ring main HV distribution network.

Dedicated HV feeders to some industrial and commercial customers may have a demand greater than the 80% limit and these will be considered on case by case basis by the Manager Asset Strategy and Planning or alternatively the Capacity Planning Manager.

5.4.1 Hub System

A hub system will be adopted in major town centres where rapidly changing development patterns and load types exist. Refer to Figure 1 for a basic example of a hub system circuit diagram.

The system provides an 'N-1' security standard to the HV distribution network. It involves the supply of load blocks via standard network feeders with the backup provision being shared between the load blocks in the same system. The backup is provided via a dedicated, unloaded hub cable connected directly to the 'switching hub' from a zone substation feeder circuit breaker. Under no circumstances is load permitted to be permanently connected to this cable.

A hub system will utilise up to three network feeders to supply load blocks. These feeders along with the dedicated backup feeder will be marshalled into a 'switching hub' located within the CBD, usually located within major customer installations. Consideration is to be given to the use of SCADA for the control of the hub systems within a given area.

For new installations, the "hub" room will need to be a separate room adjacent to an indoor distribution substation. Application and development of the 'hub' systems is to be determined by Asset Strategy & Planning. Therefore all load applications within major town centres must be forwarded to Asset Strategy & Planning for review.

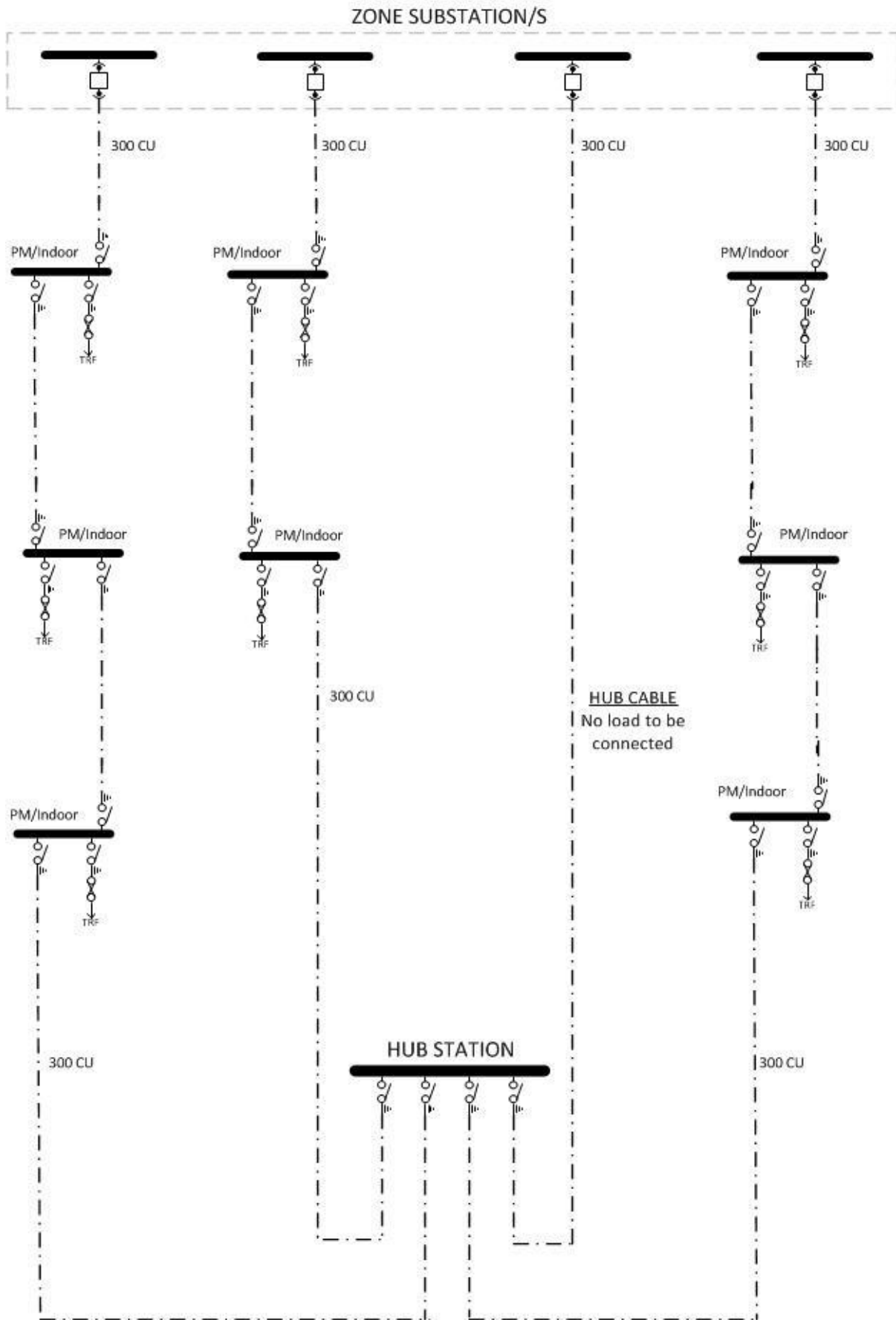


Figure 1: Basic example of a Hub Station circuit diagram

5.4.2 High voltage customers

Dedicated HV customers supplied directly from an Endeavour Energy Zone, Transmission Substations or critical/strategic assets are required to meet the following:

- The cable must be constructed to Australian Standards and be compatible with Endeavour Energy's standard terminations and equipment;
- Whilst the cable does not need to be approved by Endeavour Energy (e.g. go through the AML processes) the customer, or their representatives, are required to provide evidence to the Mains Assets Manager that the manufacturing plant proposed to make the cable is capable of building such cables and performing the specified type tests to the IEC / Australian Standards. A complete type test for the cable must be provided to the Mains Assets Manager;
- Only Endeavour Energy approved terminations must be used within the Zone or Transmission substation;
- Copies of sample and routine tests post manufacturing are to be supplied to Endeavour Energy to confirm the cable has met all of the testing requirements detailed in the Australian Standards and;
- All joints and terminations within Endeavour Energy's Zone or Transmission substations will need to be installed by Endeavour Energy staff.

5.5 HIGH VOLTAGE CROSS-FEEDER TIES

5.5.1 Urban developments

Cross-feeder ties must be provided as follows:

- One (1) tie approximately one third along feeder route to another feeder supplied by a different transformer or a transformer group.
- A second tie approximately two thirds along feeder route to another feeder supplied by a different transformer or a transformer group.
- The end of feeders should be tied to one of the adjacent feeders, or cross zone tied to the adjacent zone where appropriate.

5.5.2 Non-urban developments

In non-urban areas, the requirement for cross feeder or cross zone ties will be determined by the Manager Asset Strategy and Planning on a case-by-case basis and considered justifiable if any the following conditions are met:

- total length of the tie is less than 2km;
- the load supplied by the feeder tie is greater than 2MVA;
- the proposed feeder tie is part of the strategy for improving reliability in an area with identified substandard reliability performance; and,
- the number of customers at risk due to lack of support is greater than one hundred (100).

The following factors must be taken into consideration in justifying a tie:

- cost to establish the link, including easements and future maintenance;
- loading of the feeders;
- the outage rates of the feeders including response and repair times;
- access to the tie route and switching points;
- options for standby generation in lieu of feeder tie; and,
- Company procedure GRM 0003 – Risk Management.

5.6 HIGH VOLTAGE ISOLATION POINTS

HV isolation points must be established in each of the substations and switching stations by providing a three phase isolator at each feeder cable termination.

For indoor substations with two (2) or more transformers (irrespective of sizes), a ring switch for each transformer or rackable breaker must be provided for each transformer's HV bus feed.

Where high voltage customers with total load of the substation of 1MVA or more, or where it is considered operationally vital to the network, a bus section switch must be provided on the high voltage bus bar. Refer to section 6 for more details.

At overhead/underground transition points, isolation points must be established in accordance with the requirements of MDI 0026.

5.7 HIGH VOLTAGE MAINS DRAWINGS

Refer to MCI006 for drawings of trenches, jointing and termination of high voltage cables.

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SECTION 6 – DISTRIBUTION SUBSTATIONS

6.1 ACTIONS

In producing any design, MCI0006 – Underground Distribution Construction Manual, must be consulted.

6.2 TYPE OF SUBSTATIONS

Distribution substations can be one of three types: pole mounted or padmount (ground) or incorporated within a building or structure as an indoor (chamber) substation.

The following clauses detail all the minimum requirements for padmount and indoor type distribution substations and switching stations.

6.2.1 UML

UML developments will utilise either padmount or indoor substations.

6.2.2 URD

URD substations for class 1 and low rise class 2 buildings less than or equal to 3 stories will be padmount as stated in section 4.6 of this instruction with a transformer no larger than a 500kVA.

6.2.3 UID/UCD

UID/UCD substations and high-density multi-occupant developments (including residential) are preferred to be padmounts where possible meeting all requirements detailed in this section for access, location and segregation. Indoor substations can be used if the installation of padmount substations is not reasonably achievable or is a requirement of council development conditions.

Where new or augmented load exceeds 1500kVA multiple padmount substations or multiple transformers for indoor substation of equal rating will be installed.

Where more than one transformer is used to supply a site, each transformer must be connected to a separate section of busbar and the transformers must not be operated in parallel outside of or within the installation. The provision of bus section couplers to interconnect the separate sections must be installed in accordance with the Service and Installation Rules of New South Wales including appropriate signage and the ability to be locked by Endeavour Energy.

6.3 DISTRIBUTION SUBSTATIONS, SWITCHING STATIONS AND AUTOTRANSFORMER SUBSTATIONS

6.3.1 General information

Padmount substations consist of a transformer, HV switchgear and LV switchgear. They are designed to be interchangeable and therefore interface areas are critical.

Two (2) sizes of padmount substation have been chosen as Endeavour Energy's standard: sizes 14 and 16. Both units have the same footprint but their heights are 1450mm to 1600mm respectively. A standard easement size (suitable for 1500kVA transformer) will be used irrespective of the transformer being installed onsite.

Padmount switching stations and autotransformer substations are similar to padmount substations except switching stations have only high voltage switchgear (either 11kV or 22kV) for switching local HV feeders. Autotransformer substations, along with auto transformers, have 22kV switchgear at one end and 11kV switchgear at other.

Padmount switching stations are not allowed except for HV customers.

Padmount/indoor substations and customers' surrounding environment are to be designed so that the transformer can be installed or removed vertically or horizontally without moving the high or low voltage switchgear, de-energising any assets other than those being moved or the need to lift the equipment over other transformers and/or switchgear. There must be adequate space around the substation and appropriate crane and vehicular access to perform the above as detailed in Section 7 – Substations and Switching Stations of MCI 0006. There must be no awnings at low heights established around the substation that inhibit access to the equipment.

Endeavour Energy's standard method of lifting complete padmount substations with a special steel spreader rig must be followed due to the design of the plinth lifting system.

Indoor substations must be housed in a suitable ground level room provided by the customer, with appropriate crane and vehicle access. The substation room can be a part of the customer's building (partially or fully) or can be in a separate building. Refer to clause 6.4.2 below for details.

The method of providing supply will depend upon an assessment based on the estimated maximum and diversified demand of the installation, and the existing or planned reticulation/distribution system in the area.

All work must comply with requirements of Section 7 – Substation and switching station in MCI 0006. Substations will include everything necessary or usually supplied for the operation of the equipment, whether directly specified or not.

Design and construction of substations, are required to comply with the requirements of the following standards:

- Underground distribution construction standards manual MCI 0006
- Distribution earthing design, construct and test EDI 100
- Selection and loading of distribution transformers SMI 116
- Commissioning and testing of distribution assets SDI 120

6.3.2 Substation access

Full details of substation access requirements are contained in MCI 0006 and must be referred to in producing any designs. Basic access requirements are:

- Substation will be located at the front and inside the property boundary with unrestricted 24 hour per day personnel and vehicle access to the substation directly from a **public** street. Driveways are not regarded as public street access.
- Padmount substations can be located in open public spaces such as parks or within residential/commercial lots.
- For indoor substations, personnel access will be for the dedicated use of Endeavour Energy staff. Where a shared access is accepted by Endeavour Energy a right of way will be obtained in Endeavour Energy's favour.
- Access roads, tracks, bridges, tunnels and the like must be suitable for Endeavour Energy's standard trucks to enter, turn, load/unload and exit. There must be adequate room to turn around without the need to reverse more than 30m.
- Access through security areas is not permitted unless approved by the Substation Assets Manager, for example, dogs, restricted access airport gates, farm gates and the like. Where secure access is permitted they will use Endeavour Energy's standard key.
- Padmounts (including the easement) must not be located in or under part of any building, without approval from the Substation Assets Manager.

- In all situations where multiple items of equipment are installed, provision will be made to allow a single transformer, switchgear or complete padmount to be installed or removed without affecting other transformers or equipment.
- Where access is available by a vehicle driveway directly to the substation, and the substation is located on the perimeter of the driveway, this can be regarded as street level access provided all other requirements of this standard are met.
- Any special lifting equipment required is to be provided and maintained by the customer at the customer's cost. All lifting equipment must be motorised and maintained by the customer and have provision for alternative source of supply.
- The design must confirm substation access areas will be located so they are safe at all times. This can mean bollards or safety rails will need to be erected to protect staff entering or leaving the substation.
- Substations (and switching stations) must not be located within 6 metres of road intersections or bends to reduce the risk of possible vehicle impact damage.
- Where a substation location is not immediately apparent from the street, a sign needs to be erected indicating the substation location at Endeavour Energy's discretion.

6.3.3 Service conditions

The equipment used must be suitable for use on Endeavour Energy's 11kV/400V and 22kV/400V three phase 50Hz system, suitable for having the neutral point of the supply source non-effectively earthed. The highest system voltages are 12kV and 24kV rms respectively.

The service conditions for the cubicle housing, plinth, culvert and transformer will be in accordance with the outdoor standard requirements of clause 2.1 of AS 62271.1:2012.

Equipment installed in the cubicle of the padmount substation is in accordance with the indoor standard requirements of clause 2.1 of AS 62271.1:2012 except that the equipment will be subjected to higher levels of humidity.

The external equipment must be designed for operation in the ambient temperature range of -10°C to 40°C . The air temperature inside the padmount cubicle can reach and cause internal equipment ambient to be 55°C due to transformer losses, the effects of solar radiation and additional heat contribution from the switchgear. The padmount substation can be a dusty and moist environment. All ratings and equipment must be suitable for this environment.

6.3.3.1 Environment

All ferrous parts of the switchgear must be treated to provide acceptable surface finish and protection. The manufacturer will provide full details of the surface finish provided on the switchgear parts.

Where required, equipment may need to be raised or have extra treatment to minimise corrosion on all metal components particularly those in contact with the plinth.

All component parts must be supplied and tested in accordance with the appropriate Australian Standard.

The insulation level must be in accordance with the technical requirements stated. All insulation must be of a type and quality that will give normal life expectancy without deterioration.

The switchgear must face the end of the cubicle and it will be possible to operate all equipment and replace all fuses with the equipment installed in the cubicle.

All operational functions are carried out from the end door only. Indoor layout will be the same as for a padmount substation.

All external connections will be terminated as indicated in MCI0006 using crimp lugs and stainless steel or hot dip galvanised bolts or plug in type connectors. Clamps or *u-bolt* connections are not acceptable.

All equipment **must** be enclosed to meet the requirement of *dead front, bottom, sides and protected back* to the extent that there is no safety hazard to operating staff when the cubicle door is removed. The equipment **must** be fully shrouded to prevent accidental *shorts* by human error, flying objects or rodents.

6.3.4 Sound levels

The complete substation **can** be installed in a residential area in close proximity to family residences. It is necessary to keep noise and radio interference to levels that at least comply with the relevant Australian Standard (lower level) and in some cases even lower according to local council requirements.

Refer to Section 7 – Substations and switching stations in MCI 0006 for noise separation requirements for padmount substations.

6.3.5 Substation approval

Any variation from the Endeavour Energy standard must be reviewed by the **Substation Assets Manager**. This **can** include but not be limited by such items as design, construction, maintenance, appearance and access.

6.3.6 Provision of a site

The *Electricity Supply Act 1995* (Section 28) states that where a customer requires a supply that in the opinion of the distribution network service provider (DNSP) exceeds that which can be provided by a service line from its street mains, a site for a substation in the location and to the requirements of the DNSP (Endeavour Energy) **will** be provided.

For all contestable works projects, Endeavour Energy is the determining authority for all electricity works under part 5 of the Environmental Planning and Assessment Act. All other ancillary or supporting structures or features such as fire-walls, retaining walls, architectural screening, gardening and the like that are required to allow the electricity works to be located at a site are to be determined as part of the Development Application under part 4 of the Environmental Planning and Assessment Act by the local council.

ASPs will be required to provide evidence of approval for any such structures prior to certification of designs.

6.3.7 Substation near hazards

Substations contain HV and LV electricity, oil, plastics, concrete and other materials. In some situations, a substation **can** be regarded as a hazardous source, or be susceptible to hazardous sources.

Therefore, substations in or near hazardous areas **will** be dealt with strictly in accordance with Australian Standards and statutory requirements. The minimum distances to be maintained from hazardous locations are set out in **AS 60079.10:2009**. Reference **will** be made to **AS 60079.10:2009** and any relevant statutory authority, in determining the siting of a substation when in hazardous locations. Padmount substations in or near hazardous areas, **will** have stainless steel cubicles as long as they comply with **EDI 100** for earthing.

6.3.8 Effects of electric and magnetic fields (EMF)

All electrical equipment will produce EMF. In some situations, EMF **can** cause some electronics equipment to distort in some manner.

6.3.9 Substation typical layout drawings

All substation construction drawings are contained in Section 7 – Substations and switching stations in MCI 0006. These drawings include typical layout drawings, lifting arrangement and the like.

6.3.10 General requirements

Refer to Section 7 – Substation and switching stations in MCI 0006 for details, especially for but not limited to the following requirements:

- Easement and covenants.
- Segregation requirements from other structures.
- Minimum substation access requirements.
- Protection from vehicles.
- Flooding and drainage.
- Condensation mitigation.
- Numbering, warning and identification signs.
- Consumer mains.
- Earthing.
- Inspection and testing.

6.3.11 Cubicle

Fibreglass and stainless steel cubicles are suitable for use in the distribution network of Endeavour Energy. However stainless steel cubicles can only be used in common earthed locations (as defined in EDI 100).

For full details of the cubicle requirements for padmount substations and switching stations, refer to ETS 0077

6.3.12 Plinth and culvert

All substation or switching station plinths will be suitable for mounting on the standard culvert. The centre of gravity of the substation will be suitable for this arrangement. The total weight of the substation including the plinth (but excluding the culvert) will not exceed 8,000kg; the culvert weight is 2300kg.

Only precast plinths and culverts will be used for padmount substations and switching stations. Where it is not possible to use a precast plinth and culvert, approval will be obtained for an alternate method.

For full details of plinth and culvert requirements for padmount substations or switching stations, refer to ETS 0072 and Section 7- Substations and switching stations in MCI 0006.

6.3.13 Segregation requirements from other structures

MCI 0006 lists most of the details for the segregation of substations from other buildings and equipment for operations, maintenance, earthing, fire and noise and should be referred to when designing any substation.

FRL (fire resistance level) describes the time (in minutes) that structural adequacy/integrity/insulation is maintained, as defined in the National Construction Code.

Where the minimum clearances indicated in MCI 0006 for fire zones cannot be achieved, combustible structures and non- FRL rated openings, for example, windows, garage doors and the like can be permitted within the fire rated area provided that suitable screening walls is installed to protect these areas. Screen walls must have a 120/120/120 FRL (refer Figure 2, Figure 3 and Figure 4).

Screen walls as detailed below for the purpose achieving segregation risk reduction for noise, blast, fire and the like where required for the purpose of installing electricity assets at a site must be approved by the local council or other relevant body. The screen walls must be wholly within the one property boundary. Screen walls will be located outside the standard easement. Then the easement will be altered and increased to accommodate the screen wall inside the new larger easement. In determining the length and location of any screen wall, guaranteed setbacks as determined in the Development Application may be used. Refer MDI0044 – Easements and

Property Rights for the requirements of Restrictive Covenants required to be placed onto any screen wall.

Where padmount substations are not placed on solid ground (i.e. located over any tenanted area, car park or similar void):

- 1) The substation needs to be approved by the Substation Assets Manager.
- 2) The transformer will need to be natural ester oil (oil having high flash point).
- 3) All cable and possible entry points to the building will need to be sealed with suitable fire sealant system.

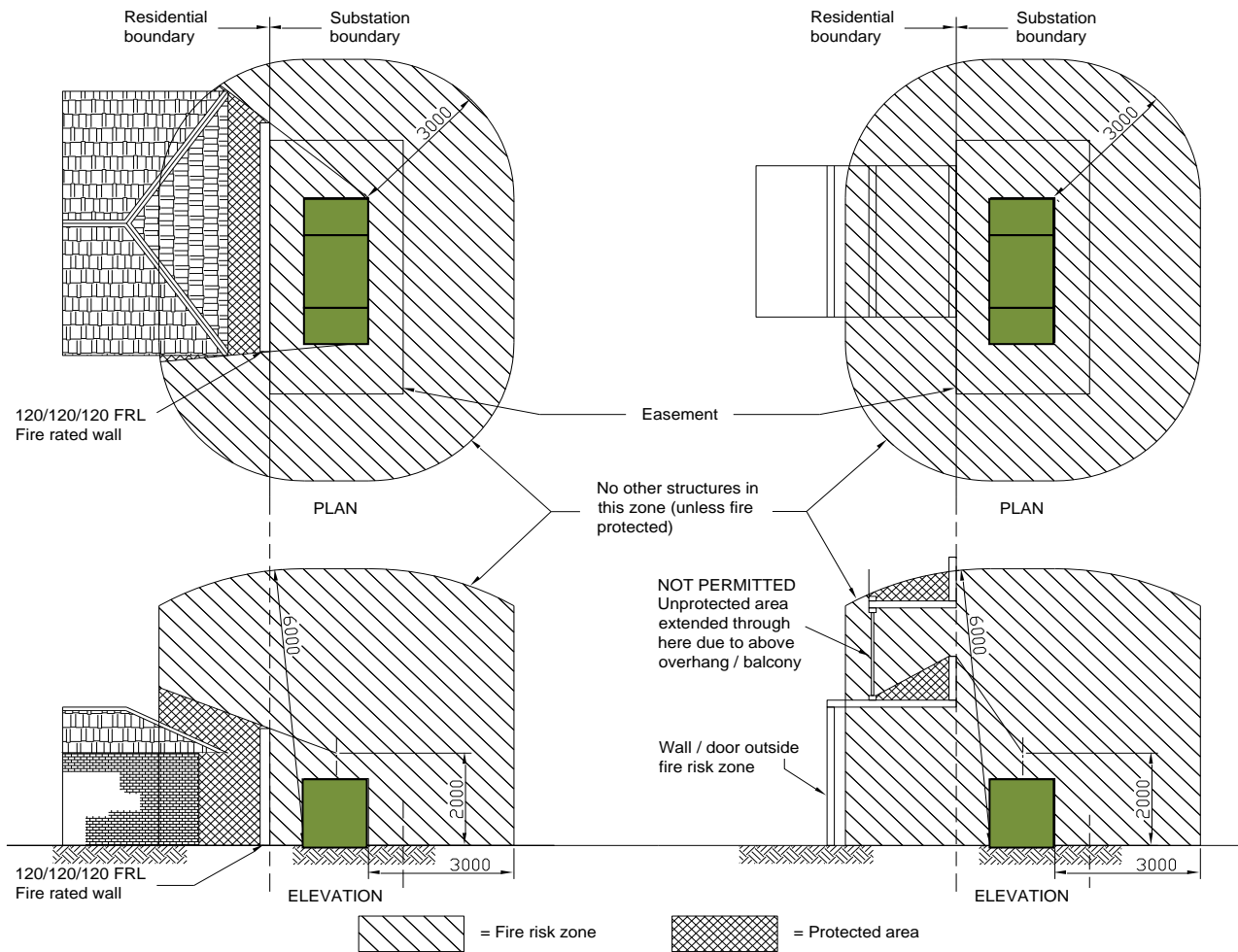


Figure 2 - Example use of screen walls in fire zones

No structure should overhang the easement. No structure should overhang a protected area which could trap smoke or fire and cause it to enter any openings in the structure.

AS 2067:2016 includes drawings for fire risk zones of non-fire protected buildings/doors/vents and the like. The following drawings are extracts (figure C5 and C6) from the standard demonstrating clearances required around indoor substations.

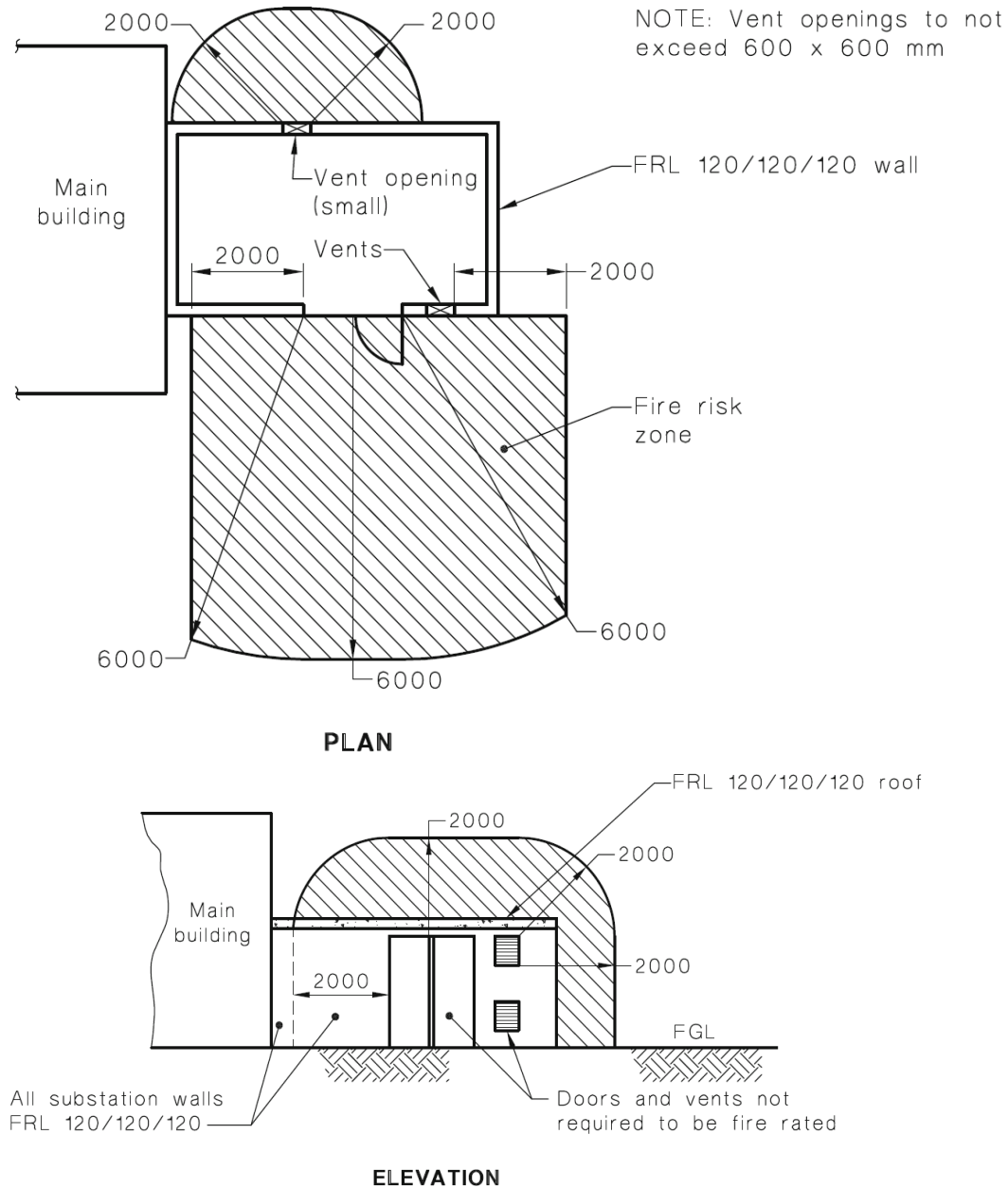
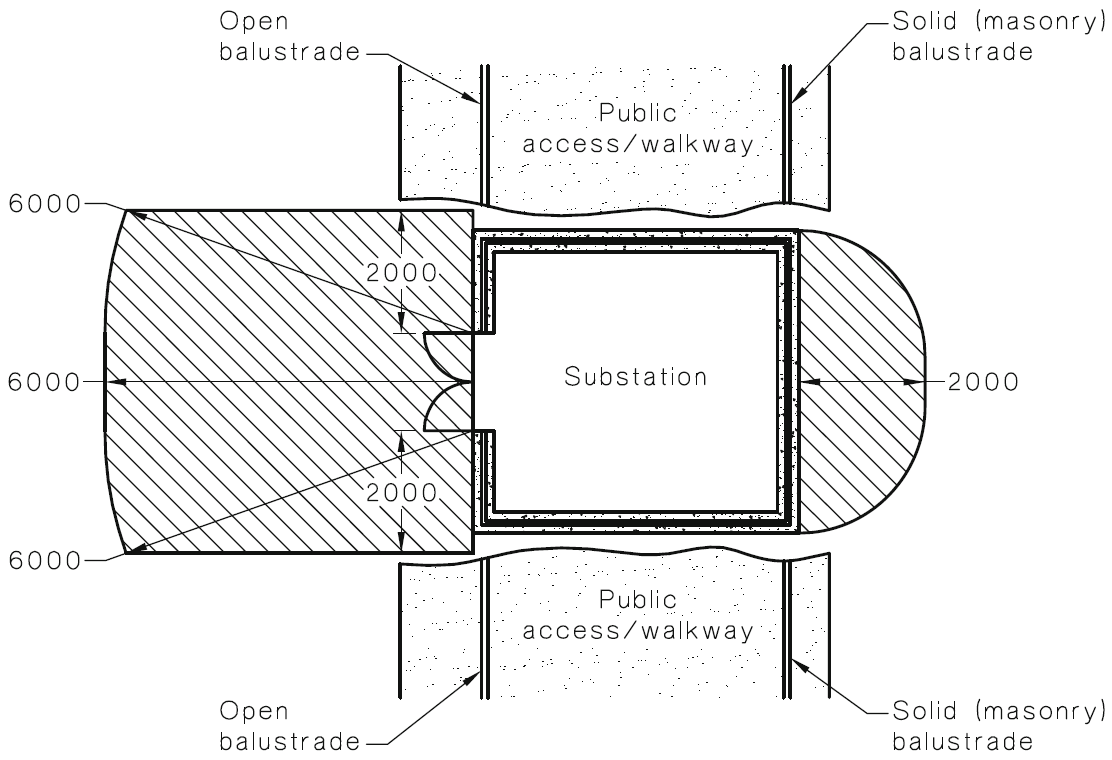
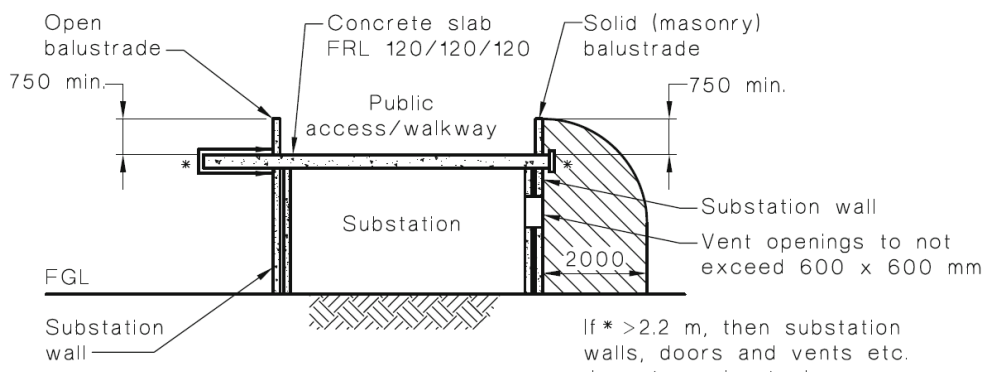


Figure 3 - From AS 2067 - Figure C5 Attached or adjacent substation with fire-rated walls and roof non-fire-rated doors and vents



PLAN



ELEVATION

LEGEND:
 = Fire risk zone

NOTE: This drawing is indicative only.
 The fire risk zone extends 6000 mm from the edge of the door opening. If dry-type equipment is installed the 6000 mm distance may be reduced to 2000 mm.

Figure 4 - From AS 2067 - Figure C6 Indoor substation with public access above

6.4 INDOOR SUBSTATIONS

Indoor substation building must comply with the requirements of the National Construction Code. Full details of the substation construction requirements (and some basic building design details) are contained in Section 7 – Substations and switching station of MCI 0006 and must be referred to when producing any design. Basic building requirements covered in MCI 0006 include but are not limited to:

- Building design must be by a practising structural engineer and certified accordingly.
- Building to be fire rated (two [2] hours in all areas, including common doors in multiple room substations).
- Ventilation (natural and forced ventilation).
- Blast wall rated buildings where oil filled transformers are installed.
- Drainage.
- Alarms.
- Access requirements.
- Conduits and cable trays.
- Lifting and pulling fixtures.
- Light and power.
- Painting.

6.4.1 Building area for Endeavour Energy's sole use

The indoor substation chamber, chamber access, ventilating shafts and cable ducts are for Endeavour Energy's exclusive use and cannot be used to contain other services or give access to other services or areas.

Consideration will be given to sharing of passageways, where the substation chamber can be made secure against entry by other than authorised personnel and a right of way is obtained in Endeavour Energy's favour.

6.4.2 Substation location within a building

Where a substation is required within a customer's premises, it must be located entirely at street or ground level with personnel and plant access off same level. Any deviation from this will require the Substation Assets Manager approval in writing.

Indoor substations require the use of either dry-type transformers or less combustible insulating liquids (K-class) with a flash point exceeding 300°C. Endeavour Energy uses natural ester oils for K-class insulating liquids for sealed transformers. Where tenants may be below the substation and potentially affected by fire i.e. High rise buildings, the selection of a dry or high flammability transformer must be at the Substation Assets Manager's approval based upon risk assessment.

All indoor substations having liquid insulation must have bunds and all cable entries must be sealed with a fire sealant system as detailed in Section 7 – Substations and Switching stations of MCI 0006.

All rooms containing transformers and/or switchgears will have a minimum of two (2) access/exit doors spaced diagonally opposite and as far apart as possible.

The building design will be such that each of the major equipment could be removed without dismantling/disturbing any other equipment.

Refer to Section 7 – Substations and switching stations in MCI0006 for more details on access requirements.

Notes:

- 1) It is important to note that a substation with a separate transformer and switchgear room will require more floor space, special ventilation, and additional personnel and equipment access.
- 2) Where dry or transformers filled with natural ester oil (oil having high flash point) are used, the customer will pay for the extra cost of the transformer. Dry transformers can take up to six (6) months to obtain.
- 3) Transformers produce a low frequency hum (refer to ETS 0070, ETS 0073 and ETS 0079) and also produce electrical and magnetic fields that can have an impact on people and equipment, such as computer monitors. This should be taken into account when locating substations.

All substation building designs must be in accordance with standard Endeavour Energy drawings in Section 7 – Substation and switching stations of MCI 0006. Where modifications are required to the standard substation layout to enable it to be incorporated into the building, approval for the modification is required from the Substation Assets Manager

6.4.3 Security of supply

Where individual substations are located on the same site, but housed in separate buildings, segregation between these substations can be achieved with HV switches, depending on Endeavour Energy’s requirements

If it is considered that more security of supply is required for the customer’s processes than is offered by the standard configurations, other arrangements can be used, for example:

- Individual rooms for each transformer and associated switchgear.
- Separate rooms for switchgear and transformers.
- Dry transformers.
- Additional HV feeder supplies.
- Double bus-section isolators (in existing older substation).

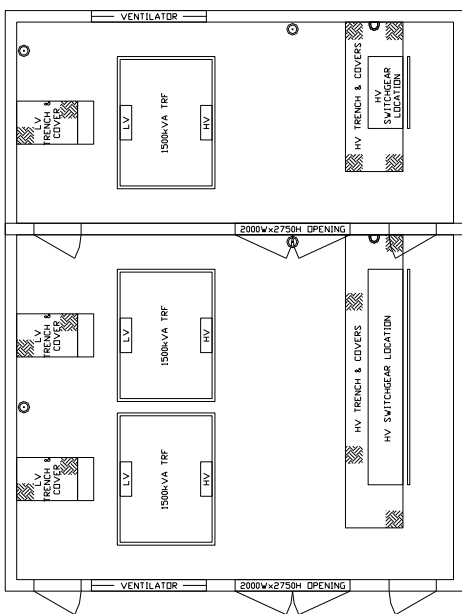


Figure 5 - Three (3) transformer substation

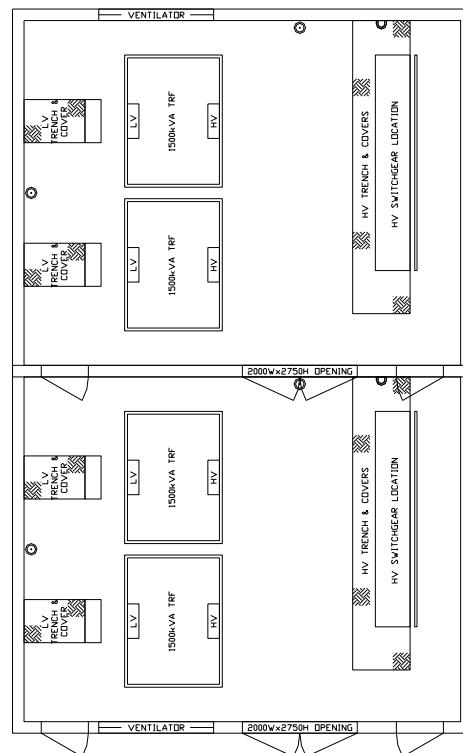


Figure 6 - Four (4) transformer substation

Notes:

- 1) Additional access doors, ventilation and the like may need to be installed, in addition to those shown on the standard drawings, to suit Endeavour Energy's requirements.
- 2) Cables supplying multiple rooms will be segregated from each other (to prevent damage from fire or explosions in one room taking out the supply to the other room) either by laying them in separate trenches or by concrete encasing. Exposed cables from different supply points will not be laid through one room's trench into the other room.

6.4.4 Building construction drawings

The requirements for an indoor substation are set out in Endeavour Energy's standard layout drawings located in Section 7- Substations and switching stations in MCI 0006. These layout drawings are to be read in conjunction with this instruction.

The layout drawings can be used for construction provided that the room is identical in size to the layout drawing, and the location of incoming conduits and the room orientation are clearly marked on the site layout drawing.

The dimensions shown on the layout drawings indicate finished sizes required in the building, and allowance must be made for wall and floor finishes. Standard substation layout drawings are also issued to customers to enable preparation of architect's drawings.

Endeavour Energy's requirements will be incorporated into the customer's construction drawings and specification. These drawings will be drawn to a 1:50 scale, contain all dimensions, and will be sufficiently detailed to define the construction of the room.

The standard reference drawings (that is, other than the layout drawings) can also be used for building purposes provided that accurate cross-reference is made between the architect's and consultant's drawings and Endeavour Energy's drawings, so that any possibility of misinterpretation is avoided.

Drawings are required indicating the location of the substation in relation to adjoining construction, property boundaries, and the like.

If not on the street alignment, the drawings will also indicate the access route, type of road surface, relative levels of the roadway, any overhead construction and details of levels external to the substation. Drawings will also indicate all cable access information, for example, a conduit route, pits and alcoves.

For all Contestable Works projects, drawings and any relevant specifications must be submitted to the Manager Network Connections or the nominated representative for certification in accordance with Endeavour Energy's certification process. For new construction or modification to existing buildings by Endeavour Energy staff all designs and drawings must be submitted to the Substation Assets Manager.

Such approval, when granted, does not absolve the customer, the architect and/or consultants from the responsibility of confirming the substation complies with the Building Code of Australia and any specific requirements of other statutory authorities.

Note: Construction of the substation must not commence before written approval of the construction drawings is received.

If construction commences without approval, Endeavour Energy will hold itself free to refuse to accept the substation building if the work carried out is not to Endeavour Energy's standards.

6.4.5 Substation minimum room dimensions

Because of considerable variation in the space requirements for substations due to various types of equipment and different access arrangements, early consultation is essential so that Endeavour Energy's requirements can be determined before detailed design begins.

As a guide, the minimum internal room dimensions (excluding any lifting equipment) are set out in the following tables:

- Width = looking at HV end of transformer – left to right.
- Depth = looking at HV end of transformer – front to back.

Table 2 - Typical room size for transformer and switchgear in the one (1) room

No. of transformers	Minimum internal room size, mm (approx.)		
	Width	Depth	Height
1	5700	4600	2700
2	6000	7600	2700
3 (dry only – all 3)	8500	7600	2700
4 (dry only – all 4)	11000	7600	2700

Table 3 - Typical room size for transformers and HV switchgear in separate rooms

No. of transformers	Minimum internal room size, mm (approx.)					
	Switchgear room			Transformer room		
	Width	Depth	Height	Width	Depth	Height
1	3100	4350	2500	3750	4600	2700
2	3100	5100	2500	6000	6100	2700
3	3100	5850	2500	Use multiples of standard room sizes or dry transformers		
4	3100	6600	2500			

Notes:

- 1) Actual room sizes should always be checked against Endeavour Energy's latest standard drawings, located in Section 7 – Substations and switching stations in MCI 0006. Where dry type transformers are required, the door and room sizes may need to be increased. The transformer mass may also increase to 5500kg and is required to be confirmed by the Substation Assets Manager before the design is completed and certified.
- 2) Substations requiring more than two (2) transformers must have multiple transformer rooms with a maximum of two (2) transformers in each room. Rooms with more than 2 transformers will only be allowed at the Substation Assets Manager's discretion (Refer to Figure 5 and Figure 6). If approval is given for more than 2 transformers then they must all be dry type transformers.
- 3) The room dimensions set out above are clear inside dimensions and exclude columns, beams and any other intrusions.
- 4) The height is the clear ceiling height excluding beams, lifting hooks/cranes, air ducts and the like.
- 5) The standard access door locations may need to be varied (after Endeavour Energy's approval) to better suit site conditions.
- 6) The design must be such that each of the major equipment could be removed without dismantling/disturbing any other equipment.
- 7) In CBD, and at the Substation Assets Manager's discretion, a small alcove style switching room or an oil filled padmount style indoor substation, refer to Figure 7 and Figure 8, may be permitted (refer to Section 7 of MCI 0006 drawings for details of room dimensions) provided that:

- (a) There is no distribution network requirement to have additional switchgears/feeders currently or in future (to be confirmed by the Asset Strategy and Planning branch), other than that to feed one transformer.
- (b) Acceptable access to the transformer location is available.
- (c) HV cables feeding the transformer and switchgears are laid in ducts having a minimum internal diameter of 125mm. It is mandatory that all ducts will maintain the orientation/configuration for the entire length.

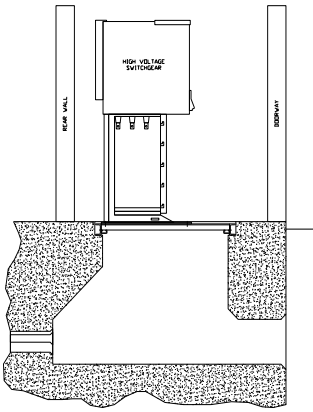


Figure 7 - Alcove style switching room

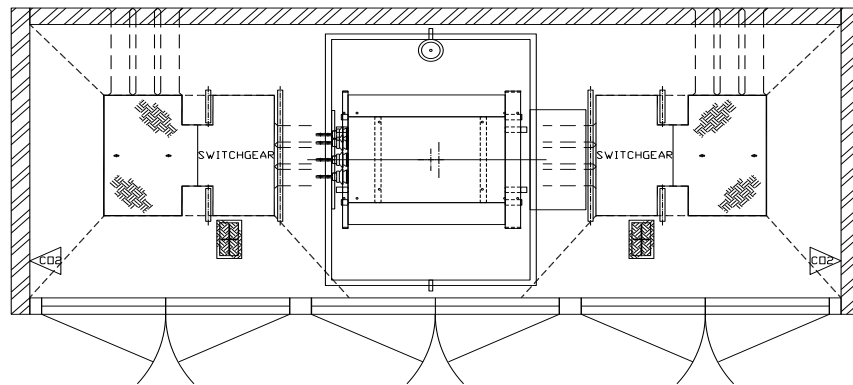


Figure 8 - Padmount style indoor substation

6.4.6 Cable basements

Cable basement substations (where access to the cables would be considered a confined space, an example would be hatch access via ladders) are not permitted. All cabling will be run through ducts or in cable trenches with removable covers.

6.4.7 Ventilation/pressure relief systems

For all new indoor constructions or where there is a change to an existing building or transformer size/quantity greater than the original design a ventilation design and report needs to be carried out. For full details of the ventilation/pressure relief systems and design requirements, refer to Section 7 – Substations and switching stations in MCI 0006.

The full load equipment losses to be provided for are 16 kW for each oil filled transformer, or 20kW for each dry transformer. The ventilation system must be designed to cater for the maximum number of transformers the room can accommodate.

Two-stage louvres must be installed on all available doors and walls to achieve the maximum natural ventilation and pressure relief area irrespective of if forced ventilation is added. Generally, in order to achieve the temperature as specified below, forced ventilation into the room by means of a fan(s) will also be required. Forced ventilation systems must be designed, supplied, installed and maintained by the customer without the need to enter the substation. The ventilation must be forced into the room and not extracted out and be sufficient to maintain a maximum temperature of 5° C inside the substation building, above the air intake temperature, the fans will start when the temperature inside the room reaches 35 °C.

Intake air (from outside) must be relatively dust free and as such filters are required; they will be fitted to the outside of the substation and regularly maintained by the customer. Filters are necessary when dust or other substances present in the area could impair the operation of equipment.

All walls will be suitable to withstand an internal pressure of at least 2.0 kPa. To achieve this rating walls will be made from either solid concrete, double brick or core filled concrete blocks.

An area of 4m² of louvre will generally provide adequate pressure relief for equipment failures.

Roof ventilators can be used where a substation is a freestanding structure.

6.4.8 Substation bund walls

Where oil filled transformers are installed, individual bund walls will need to be installed around each transformer suitable for retaining the full amount of oil. All associated cables and ducts will need to be sealed to prevent oil and fire spreading (refer to Section 7 – Substations and switching stations in MCI 0006).

Bund walls are not to reduce the effectiveness of cooling of the transformers.

6.5 CABLING TO THE SUBSTATION

Connections from the HV network to the substation switchgear will be in three (3) core cables or full fault rated single core cables up to 300mm². Single core cables can only be used if approved by the Substation Assets Manager.

The full cable route must be designed to allow for large radius bends (minimum two meters up to three metres radius) on all cables, cables will be supported for their full length, and there must be no sharp edges in contact with the cables.

Where necessary, there must be suitable areas set aside to install and operate cable push/pulling equipment. This will generally be in the form of concrete pits.

Cables connected to the network that pass through one substation room to another substation room must be segregated completely (by concrete encased conduits). This will prevent a fault in one trench from damaging the cables to the second substation room.

6.6 CABLE PITS AT PADMOUNT SUBSTATIONS

Where pits are required for cables to enter into a substation only approved pits will be used. Where a new design or on site constructed pit is used then the process will be as follows.

There is no Australian standard relating to electrical or communication pit performance. Pits are selected by size, volume and location. Cover loadings are transmitted to pit structures. For further information AS 4198-1994 can give assistance in designing a suitable pit.

Concrete pits must be submitted for approval to the Substation Assets Manager; they must be designed and certified by a practicing structural engineer to accommodate access covers to AS 3996:2006. Construction must not commence without an approved drawing.

Where a padmount or switching station is erected in a concrete, tile, or similar hard surfaced area or in an area where future access for excavation can be restricted, a cable pit with an access opening of at least 1000mm square x 1100mm deep must be provided at the HV and LV end of the padmount substation.

It is essential to refer to MCI0006 section 7 for details on pits and lids.

Pits must have pulling eyes for all cables, rated at 25.0 kN minimum and must have full opening hatch rated as a minimum Class B (80 kN) in accordance with AS3996:2006. Where the traffic is expected to exceed the Class B rating then the pit and lid must be rated to suit the location as detailed in AS 3996:2006.

The pit lids must be of concrete construction at least 50mm thick with suitable lifting points/eyes as detailed in this standard and AS 3996:2006. The lid weight and class rating must be marked on the lid.

The access pits needs to be open on the padmount side to allow the cables to be laid in and out during installation and maintenance to prevent excessive bending and damage.

The pit must be suitable to allow cable or conduit access (through knock outs or similar) for at least six (6) x 125mm conduits on all sides or more when required for the specific project.

6.7 CABLING BETWEEN SWITCHGEARS AND TRANSFORMERS

The connections between the HV fuse-switch and distribution transformer will be three (3) single core 35 mm²-aluminium or 25 mm² copper, XLPE insulated cable with copper screen having a minimum 3 kA, fault rating and the connection between the HV circuit breaker will be three (3) single core 70 mm² single core copper, XLPE insulated cable with copper screen having a minimum 10 kA fault rating (refer to ETS 0068 for full details of HV cables).

These connections must be suitable for connection to the outgoing terminals of the fuse carrier or circuit breaker on the switchgear, and connection to the HV terminals of the distribution transformer. The cable earth screen must be connected to the earth terminal at both the switchgear end and at the transformer end to the transformer tank.

The cable must allow for the minimum cable bending radius shown on the layout drawings. For more details on minimum cable bending radii, refer to Sections 4 and 5 of MCI 0006 for LV and HV cables respectively.

The cable will require support at both the transformer and switchgear. Details of the support frame for the cables at the transformer are set out in detail in Section 7 – Substations and switching stations in MCI 0006.

6.8 TRANSFORMERS

For full details of transformer requirements for padmount and indoor substations, refer to:

(a) ETS 0070 for oil filled transformers;

(b) Refer to ETS 0079 for dry transformers (room sizes may need to be increased and transformer mass may increase to 5500kg, refer to clause 6.4.5 - Substation minimum room dimensions);

(c) Refer to ETS 0073 for auto-transformer requirements.

Endeavour Energy's standard substation transformers are 3 phase, mineral or K-class insulating liquid filled and of the sizes listed in Table 4:

Table 4 - Transformer and LV equipment ratings

Transformer rating (kVA)	LV equipment symmetrical fault rating – with one (1) transformer (kA)	LV equipment symmetrical fault rating – with two (2) transformers in parallel (kA) * where approved (refer 6.2.3)
315	30	Not approved
500	30	Not approved
1000	32	62 *
1500	40	75 *

Note 1: The ratings of dry type transformers are 500kVA, 1000kVA and 1500kVA.

6.9 HIGH VOLTAGE SWITCHGEAR

6.9.1 General

Only Endeavour Energy approved switchgear will be used. For full details of the high voltage switchgear requirements, refer to ETS 0068.

As indicated in ETS 0068 only switchgear arranged in predetermined modules is allowed. A module is limited to one (1) transformer unit and up to a maximum of three (3) network feeder units.

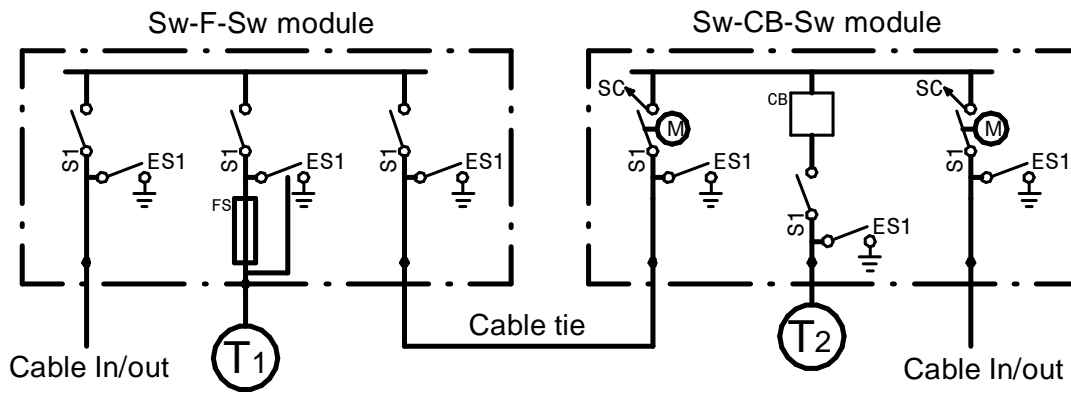


Figure 9 – Example two (2) transformer arrangement

The cable between switchgears or switch units will be the same size as the largest network feeder cable to any one of them and a minimum of 240mm² Aluminium. Single core cables with fully rated screens can be used for this purpose.

The fault rating and the switchgear capacity must be considered, taking into account future load growth and network changes. The fault rating (short circuit current rating) of the 11kV and 22kV switchgears must be a minimum of 16kA for one (1) second.

Provision must be made on the switchgear for clamping of incoming cables. A floating frame (*unistrut, gal steel, or marine grade aluminium*) is also provided in the culvert for clamping of the single cores of the incoming 11kV and 22kV feeder cables. Three core cables will be split into three single core cables in the culvert or trench.

Note: High voltage switchgear must face the end of the padmount cubicle or into the clear access area of the indoor substation. It must be possible to operate all equipment and insert and remove all fuses with the end cubicle door open.

The design must be suitable for all Endeavour Energy 11kV and 22kV cables up to 300mm².

6.9.2 Fuses

For full details of the fuse requirements for standard padmount substations, refer to ETS 0071 and Section 7 – Substations and switching stations of MCI 0006.

Medium and low voltage fuses are to be supplied with each substation except for 1500kVA and auto transformer substation where HV circuit breakers will be used. The fuses will be selected from the component lists approved by Endeavour Energy.

6.9.3 High voltage cable direct connection

Direct connection of an underground cable from a drop out fuse to a transformer is not permitted. Terminations must be in accordance with the requirements of MDI 0026.

6.10 LOW VOLTAGE SWITCHGEAR

Endeavour Energy uses the same LV switchgear for indoor substations as is used in padmount substations. The LV switchgear is also to be installed in the same relative location as when it is used in a padmount situation (directly in front of the LV bushings of the transformer over the LV trench).

Where Endeavour Energy gives approval for the LV switchgear to be located in a different location than the indoor substation, or the LV cables are required to be extended for any reason, these costs will be paid by the customer.

For full details of LV switchgear requirements for substations refer to ETS 0069 and MCI 0006.

Three (3) types of low voltage switchgear are required for use in the substation. These are the low voltage fused distribution board, the low voltage circuit breaker assembly, and the load break switch (for use with the 1500kVA transformer only).

Crimp cable lugs in accordance with Drawing no. 078239 are to be provided and crimped onto the consumer's mains.

6.11 EARTHING

For full details of the earthing requirements, refer to EDI 100.

Padmount substations' earth grid can be either common or separate earthing. Common earthing is the preferred arrangement for the indoor substations.

6.11.1 Padmount substations

6.11.1.1 Common earthing

All HV earth connections and LV earth connections are bonded together to form one earth system. For details refer to EDI 100.

Where metallic cubicles are used, the following requirements are also to be met:

- All doors and adjacent door jambs are to have an earth stud fitted with an earth braid of sufficient length to allow doors to be removed and placed against the outside of the cubicle.
- All bolted sections of the cubicle are to be electrically connected to each other using earth braids or equivalent.
- Earth braids are to be a minimum size equivalent to 70mm² copper cable.
- A separate M12 earth stud is to be provided at each end of the cubicle for connection to the HV earth bar.

6.11.1.2 Separate earthing

If not provided in the LV switch frame the low voltage neutral bar is to be isolated using a 6.6kV insulator (suitable to withstand 12.7kV for 10 sec) from all other metallic components.

Metallic cubicles or plinths are not permitted in a separately earthed area. For details refer to EDI 100.

6.11.2 Padmount autotransformer substations

For the purposes of earthing, a HV earth bar must be provided in both 11kV and 22kV ends. The following must be connected to the earth bars.

22kV earth bar	11kV earth bar
<ul style="list-style-type: none"> • Transformer neutral • Transformer tank earth • 22 kV cable earth screens • 22 kV switchgear frame • 22 kV switchgear earth bar • 22 kV protection CT neutral • Substation enclosure (if metallic) • Any other metal frame/component • Dual connection to 11 kV earth bar • 2 x connections to underground earth electrodes (grid) • 3 x spare 	<ul style="list-style-type: none"> • 11 kV cable earth screens • 11 kV switchgear frame • 11 kV switchgear earth bar • Any other metal frame/component • 11 kV MDI CT neutral • 11 kV protection CT neutral • 2 x connections to underground earth electrodes (grid) • 3 x spare holes

For details refer to EDI 100

6.11.2.1 Common earthed autotransformer substation

For details refer to EDI 100.

6.11.2.2 Separate earthed autotransformer substation

For details refer to EDI 100.

6.11.3 Padmount switching station

Refer to EDI 100 and MCI 0006.

6.11.4 Indoor substations

A buried earth grid is necessary for the substation: this can be installed in unexcavated or suitably filled and consolidated ground.

For a slab on ground construction, the earth grid system is usually installed directly under the slab before pouring.

The use of suspended slab construction requires the installation of earth cables between the substation and the earth grid. In this case, the earth grid is usually installed under the bottom floor of the building, preferably directly below the substation.

The installing contractor will place copper conductors for the building into the concrete floor. Where a waterproof membrane forms part of the floor construction, the conductors will be fitted with a water barrier. The builder **must** arrange suitable incorporation of the conductors and barriers within the floor construction.

Note: Care needs to be taken to **check** that the earthing system is installed prior to the pouring of the lowest basement slab.

As the installation of the grid requires the driving or drilling of holes for earth electrodes, it is essential that there are no obstructions or other services such as sewers, drains, water, gas or Telstra services, and the like under substations. This does not preclude the use of building space on lower floors where the substation floor is not the lowest floor.

All earth conductors are to be as specified in EDI 100. All connections are to be terminated using crimp lug connections of adequate current rating.

The standard size earthing cable is a min of 70mm² copper

For earthing requirements of indoor substations, refer to MCI 0006 and EDI 100.

6.12 SEALING CABLE PENETRATIONS

Moisture on some high voltage switchgear is undesirable and all practical steps should be taken to limit the ingress of moisture in areas where high voltage switchgear is installed.

To prevent the travel of fire all cable/conduit penetrations will be sealed with fire resistant material such as Sikaflex 11FC.

6.13 UNDERGROUND SERVICES

It **will** be the customer's responsibility to supply and install underground services fitted with lugs and cable support clamps for fixing to the LV switchgear, in accordance with MCI 0006.

Where underground services are of a quantity, size or type not suitable for direct connection to the LV switchgear in the substation, it **will** be the consumer's responsibility to supply and install, at their cost, a suitable connection box, complete with all necessary termination facilities.

Cables compatible with the LV switchgear **will** be installed between the equipment and the connection box at the consumer's cost. The connection box **will** be installed external to the substation easement.

Any cable entry to the substation basement or trench by service **must** be sealed after installation of cables with a sealant that is impervious to oil and water, and have a fire resistance level of no less than 120/120/120 (for example, Dow Corning *Firestop 3-6548* silicone RTV foam or Hilti *CP 636* fire prevention mortar).

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MAINS DESIGN INSTRUCTION

ASSET STANDARDS AND DESIGN

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SECTION 7 – TECHNICAL BULLETINS

7.1 GENERAL INFORMATION

This section of the design manual contains all the relevant technical bulletins that have been issued.

Technical bulletins are used as an information source for changes that may occur between amendments to Standards and for additional sources of information that may be related to new products or practices that are introduced.

Note: Reference should always be made to the relevant section of this manual for the task undertaken to confirm all aspects are covered. Technical bulletins focus on specific problems and do not always cover all necessary requirements.

7.2 LIFETIME OF A TECHNICAL BULLETIN

A technical bulletin may become obsolete for many reasons, including:

- A Standard has been created or amended to include the technical bulletin details.
- Work practices set out in a technical bulletin have been in place for an extended period of time.
- The new product mentioned in a technical bulletin has been in use in Integral for an extended period of time.
- A new technical bulletin supersedes an old technical bulletin.

7.3 TECHNICAL BULLETIN REFERENCE LIST

The following list should be updated by the user as technical bulletins are added or removed from their folder.

Bulletin no.	Date	Description

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