Teresa Gizzi

From:	Cornelis Duba <Cornelis.Duba@endeavourenergy.com.au>
Sent:	Friday, 28 September 2018 12:32 PM
To:	DPE CSE Information Planning Mailbox
Cc:	Teresa Gizzi
Subject:	NSW Planning & Environment Notice of Exhibition State Significant Development SSD 8980 RE Bowral and District Hospital Redevelopment
Attachments:	Endeavour Energy MCI+0006+S07 Substations & Switching Stations.pdf

The Secretary
NSW Planning & Environment

ATTENTION: Teresa Gizzi, Social Infrastructure Assessments

Dear Sir or Madam

Further to my below email of earlier today in response to the Department's letter of 27 August 2018 regarding State Significant Development SSD 8980 at 97-103 Bowral Street, Bowral (Lot 4 DP 858938) for 'Bowral and District Hospital Redevelopment', please find attached a copy of Endeavour Energy's Mains Construction Instruction MCI 0006 'Underground distribution construction standards manual', Section 7 ' Substations & Switching Stations' which was too large to attach to my previous email.

Yours faithfully
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Development Application Specialist
Network Environment & Assessment
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From: Cornelis Duba
Sent: Friday, 28 September 2018 12:30 PM
To: 'information@planning.nsw.gov.au'
Cc: Teresa.Gizzi@planning.nsw.gov.au; Philip Wilson (Philip.Wilson@endeavourenergy.com.au)
Subject: NSW Planning & Environment Notice of Exhibition State Significant Development SSD 8980 RE Bowral and District Hospital Redevelopment

The Secretary
NSW Planning & Environment

ATTENTION: Teresa Gizzi, Social Infrastructure Assessments

Dear Sir or Madam

I refer to the Department's letter of 27 August 2018 regarding State Significant Development SSD 8980 at 97-103 Bowral Street, Bowral (Lot 4 DP 858938) for 'Bowral and District Hospital Redevelopment'. Submissions needed to be made to the Department by 27 September 2018. I apologise for the late submission but trust that Endeavour Energy's recommendations and comments will still be considered.

As shown in the below site plan from Endeavour Energy's G/Net master facility model (and the extract from Google Maps Street View) there is:

- Padmount substation no. 30147 and associated low voltage and 11,000 volt / 11 kV high voltage underground cables off Ascot Road not held under easement.
- Low voltage and 11 kV high voltage overhead power lines to the Ascot Road and Sheffield Road road verges / roadways.
- 'Out-Of Service' low voltage / streetlight off Bowral Street.

Please note the location, extent and type of any electricity infrastructure, boundaries etc. shown on the plan is indicative only. Generally (depending on the scale and/or features selected), low voltage (normally not exceeding 1,000 volts) is indicated by blue lines and high voltage (normally exceeding 1,000 volts but for Endeavour Energy's network not exceeding 132,000 volts / 132 kV) by red lines (these lines can appear as solid or dashed and where there are multiple lines / cables only the higher voltage may be shown). This plan only shows the Endeavour Energy network and does not show electricity infrastructure belonging to other authorities or customers owned electrical equipment beyond the customer connection point / point of supply to the property. This plan is not a 'Dial Before You Dig' plan under the provisions of Part 5E 'Protection of underground electricity power lines' of the *Electricity Supply Act 1995* (NSW).

In regards to the padmount / high voltage customer substations and associated underground cabling on the site are not held under easement, they are protected assets under the *Electricity Supply Act 1995* (NSW) Section 53 'Protection of certain electricity works'. The owner or occupier of the land cannot take any action by reason of the presence or operation of the electricity works in, on or over the land ie. they cannot remove the electricity infrastructure from the property. These protected assets are managed on the same basis as if an easement was in existence.

In accordance with the attached copy of Endeavour Energy's Mains Design Instruction MDI 0044 'Easements and Property Tenure Rights', and as shown in the following extract of Table 1 – 'Minimum easement widths':

- The padmount substation requires a minimum easement of 2.75 x 5.5 metres (centred in accordance with the substation layout /orientation).
- The low voltage and 11 kV underground cables (assumed to have no concrete protection unless proven otherwise) requires a 3 metre minimum easement width ie. 1.5 metres to both sides of the centre line of the cable ducts.

Table 1 - Minimum easement widths

	Voltage	Asset Type	Construction	Minimum Easement (m)
Underground Assets	400V - 22kV	Cables	Underbore / Ducted / Direct buried	3
			Ducted < 100m and with concrete protection *(min 50 mm concrete cover at standard burial depth)*	1
Other	-	Padmount Substation		2.75 x 5.5 *(see clause 5.3.6)*

The following is a summary of the usual / main terms of Endeavour Energy's electrical easements requiring that the land owner:

- Not install or permit to be installed any services or structures within the easement site.
- Not alter the surface level of the easement site.
- Not do or permit to be done anything that restricts access to the easement site without the prior written permission of Endeavour Energy and in accordance with such conditions as Endeavour Energy may reasonably impose.

Endeavour Energy's preference is for no activities or encroachments to occur within its easement areas. Most activities are prohibited within the padmount substation easement area. If any proposed works (other than those approved / certified by Endeavour Energy's Network Connections Branch as part of an enquiry / application for load) which encroach/affect Endeavour Energy's easements or protected assets, contact must first be made with the Endeavour Energy's Easements Officer, Philip Wilson, on direct telephone 9853 7110 or alternately by email Philip.Wilson@endeavourenergy.com.au or Easements@endeavourenergy.com.au .

Subject to the foregoing and the following recommendations and comments Endeavour Energy has no objection to the Development Application.

- Network Capacity / Connection

Endeavour Energy has noted the following in the Environmental Impact Statement – Part 3:

9.2.2 Assessment

Integration of Services into Design

Integration of services into the design of the development is briefly addressed by MSJ in their Architectural Design Statement (**Appendix 11**). The relevant section is extracted below:

- the substation has been located at the centre of the site away from the boundaries where it can be more effectively screened.

This EIS is also accompanied by Electric, Civil and Hydraulic Services Reports/Drawings that detail the way infrastructure is integrated into the proposed design. The integration of services into the design of the site will minimise amenity impacts by enhancing the site's operation. Improving the operational capacity of B&DH will provide a net positive impact in the delivery of quality health care services throughout the SWS LHD.

9.10.2 Assessment

Electricity

An Electrical Services, ICT and Security Report (**Appendix 28**) has been prepared by Wood & Grieve Engineers (WGE) which addresses electrical services. The report confirms that a new 1,000kVA substation will be required at the south west of the new building as part of the proposed works. A new substation will serve a new main switchboard located in the new building. A new generator will be installed in an external acoustic enclosure and will have a nominal standby rating of 440kVA (352kWe). The new building will be supplied of continuous power by a new centralised UPS room.

A complete list of the proposed electrical services provided as part of the redevelopment are outlined on the report by WGE. The statement also confirms that sustainability and energy saving initiatives will be implemented in the design.

The Electrical Services, ICT and Security Report– Part 1 contains the following advice:

5. Proposed Electrical Services Arrangement

5.1 Main Electrical Supply

New Substation

The maximum demand of the new building (Main Works) is estimated at 700kVA (1011A).

As the effective spare capacity of the existing Main Switchboard is in the order of 140kVA (200A), there is insufficient spa
capacity on the existing LV supply to serve the new building (Main Works).

As part of the Main Works, a new 1,000kVA padmount substation and associated easements will be required to be provic
the site.

The location of the substation shall be selected with due consideration of:

1. Minimum separation distances to combustible building surfaces required by Endeavour Energy standards and recommended by AS 2067.
2. Electromagnetic compatibility.
3. Distance to the new main switchboard.
4. Future expansion space.
5. Proximity to joints in telecommunications cabling.
6. Proximity to fire hydrant booster pump rooms.

The Architectural Design Statement also addresses the proposed new substation location.

3.2.1 Substation & Main Switch Room

These were located in Substation and associated Main Switch Room have been located on the ground level as both require truck access.

The new substation has been located in the middle of the site behind the proposed new building where it can be screened by landscaping and not affect the established north east garden or the main public fronts of the new public access and the Bowral St streetscape with its established trees.

The main switch room has been located inside the building fronting the service access area to minimise the impact on views and site open space.

The fact that provision is being made for the substation is a positive. Endeavour Energy’s general requirements is for a padmount substation easement to have a minimum size of 2.75 x 5.5 m and also have the additional restrictions for fire rating (and possibly swimming pools and spas which in this instance does not appear to be applicable) which should not affect any adjoining property, be at ground level and have direct access from a public street or be supported by an appropriate right of access. Generally it is the Level 3 Accredited Service Provider’s (ASP) responsibility (engaged by the developer) to make sure that the substation location and design complies with Endeavour Energy’s standards the suitability of access, safety clearances, fire ratings, flooding etc.

Please find attached for the applicant’s information copies of Endeavour Energy’s:

- Mains Design Instruction MDI 0044 ‘Easements and Property Tenure Rights’
- Mains Construction Instruction MCI 0006 ‘Underground distribution construction standards manual’, Section 7 ‘ Substations & Switching Stations’.
- Mains Design Instruction MDI 0028 ‘Underground distribution network design’.

Endeavour Energy’s Network Connections Branch have advised that they are presently reviewing the proposed method of supply (PMOS) and in due course will issue a Design Brief (Endeavour Energy reference Urban Local Government ULL2727) ULL2727) to advise the Level 3 ASP of the supply requirements for the Bowral and District Hospital Redevelopment’. For further details are available by contacting Endeavour Energy’s Network Connections Branch via Head Office enquiries on telephone: 133 718 or (02) 9853 6666 from 8am - 5:30pm or on Endeavour Energy's website under 'Home > Residential and business > Connecting to our network' via the following link:

http://www.endeavourenergy.com.au/

- Earthing

The construction of any building or structure (including fencing, signage, flag poles etc.) whether temporary or permanent that is connected to or in close proximity to Endeavour Energy's electrical network is required to comply with Australian/New Zealand Standard AS/NZS 3000:2007 'Electrical installations' to ensure that there is adequate connection to the earth. Inadequate connection to the earth places persons, equipment connected to the network and the electricity network itself at risk if there is a leaking/fault current which cannot flow into the grounding system and be properly dissipated.

- Prudent Avoidance

The electricity network is operational 24/7/365 ie. all day, every day of the year. The electricity industry has adopted a policy of prudent avoidance by doing what can be done without undue inconvenience and at modest expense to avert the possible risk to health from exposure to emissions form electricity infrastructure such as electric and magnetic fields (EMF) and noise which generally increase the higher the voltage ie. Endeavour Energy's network ranges from low voltage (normally not exceeding 1,000 volts) to high voltage (normally exceeding 1,000 volts but not exceeding 132,000 volts / 132 kV). In practical terms this means that when designing new transmission and distribution facilities, consideration is given to locating them where exposure to the more sensitive uses is reduced and increasing separation distances. Endeavour Energy believes that likewise Council should also adopt a policy of prudent avoidance by the siting of more sensitive uses away from any electricity infrastructure – including any possible future electricity infrastructure required to facilitate the proposed development. Even with less sensitive non-residential development, Endeavour Energy believes that a policy of prudent avoidance should be considered.

Please find attached a copy of ENA's 'Electric & Magnetic Fields – What We Know, January 2014' which can also be accessed via the ENA's website at http://www.ena.asn.au/ and provides the following advice:

> *Localised EMFs may also be encountered in specific situations such as near substations, underground cables, specialised electrical equipment, or at elevated locations near lines. Note that the strengths of EMFs decrease rapidly with distance from the source.*

Typical magnetic field measurements associated with Endeavour Energy's activities and assets given the required easement widths, safety clearances etc. and having a maximum voltage of 132,000 volt / 132 kV, will with the observance of these separation distances not exceed the recommended magnetic field public exposure limits.

- Network Access

It is imperative that the access to the existing electrical infrastructure within the precincts is maintained at all times. To ensure that supply electricity is available to the community, access to the electricity infrastructure may be required at any time. Restricted access to electricity infrastructure by maintenance workers causes delays in power restoration and may have severe consequences in the event of an emergency.

- Vegetation Management

The planting of large trees in the vicinity of electricity infrastructure is not supported by Endeavour Energy. Suitable planting needs to be undertaken in proximity of electricity infrastructure. Only low growing shrubs not exceeding 3.0 metres in height, ground covers and smaller shrubs, with non-invasive root systems are the best plants to use. Larger trees should be planted well away from electricity infrastructure (at least the same distance from overhead power lines as their potential full grown height) and even with underground cables, be installed with a root barrier around the root ball of the plant. Landscaping that interferes with electricity infrastructure may become a potential safety risk, cause of bush fire, restrict access or result in the interruption of supply. Such landscaping may be subject to Endeavour Energy's Vegetation Management program and/or the provisions of the *Electricity Supply Act 1995* (NSW) Section 48 'Interference with electricity works by trees' by which under certain circumstances the cost of carrying out such work may be recovered.

Please find attached for the applicant's reference a copy Endeavour Energy's 'Guide to Fencing, Retaining Walls and Maintenance Around Padmount Substations'.

- Dial Before You Dig

Before commencing any underground activity the applicant is required to obtain advice from the ***Dial Before You Dig* 1100** service in accordance with the requirements of the *Electricity Supply Act 1995* (NSW) and associated Regulations. This should be obtained by the applicant not only to identify the location of any underground electrical and other utility infrastructure across the site, but also to identify them as a hazard and to properly assess the risk.

- Excavation

Applicant should be advised of the following object of Section 49A 'Excavation work affecting electricity works' of the of *Electricity Supply Act 1995* (NSW) covering the carrying out or proposed carrying out of excavation work in, on or near Endeavour Energy's electrical infrastructure.

Electricity Supply Act 1995 No 94

Current version for 8 January 2016 to date (accessed 30 March 2016 at 08:12)
Part 5 > Division 2 > Section 49A

49A Excavation work affecting electricity works

(1) This section applies if a network operator has reasonable cause to believe that the carrying out or

(a) could destroy, damage or interfere with those works, or

(b) could make those works become a potential cause of bush fire or a potential risk to public safe

(2) In those circumstances, a network operator may serve a written notice on the person carrying out

(a) to modify the excavation work, or

(b) not to carry out the excavation work, but only if the network operator is of the opinion that mo interference with, the electricity works concerned or in preventing those works becoming a pot

Excavation in proximity of electricity infrastructure can affect its integrity. If any excavation work affects Endeavour Energy's electricity infrastructure, prior contact must be made to Endeavour Energy's Regional Service Central via Head Office enquiries on telephone: 133 718 or (02) 9853 6666 from 8am - 5:30pm or alternately email Regional.ServicesCentral@endeavourenergy.com.au .

- Demolition

Demolition work is to be carried out in accordance with Australian Standard AS 2601—2001: 'The demolition of structures'. All electric cables or apparatus which are liable to be a source of danger, other than a cable or apparatus used for the demolition works shall be disconnected ie. the existing customer service lines will need to be isolated and/or removed during demolition. Appropriate care must be taken to not otherwise interfere with any electrical infrastructure on or in the vicinity of the site eg. streetlight columns, power poles, overhead power lines and underground cables etc.

- Demolition

Demolition work is to be carried out in accordance with Australian Standard AS 2601—2001 ' The demolition of structures'. All electric cables or apparatus which are liable to be a source of danger, other than a cable or apparatus used for the demolition works shall be disconnected ie. the existing customer service lines will need to be isolated and/or removed during demolition. Appropriate care must be taken to not otherwise interfere with any electrical infrastructure on or in the vicinity of the site eg. streetlight columns, power poles, overhead and underground cables etc.

- Public Safety

Workers involved in work near electricity infrastructure run the risk of receiving an electric shock and causing substantial damage to plant and equipment. I have attached Endeavour Energy's public safety training resources, which were developed to help general public / workers to understand why you may be at risk and what you can do to work safely. The public safety training resources are also available via Endeavour Energy's website via the following link:

http://www.endeavourenergy.com.au/wps/wcm/connect/ee/nsw/nsw+homepage/communitynav/safety/safety+brochures

If the applicant has any concerns over the proposed works in proximity of the electricity infrastructure, as part of a public safety initiative Endeavour Energy has set up an email account that is accessible by a range of multiple stakeholders across the company in order to provide more effective lines of communication with the general public who may be undertaking construction activities in proximity of electricity infrastructure such as builders, construction industry workers etc. The email address is Construction.Works@endeavourenergy.com.au .

- Emergency Contact

In case of an emergency relating to Endeavour Energy's electrical network, the applicant should note the Emergencies Telephone is 131 003 which can be contacted 24 hours/7 days.

I appreciate that not all the foregoing issues may be directly relevant or significant to the Development Application. However, Endeavour Energy's preference is to alert proponents / applicants of the potential matters that may arise should development within closer proximity of the existing and/or required electricity infrastructure needed to facilitate the proposed development on or in the vicinity of the site occur.

Could you please pass on a copy of this submission and the attached resources to the applicant? Should you wish to discuss this matter, or have any questions, please do not hesitate to contact me or the contacts identified above in relation to the various matters. Due to the high number of development application / planning proposal notifications submitted to Endeavour Energy, to ensure a response contact by email to Property@endeavourenergy.com.au is preferred.

Yours faithfully
Cornelis Duba
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Network Environment & Assessment
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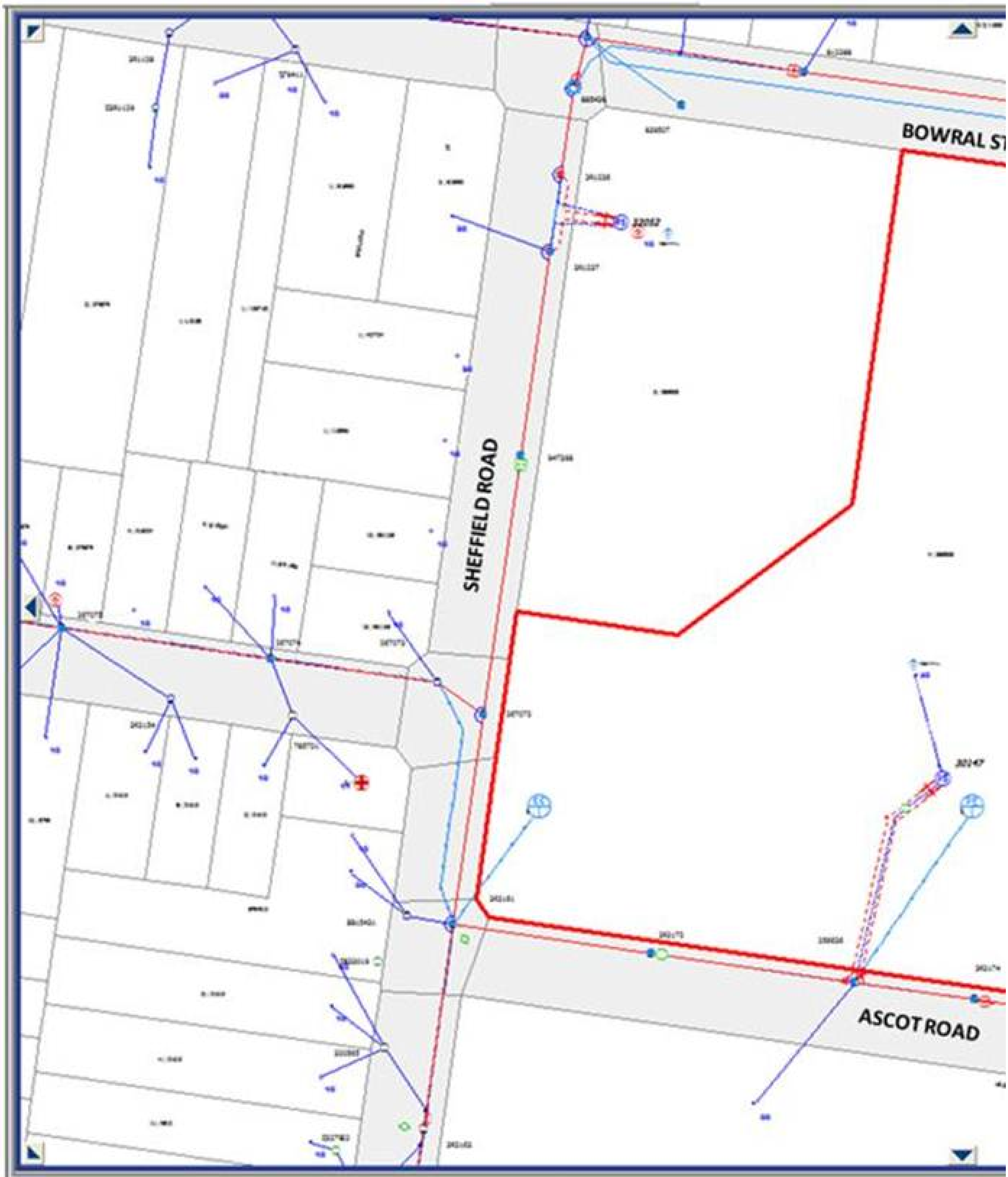
Endeavour Energy



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1/0
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1/0
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267073
267072
785721
1/0
1/1
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0/0
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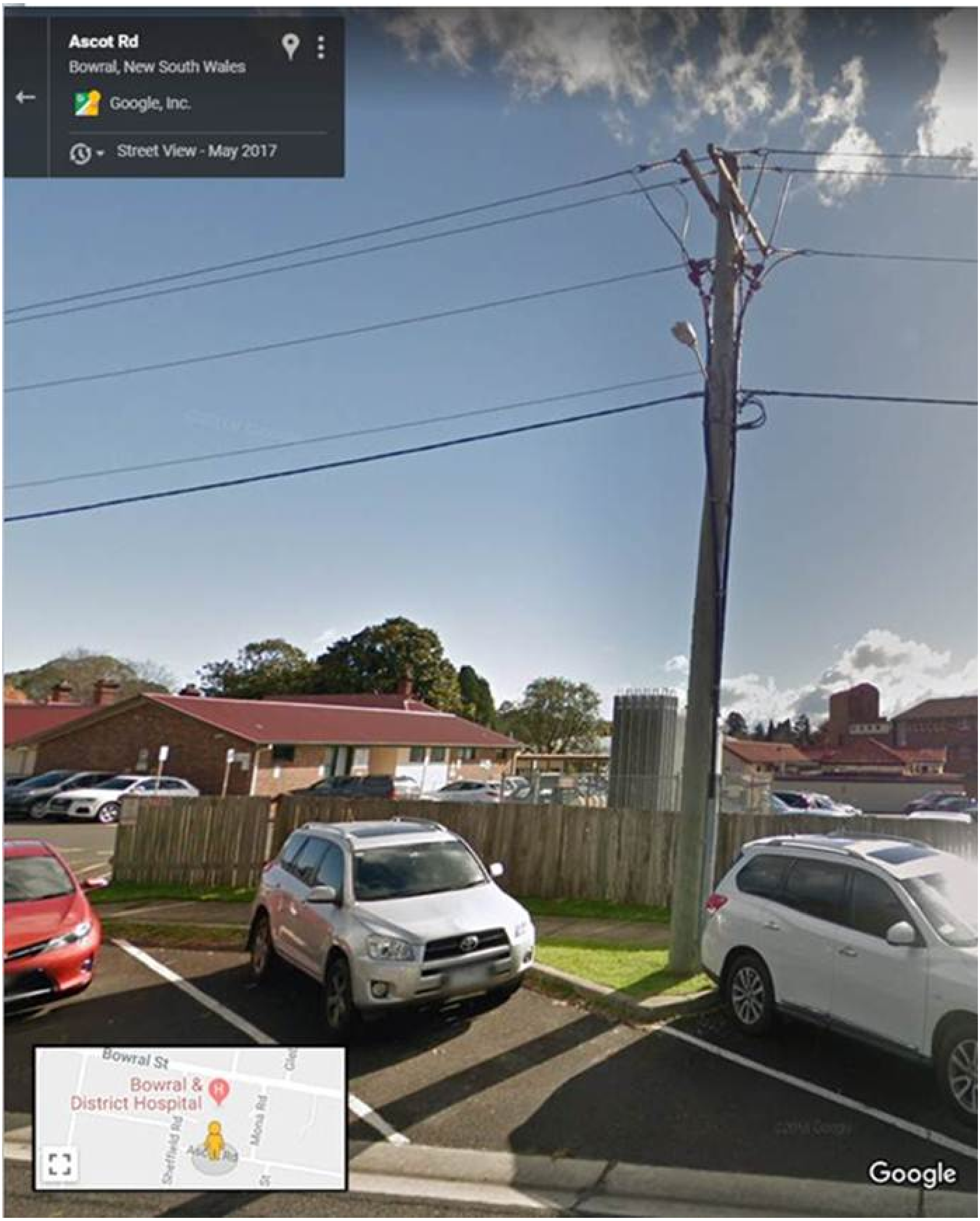
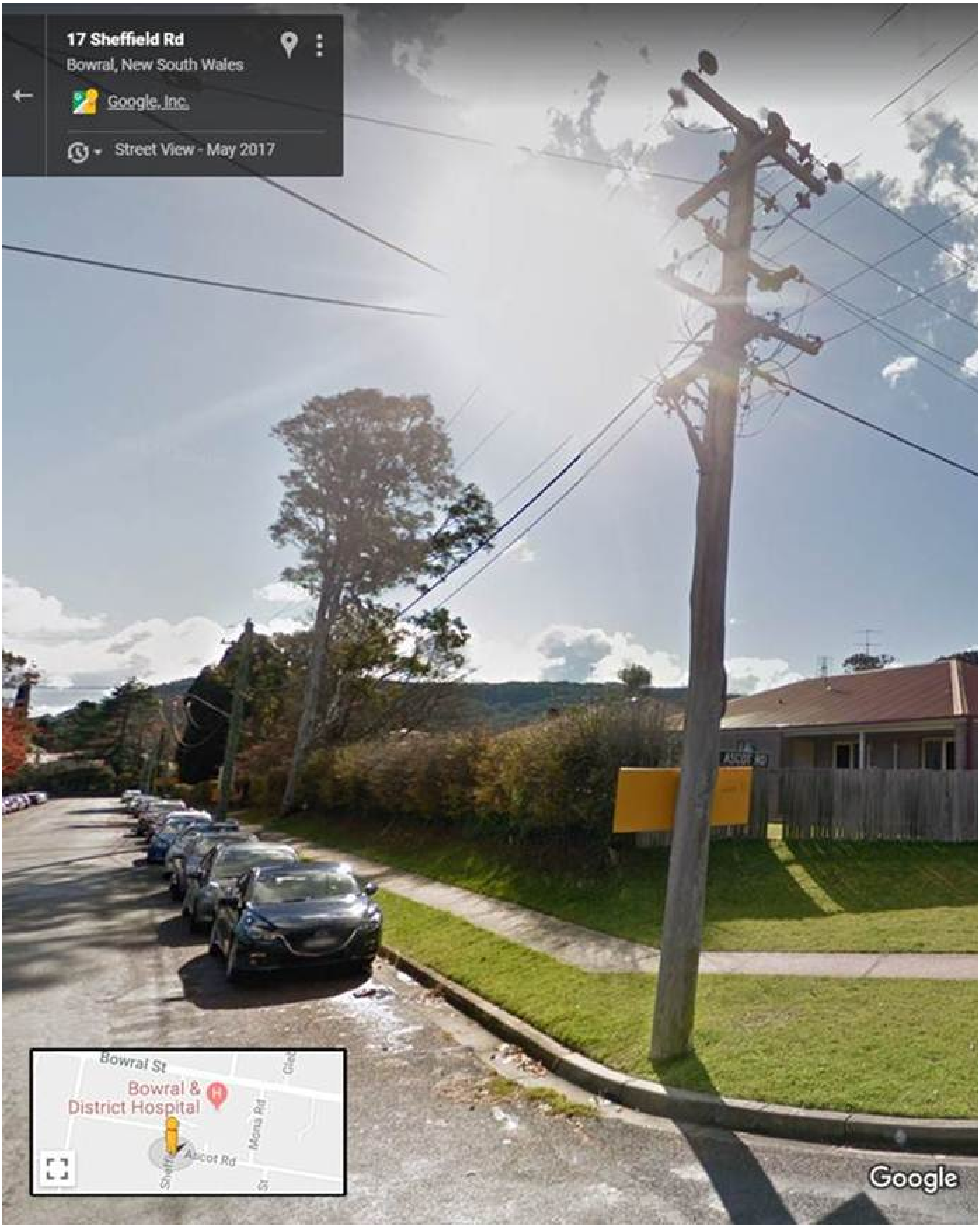
S815431
D833019
4/0
1/0



Pole no. 256636 in Ascot Road from which there are LV and 11 kV underground cables going to padmount substation no. 30147 on the site.


17 Sheffield Rd
Bowral, New South Wales
Google, Inc.
Street View - May 2017
Bowral St
Bowral & District Hospital
Mona Rd
Ascot Rd
Google


101 Bowral St
Bowral, New South Wales
Google, Inc.
Street View - Feb 2018
Bowral St
Bradman Museum
International Cricket
Bowral St
Glebe St
Bowral &
District Hospital
Mona Rd
Google

Document No: MDI 0044

Amendment No: 1

Mains Design Instruction

Easements and Property Tenure

IMPORTANT DISCLAIMER

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MAINS DESIGN INSTRUCTION

ASSET STANDARDS & DESIGN	Document No Amendment No Approved By Approval Date	MDI 0044 1 GMAM 06/03/2017

MDI 0044 – Easements and Property Tenure

CONTENTS

1.0 PURPOSE

To set out Endeavour Energy's design requirements for new easements, other property tenure requirements, and the management of existing easements.

2.0 SCOPE

This instruction covers:

- The rights Endeavour Energy has within its own easements;
- The determination of the minimum easement size for an asset;
- Process for acquiring, modifying and removing easements;
- The definition of controls for the safe operation of activities within easements; and,
- The definition of activities which are prohibited within easements.

The instruction does not cover:

- The release process of easements, which is covered in Company Policy 9.2.4.
- The process for managing existing encroachments, which is defined in Company Procedure GAM 0098.

3.0 REFERENCES

Internal

- Company Policy 9.2.3 – Property Tenure for Network Assets
- Company Policy 9.2.4 – Network Easement Release
- Company Procedure GAM 0098 – Management of Existing Encroachments
- Company Procedure GAM 0114 – Granting Dispensation for Engineering Documents
- Environmental Management Standard EMS 0006 - Maintenance and construction of access tracks
- Mains Construction Instruction MCI 0006 – Underground distribution construction standard
- Mains Design Instruction MDI 0028 – Underground distribution design
- Mains Design Instruction MDI 0031 – Overhead distribution: Design standards manual
- Mains Design Instruction MDI 0047 – Overhead transmission design
- Substation Design Instruction SDI 100 – Distribution Earthing Design, Construct and Test
- Endeavour Energy General Terms & Conditions for Connection of Public Lighting Assets (March 2011)
- Network Management Plan November 2013

External

- *Electricity Supply Act* 1995*
- *Roads Act* 1993*
- *Land Acquisition (Just Terms Compensation) Act* 1991*
- *Conveyancing Act* 1919*
- State Environmental Planning Policy (Infrastructure) 2007
- ISSC 20 - Guidelines for the Management of Activities within Electricity Easements and close to Electricity Infrastructure (April. 2012)
- ENA National Electricity Network Safety Code (Doc 001-2008)

- AS / NZS 7000:2016 Overhead Line Design – Detailed procedures
- AS / NZS 4853:2012 – Electrical hazards on metallic pipelines

** - Act current as of 19/02/2016*

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 Abbreviations

EPR
Earth Potential Rise

HV
High voltage

LV
Low voltage

LPI
Land and Property Information

4.2 Definitions

Easement
An easement is an encumbrance on the title of land (which may be limited in width and height above or below the land) conferring a right to inspect, construct, operate, maintain, repair, renew, replace or upgrade electrical infrastructure.

Positive Covenant
A type of property tenure that requires expenditure by the land owner is required to meet the terms of the covenant.

Property tenure
A broad term covering the rights of the company to carry out network operations within land not owned by the company – exercising statutory rights in accordance with relevant legal requirements and the creation of appropriate recognised property rights. Typical property tenure include easements, Restrictions on Use, Positive Covenant and long term leases.

Public road
Defined under the Roads Act 1993. A road usually includes a vehicle carriageway and associated footpath areas on each side of the carriageway.

Restrictions on use of land
Conditions imposed on the use of the land, to inform the landowner and put limitations on the use of land due to the risk that exists by the electrical asset being located within the burdened lot.

5.0 ACTIONS

5.1 General Requirements

This standard covers two aspects of easement (and other types of property tenure) management:

- The design requirements relating to easements – easement size, creation, modification and release, rights of way and community titles.
- The management of existing easements – encroachments, transfer hazards and rights granted by the Electricity Supply Act 1995.

The general philosophy behind Endeavour Energy's approach to design and management of easements is to secure both the safe operation of the electrical network and, the safety of its employees, contractors and the public. Where a design, activity or proposal could compromise the electrical network or put an employee or the public at risk, the Electricity Supply Act 1995 allows Endeavour Energy to restrict and/or prohibit the activity. Refer to Clause 5.11 for further details.

All Endeavour Energy easements must comply with the requirements of this document, which is based on ISSC 20 "Guidelines for the Management of Activities within Electricity Easements and close to Electricity Infrastructure". However, where this standard and ISSC 20 differ, this standard will take precedence.

All new/proposed transmission and distribution infrastructure, which is not constructed on public roads, an easement in favour of Endeavour Energy must be created in accordance with the requirements of this standard.

5.2 Management process of easements

The following flowchart details the management process for easements.

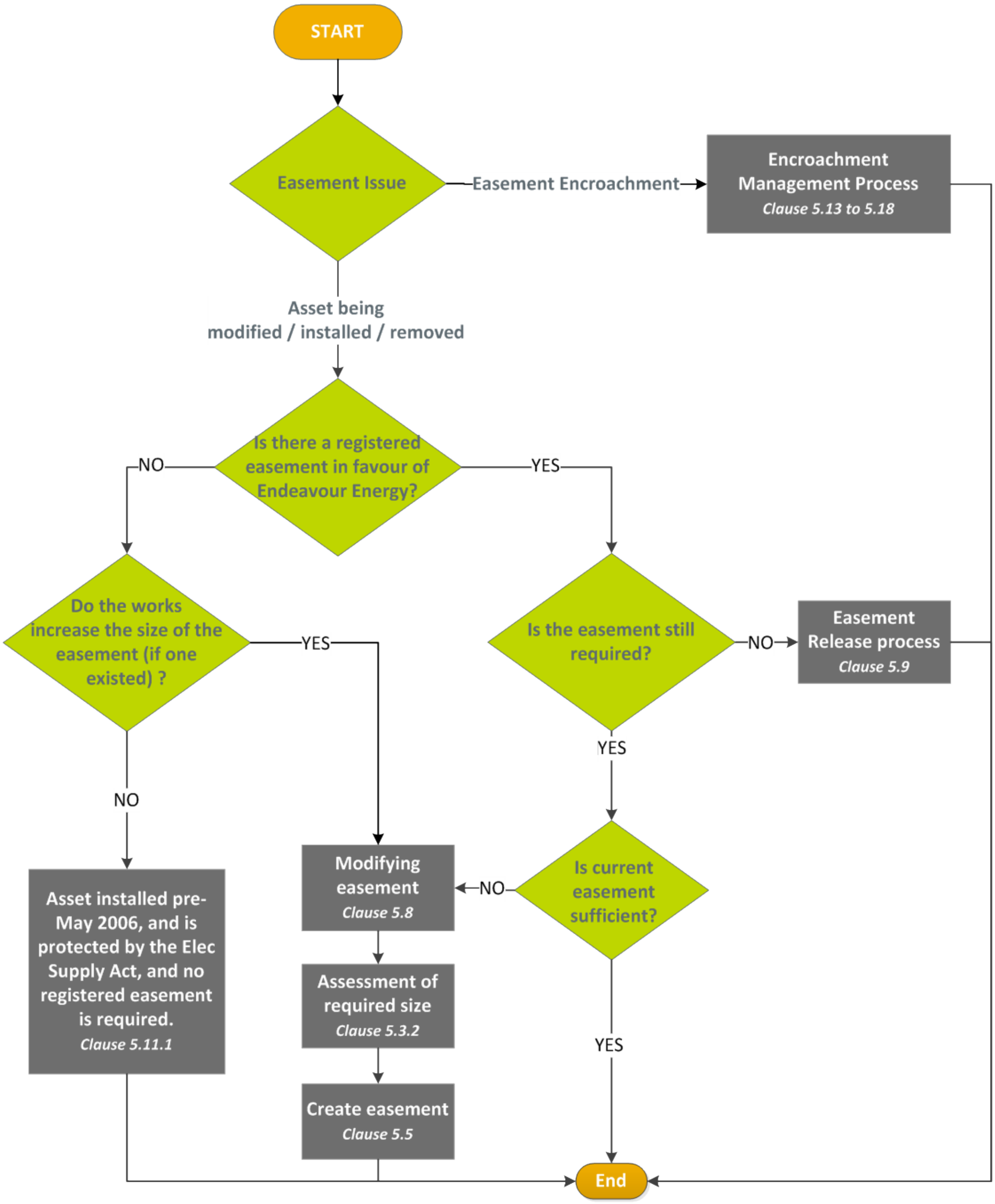


Figure 1 - Easement Management Flowchart

5.3 Minimum easement widths

The minimum easement widths are specified in Table 1. Larger easements may be specified and/or required on a project by project basis. All designs must certify that the easement widths in Table 1 are suitable for the span lengths / conductors used in the design.

5.3.1 Minimum easement required for overhead lines

For overhead lines, the minimum easement width for each span must be the greater width of the following three criteria:

- The width of the structure plus, two (2) times the sum of:
  - Conductor blowout, including insulator swing where applicable, (at 50°C and 500 Pa wind pressure); and,
  - The appropriate clearance from Table 3.7 of AS/NZS 7000 (Refer to Figure 2)
- Minimum maintenance requirements for the type of construction.
- The easement widths specified in Table 1.

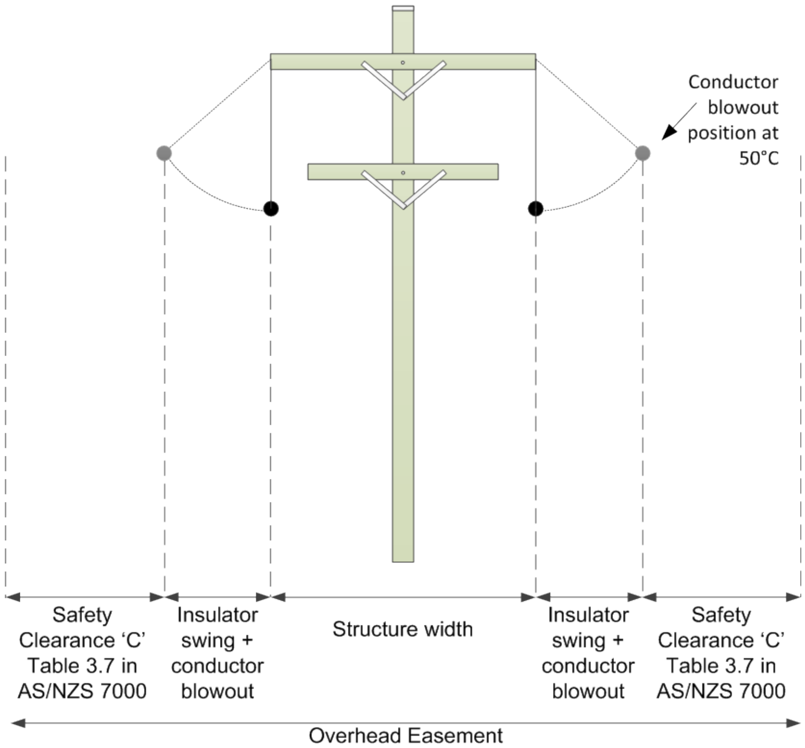


Figure 2 - Minimum overhead easement

New overhead assets must be fully contained within an easement (or other types of property tenure) and not encroach adjoining properties. Existing lines encroaching a property (without a formal easement) are permitted to remain, and may be replaced or uprated, as long as there is no increase in this encroachment. Refer to Figure 5.

5.3.2 *Minimum easement required for network assets*

The table below details the minimum easement widths for various network assets. Refer to Annexure 4 for graphical representation for a cable joint system; pole stay and padmount clearances.

Table 1 - Minimum easement widths

	Voltage	**Asset Type**	**Construction**	**Minimum Easement** (m)
Overhead Assets	400V– 22kV	Bare Construction	All	9
		ABC		
		CCT		
	33kV / 66kV	Bare conductor *(see Note 2)*	Line post insulators	18
			33kV Suspension Insulators	18
			66kV Suspension Insulators	25
			H pole Structures	30
	132kV	Bare conductor *(see Note 2)*	Line post insulators	25
			H pole Structures	30
			Steel tower	30
Underground Assets	400V - 22kV	Cables	Underbore / Ducted / Direct buried	3
			Ducted < 100m and with concrete protection *(min 50 mm concrete cover at standard burial depth)*	1
	33kV - 132kV	Cables *(single feeder only)*	Ducted / Direct buried	5
			Cable Pits / Joint Bays	6
	-	Communications cables	Ducted / Direct Buried	1
		Earthing conductors		1
		Bonding leads		1
		Link Box / Comms Pit		2.0 x 2.0
Other	-	Streetlight Column / Service Pillar	-	1.0 x 1.0
		Switching Station		2.75 x 2.75 *(see clause 5.3.6)*
		Padmount Substation		2.75 x 5.5 *(see clause 5.3.6)*
		Auto Transformer		
		Indoor Substation		See clause 5.3.5
		Pole stays / Ground stays		See Note 2
	Rights of Access	Vehicle access tracks easement in rural areas *(see Note 3)*		5
		Vehicle access in urban areas		5 *(see Note 5)*
		Pedestrian access only		1.2

Notes:

1. All Network assets, except for padmounts / switching stations, must be positioned in the centre of the easement. Refer to Drawings 016665 and 282551 for easement details of padmounts and switching stations. For non-symmetrical assets, such as post insulators, the centre must be measured from the position of the conductors at rest.
2. The easement for a termination pole/structure or for an aerial / ground stay must extend at least half the easement width beyond the last network pole or stay.
3. For further details regarding the construction and maintenance requirements of access tracks, refer to EMS 0006.
4. For an overhead line which its operating voltage differs from its constructed voltage, the easement must be for the constructed voltage.
5. Applies to straight line of access only. If angles or bends are required in the access path, then width to be determined by assessing a truck turning diagram, and gaining approval from the relevant Endeavour Energy Operations Manager. .

5.3.3 Parallel overhead feeders

When considering overhead lines installed in parallel, an optimised easement width may be determined in accordance with the following principles:

- It is not necessary to consider the lines blowing toward each other with the maximum wind load. Instead consider the line with the larger sag blowing under maximum wind load toward the other line in its vertical position.
- Allowance must be given for physical movement of the line (conductors and insulators swinging), as well as electrical clearances and climbing corridors.
- Minimum horizontal separation between the two centrelines of the two feeders must be no less than 10m.

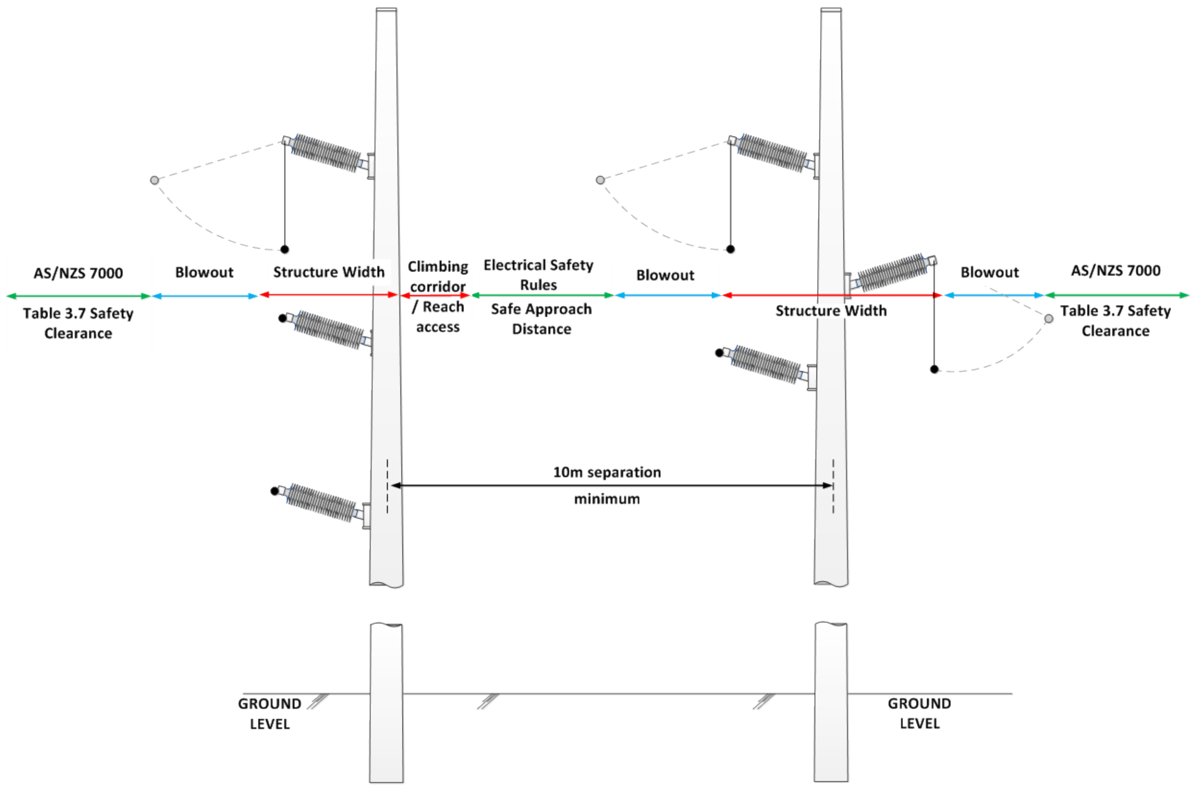


Figure 3 – Easement requirements for parallel feeders
(Structure on the right assumed to have the greatest conductor blowout)

5.3.4 Request for dispensation to the minimum easement width

A request for dispensation must be made to Endeavour Energy's Mains Assets Manager for any proposed easement that is smaller than the stated minimum width listed in Table 1. The submission must show there is no reduction in access for maintenance purposes and that the easement provides adequate electrical clearance to any existing and/or planned structures that may be built adjacent to the easement.

All designs must consider the following factors when determining an easement width:

- Electrical safety clearance
- Insulator and conductor blowout
- Access for maintenance, repair and upgrading
- Future requirement for additional feeder(s)
- Public safety based on potential earth potential rise (EPR) and electromagnetic field (EMF) issues
- Radio and television interference
- Audible noise
- Cable duct / jointing bay requirements

5.3.5 Indoor substations

The boundaries of an easement for indoor substation must be defined by the internal face of the walls, ceiling, floor, and cable trenches of the substation room.

An easement for the cables that enter and exit the substation room will also be required if they are not installed within public roads and/or existing Endeavour Energy easements.

A right of access may also be required to give Endeavour Energy employees, vehicles, and equipment unrestricted access to the indoor substation at all times.

5.3.6 Padmount substations and switching stations

The easement size for a padmount substation must be increased when a retaining wall or safety bollard has been installed/built to protect a padmount substation from vehicle impact, as indicated in Figure 4.

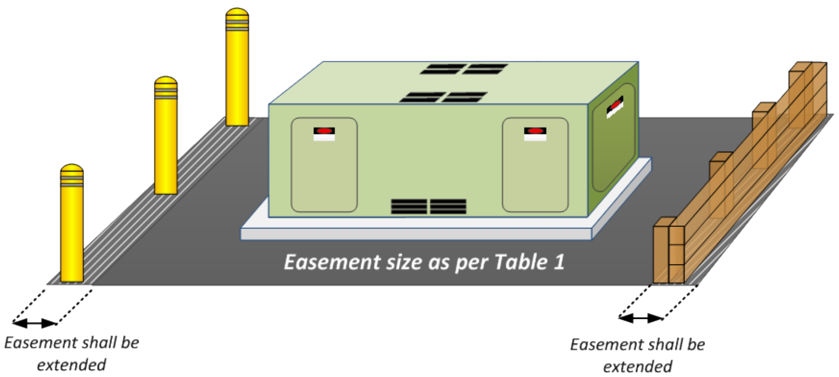


Figure 4 - Easements to include retaining wall or safety bollard

5.4 Assets within special areas

5.4.1 Assets within the road verge

Assets installed within a road carriageway cannot be provided with an easement. However, overhead assets proposed to be installed within the road verge still require the clearances specified in Table 1 and Clause 5.3.1.

As a minimum, the separation between the power line and the property line, must be the conductor blowout (at 50°C and 500 Pa wind pressure) and Safety Clearance ‘C’ from Table 3.7 of AS/NZS 7000.

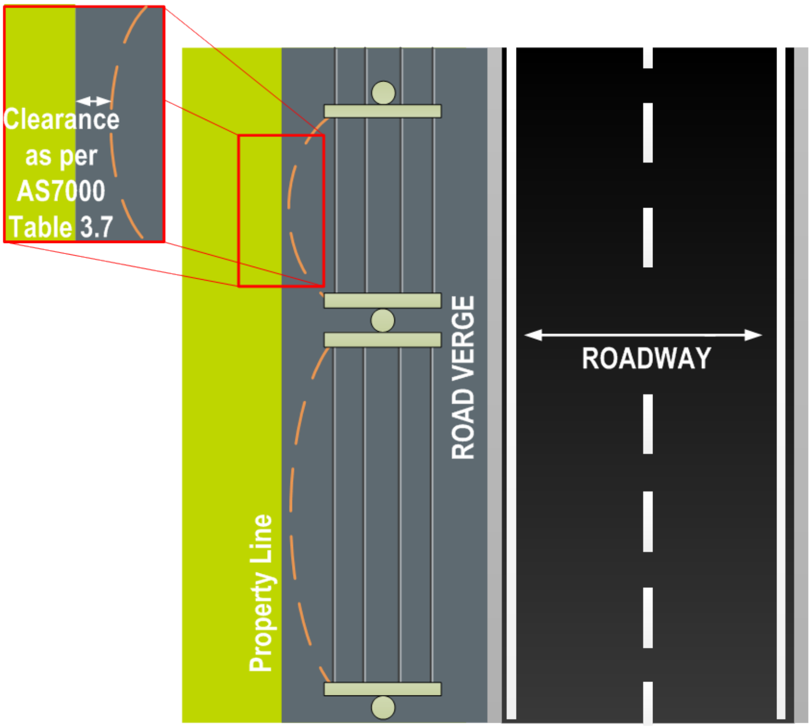


Figure 5 - Roadway requirements

5.4.2 Assets within roadways

Assets installed within a public road (as defined in the *Roads Act 1993*) requires the consent of the appropriate road authority to be obtained prior to the construction of any electrical works. Neither the *Roads Act 1993* or the *Electricity Supply Act 1995* requires an easement within public roads.

5.4.3 Overhead lines crossing private property

Where Endeavour Energy overhead lines cross private property, the line must be protected by a registered easement. The minimum width of this easement must be in accordance with the requirements in Clause 5.3.1 and 5.3.2.

5.4.4 Easement over Railway Corridor land

In 2002, Endeavour Energy entered into a *Master Access Deed* with Transport for NSW (then Railcorp), covering all new and existing Endeavour Energy network assets located within any rail corridor. This deed defines a rail corridor as any land owned by Transport for NSW. Network assets located within a rail corridor under the provisions of the *Master Access Deed* do not require easements.

Transport for NSW may also permit developers to install network assets in a rail corridor under an *Individual Access Deed* or *Deed of Release and Indemnity*. Any deed between the developer and Transport for NSW, will need to provide the same minimum requirements as those under the Master Access Deed and be transferable to Endeavour Energy for any new network assets installed by the developer.

Transport for NSW's process for third party works within the rail corridor is documented on its website, which includes the application form. Applications for rail corridor access must be submitted to the Rail Corridor Management Group in Sydney.

The ARTC website must be consulted for contact information regarding proposed rail corridor access.

5.4.5 Easements over National Park Land

Land dedicated as a wilderness area, national park, state recreation area, regional park, or nature reserve is managed by the NSW Office of Environment & Heritage.

Endeavour Energy is usually required to enter into a Formal Deed of Easement under Section 153 of the National Parks & Wildlife Act 1974 whereby compensation or an annual rent may be payable. The minimum easement dimensions given in Table 1 still apply, however, specific requirements will need to be negotiated with NSW Office of Environment & Heritage.

5.4.6 Easements over Forestry Land

Land dedicated as state forest is managed by Forests NSW/Department of Primary Industries and may be subject to native title.

Forests NSW will grant a limited form of property tenure under an Occupation Permit and an annual rent may be payable. The minimum easement dimensions given in Table 1 still apply, however, specific requirements will need to be negotiated with Forests NSW.

5.4.7 Easements in water catchment areas

Land that is classed as a water catchment area by the Sydney Catchment Authority, the standard easement terms do not always apply fully. The minimum easement dimensions given in Table 1 still apply, however, specific requirements will need to be negotiated with Sydney Catchment Authority.

5.4.8 Community Title developments

5.4.8.1 Asset ownership

The ownership of electrical assets (both HV and LV) within a community title development will only be accepted (owned and maintained) by Endeavour Energy if they are installed in accordance with Endeavour Energy's standard requirements and installation practices.

Endeavour Energy will generally own and maintain all high voltage electrical equipment within the development.

Endeavour Energy or the Community Title Association may own and maintain the low voltage electrical equipment and/or street lighting network.

Annexure 3 outlines the relevant by-laws that must be incorporated into the Community Title Management Plans to define the ownership and access requirements for the electricity assets within the development.

Community title developments and their management associations or developers are not considered to be public lighting customers under the NSW Public Lighting Code and therefore must meet the requirements stated in Endeavour Energy's *"General Terms and Conditions for Connection of Public Lighting Assets".*

5.4.8.2 Asset construction

For all assets the installation must provide the same level of security and access as normally would be found in standard urban residential development, this includes:

- All cables / spare conduits being located in the standard allocation within the road verge

- All pillars, padmount substations and switching stations are located in acceptable areas as stated in MDI 0028.
- No other assets and/or utilities being installed directly above the electrical assets
- Minimum distances between electrical assets and other utility services being maintained
- Sufficient access for Endeavour Energy vehicles (including trucks and EWP's) to access and maintain the assets without the need to close and/or block private roads.

5.4.8.3 Easements within Community Title developments

All assets owned by Endeavour Energy within a Community Title development and not installed within a public road, are to be provided with an easement to allow for future maintenance and repair.

For assets other than underground cables, the minimum easement widths defined in Table 1 must be achieved. However, the minimum easement widths for underground cables defined in Table 1, do not apply to Community Title developments. An easement the size of the trench width plus 500mm either side must be achieved as a minimum,

All easements must be created under a Section 88B of the Conveyancing Act 1919.

5.5 Easement creation

Easements must be created in favour of Endeavour Energy and can be created by one of the following three methods:

- Creation by Section 88B of the Conveyancing Act;
- Creation by Deed or transfer granting easement; and,
- Creation by compulsory process.

The easement must be defined on a plan, and registered at LPI.

A restrictive or positive covenant cannot be compulsory acquired.

5.6 Easement terms

The easement terms defines the rights and restrictions for an easement for Endeavour Energy and the landowner. The terms of an easement must be defined to the landowner in writing. Annexure 1 contains the standard easement terms for Endeavour Energy's:

- Overhead Lines, Underground Cables, Padmounts, Switching Stations and streetlighting;
- Indoor Substations; and,
- Rights of Access.

There may be additional rights and restrictions required for certain easements so that Endeavour Energy interests are protected.

An owner may have specific site requirements that require amendment to the standard terms. The details of any proposed amendment are to be submitted to Endeavour Energy's Mains Assets Manager for review prior to certification of the design for approval.

5.7 Other types of Property Tenure

Restrictions on the use of land are sought by Endeavour Energy on land on which its infrastructure exists to protect the integrity and security of its network, whilst still allowing the landowner to own and make use of their land.

A positive covenant is sought when Endeavour Energy will allow activities on the site but only with additional controls. An example of a positive covenant is requiring the installation of fire proof screen walls near Endeavour Energy's electrical assets.

In situations where Endeavour Energy requires covenants to be provided around electrical equipment / assets, the following standards terms defined in Annexure 3 must be used.

5.8 Modifying assets with an easement

Where an existing asset (post May 2006) is to be replaced/upgraded/modified, and there will be an increase to the existing easement size, then the designer must go through the process of applying for a new easement.

An easement may be reduced in size if:

- The easement meets the minimum size requirements as detailed in Table 1;
- If approval is sought and granted from Capacity Planning Manager, and the corresponding Regional Transmission/Distribution Manager.
- A design for the existing line demonstrating the asset will have sufficient access and clearance.

5.9 Easement release

Easements may be released if the need arises and the easement has no / limited benefit to Endeavour Energy. Easements releases must be managed in accordance with Company Policy 9.2.4.

5.10 Easement height

Easements do not have a specified height to which they apply. Endeavour Energy does not allow assets to be installed above its assets, as this presents access, safety and reliability risks. Where all other options have been exhausted, a dispensation must be submitted as described in Company Procedure GAM 0114.

5.11 Rights granted by the Electricity Supply Act

5.11.1 Protection of assets installed before May 2006

Section 53 of the Electricity Supply Act 1995, protects Endeavour Energy infrastructure that was constructed prior to the commencement of the *Electricity Supply Amendment (Protection of Electricity Works) Act* 2006 (26th May 2006), from action from the owner of the land in which Endeavour Energy infrastructure exists.

Endeavour Energy may maintain, operate, repair, replace or upgrade the infrastructure despite whether a registered easement exists. However, this protection does not exist for new assets which are constructed on private land after the 26th of May 2006, and as such, easements must be acquired for new assets.

5.11.2 General protection of network assets

The following summarises the powers Section 49 and 49A of the Electricity Supply Act 1995, grants Endeavour Energy:

Section 49 – Endeavour Energy may serve a written notice to a person who has control of a structure, which may interfere, destroy or damage Endeavour Energy's network to remove the imposing structure. This is regardless if the person owns the land on which Endeavour Energy's asset exists.

Section 49A - Endeavour Energy may serve a written notice to a person who is carrying out excavation work in, on or near its network which may destroy or damage Endeavour Energy's network to cease work immediately.

5.12 Works on assets without a registered easement

Endeavour Energy is legally required to provide a safe and reliable network. As such, where the need arises where a network asset is required to be modified or replaced, and does not have the benefit of an easement (installed before May 2006), Endeavour Energy will evaluate all possible options in the refurbishment/replacement of the asset.

In assessing the upgrade of the asset the following factors will be considered:

- If there will be an increase in the required size of the easement;
- Is it a like-for-like replacement.
- The impact on the customer and the aesthetic nature of the new asset;
- The risk to the customer, to the public or to Endeavour Energy employees of the current installation;
- The preference of the customer;
- The required access to maintain and install the new asset.

Where the evaluation has concluded that the asset needs to be replaced/modified, Endeavour Energy reserves the right to do so. However, where the rectification works will increase the size of the required easement width, an easement must be created for the rebuilt asset.

5.13 General requirements on encroachment management

For easements managed by Endeavour Energy, encroachments fall into three (3) categories – *permitted*, *prohibited* or *controlled*.

- Permitted activity – An activity which is allowed within an easement, but must still adhere to the minimum safety requirements within the easement.
- Prohibited activity – An activity that must not be performed under any circumstance within the easement.
- Controlled activity – An activity which is allowed only if it meets both the minimum safety requirements for that type of easement with additional controls which are specified in the appropriate clause detailed below. Approval from Endeavour Energy is required for any controlled activity.

The main principle behind these categories is to maintain a high level of safety of the public and Endeavour Energy employees, whilst also allowing Endeavour Energy to inspect, operate, maintain, access and upgrade its network.

The activities listed below are not exhaustive, and where an activity/encroachment is not covered, a request to Mains Assets Manager must be submitted, which is to include:

- a full risk assessment detailing the risk to the network and safety and suitable controls.
- an overview of the easement, all current and proposed Endeavour Energy assets as well as all current and proposed encroachments

Refer to Annexure 5 for the current list of identified encroachments, how Endeavour Energy manages these, and the applicable clauses.

Encroachments on assets which do not have a formal easement, must be treated as though an easement does exist as per clause 5.11, and how the applicable encroachment is handled in the following sections. Table 1 may be used as an indication as to the applicable easement width, however, an assessment of the minimum easement size required to maintain access and safe operation of the asset is required.

5.14 Encroachments on overhead line easements

5.14.1 Minimum safety requirements for overhead line easements

For an overhead line easement, the following criteria must always be met, to maintain the safe operation of the network and employees:

- Minimum ground clearances, as defined in MDI 0031 and MDI 0047 are maintained, when the conductor is operating at maximum design temperature;
- Sufficient clearance is maintained to accommodation for overhead line blowout (500Pa, with the conductor operating at 50ºC);
- Minimum separation clearances between the network and objects/structures are maintained to this standard and AS/NZS 7000.
- Does not allow a person to breach the safety clearances to the network, namely, allow any part of a person to be greater than 4.3m above the ground (See Figure 6) ;
- Access to Endeavour Energy assets are not reduced and the minimum requirements of Figure 6 and clause 5.19 are adhered to.

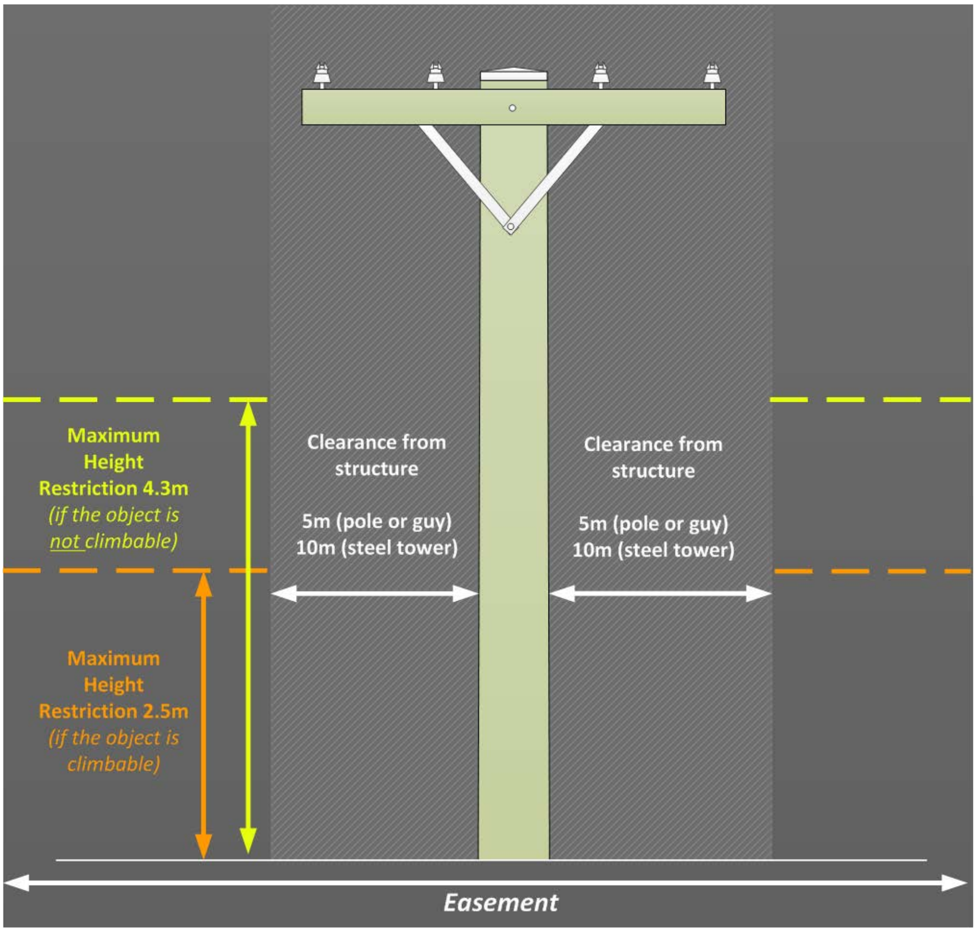


Figure 6 - Overhead line restriction within easement

5.14.2 Prohibited activities / encroachments

The following activities / encroachments listed below are prohibited within all Endeavour Energy easements and will not be approved:

- Construction of habitable buildings (permanent or temporary);
- Construction of garages or large sheds, whether permanent or temporary, or any other structure which may allow safety clearances to be breached;
- The installation of fixed plant (such as conveyor belts) or equipment, or its footings;
- The planting of trees that exceed a height of three (3) metres ;
- The placement of obstructions which may hinder access requirements;
- In-ground or above-ground swimming pools (permanent and / or temporary constructions);
- The storage and / or use of flammable, combustible, corrosive or explosive material;
- The storage and / or handling of conductive material of lengths in excess of three (3) metres;
- Lighting of any fires (this does not include back burning, refer to section 5.14.4.8);
- Parking of large vehicles (such as tankers and semi-trailers with large loads);
- The setting up of campervans or tents, which would allow persons to reside in the easement;
- The construction of flag poles and/or weather vanes which are taller than 4.3m;
- Electric fencing;
- Ploughing near electricity structures or stay poles/wires, that may impact the assets structural integrity;
- Use of any types of explosives;
- Flying of kites, model aircraft or drones;
- BMX bike riding (with jumps);
- Installation of flood lighting;
- Any activity which involves firearms.

Where an activity or encroachment is found to be being undertaken/installed and is on the above list, arrangement of its removal must be made. Any cost incurred will be at the expense of the owner of the land.

5.14.3 Permitted activities / encroachments

The following activities/encroachments are allowed within Endeavour Energy easements if it meets the minimum safety requirements detailed in clause 5.14.1:

- Low growing vegetation;
- Ground cover/surfaces such as wood chips and bluemetal stones;
- Storage of non-combustible, non-explosive, non-conductive, non-corrosive materials.

5.14.4 Controlled activities / encroachments

All controlled activities require approval to be sought from the applicable Regional Easement Officer of Endeavour Energy, in writing as set out in Clause 5.18.2. The Easement Officer will assess the activity/encroachment as defined Clause 5.18. The proposed activity must not commence unless approval is received in writing from Endeavour Energy Regional Easement Officer.

All these controlled activities must meet the required minimum safety requirements detailed in clause 5.14.1, as well as any additional controls listed below.

5.14.4.1 Minor structures

The following minor structures are permitted:

- clothes hoists;
- playground equipment;

- shade cloths / umbrellas;
- non-metallic fences (Endeavour Energy may require gates);
- small brick barbecues.

All metallic parts must be effectively earthed and no electrical supply must be brought within the easement.

If Endeavour finds that a structure impedes access or presents an unacceptable level of risk, Endeavour Energy reserves the right to have the structure removed, or to remove it at the owner's expense.

5.14.4.2 Non-habitable buildings (carports and metallic garden sheds)

Carports or metallic garden sheds can be installed within an overhead line easement provided they are effectively earthed, and no power is connected to the structure. Only metallic sheds which will not be inhabited must be approved.

5.14.4.3 Erection of conductive fencing / sound walls

All conductive fencing and/or sound walls crossing or running parallel to an easement are to be effectively earthed and / or have interval breaks in electrical continuity to prevent electromagnetic induction and transferred voltage hazards. Refer to drawing 242450, 242451 and 069575 for requirements for fencing.

A minimum 4.2 metre wide opening or gate (with provision to accept Endeavour Energy locks) for vehicle access will be a condition of approval.

5.14.4.4 Metal safety barriers and guardrails

Where a metal barrier (Armco guardrail or similar) crosses and continues beyond an easement, the following is required:

- The section of barrier within the easement must be earthed.
- A minimum 300 mm clear air gap must be left between the end of the barrier within the easement boundary and the starting point of the barrier beyond the easement boundary.

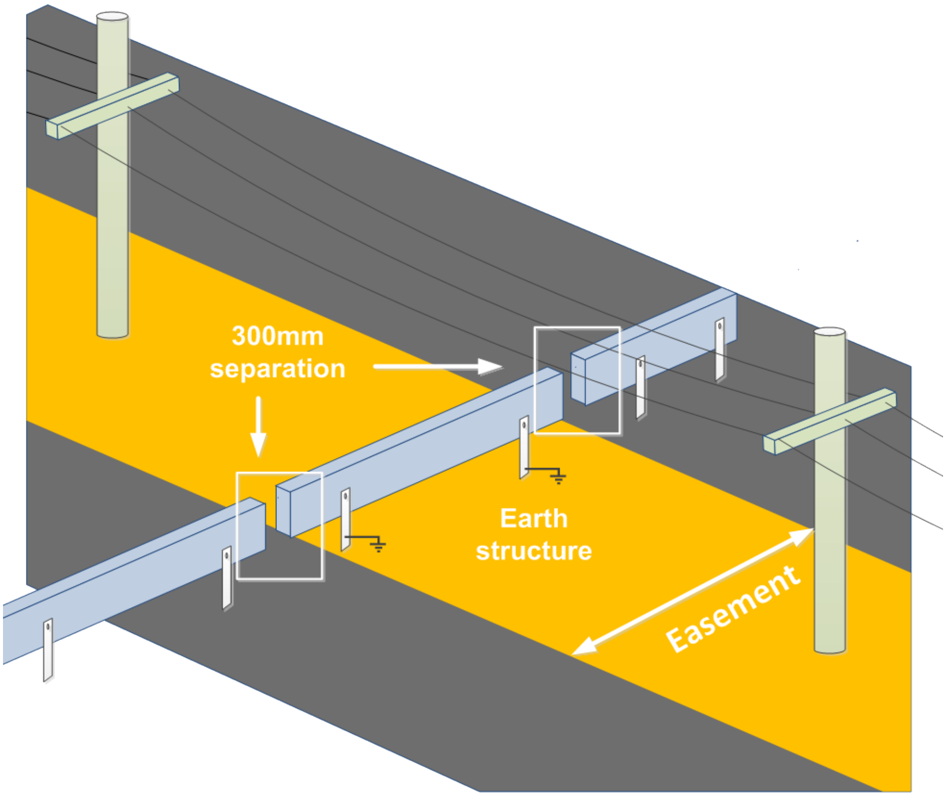


Figure 7 - Safety Barrier Requirement

5.14.4.5 Retaining walls

All proposed retaining walls must be made as to provide sufficient strength for any future work to be performed by Endeavour Energy, and must not impact the maintenance activities required on any assets within the easement.

5.14.4.6 Parking of vehicles or mobile plant

Parking within an overhead easement is subject to the vehicle:

- having a height limitation of 4.3 metres;
- is not occupied;
- is not connected to power; and,
- must be able to be readily removed if Endeavour Energy requires access to its assets.

5.14.4.7 Operation of mobile plant and equipment

No mobile plant and equipment must exceed a maximum height of 4.3 metres.

Within an overhead easement area, approval for the operation of mobile plant and equipment is dependent upon available clearances to the conductors under maximum operating conditions, power line voltages, vehicle operating heights and the level of accreditation of the vehicle operator.

Consequently, each application for the operation of mobile plant and equipment will be processed by the Regional Easement Officer and assessed for compliance with relevant Safework NSW legislation. A dedicated observer must also be present so that clearances are maintained.

Precautions must be taken to prevent collision or interference with overhead structures or stay poles.

5.14.4.8 Back burning

Back-burning operations carried out by fire authorities or bushfire brigades must be referred to Endeavour Energy's Control Room Manager and must include a map of the area showing the time, date and the area of the burn. An Endeavour Energy representative may attend back-burning procedures to maintain the safety of structures and conductors.

5.14.4.9 Agricultural pursuits

Agricultural pursuits, such as dusting, harvesting, netting and irrigation must have the following controls:

- Clear, defined vehicle access to structures is required to prevent damage to crops.
- Irrigation systems must not be placed within five (5) metres of the overhead conductors at any time.
- The location of any irrigation equipment must be such that it is not capable of projecting a solid jet of water to within three (3) metres of any overhead conductor.
- Gun type irrigators must have the water jet directed away from the conductors.
- Care must be taken when moving equipment around such as irrigation pipes or equipment, grain augers and the like.
- The equipment must not interfere with maintenance or safe operation of the power line, nor must it interfere with access to electricity assets.
- No electrical supply brought within the easement without prior approval of Endeavour Energy..

5.14.4.10 Rainwater tanks

Rainwater tanks must have the following controls:

- Above ground rainwater tanks, either for fire-fighting purposes or rainwater harvesting, erected within an easement, must be fully enclosed and of non-conducting material. (Concrete is considered to be a conductive material)
- All pipework is to be non-conductive and no electrical supply must be supplied to the tank for any purpose (including pumps and/or lighting).
- Any pumps and/or lights must be installed outside the easement.
- Ladders must not be installed on the rainwater tank.
- Rainwater tanks must not be installed within five (5) metres of a pole or stay pole, 10 metres from a steel structure or within five (5) metres of the vertical projection of the conductor.
- The tank and associated pipe work must not interfere with maintenance or access to electricity assets.

5.14.4.11 Detention basins

Applications for detention basins will be considered, subject to:

- The location has local council approval;
- The location is not within five (5) metres of a pole or stay pole or 10 metres from a steel structure;

- Sufficient clearance is maintained to all structures along the easement to allow unrestricted access.

5.14.4.12 Quarrying, filling, earthworks, or change of ground contours

Approval by the Easement Officer may be given, subject to:

- The maintenance of standard ground clearances (if conductor heights need adjustment, this will be at the proponents expense);
- Equipment/machinery performing earth works maintains standard clearances to the overhead lines;
- access maintained to all line structures;
- the subsoil stability and surface drainage in the vicinity of structures is not adversely affected; and,
- excessive quantities of dust are not generated.

5.14.4.13 Roads (other than access tracks)

For roads proposed within an existing easement, the minimum ground clearances as specified in MDI 0047 and MDI 0031 must be achieved.

Where alterations to conductor height and/or relocation of poles are required for the development of the road, this will be at the cost of the developer. This will include any work required to maintain safety clearances arising from activities in the easement after the road works are completed.

Where a road is proposed to run parallel to a feeder, a risk assessment evaluating the risk of impact with each structure as outlined in MDI 0031 must be submitted.

Earthing conductors may have been laid near, around and between the structures and must not have their electrical integrity compromised. Where a developer plans to construct a road which crosses the easement, the onus is on the developer to locate and avoid all earthing cables. If earthing cables are damaged, Endeavour Energy must be notified immediately.

Roads and driveways that are required for access to electrical infrastructure must be capable of carrying a 30 tonne truck.

5.14.4.14 Installation of utility services

Applications for the installation of telephone, water and sewerage services (overhead, underground, or on the surface) may be considered for approval by Endeavour Energy's Mains Assets Manager. The approval of the installation of these services will be based on:

- There is no practical alternative available;
- Any services within 15 metres of a structure must be constructed of non-conducting materials;
- The integrity of all line structures and stay pole/wires are to be maintained at all times;
- Designers and installers of utility services must consider any hazards associated with induced voltages and transferred earth potentials, in accordance with AS 4853, which must be controlled. Applications will require a risk assessment and proposed controls for each of the identified hazard.

Establishment of an easement for other utilities assets within Endeavour Energy's easement may be required.

5.14.4.15 Residential/Commercial subdivisions

Where subdivisions of property are proposed for land in which Endeavour Energy has an easement, the following requirements must be met:

- Unrestricted access to Endeavour Energy's structures are retained;
- No structures are to be erected within the easement;
- Structures suitably protected against motor vehicle impact;
- The number of crossings of Endeavour Energy's overhead line by utilities must be minimised, and complies with 5.14.4.14.

5.14.4.16 Domestic recreational activities and recreational facilities

Approval will be given for domestic recreation activities, but will not include activities that may interfere with clearances to the conductors, such as those listed in 5.14.2.

Approval will be given for recreational facilities, such as tennis courts, subject to:

- fencing is to be non-conductive material or must be effectively earthed (refer to section 5.14.4.3);
- Height of any fence is 4.3 metres or less;
- facilities surface construction will be required to withstand the movement of large heavy plant up to a 30 tonne truck; and,
- not located within five (5) metres from a power pole or ten (10) metres from a steel structure.

5.14.4.17 Storage of organic materials

Small amounts of organic materials, such as leaves and compost, may be stored underneath overhead powerlines, provided they do not impede access to structures and do not create a fire hazard.

5.15 Encroachments on underground easements

5.15.1 General information for underground asset easements

Where relocation of existing assets are proposed, the costs to enable the activity to proceed, will be borne by the applicant.

Safework NSW (previously Workcover Authority of NSW) Publications provides guidance on risk control measures when working close to electricity infrastructures both below and above ground. Refer to *Code of Practice – Work near Overhead Power Lines* or *Work Near Underground Assets Guide*.

5.15.2 Minimum safety requirements for underground asset easements

For an underground asset easement, the following criteria must **always** be met, to maintain the safe operation of the network and employees:

- Before commencing any underground activity, all applicants are required to obtain advice from the ***Dial before You Dig*** **1100** service in accordance with the requirements of the Electricity Supply Act and associated Regulations.
- Ground contour does not substantially change, which would impact the rating of the conductors;
- Any storage of an asset is temporary in nature and can be moved at a given notice or the cost of removal of the encroachment will be at the expense of the owner, if Endeavour Energy requires access to its asset;
- No mechanical compacting is to occur within an easement.
- Access to Endeavour Energy joints/joint bays are not impeded.
- No excavation which is greater than 300mm deep must occur.

5.15.3 Prohibited activities / encroachments

The following activities / encroachments listed below are prohibited within all Endeavour Energy easements and will not be approved:

- Construction of habitable buildings (permanent or temporary)
- Installation of minor structures (such as shade cloths, clothes lines, flood lights, playground equipment, fences and BBQs.)
- Installation of all types of garages, sheds, shipping containers, or carports.
- Installation of sound walls or safety barriers.
- Installation of conductive fencing which runs through an easement.
- Installation of rainwater tanks;
- Electric fencing;
- Retaining walls running longitudinally above underground assets;
- The installation of footings for fixed plant or equipment;
- Plants with significant root systems that grow greater than 400 mm below ground level;
- In-ground or above-ground swimming pools and spas (permanent and / or temporary constructions)
- Ploughing that is greater than 300mm deep, or at a depth greater than 400mm above underground assets
- The storage and / or use of flammable, combustible, corrosive or explosive material
- Changing of the ground level such that relative depth of underground cables increases or decreases
- Permanent surfaces, such as asphalt or concrete;
- The placement of obstructions which may hinder access requirements
- Concrete driveways located above and/or that restrict access to existing cable joints/pits.
- Use of explosives;
- Installation of tennis courts;

Where an activity or encroachment violates the above requirements, arrangement of its removal must be made. Any cost incurred will be at the expense of the owner of the land.

5.15.4 Permitted activities / encroachments

The following activities/encroachments are allowed within Endeavour Energy easements if it meets the minimum safety requirements detailed in clause 5.15.2:

- Tents;
- Flag poles and/or weather vanes;
- Sound walls;
- Metal safety barriers;
- Parking of small vehicles;
- Shrubs with root systems that are less than 400mm;
- Alternative ground surfaces (such as Bluemetal stones and woodchips);
- Storage of non-combustible, non-flammable, non-explosive material;
- Rainwater tanks;
- Detention basins;
- General recreational activities, the flying of kites and model aircraft, and the use of firearms;

5.15.5 Controlled activities / encroachments

All controlled activities require approval to be sought, from Endeavour Energy's Regional Easement Officer, in writing as set out in Clause 5.18.2. The Easement Officer will assess the activity/encroachment as defined Clause 5.18. The proposed activity must not commence unless approval is received in writing from Endeavour Energy Regional Easement Officer.

Controlled activities must meet the minimum safety requirements detailed in clause 5.15.2, as well as any additional controls listed below.

5.15.5.1 Fencing

A minimum 4.2 metre wide opening or gate (with provision to install Endeavour Energy locks) for vehicle access will be a condition of approval of fencing on the boundary of the easement.

Where fencing runs through an easement, the posts must be located outside the easement.

5.15.5.2 Metallic pipes (greater than 3 metres)

The storage of metallic pipes greater than three (3) metres is acceptable provided the metallic pipes can be moved upon request.

5.15.5.3 Fixed plant and/or equipment

Fixed plant is generally not allowed within Endeavour Energy's underground easement areas. This is due to potential access issues as well as risk of damage to Endeavour Energy's assets for the installation fixed plant footings. A proposal where fixed plant crosses an underground easement perpendicularly, will be considered upon application.

5.15.5.4 Parking of Mobile plant, equipment or vehicles

Within an underground easement area, approval is dependent upon an adequate surface to support the mobile plant/vehicle (up to 30 tonne) or equipment likely to be parked to prevent the crushing of the cables/ducts or erosion of the ground. In some instances, the activity may require supervision by an Endeavour Energy representative at the operator's expense.

5.15.5.5 Agricultural pursuits

Agricultural pursuits, such as dusting, irrigation and grazing are permitted within an underground easement. However, any activity which is likely to affect the ground level (such as ploughing and the planting of crops) is not allowed within the easement.

Equipment and/or crops must not interfere with access to electricity assets.

5.15.5.6 Roads and concrete driveways

Roads and concrete driveways are permitted within Endeavour Energy underground easements where:

- Cables are in existing continuous ducts;
- The roadway/driveway is capable of supporting the heaviest vehicle likely to traverse the driveway;
- The thermal rating of the cable is not compromised by the installation;
- The concrete driveway is not proposed to be installed within a distance that would restrict access / maintenance of a joint / pit.
- The concrete driveway is not proposed to be installed over a joint / pit.

The need for (including size and quantity) spare conduits must be confirmed with Network Capacity Planning prior to construction within Endeavour Energy's easements. All required conduits must be funded by the applicant.

If a roadway/driveway is found to be installed without the installation of spare ducts, the owner of the driveway must bear the cost of installing additional ducts, which will be done either by digging up the driveway or under-boring if required by Endeavour Energy at a future stage.

5.15.5.7 Installation of utility services

The installation of underground services must comply with MCI 0006 and Drawing 403230 Sheets 1 – 12.

5.15.5.8 Residential/Commercial subdivisions

Where subdivisions of property are proposed for land in which Endeavour Energy has an easement, the following requirements must be met:

- Unrestricted access to Endeavour Energy's structures are retained;
- No structures are to be erected within the easement;

5.15.5.9 Retaining walls

Retaining walls must not be approved where they run longitudinally over an underground easement.

Retaining walls which encroach on an underground easement, must be:

- Built using concrete material (for example, *Besser* blocks, concrete / clay bricks);
- Have mustow foundations;
- Must be a maximum of one (1) metre in height

Where foundations require digging post holes, these must be located outside the easement.

5.16 Encroachments on Padmount Substation or Switching Station easements

5.16.1 General information for padmount substation easements

For the purpose of this section, wherever a padmount substation is referenced, this also applies a ground substation, padmount substation and switching station.

Where the relocation of existing assets is proposed, the costs to enable the activity to proceed will be borne by the applicant.

Workcover Authority of NSW Publications provides guidance on risk control measures when working close to electricity infrastructures both below and above ground. Refer to *Code of Practice – Work near Overhead Power Lines* or *Work Near Underground Assets Guide*.

5.16.2 Minimum safety requirements for padmount substation easements

The minimum safety requirements padmount substations easements are outlined below and must **always** be met to maintain the safe operation of the network and employees:

- Screening vegetation for padmount substations must be planted outside the easement. Any vegetation adjacent to the easement must not obstruct access to the padmount substation and must be maintained in such a manner as to allow easy access to Endeavour's assets.
- The ground contour surrounding the padmount substation does not substantially change;
- Storage of an object/machinery is temporary in nature and can be moved at a given notice and if Endeavour Energy requires access to its asset the cost of removal of the encroachment will be at the expense of the owner;
- No building overhangs within the six (6) metre airspace above a padmount substation site;
- No construction must occur within the padmount substation / switching station easement;
- No mechanical compacting is to occur within an easement.
- Access to Endeavour Energy joints/joint bays and the padmount substation must not be impeded and must comply with clause 5.19.

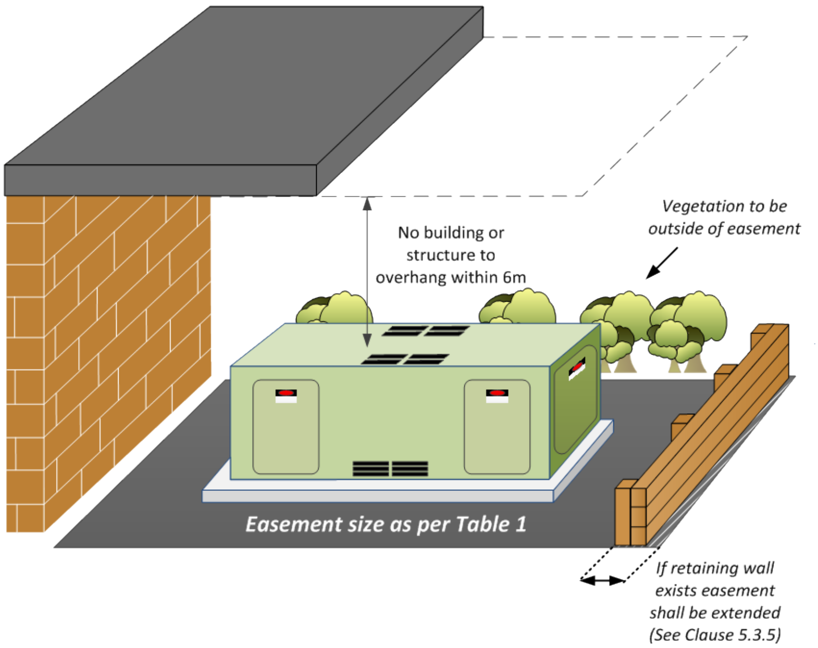


Figure 8 - Padmount Substation Easement Requirements

5.16.3 Prohibited activities / encroachments

Most activities are prohibited within the padmount substation easement. For a full list refer to Annexure 5 – Encroachment reference guide.

5.16.4 Permitted activities / encroachments

The following activities/encroachments are allowed within Endeavour Energy easements if it meets the general requirements in Clause 5.16.2.

- The use of mobile plant and/or equipment;
- Planting of vegetation with a root system not greater than 400mm;
- The installation of easily removable surfaces other than grass (bluemetal or woodchips);

5.16.5 Controlled activities / encroachments

All controlled activities require approval to be sought, from Endeavour Energy's Regional Easement Officer, in writing as set out in Clause 5.18.2. The Easement Officer will assess the activity/encroachment as defined Clause 5.18. The proposed activity must not commence unless approval is received in writing from Endeavour Energy Regional Easement Officer.

All controlled activities must meet the minimum safety requirements detailed in Clause 5.16.2, as well as any additional controls listed below.

5.16.5.1 Mobile plant/equipment and Parking of vehicles

Where a padmount substation is in the vicinity of a parking facility, suitable crash and impact protection from vehicles must be installed. These must be positioned in such a way to allow access to the substation to be maintained. Any proposals for the installation of suitable vehicle impact protection measures are subject to approval from the Regional Easement Officer.

5.16.5.2 Agricultural pursuits

Agricultural pursuits are prohibited within a padmount substation easement. Grazing would be the only activity that would be permitted.

5.16.5.3 Roads and concrete driveways

Roads and concrete driveways are permitted within the padmount easements where:

- Cables are in existing continuous ducts;
- The roadway/driveway is capable of supporting the heaviest vehicle likely to traverse the driveway;
- The thermal rating of the cable is not compromised by the installation;
- Suitable crash and impact protection must be installed, positioned in such a way to allow access to the substation to be maintained.

5.16.5.4 Retaining walls

Retaining walls built around distribution substations or switching stations, as part of reticulation requirements, must be outside the standard easement Refer to 5.3.6.

Proposed retaining walls must not impact the maintenance activities performed by Endeavour Energy on any assets within the easement.

5.16.5.5 Fencing

For fencing requirements around a padmount substation refer to MCI 0006 – Section 7.

Fencing surrounding an easement must comply with Table 2.

Table 2: Fencing near a Padmount Substation

Padmount Earthing	Fence Allowed	
	On easement boundary	Through easement
Common Earthed	YES	NO
Separately earthed	If within 4m of padmount, fence posts must be insulated and a touch-voltage assessment required.	NO

5.17 Transfer earth hazards

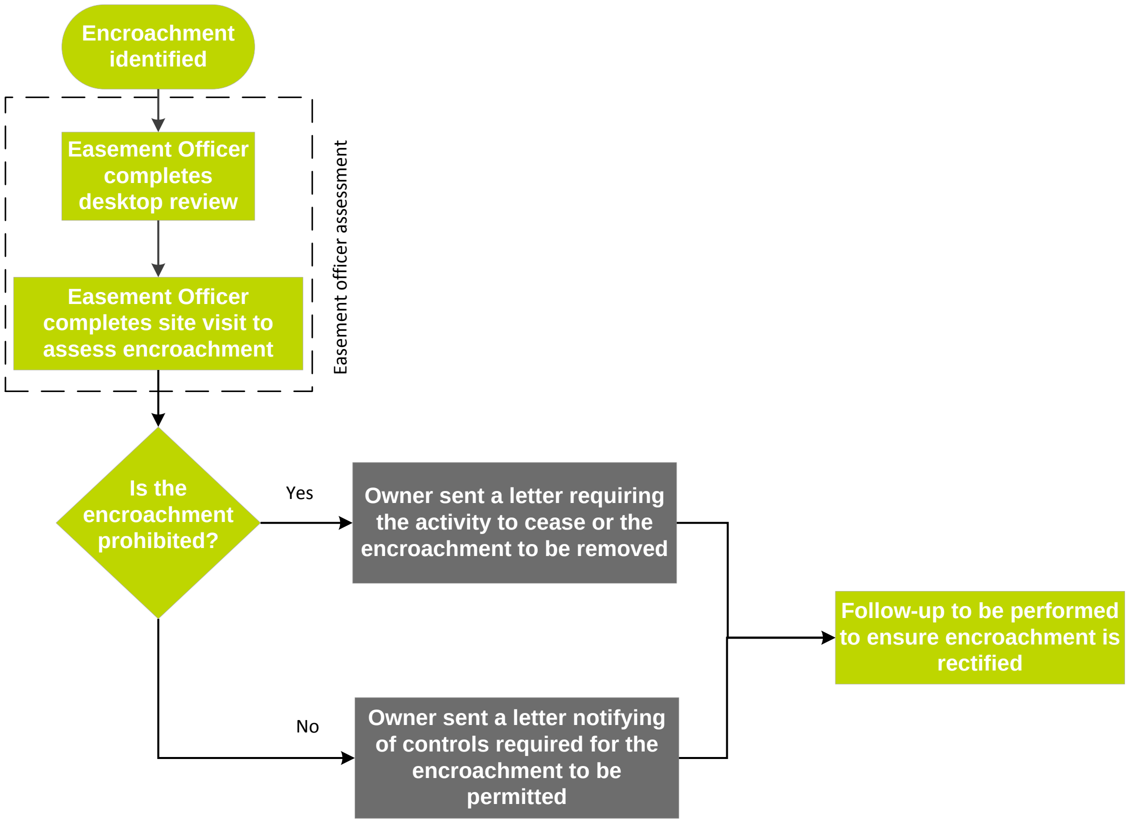
In addition to all requirements stipulated in this standard the risk of transfer earth hazards associated with Endeavour Energy's assets and/or equipment, structures or objects must be managed in accordance with SDI 100 "Distribution earthing design, construct and test".

This requirement may impose restriction zones around Endeavour Energy's assets limiting the use of land within the defined area(s).

5.18 Encroachment management process

5.18.1 Existing encroachment management process

Endeavour Energy will manage existing encroachments that have not been previously approved, according to the flowchart below:



5.18.1.1 Easement Officer Review

Once identified, the Easement Officer will perform both a desktop assessment and a site visit to determine whether the encroachment is permitted, controlled or prohibited, as defined in Clause 5.11, or whether with possible controls can overcome / lessen the encroachment.

On completion of the assessment, a letter will be sent to the owner, identifying:

- Explanation of the terms of the easement;
- Identifying the hazards to themselves, members of the public and Endeavour Energy's employees;
- Providing advice on possible solutions to overcome / lessen the encroachment.
- The outcome of the assessment:
    - Where the encroachment is determined to be a "controlled activity", conditional approval for it to continue must be given only if the applicable controls (as defined in Clause 5.11) are used.
    - Where the encroachment is determined to be a prohibited activity/structure, the owner will be required to remove the encroachment or cease the activity.

A follow-up site visit will be completed within 30 days to check whether the encroachment has been adequately managed.

Legal action will be considered when all other avenues are exhausted.

The local council must be included in correspondence to highlight the need for their approval process to include a corresponding approval from Endeavour Energy where easements are involved.

5.18.2 Applications for controlled encroachments

All applications for an activity or encroachment, or requests for advice, must be referred to Endeavour Energy's Regional Easement Officers. Applications must be addressed to:

> Regional Easement Officer – North / Central / South *(see table below)*
> Endeavour Energy
> PO Box 811
> Seven Hills NSW 1730

Endeavour Energy's network franchise area has three (3) regions, responsible for the local government areas set out in the following table:

Region	Local government areas
North	Bathurst, Baulkham Hills, Blacktown, Blue Mountains, Hawkesbury, Lithgow, Parramatta, Penrith, plus parts of Hornsby, Mid-Western and Ryde.
Central	Camden, Campbelltown, Fairfield, Cumberland (Holroyd), Liverpool, Wingecarribee, Wollondilly, plus parts of Bankstown.
South	Kiama, Shellharbour, Shoalhaven, Wollongong.

5.18.2.1 Application requirements

Due to the varied circumstances that apply to easements, all applications will be assessed individually, and will be site specific.

All applications require the following:

- The application is to be made in writing.
- The application is to include detailed plans, drawn to scale and with full dimensions, showing property boundaries, lot number, Deposited Plan (DP) number, any electricity structures, and other relevant information.
- A survey plan of an easement for padmount substation must show the substation number and at least two (2) offsets from adjacent sides of the concrete plinth to the easement boundary.
- Each application will require an impact and risk assessment and must be assessed on the site-specific circumstances and Endeavour Energy's risks assessment company procedure of the proposal.

5.18.2.2 Easement Officer Review

After the application has been received, the easement officer will perform a desktop review of the application and if required, a site visit.

Where Endeavour Energy is uncertain about the impact of the controlled activity or encroachment, the applicant/s will be asked to arrange an independent study of the risk at their own expense. Endeavour Energy will consider the outcome of the study when deciding on the application.

Where additional testing is required, the applicant will be responsible for:

- Arranging the test with an organisation acceptable to Endeavour Energy;
- Paying for the test;
- Supplying the test results to Endeavour Energy.

5.19 Access and Rights of Way

Where possible, access to Endeavour Energy assets must be made possible by access tracks located within Endeavour Energy easements.

Consideration must be given to securing access by the way of a land tenure agreement and/or other legal instruments such as 'Right of Ways', where:

- access tracks must traverse outside of easements;
- access options to assets is limited;
- significant investment has been outlaid to upgrade and/or construct an access; or,
- there is future development planned for an area that may affect or obstruct access routes.

The appropriate land tenure agreement and or legal instrument must be discussed with the Property, People and Services Branch.

5.19.1 Locking arrangements for shared access gates

In some cases, access to land with electricity easements is shared by Endeavour Energy with others – utilities, customers, and organisations such as the NSW National Parks and Wildlife Service or the Rural Fire Service.

Where access is through a gate protected by dedicated locks, an EL specification lock must be installed. The preferred arrangements for single or multiple locks are shown in Figure 9. Where there is more than one lock, the locks must be spaced as evenly as possible by joining with equal lengths of chain.

The entire chain must be of exact length to allow the gate to be fully secured, while allowing for the chain to be rotated so that access to the locks is possible from either side of the gate.

When replacing locks after entering or leaving, the correct ends of the chain must be connected with the lock, so that it remains a continuous loop.

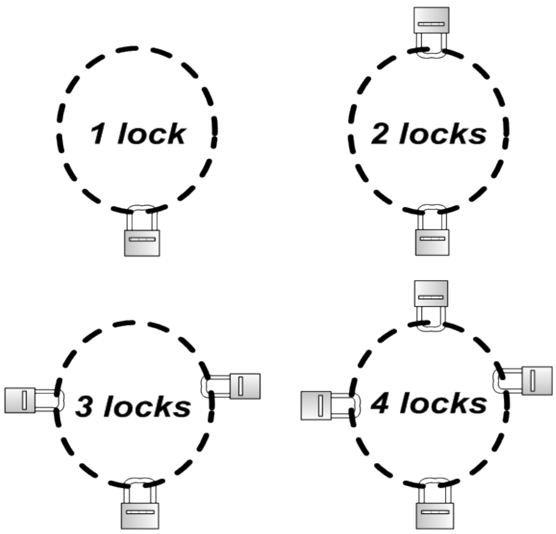


Figure 9 – Locking arrangements for shared access gates

5.20 Recording of easements in GIS

When an easement is created, the easements must be reflected in the Endeavour Energy's GIS system.

5.21 Drawings

Drawing No	Amendment	Title
016665	S	11kV and 22kV Padmount substation easement layout
086232	K	Minimum clearances near structures
282551	A	Size 16 Switching Station easement layout
289702 (Sheets 1 – 7)	A	Fencing arrangement for padmount substation easement details
403230 (Sheets 1 – 12)	A	Shared trenching arrangements
242451	B	Chain wire fence – isolation panel and earthing installation detail
069575	G	Solid Metallic Fence – Isolated panel and earthing installation detail
242450	A	Transmission Line Structure – Metallic fence clearance and isolation panel requirements.

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and responsibility for approving this instruction.

General Manager, Network Services has the authority and responsibility for all new distribution and transmission projects complying with the contents of this instruction.

Manager Asset Standards & Design has the delegated authority and responsibility for approving this instruction and the endorsing of non-standard/reductions in easement widths.

Manager Network Connections has the authority and responsibility for new contestable works electrical designs complying with this instruction.

Mains Assets Manager has the authority and responsibility for:

- Endorsing the content of this instruction;
- Keeping the content of this instruction is kept up to date;
- Approval for encroachments within easements.

Substation Assets Manager has the authority and responsibility for providing input into the content of this instruction.

Earthing and Power Quality Manager is responsible for the assessment and approval of earthing issues within easements.

Easements Officers are responsible for:

- Reviewing easement encroachment applications;
- Performing investigations into possible encroachments;
- Providing advice and consultation to stakeholders.

7.0 DOCUMENT CONTROL

Documentation content coordinator: Mains Assets Manager

Documentation process coordinator: Branch Process Coordinator

Annexure 1 STANDARD EASEMENT TERMS

A1.1 - Overhead Lines, Underground Cables, Padmounts, Switching Stations, Street Lighting, Pole/Ground Stays

1.0 Definitions:

1.1 **easement site** means that part of the lot burdened that is affected by this easement.

1.2 **electrical equipment** must be defined as stated below for each of the easement terms associated with the following asset classes:

1.2.1 *Overhead Power Lines* - includes pole, tower, overhead electrical conductors, underground earthing system, and ancillary equipment.

1.2.2 *Underground Cables* - includes underground electrical cable, duct, service pillar, underground earthing system, and ancillary equipment.

1.2.3 *Padmount Substation / Switching Station* - includes electrical transformer (padmount only), switchgear, protective housing, concrete plinth, underground electrical cable, duct, underground earthing system, and ancillary equipment.

1.2.4 *Pole Stays / Ground Stays* – includes stay pole, concrete strainer block, stay cable, stay wire, and ancillary equipment.

1.2.5 *Street Lighting* – includes the column, lantern and foundations of the street light.

1.3 **Endeavour Energy** means Endeavour Energy and its successors (who may exercise its rights by any persons authorised by it).

1.4 **install** includes construct, repair, replace, maintain, modify, use, and remove.

1.5 **owner** means the registered proprietor of the lot burdened and its successors (including those claiming under or through the registered proprietor).

1.6 **services** includes Network gas, telephone, communications, water, sewage, and drainage services.

1.7 **structure** includes building, wall, retaining wall, carport, and swimming pool; but excludes garden furniture and garden ornaments.

2.0 Endeavour Energy may:

2.1 install electrical equipment within the easement site,

2.2 excavate the easement site to install the electrical equipment.

2.3 use the electrical equipment for the transmission of electricity,

2.4 enter the lot burdened using the most practical route (with or without vehicles, machinery or materials) at all reasonable times (and at any time in the event of an emergency) and remain there for any reasonable time. This may include the installation of gates in existing fencing if access is not readily available,

2.5 install its own access gates and locks,

2.6 trim or remove any vegetation from the lot burdened that interferes with or prevents reasonable access to the easement site or the electrical equipment, and

2.7 remove any encroachments from the easement site and recover the costs of carrying out the removal work and repairing any damage done to the electrical equipment by the encroachment.

3.0 In exercising its rights under this easement Endeavour Energy will take reasonable precautions to minimise disturbance to the lot burdened and will restore the lot burdened as nearly as practicable to its original condition.

4.0 The owner agrees that, without the written permission of Endeavour Energy and in accordance with such conditions as Endeavour Energy may reasonably impose, it will not:

4.1 install or permit to be installed, any services or structure within the easement site, or

4.2 alter the surface level of the easement site, or

4.3 do or permit to be done anything that restricts access to the easement site by Endeavour Energy

5.0 Lessee of Endeavour Energy's Distribution System

5.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

5.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

A1.2 - Indoor Substation

1.0 Definitions:

1.1 **building** means the building within which the electrical equipment is located.

1.2 **easement site** means that part of the lot burdened that is affected by this easement.

1.3 **electrical equipment** includes electrical transformer, electrical switchgear, electrical cable, duct, services, ventilation, and ancillary equipment.

1.4 **Endeavour Energy** means Endeavour Energy and its successors (who may exercise its rights by any persons authorised by it).

1.5 **install** includes construct, repair, replace, maintain, modify, use, and remove.

1.6 **owner** means the registered proprietor of the lot burdened and its successors (including those claiming under or through the registered proprietor).

1.7 **services** includes Network gas, telephone, communications, water, sewage, and drainage services.

2.0 Endeavour Energy may:

2.1 install electrical equipment within the easement site,

2.2 use the electrical equipment for the transmission of electricity,

2.3 enter the lot burdened using the most practical route (with or without vehicles, machinery or materials) at all reasonable times (and at any time in the event of an emergency) and remain there for any reasonable time. This may include the installation of gates in existing fencing if access is not readably available,

2.4 install its own security doors to gain access to the electrical equipment and to prevent access by others, and

2.5 install conduits, cables, and pipes on, under or through the building for the purpose of connecting the electrical equipment with any services and to operate those services.

3.0 Endeavour Energy agrees that it will not cut, drill, alter or demolish any part of the building necessary to install or operate the electrical equipment without the written permission of the owner and in accordance with such conditions as the owner may reasonably impose.

4.0 In exercising its rights under this easement Endeavour Energy will take reasonable precautions to minimise disturbance to the lot burdened and will restore the lot burdened as nearly as practicable to its original condition.

5.0 The owner agrees that, without the written permission of Endeavour Energy and in accordance with such conditions as Endeavour Energy may reasonably impose, it will not:

5.1 install or permit to be installed any thing within the easement site, or

5.2 interfere with, allow to be interfered with, or prevent the ventilation of the easement site, or

5.3 direct or allow to be directed drainage into the easement site, or

5.4 do or permit to be done anything that restricts access to the easement site by the Endeavour Energy

6.0 Lessee of Endeavour Energy's Distribution System

6.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

6.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

A1.3 – Rights of Access

1.0 Definitions:

1.1 **access site** means that part of the lot burdened that is affected by this right of access.

1.2 **Endeavour Energy** means Endeavour Energy and its successors (who may exercise its rights by any persons authorised by it).

1.3 **owner** means the registered proprietor of the lot burdened and its successors (including those claiming under or through the registered proprietor).

2.0 Endeavour Energy may:

2.1 by any reasonable means pass across the access site for the purpose of exercising or performing any of its powers, authorities, duties or functions, and

2.2 do anything reasonably necessary for passing across the access site, including:

2.2.1 Entering the lot burdened;

2.2.2 taking anything on to the lot burdened; and,

2.2.3 carrying out work within the site of the easement, such as constructing, placing, repairing or maintaining trafficable surfaces, driveways or structures.

3.0 In exercising its rights set out in Clause 2.0, Endeavour Energy must:

3.1 complete all work properly;

3.2 take reasonable precautions to minimise disturbance to the lot burdened and owner of the lot;

3.3 cause as little damage as is practicable to the lot burdened;

3.4 restore the lot burdened as nearly as practicable to its former condition; and,

3.5 make good on any collateral damage;

4.0 Lessee of Endeavour Energy's Distribution System

4.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

4.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

Annexure 2 Terms of Restrictions on the Use of Land

A3.1 Safety Clearance between Padmount Substations and Adjacent Buildings

Terms of Restrictive Covenant numbered [xx] in the plan

1.0 Definitions:

1.1 **“120/120/120 fire rating”** and **“60/60/60 fire rating”** means the fire resistance level of a building expressed as a grading period in minutes for structural adequacy / integrity failure / insulation failure calculated in accordance with Australian Standard 1530.

1.2 **“building”** means a substantial structure with a roof and walls and includes any projections from the external walls.

1.3 **“erect”** includes construct, install, build and maintain.

1.4 **“restriction site”** means that part of the lot burdened affected by the restriction on the use of land as shown on the plan.

2.0 No building must be erected or permitted to remain within the restriction site unless:

2.1 the external surface of the building erected within 1.5 metres from the substation footing has a 120/120/120 fire rating and

2.2 the external surface of the building erected between 1.5 metres and 3.0 metres from the substation footing has a 60/60/60 fire rating

2.3 and the owner provides the authority benefited with an engineer’s certificate to this effect.

3.0 The fire ratings mentioned in Clause 2.0 must be achieved without the use of fire fighting systems such as automatic sprinklers.

4.0 Lessee of Endeavour Energy’s Distribution System

4.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

4.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

A3.2 Fire Proof Screen Walls

Terms of Positive Covenant numbered [xx] in the plan:

1.0 Definitions

1.1 **"fire proof screen wall"** means a wall of brick or concrete necessary to achieve a 120/120/120 fire rating up to a minimum height of **[***xx***]** metres from the level of the substation footing.

1.2 **"owner"** means the registered proprietor of the lot burdened and its successors (including those claiming under or through the registered proprietor).

1.3 **"prescribed authority"** means Endeavour Energy (and its successors).

1.4 **"120/120/120 fire rating"** means the fire resistance level of a building structure expressed as a grading period in minutes for structural adequacy/integrity failure/insulation failure calculated in accordance with Australian Standard 1530.

2.0 The owner covenants with the prescribed authority that the owner:

2.1 Will construct fire proof screen **[***wall/s***]** adjacent to the **[***northern, southern, eastern, western***]** **[***boundary/ies***]** of the easement for padmount substation.

2.2 Will maintain the fire proof screen **[***wall/s***]** in a satisfactory state of repair and in accordance with any reasonable conditions that the prescribed authority may impose.

3.0 Lessee of Endeavour Energy's Distribution System

3.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

3.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

A3.3 Fire Proof Walls and Roof

Terms of Positive Covenant numbered [xx] in the plan:

1.0 Definitions

1.1 **"fire proof wall"** means a wall of brick, concrete or other material necessary to achieve a [60/60/60 or 120/120/120] fire rating up to a minimum height of 6 metres from the level of the substation footing. It also includes any structures attached to the wall such as eaves and gutters.

1.1 **"fire proof roof"** means a roof constructed of concrete or other material necessary to achieve a [60/60/60 or 120/120/120] fire rating.

1.2 **"owner"** means the registered proprietor of the lot burdened and its successors (including those claiming under or through the registered proprietor).

1.2 **"padmount substation"** means padmount substation No. [xxxx]

1.3 **"prescribed authority"** means Endeavour Energy (and its successors).

1.4 **"60/60/60 or 120/120/120 fire rating"** means the fire resistance level of a building structure expressed as a grading period in minutes for structural adequacy/integrity failure/insulation failure calculated in accordance with Australian Standard 1530.

2.0 The owner covenants with the prescribed authority that the owner:

2.1 Will construct fire proof **[***wall/s***]** adjacent to the **[***northern, southern, eastern, western***]** **[***boundary/ies***]** of the easement for padmount substation.

2.2 Will maintain the fire proof **[***wall/s***]** in a satisfactory state of repair and in accordance with any reasonable conditions that the prescribed authority may impose.

2.3 Will construct fire proof roof above the padmount substation.

2.4 Will maintain the fire proof roof in a satisfactory state of repair and in accordance with any reasonable conditions that the prescribed authority may impose.

3.0 Lessee of Endeavour Energy's Distribution System

3.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

3.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

A3.4 Separation of Metal Structures to an Earth Grid

Terms of Restrictive Covenant numbered [xx] in the plan

1.0 Definitions:

1.1 **"erect"** includes construct, install, build and maintain.

1.2 **"restriction site"** means that part of the lot burdened affected by the restriction on the use of land as shown on the plan.

2.0 Except as provided in Clause 3.0, no metal structure must be erected or permitted to remain within the restriction site.

3.0 Metallic fencing may be erected within the restriction site if the fence panels are insulated from the fence posts and from the ground.

4.0 Lessee of Endeavour Energy's Distribution System

4.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

4.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

A3.5 Separation of Swimming Pools to an Earth Grid

Terms of Restrictive Covenant numbered [xx] in the plan

1.0 Definitions:

1.1 **"erect"** includes construct, install, build and maintain.

1.2 **"restriction site"** means that part of the lot burdened affected by the restriction on the use of land as shown on the plan.

2.0 No swimming pool or spa must be erected or permitted to remain within the restriction site.

3.0 Lessee of Endeavour Energy's Distribution System

3.1 Notwithstanding any other provision in this easement, the owner grants to Endeavour Energy the easement and acknowledges and agrees that any lessee of Endeavour Energy's distribution system, and any nominee of such lessee (which may include a sublessee of Endeavour Energy's distribution system from that lessee), may, without the need for any further approvals or agreements, exercise the rights and perform the obligations of Endeavour Energy as if that lessee or nominee were Endeavour Energy, but only for so long as the lessee leases Endeavour Energy's distribution system from Endeavour Energy.

3.2 The owner must do all things reasonably necessary to ensure any such lessee, and any such nominee, is able to exercise the rights and perform the obligations of Endeavour Energy.

Annexure 3 COMMUNITY TITLE BY-LAWS

To maintain access to assets the following by-law must be incorporated into all community title management statements where HV or LV (including street lighting) assets are owned and maintained by Endeavour Energy:

BY-LAW [X] ENDEAVOUR ENERGY – Access Ways

The Association agrees that if the surface of the access ways does not support the heavy vehicles, machinery and materials necessary to maintain Endeavour Energy's electrical equipment, the Association will be responsible for repairing any damage caused to the surface of the access ways during such maintenance.

This provision applies despite any other easement term to the contrary.

Where the ownership of any part of the electricity network (HV, LV or street lighting) within the community title development is to be the responsibility of the community association, the following by-law must be incorporated into the community title management statement:

BY-LAW [X] ENDEAVOUR ENERGY – Ownership of Assets by the Association

The low voltage electricity system is defined on the prescribed diagram as [eg "electricity"].

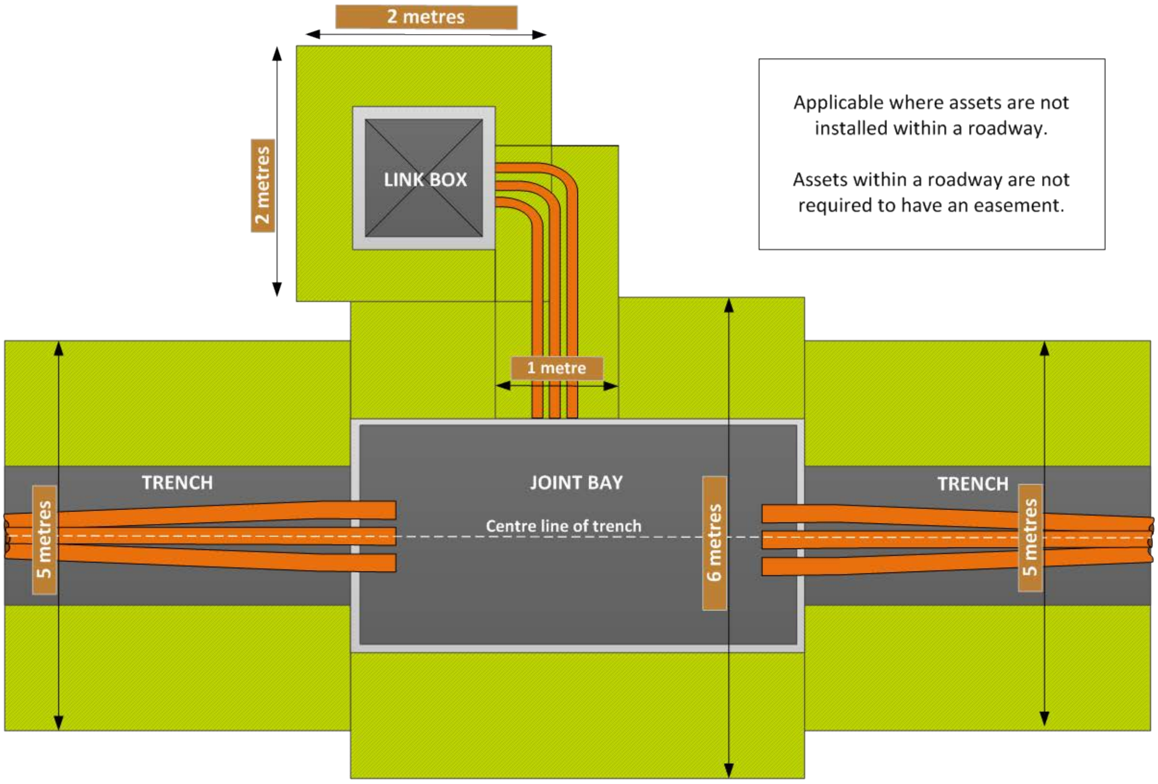
This electricity system is Association property.

The Association is responsible for the maintenance, repair, refurbishment, and augmentation of this electricity system.

The design of this electricity system has been based on a maximum demand of [as advised by the designer] Amps per dwelling.

Annexure 4 Typical easement layouts

A4.1 - Underground assets



A4.2 – UGOH and Stay pole easements

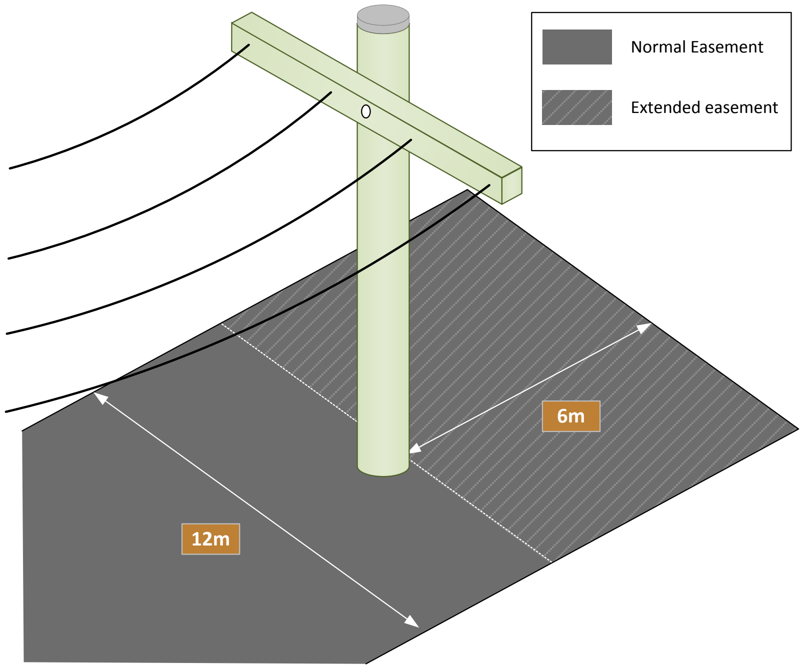


Figure 10 –UGOH pole easement

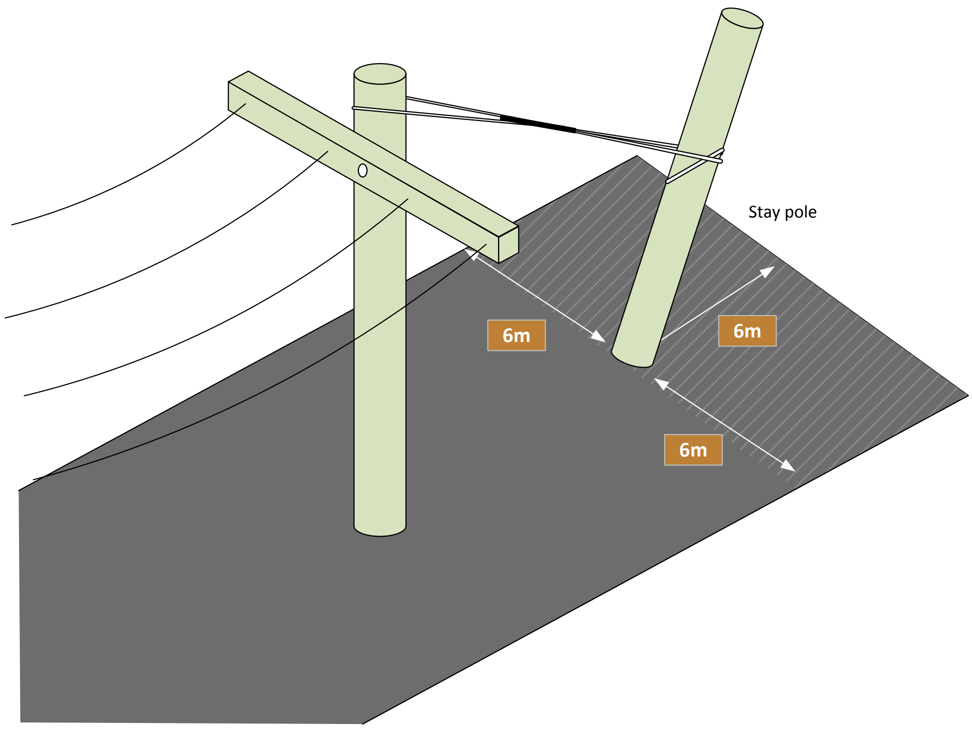


Figure 11 – Stay / Ground pole easement

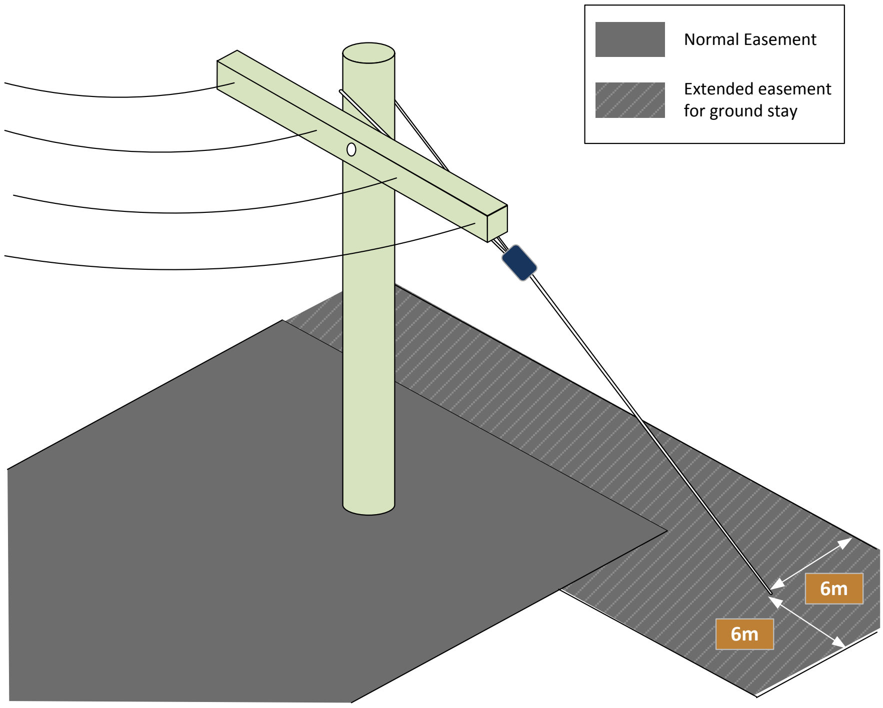
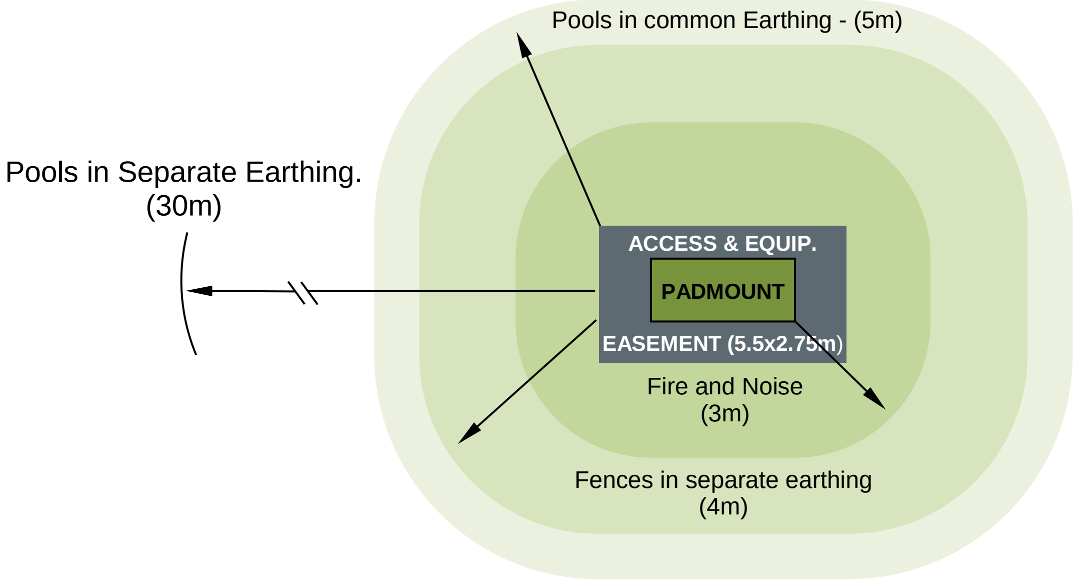


Figure 12 – Ground stay easement

A4.3 - Padmount easements and clearances



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Annexure 5 – Encroachment reference guide

Allowed - An activity which is allowed within an easement, but must still adhere to the minimum safety requirements within the easement stated in this document.
Prohibited - An activity that must not be performed under any circumstance within the easement.
Controlled - An activity which is allowed only if it meets both the minimum safety requirements for that type of easement with additional controls which are specified in the corresponding clause. Approval from Endeavour Energy is required for any controlled activity.

Category	Encroachment	Overhead				Underground				Padmount Substations			
		Allowed	Prohibited	Controlled	Clause	Allowed	Prohibited	Controlled	Clause	Allowed	Prohibited	Controlled	Clause
Buildings/ Structures	Buildings (habitable)		✓				✓				✓		
	Tents – Commercial or Recreational		✓			✓					✓		
	Shade Cloths / Umbrellas			✓	5.14.4.1		✓				✓		
	Minor structures (clothesline, playground equipment, non metallic fences and bbqs)			✓			✓				✓		
	Garages, large sheds and shipping containers (habitable)		✓				✓				✓		
	Non-habitable buildings (Carports and metallic sheds), and shipping containers (uninhabited)			✓	5.14.4.2		✓				✓		
	Flag pole / weather vane		✓				✓				✓		
Barriers/Walls	Sound walls			✓	5.14.4.3		✓				✓		
	Conductive fencing through an easement			✓				✓	5.15.5.1		✓		5.16.5.5
	Conductive on boundary of an easement			✓				✓			✓		
	Metal safety barriers			✓	5.14.4.4		✓				✓		
	Electric fencing		✓				✓				✓		
	Retaining walls			✓	5.14.4.5			✓	5.15.5.9			✓	5.16.5.4
	Metallic pipes in lengths greater than 3m		✓					✓	5.15.5.2		✓		
Fixed/ Mobile plant	Footings of Fixed plant		✓				✓				✓		
	Fixed Plant or equipment		✓				✓		5.15.5.3		✓		
	Mobile plant or equipment			✓	5.14.4.7			✓	5.15.5.4	✓			5.16.5.1
	Parking of tall vehicles, trucks, caravans, campervans		✓					✓			✓		
	Parking of other vehicles			✓	5.14.4.6	✓					✓		5.16.5.1
Vegetation	Shrubs with roots < 400mm	✓				✓				✓			
	Planting of trees which grow less than 3m	✓					✓				✓		
	Planting of trees which exceed 3m		✓				✓				✓		
	Storage of organic matter (leaves, compost)			✓	5.14.4.17			✓	5.14.4.17		✓		
Swimming Pools	Spas and Swimming pools – above ground		✓				✓				✓		
	Swimming pools – in ground		✓				✓				✓		

Category	Encroachment	Overhead				Underground				Padmount Substations			
		Allowed	Prohibited	Controlled	Clause	Allowed	Prohibited	Controlled	Clause	Allowed	Prohibited	Controlled	Clause
Fires	Lighting of fires		✓				✓				✓		
	Back burning			✓	5.14.4.8		✓				✓		
Agricultural use of the land	Agricultural pursuits such as dusting, harvesting, netting, irrigation			✓	5.14.4.9			✓	5.15.5.5			✓	5.16.5.2
	Ploughing near structures		✓			N/A					✓		
	Ploughing not near structures	✓					✓				✓		
Other	Objects which may hinder access		✓				✓				✓		
	Storage of combustible/flammable/corrosive material		✓				✓				✓		
	Storage of non-combustible, non-flammable, or non-corrosive material	✓				✓					✓		
	Rainwater tanks			✓	5.14.4.10		✓				✓		
	Detention basins			✓	5.14.4.11		✓				✓		
	Earth works – reducing cover or filling			✓	5.14.4.12		✓				✓		
	Permanent surfaces (asphalt, concrete etc)	✓					✓				✓		
	Different surfaces (bluemetal, woodchips)	✓				✓				✓			
	New Roads			✓	5.14.4.13			✓	5.15.5.6			✓	5.16.5.3
	Concrete driveways			✓				✓				✓	5.16.5.3
	Installation of Utility services – telecoms, water, LV elec, sewerage			✓	5.14.4.14			✓	5.15.5.7		✓		
	Residential/ Commercial subdivision lots			✓	5.14.4.15			✓	5.15.5.8	N/A			
	Use of explosives		✓				✓				✓		
Recreational Activities	Recreational activities – general (not including activities listed below)	✓				✓					✓		
	Recreational activities – flying kites, model aircraft, balloons		✓			✓					✓		
	Recreational activities – Flood lighting, grandstands		✓				✓				✓		
	Recreational activities – firearms		✓			✓					✓		
	Recreational activities – tennis courts			✓	5.14.4.16		✓				✓		

Note: Highlighting within the Encroachment column indicates a category which has been added since the last amendment. However, highlighting within the Overhead, Underground or Padmount columns represents a change in approach to the management of the encroachment since the last amendment.

MAINS CONSTRUCTION INSTRUCTION

ASSET STANDARDS AND DESIGN	Document no. Amendment no. Approved by Approval date	MCI 0006 4 MASD 14/3/16

MCI 0006 Underground distribution construction standards manual

Section 7 – Substations & Switching Stations

Contents

7.0 SUBSTATIONS & SWITCHING STATIONS

7.1 Actions

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

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

This section of the Underground Construction Manual contains all the drawings that are required to construct a standard distribution padmount or indoor substation, or switching station in Endeavour Energy's network. It does not contain the information required to design these substations or include specific project information.

The topics following are included as a guide to provide the minimum necessary background or clarification to the drawings. Further information on the minimum design requirement required by Endeavour Energy is detailed in MDI 00028.

7.1.1 General construction requirements

For complete details on general items including the following topics it is essential to refer to Section 3 – General construction requirements:

All terminations shall be cleaned/ scrubbed with a wire brush, electrical jointing compound applied to surfaces to be jointed, all burrs shall be removed from lug barrels.

All lugs are to be correct for their function and location ie Coastal. They shall be tightened to the correct torque value, correct size die used and correct number of crimps made.

All cables shall be sealed and where necessary shorted and tagged for identification purposes.

Cable clamps are to be used, saddles are not permitted.

All doors shall be fitted with a danger high voltage sign, substation number and emergency contact telephone number. All signs shall be free of obstructions so that full legibility exists at all times.

7.1.2 Minimum access requirements

7.1.2.1 General

Access requirements shall be in accordance with AS 2067 in addition to the following requirements.

Substations must be located at the front property boundary with unrestricted 24 hour a day employee and vehicle access to the substation directly from a public street.

Driveways are not regarded as public street access except where access is available by a vehicle driveway directly to the substation and the substation is located on the perimeter of the drive way, this may also be regarded as street level access if granted dispensation by Endeavour Energy.

All secure access areas (for example gates) shall use Endeavour Energy's standard key. Other acceptable access arrangements (if approved by Endeavour Energy) are:

- A chain with provision for Endeavour Energy and the customers locks in series.

- For solid doors or motorised gates, then a security lock box and a key shall be required along with personnel access gates. Security lock boxes shall be in a readily accessible location and be large enough to contain the security key and have an Endeavour Energy lock on the box.

Where direct access is not available, personnel and equipment access requirements will be required as set out below.

Padmounts, including the easement, shall not be located in or under part of any building, or on corners of roadways, without approval from the Network Substation Manager, refer to clauses 7.4.1 and 7.1.4 for more details.

In all situations where multiple items of equipment are installed, provision will be made to allow a single transformer, switchgear or padmount to be installed or removed without affecting other transformers or equipment.

Access areas shall be located so that they provide two (2) safe means of entry to and exit from the substations at all times. This may mean that bollards or safety rails will need to be erected to protect the persons entering or leaving the substation.

Where fencing around a padmount substation or a switching station is required a suitable gate shall be provided. The type of fence and the gate shall be approved by the Network Substation Manager. Refer to drawing 289702 for examples.

Where a substation location is not immediately apparent from the street, a sign may need to be erected indicating the substation location at Endeavour Energy Contestable Works Officer's/ Project Manager's discretion. This shall be determined on a project basis taking into account security and visibility.

7.1.2.2 Personnel access

A permanent, all-weather access route at least 1.2m wide shall be provided to the substation. Access shall be available for 24 hour use by personnel using, where necessary, Endeavour Energy's standard key.

Service areas shall generally be in accordance with clause 5.5.4 of AS 2067 except for the requirement stated below.

All aisle shall be no smaller than 750mm wide and areas for evacuation shall be no less than 600mm wide even whilst removable parts are in position or with doors open.

Where fall hazards exist, it is required by the Building Code of Australia or as indicated by Endeavour Energy, stairs and handrails shall be installed to provide safe access to, from, within and surrounding the substation (ie. any deviation of 700mm in surface levels will be considered a hazard).

Stairs for substations at levels other than ground level shall be a minimum of 1000mm wide. For raised padmounts a ladder access (min 650mm wide) can be used as the second form of escape when approved by the Network Substation Manager (refer also to clause 7.4.2).

7.1.2.3 Personnel access (additional requirements – indoor substations)

Two (2) access doors are required on each substation room. They shall open outwards and be free of any encumbrances to the outside of the substation room. These doors where possible shall be on opposite sides of each substation room, including multiple room substations. The equipment access doors may be used for general access also.

The areas external to the substation and in the immediate vicinity of each access door shall be set out in a manner that prevents the access doors and passageways being obstructed by stores, equipment, vehicles, and the like. Thresholds to door exits shall have landings not steps. Where required, barriers (such as bollards) and warning signs indicating No Parking, or other signs adequate to the particular situation, shall be erected and maintained by the customer at all times.

Access to these doors may be provided by way of passageways from the street, or an open area such as a car park, which has open access from the street. Access by way of hatchways and/or ladders is not acceptable. Passageways shall have the following unrestricted clearances.

Height - 2400mm. **Width** - 1000mm.

Where the passageways are provided with doors, for example, fire passages, the doors are to be fitted with dual entry mortice locks (capable of accepting locks as indicated in clause 7.5.5) to allow shared access for the customer and Endeavour Energy's employees. Endeavour Energy's lock cylinder will be installed in the top position.

Exit passageways shall be fire rated in accordance with the Building Code of Australia.

Cable basements are not allowed to be installed any more but access to existing cable basements shall be by way of a staircase located clear of any equipment. Handrails shall be provided along the full length of each staircase or elevated platform.

7.1.2.4 Heavy equipment access

The following provisions are required for all substation sites (refer also to Figure 33 - Truck detail -Type 1 and Figure 34 - Truck detail - Type 2):

- A sealed access road to the substation for 24-hour use for unloading and loading of equipment. Weights of up to 8000kg (complete package substation weight) will be moved from trucks or low-loaders by means of mobile cranes (point loads of up to 11000kg from any one-crane outrigger pad with a size of 550x550mm may be experienced). Access roads must be designed to cater for maximum allowable axle loadings as well as point loads as indicated.

- Endeavour Energy's two (2) standard truck mounted crane are classed as a "General purpose" vehicle and have a Gross Vehicle Mass (GVM) capacity of approx. 30 tonnes. The number of wheels on the type 1 and type 2 vehicle axels are as shown on the drawings.

- The access road must be a minimum of 3500mm wide and cater for vehicles with a total height of 4400mm along the total access to the substation. The unloading/loading area in the substation shall be wide enough to accommodate the extended outrigger of 6.5 m and withstand the point and axle loads mentioned above.

- Minimum headroom of 5500mm in the vicinity of the substation to allow unloading and installation of equipment. A suitable 'I' beam and lifting facilities (at the cost of the customer) may be considered if this requirement cannot be met.

- The access shall be suitable for a fixed truck and trailer style vehicle (Type 1 vehicle) with a minimum turning circle inside radius of 8.3 metres (22.6m overall), a width of 2.8 metres including mirrors and 10.3 metres long. The maximum gradient of access way in front of the substation shall be 1:15 or 3.9 degrees. Some vehicles are up to 11.3m long but are a truck trailer combination (Type 2 vehicle) which provides a better turning radius. If the length is seen as a problem in the loading or unloading of equipment then this shall be addressed in the design.

- The crane on the trucks will have a reach rating of approx. 25 metre-tonne.
- The crane stabiliser leg width when fully extended is up to approx. 8.5m.

Typical transformer and truck height details are shown below:

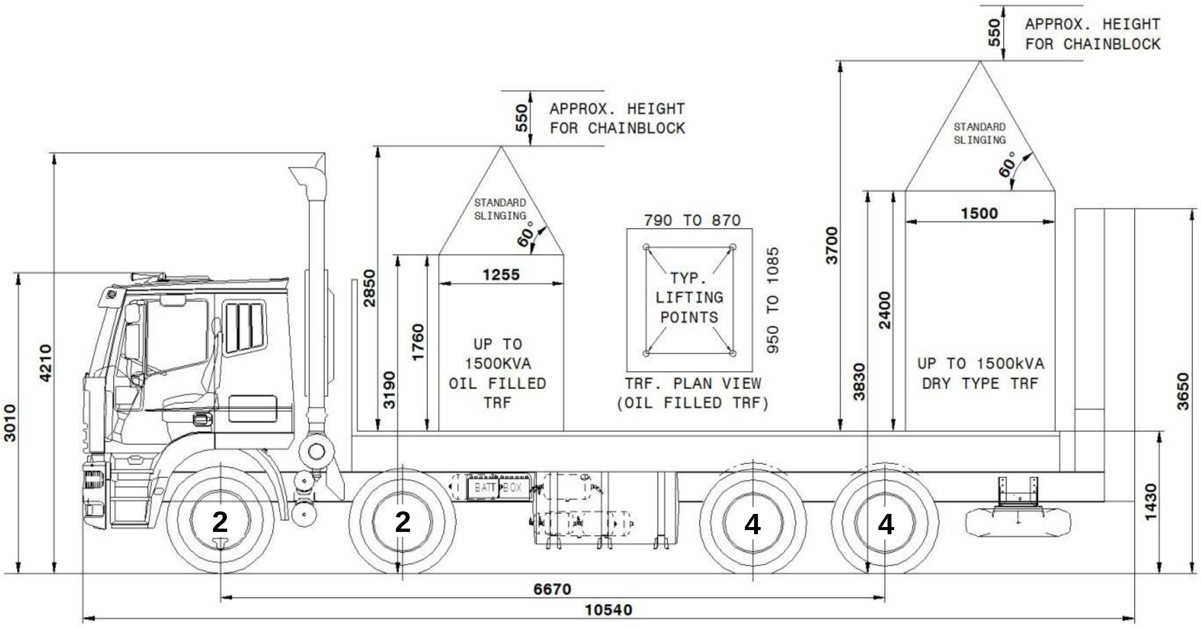


Figure 33 - Truck detail -Type 1

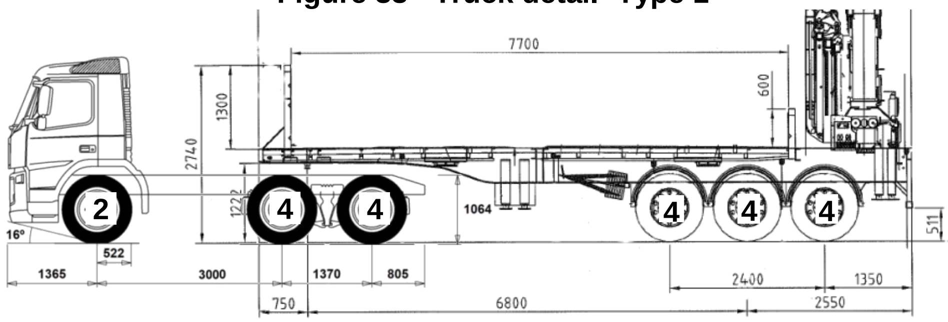


Figure 34 - Truck detail - Type 2

7.1.2.5 Heavy equipment access (additional requirements – indoor substations)

In addition to the normal access requirements up to and around an indoor substation, there are also several different equipment access requirements that need to be considered in conjunction with the building design and layout.

There needs to be a flat level surface capable of supporting without damage a transformer weighing 5,000kg in front of the substation door (or transformer set down area for a girder and trolley system) that shall be 1.5m x 1.5m square.

When required by the design, the customer shall at their cost supply and permanently install and maintain in working order a suitable lifting beam, geared girder trolley and, unless specified otherwise, a chain block/electric hoist, to suit installation of equipment with a minimum mass of 5000kg to its installed position. The chain block and lift equipment shall be able to be securely locked away in its own enclosure inside the substation and any special lifting equipment required is to be provided and maintained in working order by the customer at the customer cost.

A lifting hook (100mm diameter eye) shall be installed immediately adjacent to the beam to enable lifting/removal of the chain block/electric hoist. The lifting hook shall be designed to suit the mass of this lifting equipment.

The location of the lifting beam and hook will be shown on the layout drawing. The overall height of the transformer and slings is 2800mm for oil type transformers and 3700mm for dry type transformers. Where lifting equipment is required the room shall be designed to cater for this requirement, for example, the room height shall be 3700mm, plus chain block, plus lifting beam and any other obstructions, which may need to be lifted over during installation.

The substation building shall have adequate space so that transformers and other equipment can be installed or removed vertically or horizontally without moving adjacent equipment, de-energising any assets other than those being moved or the need to lift the equipment over any other equipment within the substation.

No changeover will be allowed from one lifting device to another. Loads must be on a landing before being transferred to another lifting device.

All methods of lifting must be submitted for approval by Network Substation Manager.

Other means of lifting than those cited will also be considered. In such cases, the customer shall provide details to the Network Substation Manager for specific approval in accordance with the dispensation process.

Manual lifting facilities are generally required unless specified otherwise.

The customer shall submit a letter of certification signed by a qualified structural engineer verifying that all lifting facilities and fixings are capable of holding the appropriate masses. The customer shall also show what suitable methods have been put in place for maintaining the lifting equipment.

Substations at levels other than ground

On some ground level and on almost all substations located at a level other than ground or street level, special requirements will need to be implemented to raise or transport the equipment to the substation level.

Before any approval of substations at other than ground level the Network Substation Manager must be satisfied that the proposed method is satisfactory and the customer will install and maintain in working order all equipment to be used in future for maintenance/replacement purposes.

Given the increased risk of and response to fire at non-ground level substations the transformers must be dry or suitable K-class oil having a high flash point (>250^{0}C).

Suitable lifting devices may include:

- Fixed crane.
- Mobile crane.
- Dedicated service elevator.
- Dedicated substation lifting device.
- Extendable platforms.
- Extendable lifting beam.

- Chain block/electric hoist.
- Any other approved device.

Minimum requirements of some of the methods have been stated in this section. However, the customer is free to design and submit any proposal for lifting of the substation equipment, including transformers to the substation level. Designs must include a detailed work method statement, safety aspects, specification of installation equipment, street access requirements, necessary approvals required before work can commence, time schedule, risk assessment and risk mitigating procedures. Any other relevant information must be included so that Endeavour Energy must be satisfied that the proposed method is satisfactory and will be able to be used in future for maintenance/replacement purposes.

Some guidance is provided below but a detailed design shall be provided to Endeavour Energy in every circumstance.

- **Fixed crane**
  Large buildings are generally equipped with cranes mounted on the rooftop, providing lifting arrangements for heavy loads on to site. These may be suitable for construction and maintenance of a substation. This is most likely to be used in conjunction with a fixed or extendable platform.

- **Mobile crane**
  A mobile crane may be suitable if the substation room is located up to 25m from street level and is accessible by road. Consideration must be given to the following:

  - The street access required for the mobile crane.
  - Weight of the heaviest (usually the transformer) equipment to be lifted.
  - Crane boom angle.
  - Obstacles at street level, such as overhead lines, ground conditions, vegetation, other buildings etc.

  An extendable landing platform may be required in some locations where the headroom of the transformer room is insufficient. An external wall of the room will need to be removable. This removable wall can be used as a ventilating louvre.

  Where suitable, forklifts may be used.

  Proposal to use a mobile crane must be accompanied by a detailed work method statement, including crane specification, crane set up time, number of streets requiring closure, approvals from local councils, etc.

- **Chain block/electric hoist**
  A chain block or an electric hoist is suitable only for lower levels. This is most likely to be used in conjunction with a fixed or extendable platform. Electric chain blocks/trolley systems shall have a backup supply other than from the substation transformer that is out of service.

- **Service elevator**
  If a service elevator is available, designed to accommodate and sufficiently rated to carry the substation equipment, including a transformer, it can be used. Details of loading and unloading equipment are to be clearly demonstrated.

- **Transfer into substation room**
  Suitable facilities shall be provided to transfer the equipment from the lifting device into the substation room. This may be in the form of a:

  - Platform.
  - Hatch.
  - Hook.
  - Winches.
  - Any other approved means.

- **Direct placement**
  If the substation ceiling is high enough, a crane may place the transformer directly inside the substation room. In this case, consideration must be given to the height of the transformer, chains, hooks and crane boom, etc.

- **Transformer hatch**
  Depending on the building site, a transformer hatch may be appropriate. A transformer hatch will allow a crane (fixed or mobile) to lower a transformer through the ceiling and directly into the substation room.

- **Platforms**
  Platforms may be fixed or extendable. These shall be designed to carry the full weight of the substation equipment, including transformers up to 5000kg.

7.1.3 Easements and covenants

The customer shall provide suitable easements, free of all encumbrances and other services, for padmount substations, underground mains and associated earthing grids.

In areas of high electrical soil resistivity, larger earthing easements may be required.

Covenants for restricted use are also required around padmounts in accordance with MDI0044.

Easements for substations shall be located outside of any Clear Zones in accordance with MDI0028 section 3.19.

7.1.4 Protection from vehicles

Substations are required to be located so they will not be subject to damage by vehicles. Where this is impractical locations requiring specific dedicated protection shall include, but not be limited to, the following:

- Loading zones (shops, factories, and commercial areas).
- Car parking areas.
- Around rubbish bin storage areas.
- Directly adjacent roundabouts, corners and ‘T’ junctions.
- Along main traffic routes.
- As determined by Endeavour Energy’s Contestable Works Officer/Project Manager.

The protection shall be installed outside the standard easement and shall be in the form of (in order of preference):

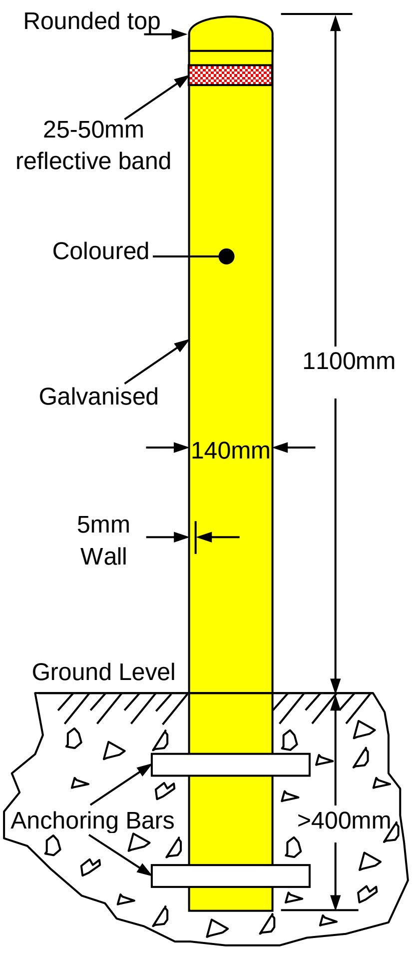


Figure 35 - Typical bollard detail

- Armco style railing or similar for high hazard areas (to be designed and constructed in accordance with AS/NZS 3845:1999)

- Posts (bollards) consisting of:
  - Refer to Figure 35 - Typical bollard detail
  - Heavy duty galvanised steel pipe 140-150mm dia x 5-6mm thick.
  - Concrete filled.
  - Powder coated standard Safety Yellow.
  - 25-50mm reflective band around top of post.
  - Rounded top to prevent injury or damage to objects that may contact bollard.
  - Project 1.1m to 1.2m above ground.
  - Minimum 400mm concreted in ground with concrete anchoring bars to prevent easy removal.

  Prefabricated bollards similar to Centurian 140 (Part No. C140BG) are acceptable. Centurian 140 bollards are available from Barrier Security Products Pty Ltd.

- Minimum 230mm high kerb - subject to approval by Endeavour Energy's Contestable Works Officer or Project/Operations Manager. Where the location is such that there is a risk of vehicles backing up to the kerb, not less than 1.5m of clearance is required between the kerb and the substation footing.

Easements are for safety, access and operational requirements, therefore protection devices shall not be located inside the standard substation easements.

7.1.5 Condensation problems

Where switchgear is used that has electrical contacts that are open to the environment (for example, Magnefix MD4 or similar) the following precautions need to be taken to limit the build-up of condensation.

The HV cable penetration must be sealed with only approved spray foam HILTI 116 or HILTI 126 or Ramset Fomofil or suitable alternative as approved by Network Substation Manager.

Large penetrations are to be sealed by laying down a sheet of twin wall Polypropylene (Plastic cardboard) and sealing the gaps around the cable. For small penetrations check that inside surfaces of the penetrations are free of liquids, dust and any other loose material and fit cardboard formwork into the penetration to a minimum depth of 75 mm (This will confirm that the expansion of the foam exceeds the surface of the penetration).

Note: Cardboard is not included in the standard spray foam kit.

Trimming of formwork around cables will be required. Moisten the area to be sealed with light spray of water; which will enhance the curing process of the foam.

Assemble the spray foam kit as outlined in the details provided with the kit. Read supplied directions carefully. Apply spray foam in a uniform manner.

Always wear protective eyewear, gloves and clothing when operating the spray foam equipment. Use only where there is adequate ventilation. Avoid skin contact. Read all instructions and first aid directions supplied with equipment.

To minimise condensation problems within substations, the inside roof surface of each cubicle (for padmounts and switching stations) is finished with a white pigmented, self-extinguishing, anti-condensation layer.

Fully sealed switchgear (Schneider RM6, Siemens 8DJH, ABB Safelink, and the like) does not require the cable penetration to be sealed.

7.1.6 Flooding and drainage

Substations are to be located such that the risk of flooding or stormwater damage is minimal.

As a minimum the level at the top of the transformer footing, HV and LV switchgear, shall not be lower than the 1:100 year flood level.

All drains within the substation site area or in the vicinity shall be properly maintained to avoid the possibility of water damage to Endeavour Energy's equipment.

In areas where, as determined by the Network Substation Manager, there is a high water table or a heightened risk of flooding, indoor substations will not be permitted.

All materials used in the construction below the substation (ground level) shall be capable of withstanding prolonged immersion in water without swelling or deterioration.

7.1.7 Consumers mains

The installer shall be responsible for providing and installing the consumer LV mains and cable support clamps for fixing to the Unistrut type rail, provided on the low voltage switchgear.

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

Single core cables that are connected to switchgear capable of supplying in excess of 300 Amps shall be designed to eliminate eddy currents. The means of clamping shall be such that the cable is not completely enclosed by a ferromagnetic material i.e. have insulated sections.

The low voltage switchgear is suitable for the connection of single core cables up to 2 x 240mm² per phase when connected to fused feeder disconnectors and up to 4 x 630mm² cables for each phase when connected to circuit breakers.

Where consumer's mains are of a quantity, size or type not suitable for connection to the low voltage switchgear, it shall be the installer's responsibility to supply and install at their cost a suitable connection box, complete with all necessary termination facilities. Cables compatible with the low voltage switchgear shall be installed between it and the connection box. The connection box shall be installed external to the substation easement.

Consumers' mains connected to low voltage load break switches (that have circuit breakers on the primary side of transformer) are limited to a maximum 10 metre cable length. These consumers' mains shall be mechanically protected so that the risk of damage to the cables is negligible. Refer to ETS 0069 for further information.

Any cable entry to the substation basement or trench by consumers' mains shall be sealed, after installation of cables, with a sealant that is impervious to oil and water and has a fire resistance level of no less than 120/120/120, for example, Dow Corning Fire Stop Foam 2001 or Hilti CP636 Fire Prevention Mortar or suitable alternative approved by Network Substation Manager.

7.1.8 Earthing

All earthing shall be in accordance with EDI 100 and Section 9 - Earthing of this instruction.

7.1.9 Inspection and testing

7.1.9.1 Inspections

On receipt of 48 hours' notice, the relevant Endeavour Energy representative (as stated in Section 2.9- Inspection of works) shall be given the opportunity to check the set out of all trenches and conduits, before backfilling or concreting is commenced. It is the responsibility of the installer to contact the relevant Endeavour Energy representative.

The installer will be required to draw a proving mandrel through conduits as indicated in Section 4.4- Conduit and cable installation. Suitable exposure of the conduits shall be the installer's responsibility.

The relevant Endeavour Energy representative (as stated in Section 2.9 - Inspection of works) shall be notified to arrange a final inspection and approval of the substation. Failure to comply with this requirement may also affect the program for providing electricity supply.

7.1.9.2 Testing

All testing and pre commissioning shall be in accordance with SDI120 and Section 10 - Testing of this instruction.

7.2 Padmount and indoor substation protection

7.2.1 Standard fuse and CB sizes

The following Table 9 and Table 10 detail the size of low and high voltage fuses and CBs to be used with the appropriate switchgear, having regard to the transformer capacity and protection grading.

For further details of requirements for the size and type of distribution protection, and for any alternative combinations to those listed here that will need to be approved, contact Endeavour Energy's Protection Manager.

The low voltage fuse and CB ratings shown are the maximum permissible to grade with the high voltage protection as listed, lower rating low voltage fuses and CBs may be used as considered appropriate based on load to be protected.

In padmount substations, the following is to be adopted as a standard practice.

a) Category 1(**Cat 1**) switchgear shall be used for all URD installations and they can use fuses up to 315A. This includes new installations and replacement of 250A units due to overloading (except as indicated in (b) below).
If there are two (2) cables on a distributor, and the 315A fuse is still insufficient to supply the load, 400A fuses may be used in the short term on the three phases of that distributor, but not on any other distributor in that substation. Where 400A fuses are used, it shall be entered into the asset management system as a defect for rectification (for example, correct the network loading problem).

b) For **Compact** switchgear, 250A is the standard. 315A can be used in the short term but shall be entered into the asset management system as a defect for rectification (for example, replace switchgear or correct the network loading problem).

c) If Category 2 (**Cat 2**) switchgear, has already been installed in URD areas, it can have fuses up to 315A fitted. Cat 1 is the standard for URD installations up to 500kVA and Cat 2 shall not be used for these transformers. Where 400A fuses have been used, they shall be replaced with 315A units. Where 400A fuses are required, it shall be entered into the asset management system as a defect for rectification (for example, correct the network loading problem).

d) Category 2 (**Cat 2**) switchgears installed in industrial or commercial areas can use fuses up to 400A.

Note: When replacing a fuse with a different size, all 3 phases shall be changed.

Table 9 - 11kV Padmount and indoor substation fuse selection chart

Transformer size KVA	Maximum LV fuse residential	Maximum LV fuse Commercial / Industrial	HV fuse rating	
			HRC	DOF **
300 - 315	315 Amp *	400 Amp *	50 Amp	40 Amp
500	315 Amp *	400 Amp *	63 Amp	63 (80) Amp
750-1000	315 Amp *	400 Amp *	100 Amp	(100) Amp
1500	N/A	LVCB or switch	CB only	N/A

Table 10 - 22kV Padmount and indoor substation fuse selection chart

Transformer size KVA	Maximum LV fuse residential	Maximum LV fuse Commercial / Industrial	HV fuse rating	
			HRC	DOF **
300 - 315	315 Amp *	400 Amp *	25 Amp	20 Amp
500	315 Amp *	400 Amp *	32 Amp	N/A
750 -1000	315 Amp *	400 Amp *	50 Amp	N/A
1500	N/A	LVCB or switch	CB only	N/A

Notes
* Maximum permissible fuse rating for underground residential areas is 315 Amp.
** DOFs feeding padmounts shall be avoided. Values supplied are for existing installations

7.2.2 High voltage fuses

The high voltage fuses shall comply with AS 1033.1 - fuse type I. IEC 60282 part 1 - fuse type I are identical dimensions. Striker type fuses must be used if required by the switchgear design; otherwise indicator type fuses are preferred. The maximum allowable power dissipation of the fuse is 27 watts (calculated based on resistance at an ambient of 20ºC).

Full range MV fuses are preferred to back up fuses.

7.2.3 Low voltage fuses

Fuses shall be blade type, complying with AS 60269, Part 2.1, Figure 1, Size 2. The utilisation category required is “gG”.

Three sizes are permitted for main feeders – 250, 315 and 400 Amps, as shown in clause 7.2.1 for maximum allowable sizes.

All blade type fuses used on Endeavour Energy’s network shall be of the dead tag type with both ends of the fuses touch safe on all sides.

The fuse must be capable of operating in a range of low voltage switchgear, at the ambient temperatures indicated, without exceeding the temperature limits stated in the testing section of ETS 0071. High watts loss fuses will not be considered.

7.2.4 LV fuse derating in padmount substations (typical values)

Fuse nameplate ratings are not the continuous rating to be applied to a fuse. To provide continuous supply for the design life of a fuse, the current ratings must be modified to take into account various factors such as the overloads, enclosure and operating temperature of the fuse. The fuse derating for padmount and indoor substations are approx. as shown in Table 11.

Table 11 - Padmount and indoor substation fuse derating

Fuse nameplate rating (Amps)	Calculated de-rated current (Amps)	
	Padmount	UID/UCD Indoor
250	210	230
315	260	280
400	330	350

7.2.5 Solid blade links

If required by switchgear design, solid blade links shall have a minimum current rating of 630 Amps and shall be fitted with insulated tags. The physical design of the link shall be suitable for the same contact arrangement as detailed in clause 7.2.3.

7.2.6 High voltage circuit breaker settings

The protection relay on high voltage switchgear is required to grade with Endeavour Energy’s upstream feeder protection relay with a sufficient grading margin. Endeavour Energy’s Protection Manager shall be contacted for upstream feeder protection relay settings details. Wherever the sufficient grading margin is not achievable, an approval by Endeavour Energy’s Protection Manager may be granted on a case by case basis.

7.2.7 Low voltage circuit breaker settings

The settings shown in Table 12 - LV CB settings shall be applied to the circuit breaker upon installation. The type and size of the breaker that is applied to each transformer size is indicative of this Standard.

The protection on the customers low voltage switchboard is to grade with these settings. If the customer or switchboard manufacturer cannot achieve grading with these settings they are to contact Endeavour Energy’s Protection Manager.

Where CBs are used for LV supply the Consumers mains are required to be suitably rated to cater for the full load and fault current level of the CB. The LV CB shall first supply the customers own LV board without feeding the customer directly.

Table 12 - LV CB settings

Trf Rating	LV CB Type	LVCB Setting	
300kVA & 315kVA (4.0%)	CM1250	Ir = 0.5, Im = 4, t = B	Pickup = 625 A Short Time = 2,500A
	C1251N	Io= 0.5 , Ir = 1.0, Im = 4 , tm = 0.2, I^2t = OFF	Pickup = 625 A Short Time = 2,500A
	XS1250NE	Io=0.63, I_1=0.8, I_2=4.00, T_1= 5sec I_3=12, T_2= 0.2sec, I^2t Ramp = OFF	Pickup = 630 A Short Time = 3,150A Instant. = 9,450
	ABB PR232 T7 1250	In = 1250A, 50Hz, I1 = 0.52 x In, t1 = 6s I2 = 1.8 x In, t2 = 0.25s , ∟ I3 = 7.5 x In, InN = OFF	Pickup = 650 A Short Time = 2,250A Instant. = 9,375A
500kVA (4.3%)	CM1250	Ir = 0.8, Im = 4, t = B	Pickup = 1,000A Short Time = 4,000A
	C1251N	Io = 1 , Ir = 0.8, Im = 4 , tm = 0.2, I^2t = OFF	Pickup = 1,000A Short Time = 4,000A
	XS1250NE	Io=1, I_1=0.8, I_2=4.00, T_1= 5sec I_3=12, T_2= 0.2sec I^2t Ramp = OFF	Pickup = 1,000 A Short Time = 4,000A Instant. = 12,000
	CM1600	Ir = 0.6, Im = 4, t = B	Pickup = 960 A Short Time = 3,840A
	ABB PR232 T7 1250	In = 1250A, 50Hz, I1 = 0.8 x In, t1 = 6s I2 = 3 x In , t2 = 0.25s , ∟ I3 = 9.5 x In, InN = OFF	Pickup = 1,000 A Short Time = 3,750A Instant. = 11,875A
750kVA (5.0%)	CM1600	Ir = 0.8, Im = 4, t = B	Pickup = 1,280 A Short Time = 5,120A
	CM2500	Ir = 0.5, Im = 4, t = B	Pickup = 1,250 A Short Time = 5,000A
	XS2500	Io=0.63, I_1=0.8, I_2=4.00 T_1= 5sec, I_3=12, T_2= 0.2sec I^2t Ramp = OFF	Pickup = 1,260 A Short Time = 6,300A Instant. = 18,900A
1000kVA (5.3%)	2 x LV CBs max 735A each	Use appropriate setting for each manufacturers CB type as shown for 500kVA transformers	
	CM2500	Ir = 0.6, Im = 4, t = B	Pickup = 1,500 A Short Time = 6,000A
	XS2500	Io=0.63, I_1=1.0, I_2=4.00, T_1= 5sec I_3=12, T_2= 0.2sec, I^2t Ramp = OFF	Pickup = 1,575 A Short Time = 6,300A Instant. = 18,900A
	NS3200N Micrologic 5.0A Rating 2000A	Ir = 0.8, tr = 8, Isd = 4, tsd = 0.2, Inst = 10	Pickup = 1,600 A Short Time = 6,400A Instant. = 20,000A
1500kVA (6.25%)	CM3200	Ir = 0.8, Im = 4, t = B	Pickup = 2,560 A Short Time = 10,240A
	NS3200N Micrologic 5.0A Rating 3200A	Ir = 0.8, tr = 4, Isd = 3, tsd = 0.2, Inst = 10	Pickup = 2,560 A Short Time =7,680A
	ABB SACE S8H PR212 3200A	I1 = 0.8, t1 = B (6s), I2 = 2 t2 = C (0.25s) , ∟, I3 = 10	Pickup = 2,560 A Short Time = 6,400A
	ABB SACE T8L PR331/P 3200A	In = 3200A, Hz = 50, In N = OFF L I1 = 0.80 x In, t1 = 3s S I2 = 2.4 x In, t2 = 0.2s , ∟ I I3 = 9 x In G I4 = OFF, T4= 0.1s	Pickup = 2,560 A Short Time = 7,680 Instant. = 28,800A
	XS3200	Io=1.0, I_1=0.8, T_1= 1sec I_2=2.00, T_2= 0.2sec , I_3=10 I^2t Ramp = OFF	Pickup = 2,560 A Short Time = 6,400A Instant. = 32,000A

7.3 Substation transformers, HV and LV switchgear and cabling

7.3.1 Transformers

Only approved transformers shall be used in padmounts and indoor substations and they shall be of the same construction and in accordance with ETS0070.

Three (3) types of transformers are available for use and they are:-

a) Mineral oil
b) FR3 natural ester oil (Environmentally sensitive, fire risk areas and indoor subs)
c) Dry type - on approval (indoor use only).

Older 11kV padmount transformer may have a spout lug connection on the HV end with insulated sleaves over the connection, newer designed padmount transformers all have bushing wells or plugs suitable for 250A screened elbows.

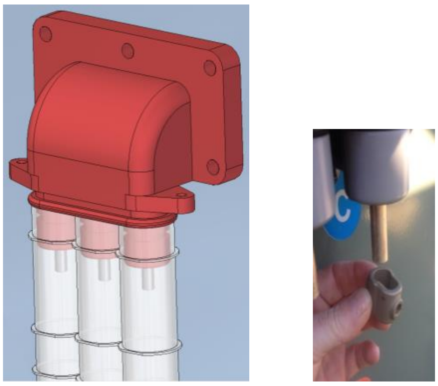


Figure 36 - Typical old style transformer HV spout connection

Figure 37 - Typical new style transformer 250A HV bushing well connection

New design transformers shall be used in all installations. Only in maintenance/upgrade cases when a new design will not practically fit can an old design transformer be used. Refurbished/used transformers may only be used by Endeavour Energy for internal maintenance/upgrade projects.

7.3.2 Switchgear

Only approved switchgear shall be used in padmounts and indoor substations and they shall be of the same construction and in accordance with ETS0068 for HV switchgear and ETS0069 for LV switchgear.

7.3.2.1 HV Switchgear

All new and replacement switchgear shall be three phase metal clad and arc vented switchgear suitable for standard 11kV and 22kV cables as required up to 300mm^2.

Extensible switchgear (assembled in one [1] complete switchboard) is no longer approved for new installations, and may only be used for extensions of existing switchgear or when assembled into approved modules.

Each transformer shall have its own independent switchgear group and there shall be no more than three (3) feeders for each transformer group.

Switching stations shall have a max of four (4) switches or feeders in each group.

7.3.2.2 LV Switchgear

All new and replacement LV switchgear shall be fully insulated touch safe and be suitable for LV feeder cables up to 240mm^2.

Two (2) hole lugs shall be used on all phase connections for low voltage switchgear except Cat 1 switchgear that can use single hole lugs.

7.3.3 Cabling and terminations

Only approved cables and termination shall be used in padmounts and indoor substations and they shall be in accordance with Section 6 of this manual and:-

- ETS0054 for 11 and 22kV cables
- ETS0055 for LV cables
- ETS0084 for joints and terminations

7.3.3.1 HV Feeder cables

Prior to terminating any feeder cable it shall be confirmed that the cable earthing is required to be bonded to the distribution MEN system or isolated.

All three (3) core feeder cables shall be trifurcated into single cores before terminating into switchgear. These tails shall be a minimum 3.2m long and all cores shall be clamped in the base of the switchgear (Siemens 8DJ10 & 8DJH-C are exempt from clamping in base of switchgear due to termination height). All single core cable lengths shall be clamped at intervals of approx. 1.5m with a floating clamp to prevent mechanical damage though movement during faults.

Where any paper insulated cable is to be cut and relocated into a substation, or the existing HV switchgear is replaced, a transition joint from paper to XLPE cable shall be used and located outside the padmount culvert or in a suitably supported location for indoor substations.

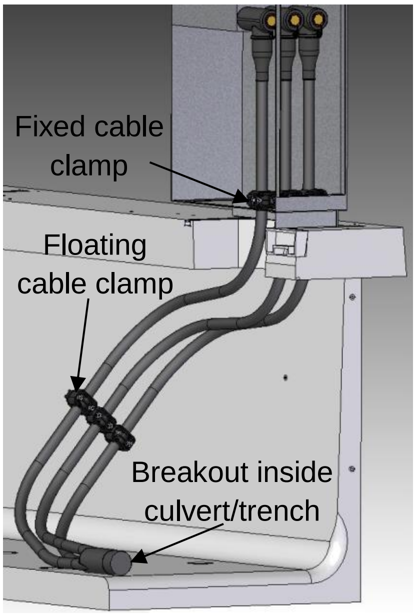


Figure 38 - Typical cable breakout

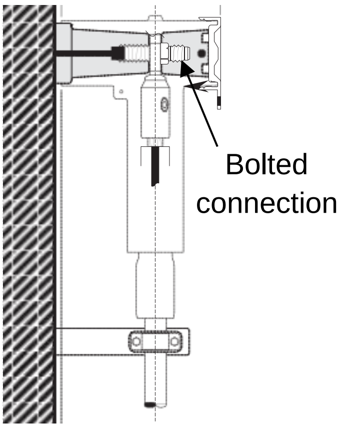


Figure 39- Typical CB/Feeder screened elbow

All new HV feeder cable terminations shall be made using a bolted or screw type connection.

For more details on HV cable terminations refer to Section 6.

Screened elbows are the preferred method of termination, check that the correct elbow is used when the earthing is required to be isolated from the MEN system.

HV cable(s) interconnecting a group of HV switchboards/ switchgear shall be rated to accommodate the largest incoming cable rating.

7.3.3.2 HV Switchgear to transformer cables

Terminations on new metal clad switchgear are:

- Fused unit - 250A screened elbows - pin type (preferred all new designs)
- Fused unit - 250A single hole lug (to suit some older designs)
- CB units - 630A screened elbows - screwed type

Connections between the high voltage switchgear and distribution transformer shall be:

- Fuse protected cables - Single core XLPE insulated 25mm^2 copper or 35mm^2 aluminium cables with individual copper screens having a minimum three (3)kA/1sec fault rating for switchgear; or,
- Circuit breaker protected cables - Single core XLPE insulated 70mm^2 copper cables with individual copper screens having 10 kA/1sec fault rating.
- For standardisation only 22kV cable shall be used on all transformer connections.
- For some older installations where there is an 11kV transformer with a connection that is a spout lug and the switchgear end is an 11kV spout lug or lug palm. In these cases approved 11kV cable may be used.

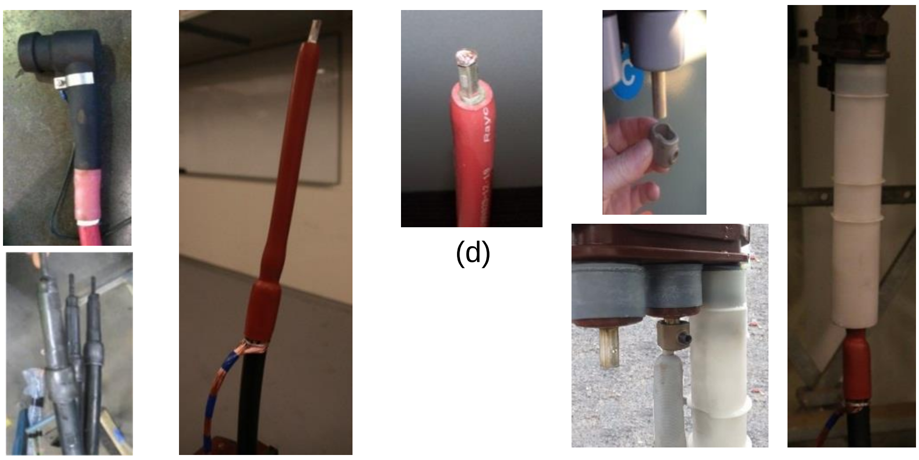
Table 13 - Typical cable connection summary

Switchgear	Min cable size (mm^2)	Switchgear end connection	Transformer end
Holec MD4	16-25mm Cu or 35mm Al	Spout lug	Note 1
Safelink ABB	25mm Cu or 35mm Al	Lug M12	Note 1
Metal clad Fuse	25mm Cu or 35mm Al	250A-Screened elbow Pin type	Note 1
Metal clad CB	70mm Cu	630A-Screened elbow Screw type	Note 1

Note 1:- All new transformer ends shall be 250A-Screened elbow Pin type, old transformers can have Spout lugs as shown in Figure 36.

If a cable needs to be constructed or modified to suit a spout lug then the following process shall be followed:

a) Remove the screened elbow and any reducer sleave on the transformer end of the cable.
b) Re-terminate the cable with an appropriate size indoor cable termination (S/C-SZ11122).
c) Hex crimp an appropriate sized tinned copper sleeve to the end of the cable.
d) Cut the crimp so that it is approx. 25mm in length.
e) Reuse the transformer ring clamp to connect the cable to the Reyrolle block.
f) Install phase insulating tubes back on to block.



(a) (b) & (c) (d) (e) (f)

Figure 40- Spout lug termination

If a lug is required on the end of a cable to connect to a palm then the same process would occur but replace the copper sleeve with an appropriate sized lug.

The cables earth screen shall be connected to the earth terminal at both the switchgear and transformer ends.

The cable shall allow for the minimum cable bending radius for the installation. For indoor substations the cable will need to suit the bending radius of the conduits as shown on the layout drawings. For padmount substations the cables need to be more flexible with a tighter bending radius due to the compact design.

For indoor substations the cables at the transformer end shall be supported as detailed on Drawing no. 061736.

Screened elbows for transformer and fused switchgear connections (250A elbow) are typically only suitable for cables up to 90mm^2. If the switchgear fuse/CB unit is located some distance away (ie remote switchroom to transformer room) from the transformer location a standard 240/300mm mains cable may not be able to be used and it will be necessary to have a suitable cable with adequate mechanical protection installed that will suit these connections.

The fuse/transformer screened elbow connection is a pin type design (see Figure 41). There have been occasions when the elbow has not been fitted correctly and the pin has not lined up with the centre of the connection. In these cases the pin has actually stretched the boot and slid down the side of the joint. It is necessary to check the connection and to confirm the retaining clip is fitted and there are no deformations of the boot prior to commissioning or serious damage can occur.

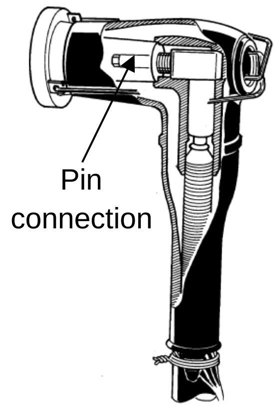


Figure 41 - Typical fuse/transformer screened elbow

7.3.3.3 LV Switchgear

All new and replacement LV switchgear shall be fully insulated touch safe and be suitable for LV feeder cables up to 240mm^2.

Cables between the transformer and switchgear shall be made with flexible cables.

Where the LV switchgear is located in a separate room or too far away from the transformer then a transition box may be required at the request of the Network Substations Manager.

Single core LV cables from the transformer to the remote located LV switchgears shall be laid in quadrature with 2 times the cable diameter separation between each group (multiple single core cables of each phase and neutral bundled together) and arranged as shown in Figure 42 and as detailed in AS3008 appendix D.

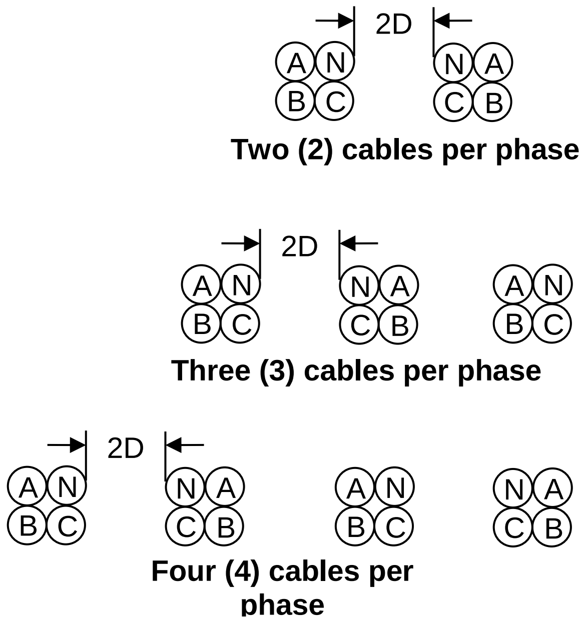


Figure 42 - Typical cable arrangement for multiple cores per phase

For loads less than 330A in padmounts and 350A in indoor substations, fuse strips are used. For individual customer circuit loads greater than this, circuit breakers are required.

All terminations to the transformer are to be insulated with Endeavour Energy approved boots. Terminations to LV cables are to have insulation up to the palm.

Only dead tag fuses shall be used in LV rated switchgear.

7.4 Padmount substations

7.4.1 Segregation requirements for other structures

Padmount substations shall be located where practical at the front property boundary.

There are a number of restrictions to construction near substations. Figure 43 shows the overall view detailing individual requirements where easements and covenant are required. Refer to EDI 100 for further information on easement and covenants required for general earthing and metallic fences /structures in substations with separate earthing.

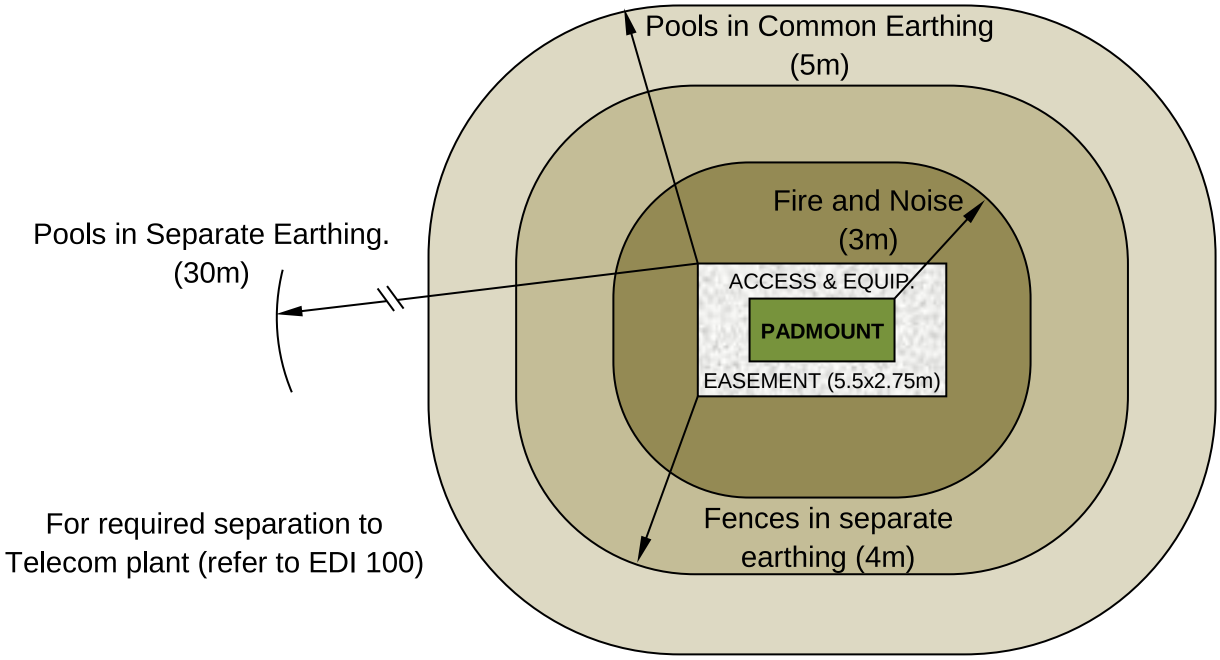


Figure 43 - All restrictions (Easement and covenants will be required)

7.4.1.1 Noise

Padmount substation sites shall comply with a nominal three (3) m noise separation between the substation and any building/living area. This three (3) m will usually satisfy acceptable noise levels in residential premises. Where a suitable fire/baffle wall is erected (by a developer/customer without cost to Endeavour Energy and with a certified sound report) the noise restriction may be reduced accordingly if approved by Endeavour Energy.

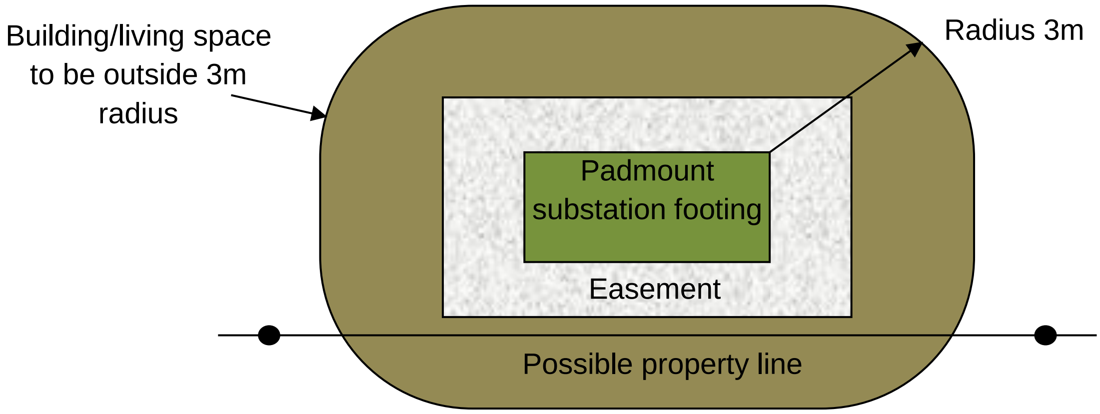


Figure 44 - Minimum clearance to building/living areas

7.4.1.2 Fire

Padmount substations require separation from neighbouring areas and buildings that are subject to fire risk. Separation may be by means of adequate clearances or building components having minimum fire resistance level (FRL) as set out in Figure 45.

Fire ratings shall be achieved by static means (that is, walls or distance) rather than active system (that is, deluge showers and the like).

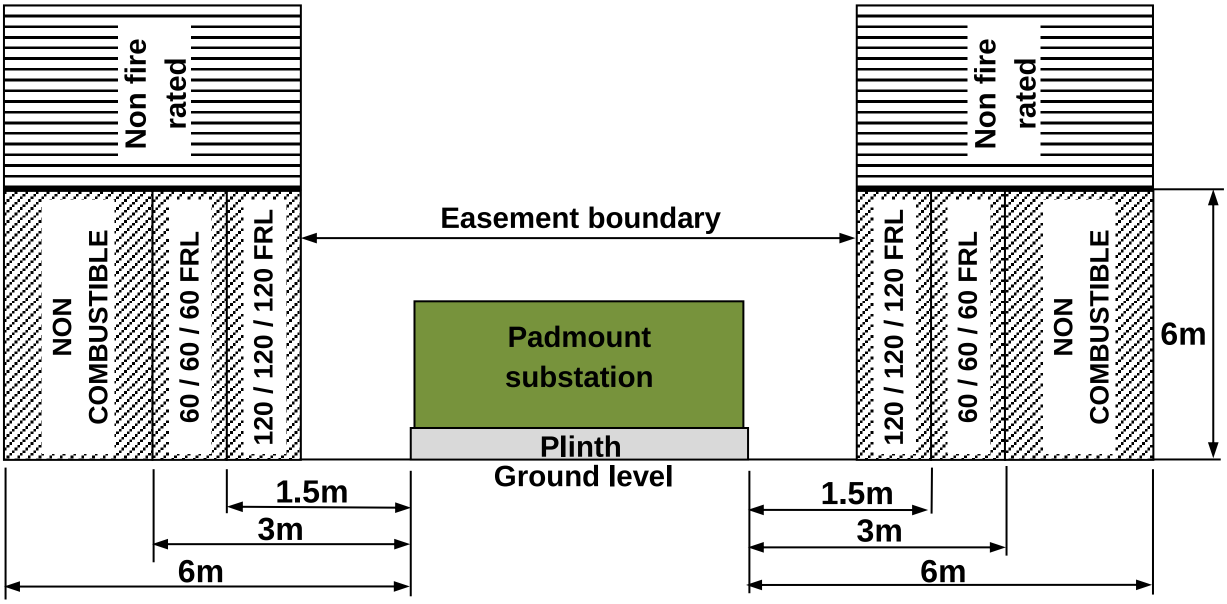


Figure 45 - Minimum FRL clearances for components

FRL means the grading period in minutes. The three (3) figures represent structural adequacy/integrity/insulation.

FRL of the materials, components and structures of the walls (barrier) shall be determined in accordance with the tests prescribed in AS 1530.4:2005 and the details below:

a) When a padmount substation is located under the overhang of a building, the substation may be considered to be within the building and the elements of the building above and adjacent to the substation must have an FRL of 120/120/120. In these circumstances, a ruling must be obtained from the relevant government body.

b) Personnel access doors and fire exit doors to a building are not permitted within three (3) metres of the padmount plinth.

c) The material used in the construction of buildings between 3m and 6m shall be non-combustible, class 1 and 10 buildings are exempt but shall be considered.

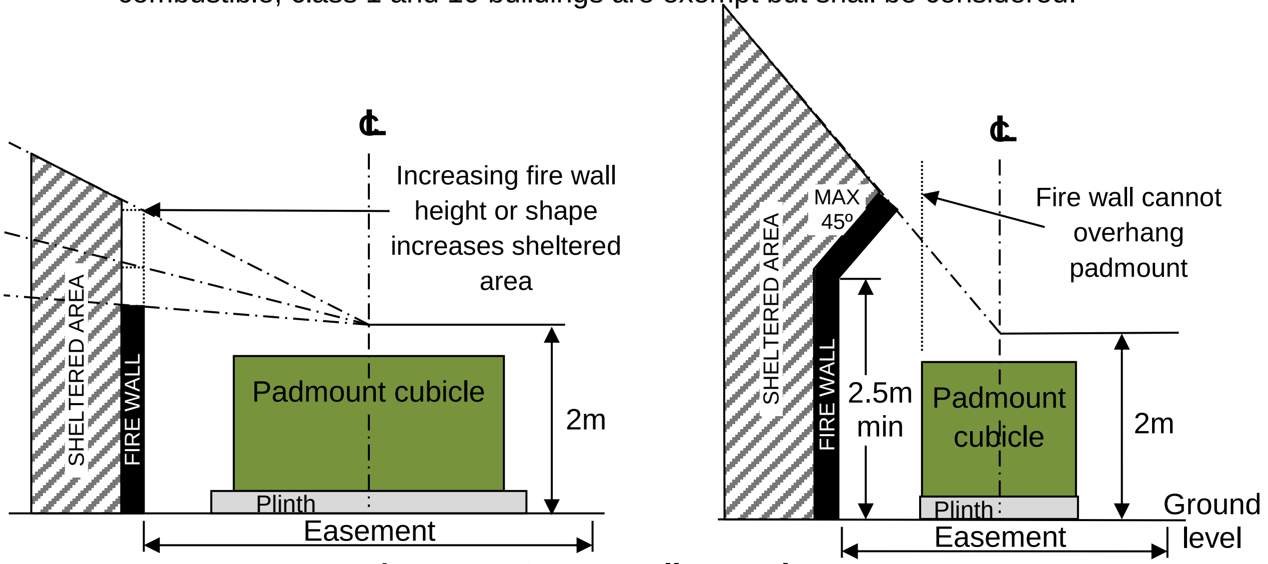


Figure 46 - Screen wall examples

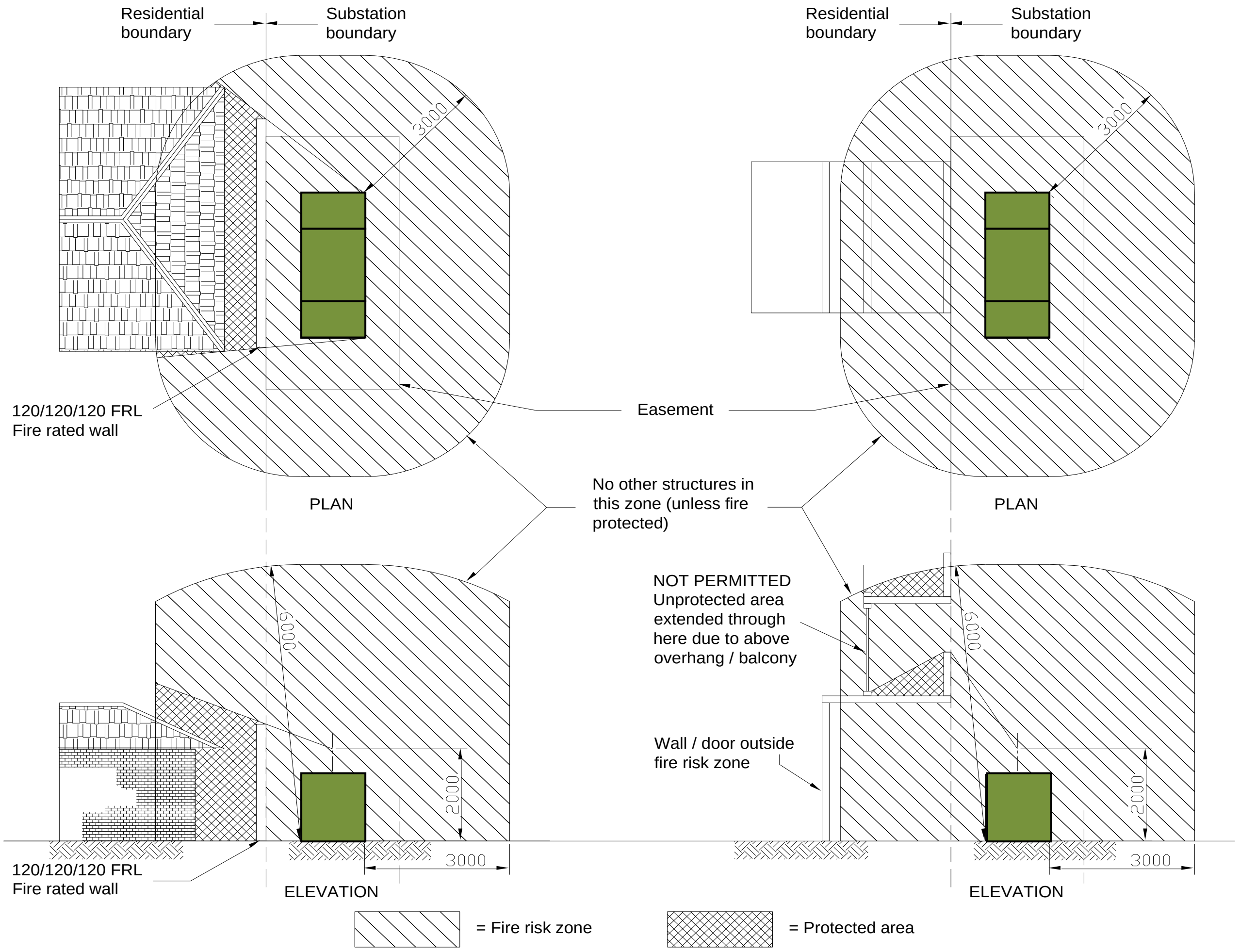


Figure 47 - Typical effect of screen walls

Where minimum clearances cannot be achieved, non FRL openings, for example, windows, may be permitted within the fire rated area of Figure 45 provided that suitable screening walls are installed to create sheltered areas. Such openings shall be within these sheltered areas as shown in Figure 46. Screen walls shall have a 120/120/120 FRL.

Screen walls shall be located outside the standard easement and no structure shall overhang the easement. No structure shall overhang a protected area that could trap smoke or fire and cause it to enter any openings in any structures.

7.4.1.3 Earthing

An accredited designer shall complete the design of the earthing system. More specific details of earthing constructions can be found in EDI 100 and the Earthing section of this manual.

Refer to EDI 100 for exclusion zones in respect of telecommunication equipment, fencing, conductive structures, metallic pipe lines, swimming pools and spa.

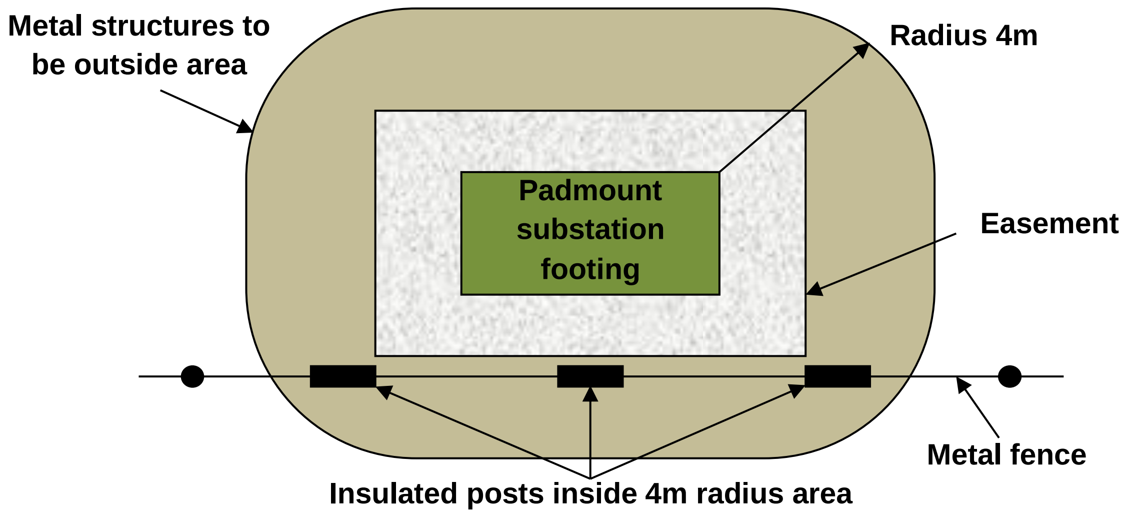


Figure 48 - Metal fence or metal clad building exclusion area

7.4.2 Substation site

7.4.2.1 Site contours and retaining walls

The easement represents the minimum working area required for normal operation of the substation and the following requirements must be adhered to:

- Substation site shall be flat and level over the entire easement area. It is the responsibility of the ASP to determine the easement location. Endeavour Energy will assess the easement based on the location, access and other conditions as indicated in this standard.
- Where it is necessary to carry out excavations to provide a level site, the batter adjacent to the site shall be no steeper than 1 in 3 for at least 1m outside the easement.
- Where a step is used adjacent and outside the easement the maximum step size (up or down) permitted is 300mm in each 1000mm.
- Retaining walls are to be used only when absolutely necessary. Retaining walls may be up to 700mm in height (maximum of 1000mm after approval from Network Substations Manager) constructed from concrete or brick, but not treated pine. Where required, they shall be constructed outside the standard easement and at the

ASP's cost. The retaining wall must comply with the relevant building codes and local government requirements. For drops greater than 300mm a hand railing shall be installed unless otherwise approved by the Network Substations Manager

- Where necessary, the substation easement location and size shall be altered and increased as shown so that the retaining wall (or vehicle impact protection device, such as bollards) is wholly within the one property boundary and the easement includes the retaining wall (or vehicle impact protection device). If this condition cannot be met, an alternative may be considered on application. The property owner is responsible for maintaining the retaining wall however Endeavour Energy reserves the right to make alterations.

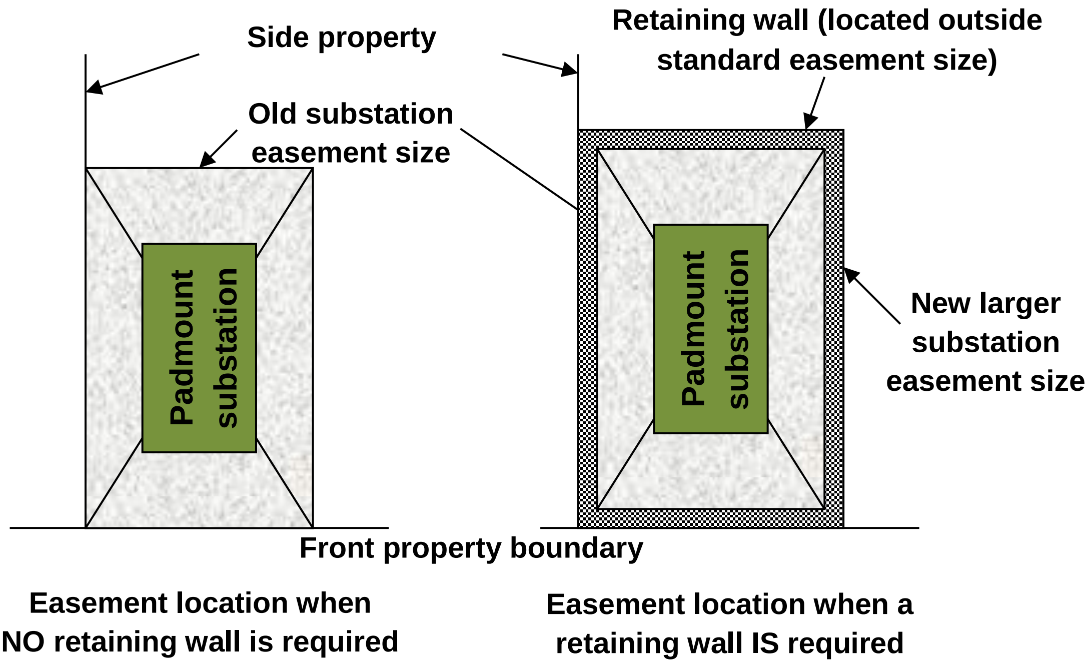


Figure 49 - Easement location details

7.4.2.2 Foundation requirements

The substation site is required to be stable and clear of any obstruction that could interfere with the installation of the earthing electrodes that may extend to a depth of 30 metres.

Drawing no. 076665 details the padmount substation culvert footing installation.

Where there is any doubt as to the suitability of the site (for example, old fill material), either test bores or a geo-technical report shall be carried out.

If the substation is to be located on a suspended slab, and there is a basement level car park, lift room, and the like below, provision must be made to prevent any oil spillage into them and they shall meet the requirements for an indoor substation. The costs of such modifications are to be met by the customer.

In such a situation, the customer shall provide physical support, mechanical protection and 120/120/120 (minimum) FRL for Endeavour Energy's incoming cables.

If modifications to prevent oil spillage are not practicable, then before finalising the design, approval will be required from the Network Substations Manager for either a padmount substation with a low flammability (FR3) transformer of it may be necessary to have an indoor substation with dry type transformer.

If the substation is to be located on or adjacent to a concreted area or any other hard surface or an area with restricted access for cabling such as raised platform substation, then 1.0mx1.0mx1.0m internal dimension access pits and lids shall be provided for the entry of HV and LV cables as shown in Figure 50. Pits and lids shall be constructed and labelled in accordance with the details in section 4 - Trenching, conduits and cable installation.

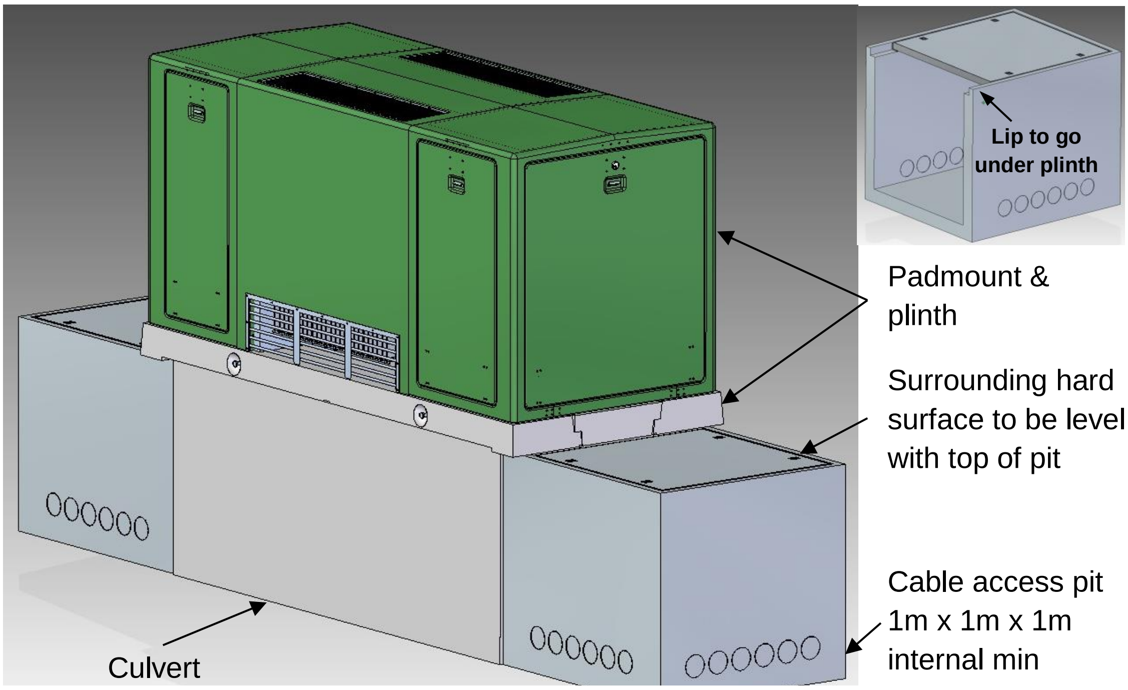


Figure 50 - Example substation with access pits

Figure 51 - Example substation raised above 1:100 flood level

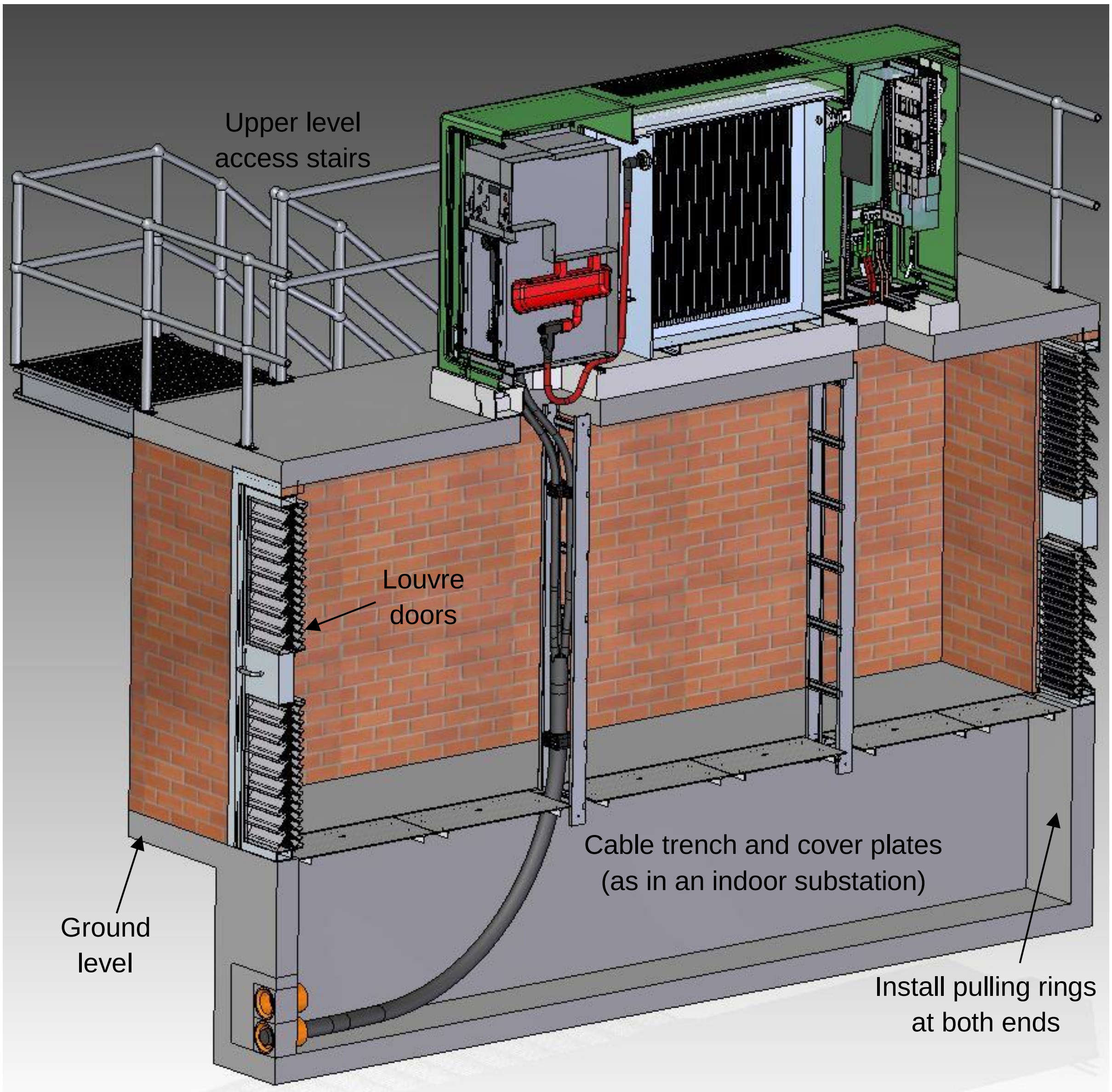


Figure 52 - Section view of example raised sub

If a basement is used under a raised substation for cable access then the basement shall have two (2) doors with a concrete floor. The floor and trench shall be sloped and drained to a suitable location to prevent water pooling or silt forming. A couple of points for natural drainage shall be provided to drain the trench. Approval by the Network Substation Manager is required if drains are installed and as a minimum all drains would need to be fitted with flame traps. The room shall be vented to help remove moisture from the room.

On the inside of the door there shall be a chain across the door to prevent entry. The chain shall be fixed at one end and have a simple hook on the other end to allow access. On the chain there shall be one sign that indicates Danger High Voltage and another sign indicating there may be trip hazards inside.

Cables shall typically enter the cable trench flat and then be laid up to the cable tray as a three (3) core cable with a bending radius suitable for the cable. If the raised platform is less than two (2)m then the cables can also be trifurcated on the trench floor and the single cores will need to be secured together at intervals of approximately 1m.

The cable shall be supported by a secure and earthed cable tray system from the floor to the roof of the basement with cable clamps at intervals of approximately 1m for the complete length to the switchgear. The cable tray system shall be hot dipped galvanised and strong enough to withstand the weight and forces developed in the cable during faults. Details of the cable tray system shall be provided for approval by the Network Substation Manager.

Pulling rings shall be installed in both ends of the trench to allow cables to be installed.

An earthing design is required for each raised substation and would generally be in line with an indoor substation.

7.4.2.3 Landscaping

The finished surface of the substation easement shall be such that it can be readily removed and/or restored. Materials such as grass, asphalt, pine bark, wood chip, blue metal, and the like are acceptable.

Screening vegetation is to be maintained in such a manner that it will allow employee access at all times. Shrubs shall be planted a minimum distance of 800mm plus half of the full-grown canopy width from the substation.

7.4.2.4 Avoidance of services and encroachments

Services such as drains, piping, or wiring are not permitted to pass through either the substation easement or the ground below it, even in those cases where an easement may not be required these requirements still remain. Sewers may only pass through the substation easement adjacent to the street boundary and only when the substation site has been lengthened accordingly. Refer Drawing no. 016665.

Neither overhead nor underground gas mains/pipes shall pass through the fire restriction area (three [3] metres) around the substation.

A 10 metre clearance distance shall be maintained between substation and fire hydrants, booster valves, and the like in accordance with AS2419.1.

To allow suitable and safe operation of the equipment, hazardous materials shall not be stored closer than four (4) metres to padmount substations. Rubbish and other combustible items must be protected by a suitably fire rated cover if stored within three (3) metres of the padmount substation.

7.4.2.5 Cubicle doors with restricted access

In some situations the width of the switchgear in padmounts requires that the cubicle doors be modified to allow extra room. This modification includes the removal of the spring latch and the fitting of a fixed bracket as shown below. This will allow an extra 40-50mm of space.

The bracket is fitted to the door after the switchgear and cubicle is installed using a spanner.

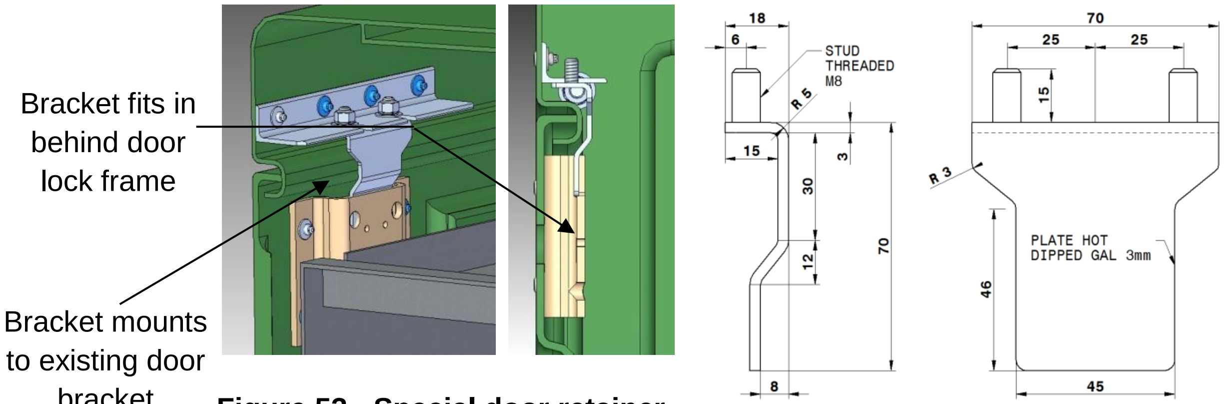


Figure 53 - Special door retainer

7.5 Indoor substations

7.5.1 Substation location

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

If a deviation is approved the HV switchgear shall still be located at street or ground level (with access at that level) and the transformers may be at another level.

Due to fire and safety requirements, dry or transformers filled with K-class oil having a high flash point (>250^{0}C) will be required in all indoor substations within or located on the external wall of other buildings or where tenants may be below or affected by fire. The selection of a dry or high flammability transformer shall be at the Network Substation Manager's approval.

7.5.2 Construction drawings

All construction shall be carried out in accordance with Endeavour Energy's approved construction drawings. Construction drawings shall include as a minimum all Endeavour Energy requirements as set out on the Endeavour Energy standard layout drawings.

The dimensions shown on the Endeavour Energy 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.

Where special alcove type switching rooms have been approved for use, the design shall be in accordance with drawing no. 053914.

Construction of the substation shall not begin before written approval of the construction drawings is received. If construction begins without approval, Endeavour Energy will hold itself free to refuse to accept the substation building if the work carried out is not suitable for its requirements.

Dry type transformers may require special consideration for room dimensions.

7.5.3 Access requirements

Refer to clause 7.1.2 – Minimum access requirements for details of the minimum access requirements to be followed.

Emergency escape lighting and signs as required in AS 2293.1 shall be provided at all exits of the building.

7.5.4 Building walls, floors, ceilings and basements

7.5.4.1 General

The design of the substation room must be carried out by a qualified; practising structural engineer and shall comply with the requirements of the Building Code of Australia and AS2067. Construction is to be of adequate strength to protect the customer's property in the rare event of equipment failure. The following clauses and clause 7.5.18 – Fire protection and rating requirements detail the minimum building criteria.

The building shall be suitable to withstand an internal pressure of minimum 2.0 kPa.

All necessary horizontal and vertical dampcourses shall be provided and the chambers shall have dry wall, floor and ceiling conditions before acceptance for installation of substation equipment.

The waterproofing of the substation chamber and the entrance and exit chambers shall be such that its effectiveness shall not be impaired by the drilling and fixing of expansion bolts for the attachment of equipment to walls, floor or ceilings.

Those parts of a substation construction, which are below ground, must include vertical and horizontal moisture barriers, and the use of drained cavities is required. The substation floor and walls must be suitable for withstanding hydrostatic pressure, incorporating waterproof membrane at construction joints.

Where required, wall anchors and/or pulling ring sockets shall be installed in the floor or walls, in the position shown on the layout drawings and in a manner to achieve any working load specified.

7.5.4.2 Walls

All walls shall be suitable to withstand an internal pressure of minimum 2.0kPa. Typically this would be achieved with solid filled concrete walls, double brick wall, or core filled concrete block walls.

a) Internal

Provided the following types of walls are erected in a tradesman like and professional manner and cleaned, then cement rendering is not required:

- Face bricks with ironed joints.
- Solid concrete block work with ironed joints.
- Concrete walls using dressed formwork.
- Concrete rendering, when required, shall be a 3:1 sand cement mix.

Internal walls must be of solid construction to maintain the fire resistance level when drilling and fixing expansion bolts for the attachment of equipment.

b) External (exposed to weather)

External walls shall preferably be of cavity construction; however, approval for alternative construction methods, such as high density concrete panels, will be considered, subject to testing to satisfy Network Substations Manager, Asset Standards and Design that they are impervious to moisture.

7.5.4.3 Floors

The floor slab shall be designed and constructed to carry the substation equipment distributed as shown and of mass indicated on the layout drawings.

The floor shall consist of reinforced concrete slab on ground construction incorporating trenches and conduits. In some instances suspended slab construction may be used, depending upon the substation design.

Generally, the substation floor level at the equipment access door shall be within the range of 150mm to 200mm above ground or road level adjacent to the door for weatherproofing.

All corners formed within trenches shall be well rounded and smooth, finished off-dressed formwork or rendered with 20mm waterproof cement render.

Trenches or penetrations shall be provided with aluminium tread plate covers to dimensions and quantities as specified on the drawings. Each section shall have two lifting eyes to the detail supplied, and two suitable lifting handles shall be provided. Steel chequer plate covers are not permitted.

The following tolerances apply to the floor grade unless specified otherwise on the layout drawings:

- ± 2.0mm over any 1500mm diameter circle.
- ± 4.0mm over the entire floor.

Topping shall be finished to a true and even surface of a steel trowel. The finished surface shall be uniform in appearance, dense and smooth, suitable for moving equipment across it by use of Aero-Caster load modules. Any surface irregularities shall be filled with Silastic compound filler prior to sealing the floor with penetrating sealers (not topical sealers).

7.5.4.4 Ceilings

Concrete (as part of another building)

The ceiling finish shall be of dressed formwork or rendered as for walls.

Roofing (as a standalone building)

For substations separated from the customer's building, the roof may consist of metal decking on metal or timber framework, in lieu of concrete, with an approved manufacturer's 60/60/60 FRL gypsum plasterboard ceiling. A vapour barrier shall be incorporated between the ceiling and metal decking. The use of the concrete roof of a substation for a garden or landscaping area is not permitted.

7.5.4.5 Cable basements

Substations with cable basements are not permitted. If a standard cable trench in accordance with the indoor substation design and drawing 297547 cannot be provided then a dispensation shall be requested through the normal process.

7.5.5 Doors

7.5.5.1 General

Doors are to be of minimum sizes as indicated below. Doorways are to be clear openings free of all projections.

All door jambs (fixed door frames) shall be made of steel and be earthed. All metal doors shall be earthed using a flexible copper braids to connect them to the door jambs.

All doors of a substation shall be of solid core construction unless specified otherwise. All doorways opening to any other part of the building must be protected with self-closing minimum 120/120/30 FRL doors. These doors and their door jamb shall be tight fitting and of an approved fire underwriters type. All doors opening to the outside of a substation shall be weather proof.

Thresholds to external doorways shall be provided with a suitable means of weatherproofing such as a 25mm step.

Where the personnel door is a louvre, a minimum clear space of 200mm above and below and 100mm past the end of the lever handle shall be provided to allow for unobstructed access. Alternatively the lever handle may be extended such that it clears both stages of the louvres.

All doors, including personnel doors, shall be fitted with a minimum of three (3) hinges. More hinges may be required for larger doors to give correct support. All hinges shall be fitted with removable stainless steel pins.

Any ventilation opening adjacent to any door lock shall be fitted with a suitable barrier to prevent unauthorised opening of the door lock and prevent vandalism to the door lock.

For doors with louvres refer to clause 7.5.17.

7.5.5.2 Hardware

A deadlocking latch bolt, operated by a handle from inside and key from outside, is to be fitted to each personnel door or designated leaf of the equipment access doors.

The following hardware and lock cylinders shall be fitted:

Personnel (timber) doors:	Lockwood 3572SS mortice lock	
	Inside furniture:	1905/90
	Outside furniture:	1801/90 or D handle
	Lock cylinder:	D2

Louvre doors can have either the above or;

Aluminium doors:	Lockwood 3582SS mortice lock	
	Inside furniture:	5905/70
	Outside furniture:	5801/70 or D handle
	Lock cylinder:	D2

Door handles are required to have adequate clearance to allow a gloved hand to operate them. Therefore, a minimum of 45mm clearance between the inside of the handle and the door shall be allowed in accordance with AS 1428.1:2009.

Door handles shall be located at a height above the flat ground level of between 900mm and 1100mm in accordance with AS 1428.1:2009.

A full-length barrier is to be fitted to the leading edge of each personnel door or designated leaf of the equipment access doors to prevent unauthorised opening of the door lock.

7.5.5.3 Lock cylinders

The hardware provided must be capable of being fitted with the following cylinders.

Lockwood 570 series - oval type (for 3572 series locks).

The Abloy “D2” cylinder is to be used to lock an Endeavour Energy Indoor substation.

7.5.5.4 Personnel door

The minimum size shall be 820mm wide by 2040mm high. All personnel doors shall open outwards and be capable of being opened from inside the substation by means of quick release emergency panic locks that is, fitted with a single action escape door lock.

7.5.5.5 Equipment door

This door may be either a roller shutter as specified below, or 180° opening hinged weatherproof and vermin proof louvre doors. Unless specified otherwise on the layout drawing, a minimum clear dimension shall be maintained of 2000mm wide by 2700mm high for transformers and equipment.

In the event of equipment failure, the equipment door is a means of providing pressure relief for the substation, therefore minimising structural damage.

The roller shutter shall be manufactured from 50mm or 75mm wide 1mm thick aluminium slats, finished to customer specification. The door shall be coated with a minimum 18 microns thick Kalcolor bronze anodising.

The roller shutter overall curtain width must be 12mm less than the doorway clear opening (refer Figure 54) and shall be fitted with padlocking facilities on the inside on both edges, which will accept Endeavour Energy’s padlocks having a 10mm shank. The roller shutter curtain shall be provided with a chain drive.

Hinged louvre doors, unless specified otherwise, shall be fitted with padlocking facilities on the inside bottom of each door, which will accept padlocks having a 10mm shank. Pad bolts fitted to the top of each leaf shall be accessible without the use of a stepladder.

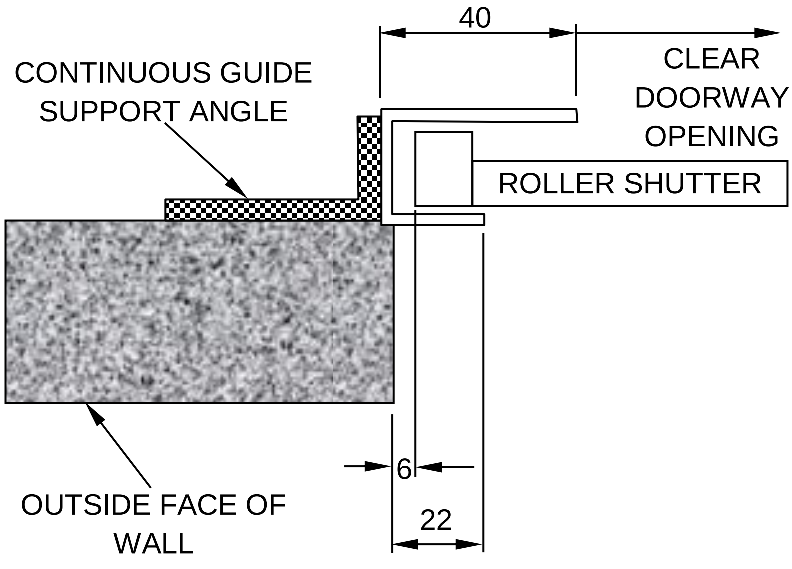


Figure 54 - Roller shutter door guide installation details (one side only shown)

7.5.5.6 Hatchway access substations

Installation of substations with hatchway access is not permitted.

7.5.6 Conduits, cable supports and enclosures

7.5.6.1 General

All electrical conduits, cable enclosures, cable trays and supports for cables shall be provided as specified. Cable pits may be required where a change in direction or level occurs. In certain locations these may require concrete Gatic style covers.

Endeavour Energy Asset & Network Planning will specify the number and size of conduits required:

- Where conduits pass through external walls they must be installed in a manner that prevents the ingress of water into cavities, pits, trenches or the substation chamber. Also at these locations all conduits greater than 100mm shall be fitted with bellmouths.
- Where Endeavour Energy's incoming conduits are required to pass through open spaces such as basement level car parks, and the like, they shall be fire rated to a minimum of 120/120/120 FRL and mechanically protected. "Danger" signs shall be fixed to the full length of all conduit routes at approx. 1.5m spacing. In instances where the conduit route deviates to avoid beams, columns, and the like, concrete encasement is required. Refer to Section 3 – General construction requirements for more details.
- Minimum cover to the top of HV conduits from ground level shall be 750mm. If this dimension cannot be achieved, concrete encasement will be required.
- Unless otherwise specified, all conduit bends are to be a minimum 1000mm radius. For some cables such as mains cables with larger bending radii (2000mm min when mechanically installed) the size of the conduit bends will need to be increased to suit the cable.

Conduits between substation rooms shall be concrete encased and sealed to prevent fire travelling between rooms or inflicting damage to adjacent cables when a fault occurs in any one of the cables.

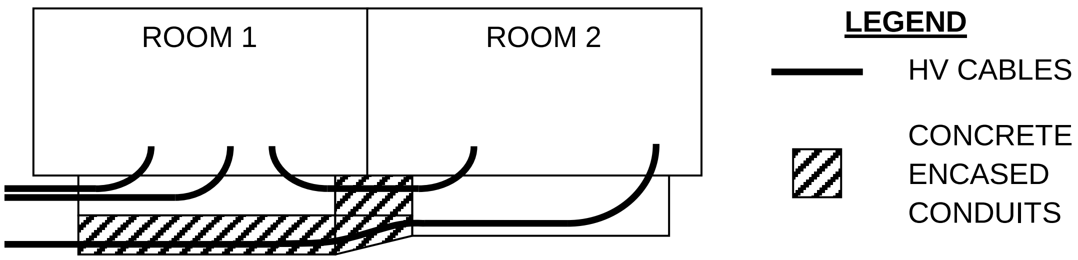


Figure 55 - Typical protected cable detail for multiple rooms

Cables are usually run along footpaths in a 600mm wide allocation, 300mm out from the property boundary. As these cables have a 2000mm minimum bending radius, it is necessary to commence bending within the customer's property. Therefore, where conduits pass through the wall of a building constructed within 800mm of the boundary, it will be necessary to construct a cabling alcove in this wall. Refer clause 7.5.6.2 Conduit specifications and Drawing no. 054738 for typical details.

7.5.6.2 Conduit specifications

Conduits shall conform to the requirements of Section 4.4 - Conduit and cable installation of this manual.

a) Types allowable for power cables shall be UPVC or Polyethylene nominal bore 125mm or 150mm smooth bore-smooth wall heavy duty underground conduit laid with appropriate sand bedding, without any further mechanical protection.

b) Type allowable for other uses within the substation shall be heavy-duty, complying with AS 2053 (Light and Power Layout).

7.5.6.3 Cable riser (where cables/conduits are not concrete enclosed)

Full access to cables is to be provided at all times. Doors extending the full height and width of the riser shall be provided. The height of the cable riser can be divided into multiple door panels provided the fire rating is not reduced at panel joints and any frames between panels do not impede access to cables. The doors are to provide a minimum 120/120/120 FRL.

The doors shall be arranged such that they provide full access when they are fully open. It is preferable to have a 180^{o} swing on these doors. Each door leaf is to swing on its frame using heavy-duty non-corroding metal. The width of the riser may be covered by single or double doors.

A clear area of at least one (1) metre is required in front of cable riser doors. Where multiple transformers are being fed, each set of cables shall be separated within the cable riser so that fire in one set does not spread to other sets or alternatively each set of cables may be placed in separate cable rises.

After installation of cables in cable risers, floor fire barriers shall be fitted. These shall be installed at all cable floor crossings/passing. The fire rating shall not be less than the fire rating of the riser. The barriers shall be easily removable and any supporting framework shall not interfere with cables and shall not diminish the floor opening.

LV control cables shall be laid in separate conduit risers.

7.5.6.4 Inspection

On receipt of forty-eight (48) hours' notice, Endeavour Energy's Network Connections employee may check the set out of conduits, before concreting is commenced. It is the responsibility of the builder to contact Endeavour Energy for this inspection.

The builder will be required to draw a proving mandrel, provided by Endeavour Energy, through the conduits where considered necessary, after the conduits has been laid. Suitable exposure of the conduits shall be the builder's responsibility.

7.5.7 Drainage

7.5.7.1 General

Substation basements, HV trenches and substation floors are to be gravity drained to a point free from risk of surcharge. HV trenches shall be drained in straight runs by minimum 50mm diameter copper or rigid PVC pipe. Where this is impractical a collection sump system may be provided if approved by Network Substation Manager.

Drainage openings in basements and trenches shall be provided with grates to prevent blockage.

LV trenches shall not be connected to the drainage system unless connect by a flame trap.

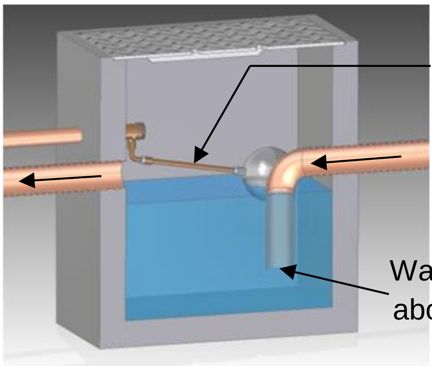


Figure 56 - Example flame trap

7.5.7.2 Basements and trenches below potential water table

In situations where the lowest level is below the level to which the water table may rise under any conditions, the underfloor area of the substation shall be filled with permeable material and drained to a point free of surcharge or otherwise to a sump external to the substation. The sump shall be fitted with an automatic discharge pump, with authorised persons only having access to the switch arrangements and the sump managed by the customer only.

The customer shall be responsible for providing, installing, wiring and commissioning all the power supply arrangements for this pump, with authorised persons only having access to the operating switches.

7.5.8 Fluid spillage/bunding

Provision shall be made within the substation for the containment of fluid spillage from the transformer(s), in the unlikely event of a fluid (oil) filled transformer tank failure. Spillage from transformers shall be contained within each transformer area by steel bund walls in accordance with clause 7.5.22 – Transformer bund wall.

7.5.9 Retaining walls

Where a retaining wall is necessary, the substation internal wall will be separated from the retaining wall by a cavity. This cavity is required to extend below the substation basement or trench floor level and be gravity drained to a point free of surcharge, or otherwise to a sump as described under clause 0 - Drainage.

7.5.10 Vermin proofing

Suitable steps shall be taken to check that the substation, when completed, is vermin proof.

7.5.11 Light and power supply

Lighting and power requirements shall be provided as indicated on the layout drawing. The distribution board within the substation is to be located as shown on the layout drawing and shall be for Endeavour Energy's use only.

The supply is to originate from the customer's distribution board. Circuit breakers or current-limiting fuse links mounted on the distribution board shall protect all circuits. This section of the installation shall comply with the AS 3000.

Cables to HV trenches for heaters, remote control motors, and the like, may be required to come from the distribution board to the HV trench.

Mounting heights above floor level:

- Top of distribution board 2000mm.
- Power points (GPOs) 1000mm.
- Light switches 1350mm.

Light fittings shall be fixed to the ceiling. Where the ceiling exceeds 4000mm, the fittings shall be suspended at 3500mm. Where wall mounted units are approved by Endeavour Energy, they shall be installed at 2200mm.

One (1) emergency exit light shall be installed within the substation adjacent to each personnel door. The 240 Volt supply to these lights shall originate from the distribution board within the substation.

7.5.12 Painting

7.5.12.1 Walls and ceilings

Painting with two (2) coats of white PVA water based emulsion, semi-gloss finish, applied to manufacturer's specification, is required when the following finishes are used:

- Concrete.
- Cement render.
- Concrete block work with ironed joints.
- Brickwork other than face brick with ironed joints.
- Plasterboard.

7.5.12.2 Floor

The building floor with exception of tiled surfaces and the basement floor area shall be sealed using a suitable sealer to minimise the formation of dust.

The sealant shall have the following properties:

- Prevent formation of concrete dust
- Abrasion resistant
- Non-slip
- Non-flammable
- Concrete penetrating type, not just a surface coating
- Resistant to oil and grease
- Chemically stable with concrete floor

The sealant colour required is golden yellow or similar.

The product Cement-aid-Diamite, or an approved equivalent that have the above mentioned properties, can be used for this purpose.

One (1) coat of the above sealant shall be applied to the building floor immediately after the building construction is complete but before any switchgear/equipment is brought into the building for installation. Subsequent coats of the sealant shall be applied prior to commissioning in accordance with manufacturer’s recommendations.

The following paints are suitable for use and others may be considered after submission, Acidol, Amerlock 2K and Durebild STE.

7.5.12.3 Steelwork

All exposed ferrous metalwork; doors and frames shall be galvanised or painted with one coat of zinc rich primer then finished with two coats of enamel paint.

7.5.13 Telephone

When requested by Endeavour Energy, the customer shall install a telephone with a direct line to an exchange in the substation room at no charge to Endeavour Energy. Endeavour Energy will pay the rental and metered calls. A 20mm diameter PVC conduit, approved by the telecommunications authority, shall be provided between the substation telephone point and the main telecommunications distribution frame in the customer's building.

7.5.14 Anti-vibration pads

Provision must be made for lifting transformers onto anti-vibration pads. This can be in the form of a lifting beam or jacks. If jacks are used, and a method other than a lifting beam is used to raise the transformer to the substation room level (platform, direct placement), a lifting beam is not required to be fitted in the substation room.

7.5.15 Rollers and jacking pads

All transformers shall be either fitted with bi-directional rollers or jacking pads to aid relocation inside the substation. Rollers shall be lockable to prevent unwanted movement.

7.5.16 Wall anchors

Wall anchors and/or pulling ring sockets shall be installed in the floor or walls, in the position shown on the layout drawings and in a manner to achieve any working load specified.

7.5.17 Ventilation/pressure relief

7.5.17.1 General

Substations require special attention to ventilation in order to dissipate continuous transformer heat losses and any overpressure developed during faults from equipment.

All louvres and louvred equipment access doors shall be two (2) stage constructions. Where louvres are inaccessible and protected from water spray (for example, three [3] metre high inside a basement) then single louvres may be allowed if approved by the Network Substation Manager.

All louvres shall be of sufficient strength to be vandal proof and corrosion resistant.

Ventilation openings must be vermin proofed using galvanised steel mesh type 'Ornamesh' Cat. No. D1020 (by Lysaght Brownbuilt Industries) or equivalent. Ventilation openings must be weatherproof.

Two-stage louvres shall be installed on all available doors and walls to firstly 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 by means of a fan(s) will also be required. Forced ventilation systems shall be designed, supplied, installed and maintained by the customer without the need to enter the substation. The ventilation must be forced into the room not extracted out and be sufficient to maintain a maximum temperature of 5º Celsius inside the substation building, above the air intake temperature.

The design of the ventilation shall be carried out by a certified ventilation engineer with the room operating at maximum load and shall demonstrate the temperatures of the room with and without any forced ventilation system operating. The design shall be submitted showing items such as:

- The maximum temperature inside the room at approx.1.8m above ground level at various external ambient temperatures.
- The ambient temperature shall be based on meteorological data associated with the area the substation is installed ie. no. of days over 30 degrees and maximums.
- Area of natural ventilation provided (the max natural ventilation shall be installed even when forced is being installed so that fans only run on rare occasions)
- A statement that the design is based on the 2 stage louvre actually being installed
- Calculations of air turn over
- If fans are installed how many days they may be in operation based on thermostat settings.
- Based on the above a statement advising if forced or natural ventilation is required.

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

An area of $4m^2$ of louvre will generally provide adequate pressure relief for equipment failures.

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

There are several variations to the two (2) stage louvre, however, the preferred options are shown in Figure 57.

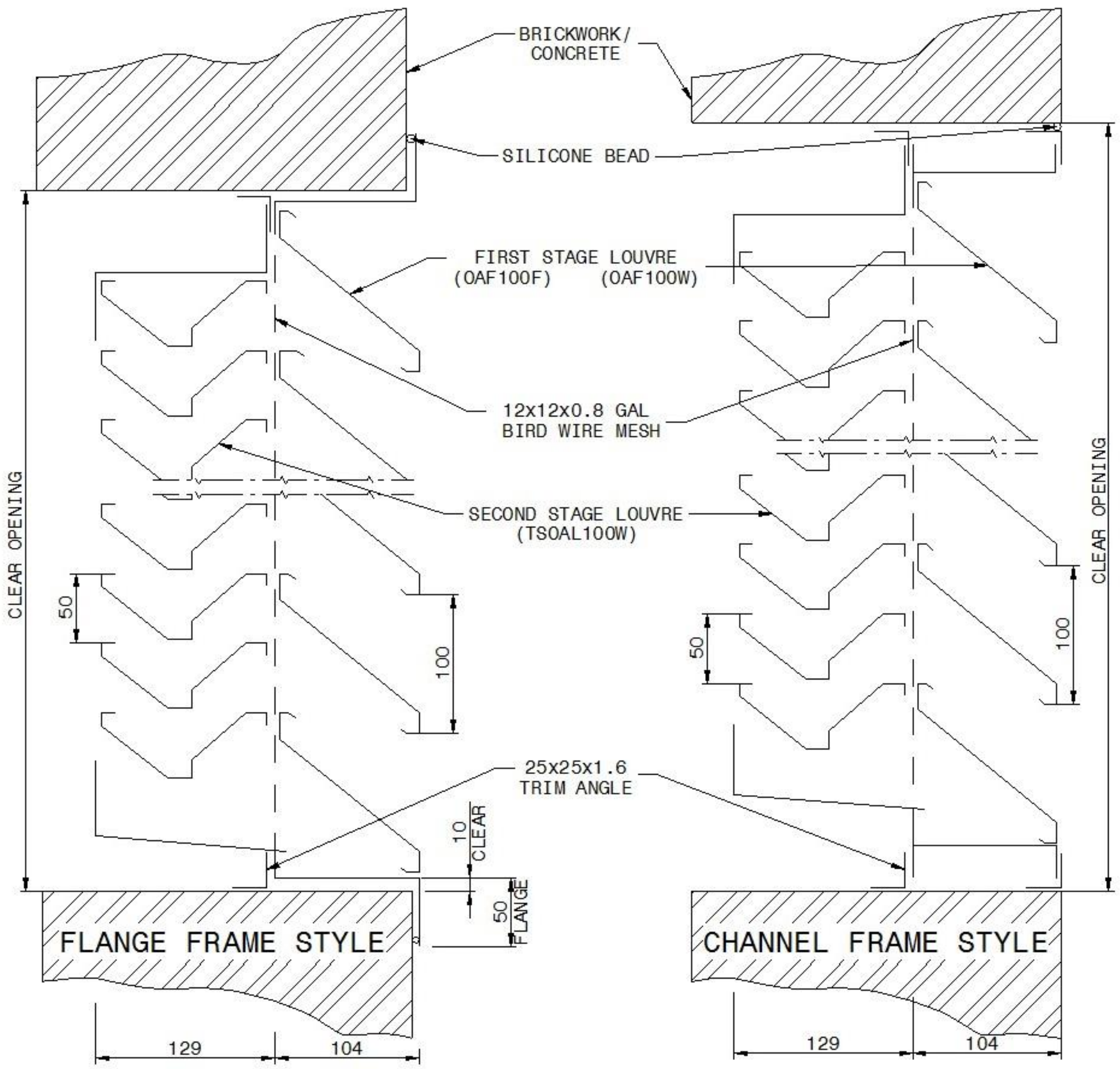


Figure 57 - Example wall louvre

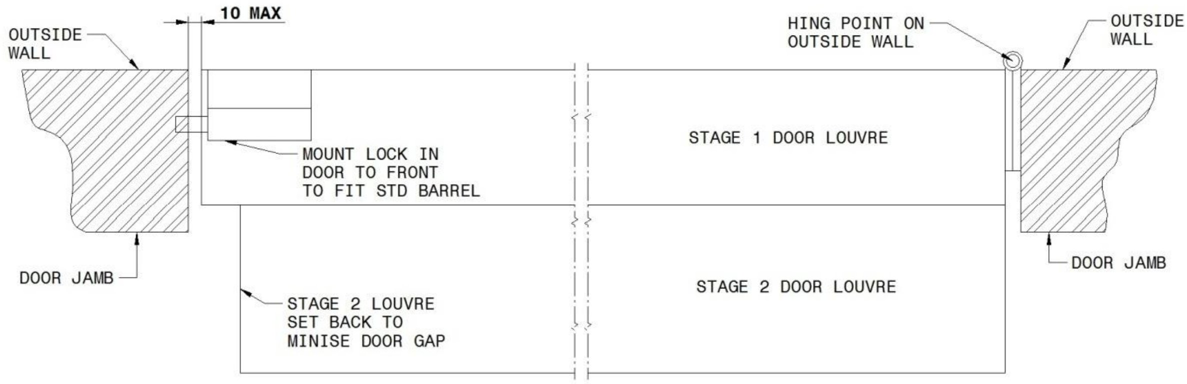


Figure 58 - Example door louvre

On doors it will be necessary to adjust the profile of the edge of the door (chamfered) as shown in Figure 58 to reduce the gap between the door and the frame (when closed) to a maximum of 10mm.

7.5.17.2 Equipment losses

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

7.5.17.3 Location of ventilation openings

Substation ventilation openings (doors or vents) shall be clear of any vents/doors/windows of the nearby buildings by three (3) m horizontally and six (6) m vertically minimum. Refer to AS 2067 and Figure 59 and Figure 60 for fire/smoke risk zones.

Ventilation openings shall be arranged to achieve an even distribution of airflow over the transformer(s) and must be designed such that hot air cannot accumulate at ceiling height.

Where required, the substation shall be provided either with full ceiling height louvres or, where this is not practical, (for example, where the ceiling height is greater than normally required), combinations of high level and low level louvres.

It is stressed that the substation chamber will not be accepted if the above stated conditions are not met.

7.5.17.4 Fire isolating dampers

All ventilating openings from the substation to inside the customer's building shall be avoided, but where approved by the Network Substations Manager, shall be provided with automatically controlled fire isolating dampers. Dampers may also be required on external openings in special cases, for example, where windows and the like are located above or adjacent to substation. These dampers shall be so arranged that they will not operate as a result of abnormal temperatures.

The fire isolating dampers shall be of the type with either curtain or individual blades with fusible link and shall comply with the requirements of AS1682. Intumescent fire dampeners are not permitted as they cannot be tested once installed.

Where dampers project into the substation chamber, they shall, if necessary, be provided with guards sufficient to protect employees from injury. Such guards shall not impair the operation of the dampers. Substations fitted with dampers must also be equipped with a high temperature alarm supplied, installed and maintained by the customer. Refer clauses 7.5.18– Fire protection and rating requirements and 7.5.19- Alarms for details.

7.5.17.5 Duct systems

Ventilation ducts must be of construction conforming in strength and fire rating with the requirements for walls separating the substation chamber from the remainder of the building.

Ventilation ducts shall be drained to a point free of surcharge. Positioning of ducts within the substation may require an increase in substation area so as to maintain clearance from the substation equipment.

7.5.17.6 Forced ventilation

Where forced ventilation is used, the fan(s) shall force air into the room and be started when the maximum temperature in the room reaches 35° Celsius, and may be stopped when the maximum temperature in the room falls below 30° Celsius at 1.6m above ground level.

The ventilation control and alarm system shall comply with the minimum requirements of Drawing no. 040883. The ventilation control may be located outside the substation but the temperature sensor and manual override must be located inside the substation.

Refer clause 7.5.19 - Alarms for alarm control location and notification details.

The forced ventilation electrical supply shall be via a dedicated circuit from the customer's main switchboard.

7.5.17.7 Ventilation alarms

The following are required where forced ventilation is installed:

Air Flow Alarm: Initiated by a sail or pressure switch in the duct work, or a relay, sensing the fan motor supply.

High Temperature Alarm: The temperature sensor shall be set in the range 48 to 50° Celsius. Refer clause 7.5.19 - Alarms for alarm control and notification details.

7.5.18 Fire protection and rating requirements

7.5.18.1 Building requirements

The whole of the substation, entrance and exit passages shall be isolated from the remainder of the customer's building by a minimum 120/120/120 FRL construction, in accordance with the Building Code of Australia and AS 2067 and the following diagrams.

Where dry type transformers are indicated in the following drawings it shall also apply to the approved transformers with K-class oil having a high flash point (>250^{0}C).

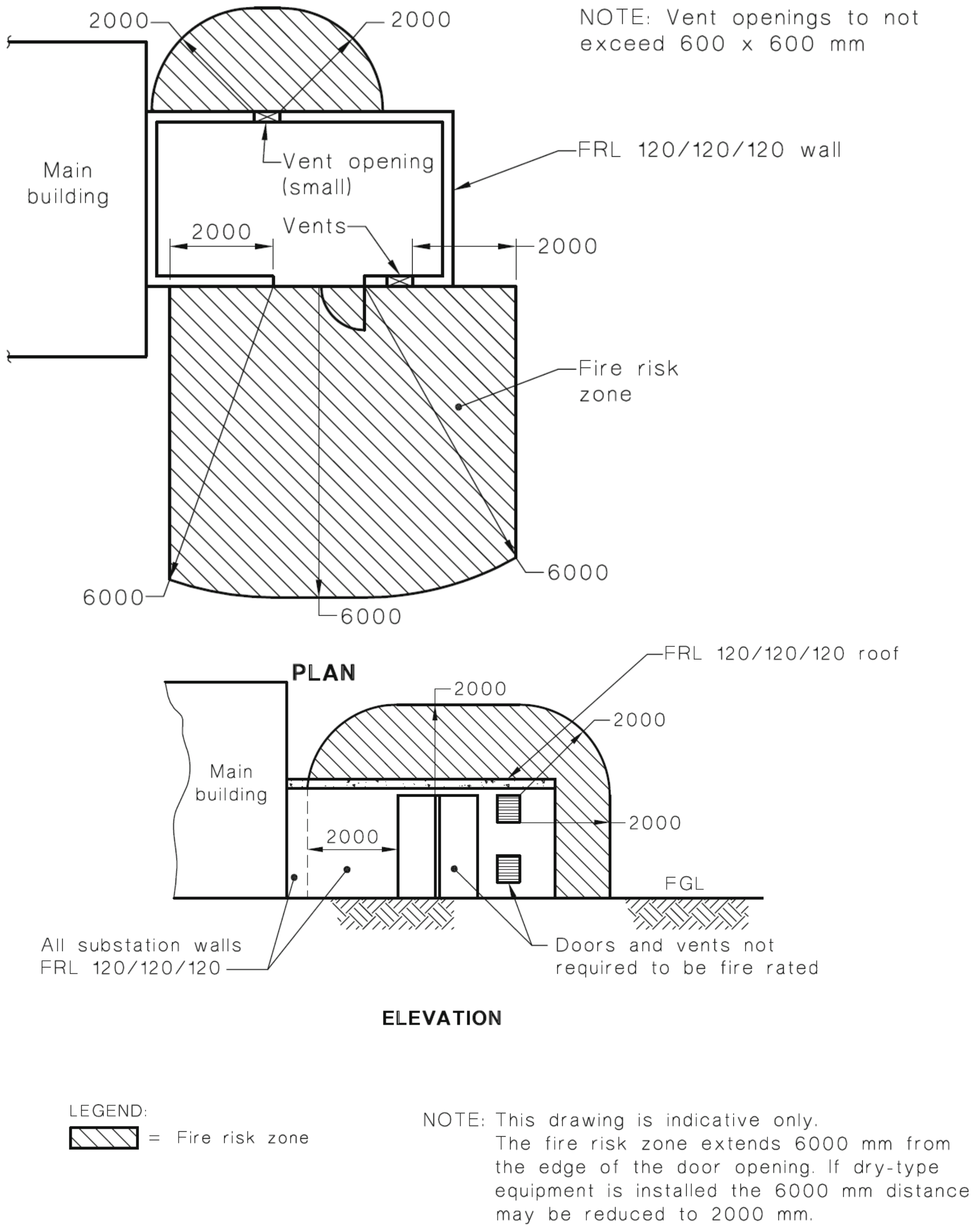


FIGURE C5 ATTACHED OR ADJACENT SUBSTATION WITH FIRE-RATED WALLS AND ROOF AND NON-FIRE-RATED DOORS AND VENTS

Figure 59 - Figure C5 from AS2067

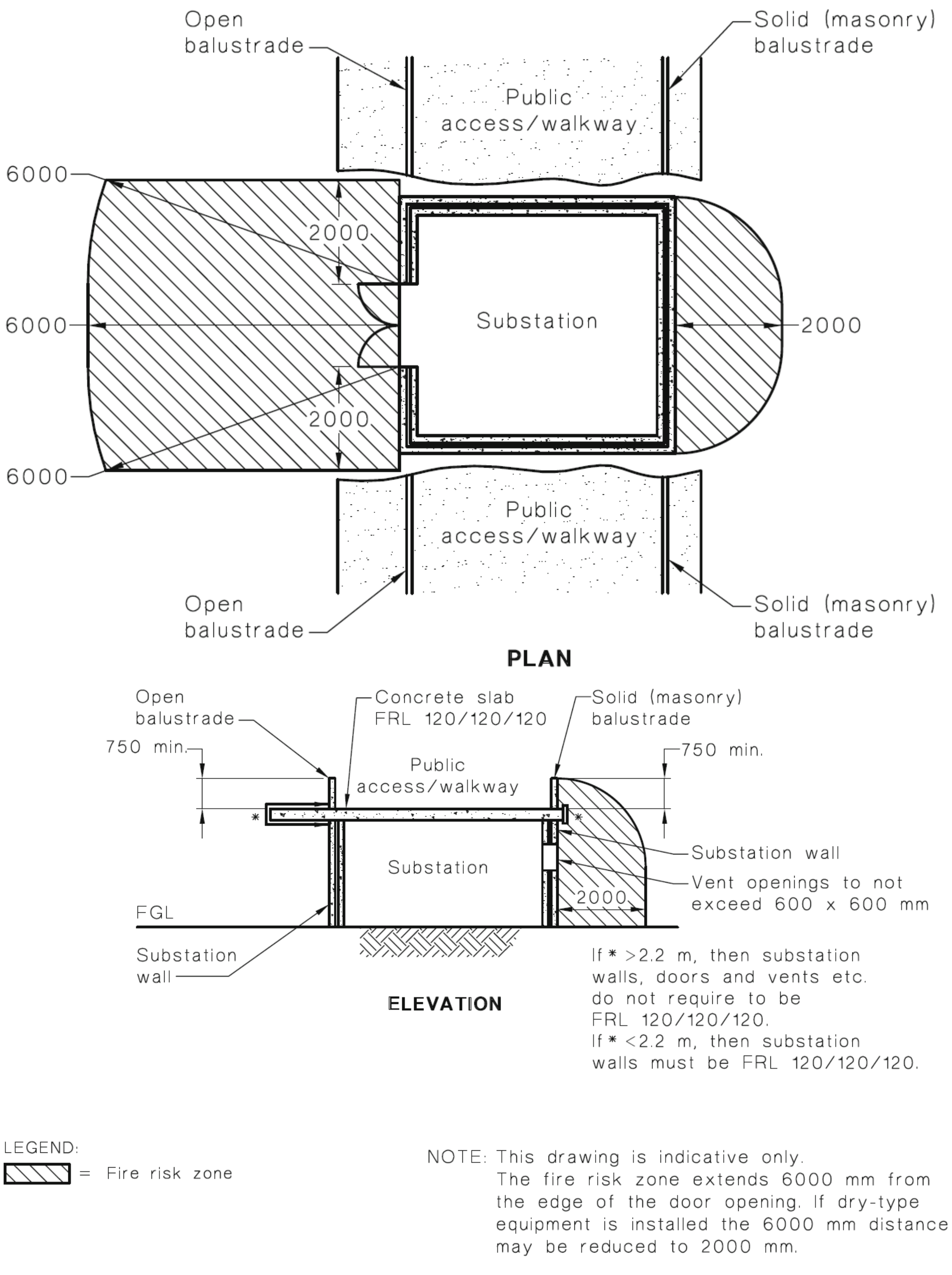


FIGURE C6 INDOOR SUBSTATION WITH PUBLIC ACCESS ABOVE

Figure 60 - Figure C6 from AS2067

7.5.18.2 Extinguishers

Two (2) fire extinguishers are to be supplied and installed by the customer in each room of the substation on suitable wall mounting brackets. The location is shown on the layout drawings and shall be 5.0kg CO_2 type. The mounting height is to be 1200mm to top of extinguisher.

Endeavour Energy will maintain the fire extinguishers.

7.5.18.3 Fire alarms

Where fire alarms are required by others to be installed in a customer's premises, the substation shall also be fitted with fire alarms. Fire detectors shall be located over the transformers and switchgear and provide an alarm to the customer's central alarm board. Smoke sensors are preferred, however, other suitable detection devices will be considered. Refer clause 7.5.19 - Alarms for notification of a fire alarm.

7.5.19 Alarms

Where alarms are required in accordance with this Standard, the following shall apply:

7.5.19.1 Control

Controls shall be located in the substation. Remote indicator lamps, warning bells together with mute push buttons shall be located external to the substation in a control room or alarm panel, together with a nameplate. The external mute button to operate only after initiation and shall be capable of resetting automatically every minute. A control switch shall be provided inside the substation to switch off the alarm once the employees commence restoration work.

7.5.19.2 Notification of alarms

Immediate notification of all alarms is required, that is, high temperature, fire and sump pump failure.

The customer shall provide a suitable notice, fixed adjacent to the alarm indicator, advising that Endeavour Energy's System Operator must be notified (phone 131081) immediately on receipt of such an alarm.

7.5.20 Substation building completion

The substation shall be completed in all respects and with suitable access available for delivery and installation of heavy equipment. Endeavour Energy relevant representative (as stated in Section 2.9 - Inspection of works) is to be notified for arrangement of a final inspection and approval of the substation. Failure to comply with this requirement may also affect the program for providing electricity supply.

7.5.21 Substation building maintenance

Endeavour Energy will be responsible for the maintenance within the substation building of fire extinguishers, replacement of fluorescent light tubes and painting of walls, ceiling and floor only. All other maintenance is the responsibility of the customer.

7.5.22 Transformer bund wall

Bund walls are required around all liquid filled transformers. Set out below is the procedure for installing the indoor substation bund wall.

7.5.22.1 Bund wall installation tools and equipment

Listed below are the basic recommended materials required to carry out this procedure for each installed transformer:

- Masonry anchors (Hilti HKD 6 mm flush anchor or equivalent) - 8 off.
- M6 x 30mm long hex head mild steel setscrews - 8 off.
- M6 round flat mild steel washers - 8 off.
- M12 x 25mm long hex head galvanised steel bolts c/w nuts - 12 off.
- 12mm round flat galvanised steel washers - 24 off.
- Sheet metal sections, as detailed in Drawing no. 240118.
- 310ml tube of Sikaflex-11FC - 4 off.
- Mineral turpentine - 500ml.
- Pair of disposable latex surgeon style gloves (box of 100) - 1 off.

7.5.22.2 Installation process

Note: When installing the bund walls in substations with three or more transformers, always start by installing the bund wall(s) on the centre transformer(s) prior to the outer transformers.

Steps:

1) Clean the area. Remove dust, dirt and debris. Wash the area with a damp cloth.
2) Partly assemble the four (4) sheet metal sections around the transformer, using two (2) M12 x 25mm bolts in the top and bottom holes (finger tight) on each section.
3) Position the partly assembled bund wall evenly around the transformer and as close to the low voltage switchgear as possible, without spanning the cable trench. Refer to Figure 61 - Plan of bund wall position and Figure 62 for location of the bund wall.
4) Using a pencil, carefully trace the position of the internal and external edges of the bund wall and the location of the eight (8) holes required for the anchors on the floor.
5) Remove the bund wall from around the transformer and completely disassemble.
6) Drill all eight (8) holes in the floor to suit the hold down anchors.
7) All peeling paint on the floor must be removed where the bund will be located.
8) Check that all mating surfaces of the steelwork and the area marked on the floor are free from dust, debris, grease, oil and water.
9) Insert the eight (8) hold down anchors into the holes in the floor and place one (1) M6 setscrew near each of these anchors.
10) Put a pair of surgeon style latex gloves on - to minimise clean up.
11) Cut the nozzle of the Sikaflex tube to achieve a hole diameter of approximately 8mm and an angle of approximately 30°. Puncture the tube's diaphragm and insert the tube into the caulking gun.

Note: It is essential that there are no gaps left in the sealant and the bead is a consistent thickness when applying the Sikaflex in the following steps.

12) Apply one (1) generous bead of Sikaflex (approximately 10mm diameter) centrally between the lines previously marked on the floor. **Note**: Check that the bead passes around both sides of the holes for the anchors.
13) Working with one piece of steelwork at a time, apply one (1) generous bead of Sikaflex to the underside of the steelwork (face with 8mm diameter holes) in a similar manner to that done on the floor in step 12.
14) Position the steelwork on floor between the marked lines and hold in place by installing the M6 setscrews in the anchors. It is essential that the initial sealant contact between the floor and the steelwork is not broken. **Note**: M6 set screws to be finger tight.
15) Apply an extra generous horizontal bead of Sikaflex along the internal side of the steelwork, between the floor and the return flange.

16) Apply a generous horizontal bead of Sikaflex between the floor and the edge of the channel, from the horizontal bead along the return flange to the bead laid between the lines on the floor (that is, between the bead laid in step 15 and the bead laid in step 12).
17) Apply a generous vertical bead of Sikaflex to the internal side of the return flange, midway between the channel and the M12 bolt holes.
18) Repeat steps 13 through 17 for each remaining piece of steelwork.
19) After all four (4) sections of the bund wall's steelwork have been positioned; insert an M12 bolt from the outside of the bund wall with one (1) flat washer under the bolt head. Then apply a bead of Sikaflex to the inside of the bund wall and around the bolt. Fit the M12 nut finger tight. **Note**: Spring washers are not to be used.
20) Repeat step 19 for all remaining M12 bolts.
21) Check the bund wall for squareness and adjust as necessary.
22) Push the bund wall down to the floor.
23) Tighten all eight (8) M6 set screws to pull the steelwork down firmly onto the floor.
24) Tighten all twelve (12) M12 bolts.
25) Inspect for excess sealant around the internal joints of the bund wall and between the gap in the steelwork at the base of each return flange. If no sealant has squeezed out of any of these areas, then apply a bead of Sikaflex to cover the area.
26) Apply Sikaflex to any visible cracks in the concrete floor on the inside of the bund wall.

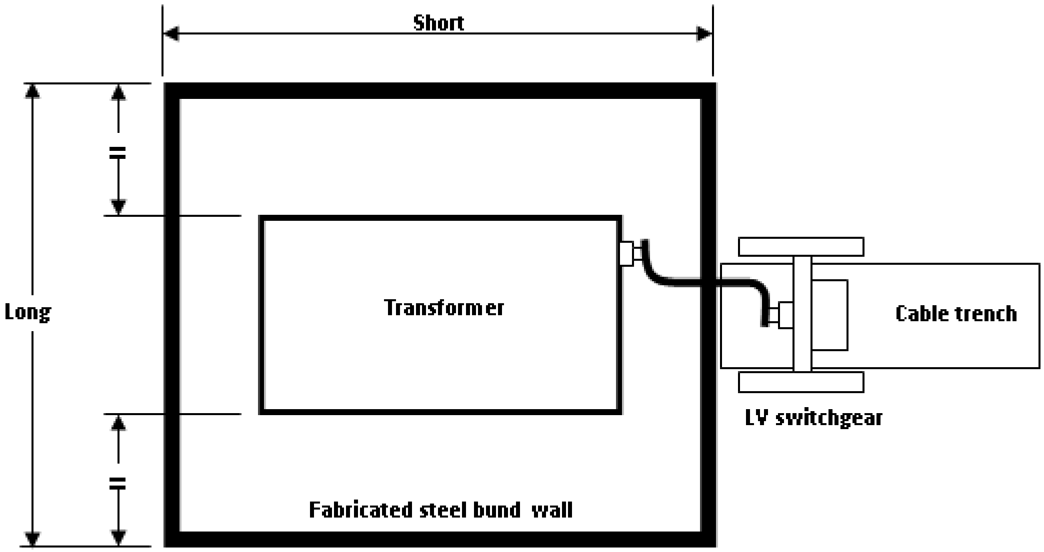


Figure 61 - Plan of bund wall position

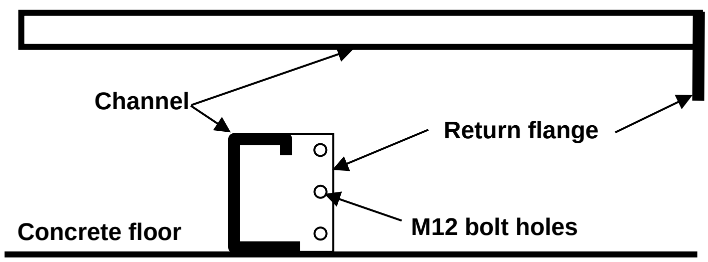


Figure 62 - Bund wall fabrication steelwork detail

7.5.22.3 Sealing conduits within the bund wall enclosure

Listed below are the basic recommended materials required to carry out this procedure for each conduit:

- 310ml tube of “Sikaflex-11FC” - 2 off (Stock code: 1536487).
- Mineral turpentine - 500ml

Steps:

1) Trim the conduit to floor level.
2) If the conduit contains multiple cables, the cables must be separated from each other to allow correct application of the sealant.
3) Insert rags into the conduit to act as a backing, preventing excessive use of the sealant.
4) Thoroughly sweep around the conduit to remove dust, dirt and debris. If sweeping is inadequate, wash the area with a damp cloth. **Note**: Avoid use of excessive water.
5) Check that all surfaces around the conduit and cables are free from dust, debris, grease, oil and water.
6) Apply a generous amount of Sikaflex to the conduit to seal it and protect it from possible exposure to fire. Check that the sealant is worked in between each cable in the conduit.

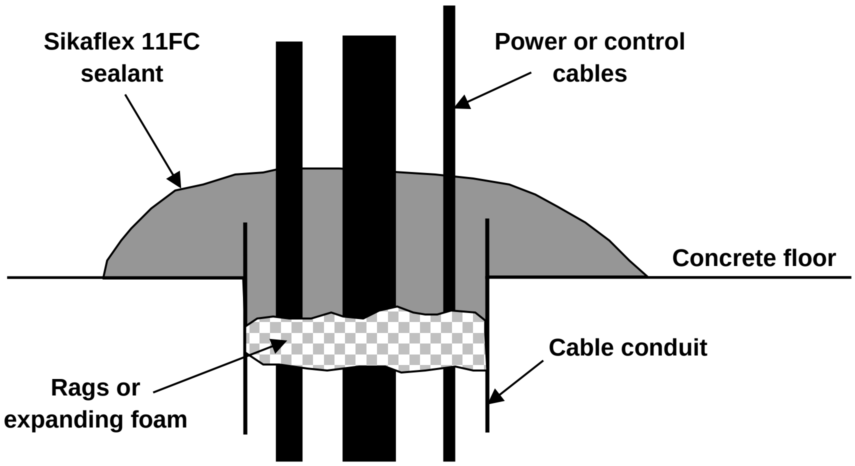


Figure 63 - Cable conduit sealing detail

7.6 Padmount switching stations

When permitted padmount switching substations shall be located where practical at the front property boundary.

For switching stations located in buildings or in alcoves of buildings, refer to the indoor substation section for details.

7.6.1 General construction details

High voltage switchgear shall face the end of the cubicle. It shall be possible to operate all equipment with the end cubicle door open.

7.6.2 Plinth and culvert details

7.6.2.1 Precast plinth and culvert

Precast concrete plinths and culverts shall be used unless approval to the contrary is given by the Network Substation Manager. The plinth and culvert are similar to a standard padmount substation design and cabling can be terminated in the same manner as in a padmount substation.

The plinth and culvert shall be constructed in accordance with Drawing no's 292827 and 075027 respectively. For details on the installation of the culvert and ground preparation, refer to the padmount culvert details, as they are to be the same, although shorter in length.

7.6.2.2 Poured plinth design

Poured concrete plinths have been used in the past and may be required in some special situations after approval from the Network Substation Manager has been given.

7.6.3 HV switchgear

Endeavour Energy requires full rated load make/break switch assemblies for the switching stations. Non-switchable fuse boards are not acceptable.

The maximum number of switches that can be accommodated in a cubicle is four (4). It will be necessary to check dimensions to confirm the latest switchgear will fit in the cubicle being used.

The switchgear is suitable for high voltage cables up to $300mm^2$.

7.6.4 Cubicle details

The cubicle must be constructed from fibreglass reinforced polyester resin or approved stainless steel fabrication.

For full details of the cubicle requirements for switching stations refer to Drawing no's 264890, 26489 and 282540. Other requirements are the same as those for padmount substations.

7.7 Substation and switching station drawings

The following drawings form part of this instruction.

7.7.1 Padmount substation – associated drawings

Drawing no.	Amend no.	Subject
016665/1	T	11/22kV padmount substation easement layout sheet 1
016665/2	L	11/22kV padmount substation easement layout sheet 2
061674	E	Padmount substation metal fence isolated panel installation detail
075027	J	11/22kV padmount and switching station invert culvert construction details
076665	E	11/22kV padmount substation culvert footing installation
077555	J	Padmount substation LV Circuit Breaker and Load Break Switch frame arrangement detail
078239	B	Low voltage equipment cable lug critical dimensions
078481	D	Package padmount substation lifting arrangement and detail
245886	C	Size 14 and 16 padmount precast concrete plinth construction detail
245887	G	Size 14 and 16 padmount and indoor transformer typical requirements
264786	B	Size 14 and 16 padmount substation exploded view
264887	B	Size 14 and 16 padmount substation fibreglass cubicle GA
266515	C	Padmount substation LV distribution board frame to suit size 14 & 16 substation arrangement details
289702	A	Fencing for padmount subs Sheets 1 - 7

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AMENDMENTS

A	ORIGINAL ISSUE	
J R No.	900019	
G	D'RN	R.J.D.
	CH'D	J.K.
	DATE	14-6-90
	JR No	900082

REDESIGNED & REDRAWN. 22kV PLINTH DIMS ADDED.

S.D.E.	J.K.	
H	D'RN	D.J.Z.
	CH'D	J.K.
	DATE	23-7-91
	JR No	910121

ISSUE WAS 1-5-90
PAGE NO. WAS 13

S.D.E.	J.K.	
J	D'RN	R.M.M.
	CH'D	D.J.Z.
	DATE	21-5-92
	JR No	920101

LV WAS MV. REF DRG 061674 ADDED NOTES 3 & 4 AMENDED

S.D.E.	C.H.	
K	D'RN	FMAIO
	CH'D	FM
	DATE	16-9-92
	JR No	...

1 OF 2 SHEETS WAS 1 OF 1 SHEETS REFERENCE DRG PAGE NO.S REMOVED

S.D.E	FM	
L	DR'N	T.A.B.
	CH'D	D.J.Z.
	DATE	15-7-93
	JR No	9300023

URD DETAIL ROTATED. TITLE AMENDED. NOTE 1 AMENDED. NOTE 6 ADDED.

S.D.E.	J.K.	
M	DR'N	C.R.T.
	CH'D	D.J.Z.
	DATE	28-10-93
	JR No	930206

SDI 117 WAS TP9. BUILDING SETBACK EXCEEDS 7.5m ADDED TO URD & UID.

S.D.M.	J.K.	
N	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	25-8-95
	JR No	950159

NOTE 2 REVISED. NORMAL INSTALLATION HEIGHT CLEARANCE WAS 3200mm. FOOTING REF DRGS DELETED.

M.S.S.	J.K.	
P	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	05-2-96
	JR No	960001

NOTE 1 REVISED. ISSUE ID SDI 104, 114 & 117 DELETED. NOTES 2,3 & 4 SDI 104 WAS SDI 105.

SEO	SQ	
Q	DR'N	R.J.H.
	CH'D	R.J.H.
	DATE	04-7-96
	JR No	960051

DIM 5500 WAS 5000 (C3). ORIG NOTE 5 DELETED, NOTE Nos REVISED ACCORDINGLY.

SEO	J.K.	
R	DR'N	B.G.H.
	CH'D	J.K.
	DATE	20-10-98
	JR No	GZ911100

EASEMENT AREA FINISH NOTE DELETED. CLAUSES REMOVED FROM NOTES 2,3 & 4. NOTE 5 ADDED.

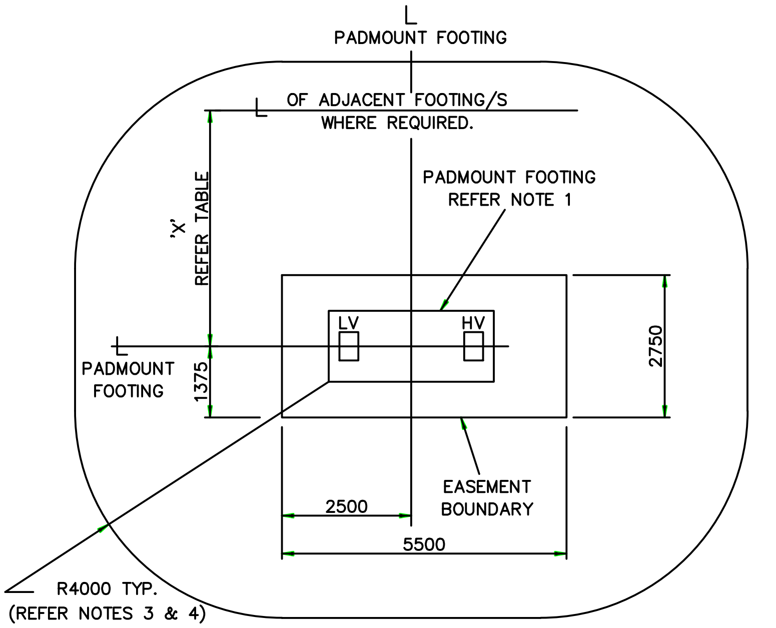
MNSA	J.K.	
S	DR'N	R.J.H.
	CH'D	R.J.H.
	DATE	18-6-99
	JR No	WX911159

11kV PADMOUNT FTG WAS 2970 x 1290.

MNAT	J.K.	
T	DR'N	GSF
	CH'D	GSF
	DATE	26-11-15
	JR No	N/A

NOTES 2,3&4 REF. TO SDI104 NOW MCI0006.

NSM	Colin Crisafulli

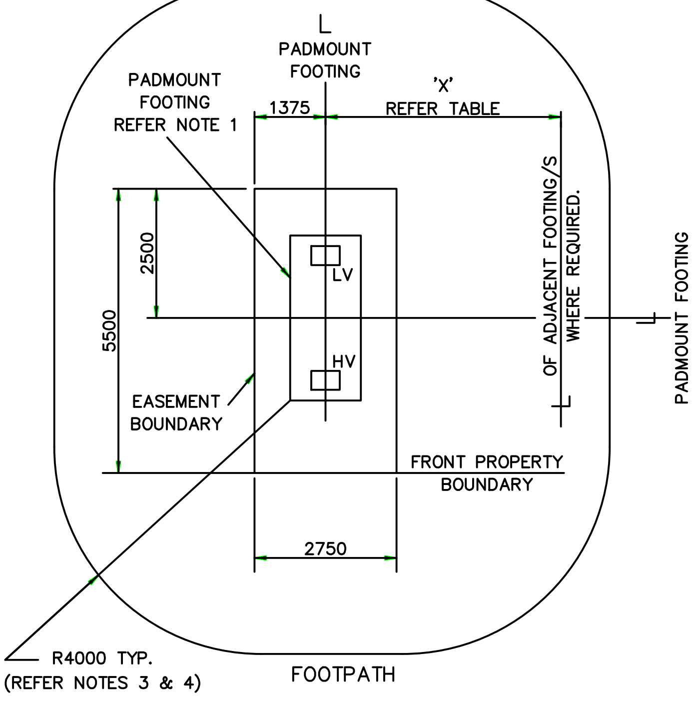


COMMERCIAL, HIGH DENSITY & INDUSTRIAL DEVELOPMENT

– ARRANGEMENT CAN BE FOR FOOTPATH ON EITHER LV OR HV SIDE OF PADMOUNT.

NOTES

1. PADMOUNT FOOTING DIMENSIONS;
   11/22kV PADMOUNT – 3190mm X 1370mm
2. HEIGHT REQUIRED ABOVE PADMOUNT FOOTING FOR NORMAL INSTALLATION TO BE 5500mm. WHERE HEIGHT IS RESTRICTED BELOW 5500mm REFER TO MCI0006.
3. EXCEPT AS NOTED IN MCI0006, ANY METAL FENCING, WITHIN THE AREA DEFINED BY A LINE 4000mm FROM FOOTING EXTREMITIES & THE EASEMENT BOUNDARY, IS TO BE CONSTRUCTED SO THAT ADJACENT PANELS ARE ISOLATED FROM EACH OTHER & FROM THE GROUND.
4. EXCEPT AS NOTED IN MCI0006, ANY METAL CLAD BU1LDING SHOULD NOT ENCROACH W1THIN THE AREA DEFINED BY A L1NE 4000mm FROM THE FOOTING EXTREMITIES.
5. IN COMMERCIAL, HIGH DENSITY AND INDUSTRIAL DEVELOPMENT AREAS, A SECOND PADMOUNT SUBSTATION CAN BE LOCATED END ON END WITH THE TWO LOW VOLTAGE ENDS FACING EACH OTHER. IN THIS CASE THE SPACING BETWEEN SUBSTATION FOOTINGS SHALL BE 1500mm, THE EASEMENT WILL THEREFORE BE 2750mm x 10500mm.



MULTIPLE PADMOUNTS WITHIN THE SAME EASEMENT

NO. OF PADMOUNTS	DIMENSION 'X' OF FOOTINGS.	EASEMENT WIDTH
2	1 x 2250	5000
3	2 x 2250	7250
4	3 x 2250	9500

– ALL OTHER DIMENSIONS REMAIN THE SAME.

UNDERGROUND RESIDENTIAL DEVELOPMENT WHERE BUILDING SETBACK EXCEEDS 7.5 METRES & UNDERGROUND INDUSTRIAL DEVELOPMENT

– SUBSTATION TO BE POSITIONED WHEREVER POSSIBLE ON LOW SIDE OF STREET. IF SUBSTATION MUST BE POSITIONED ON HIGH SIDE, DIM 5500 MUST BE INCREASED TO 6500 TO CLEAR WATER BOARD SEWERS.

– SUBSTATION TO BE POSITIONED PREFERABLY WITH HV TO FOOTPATH SIDE (AS SHOWN).

Endeavour Energy

FENCE ISOLATED PANEL INST DET	061674
REFERENCE DRAWINGS	DRG. NO.

THIS ISSUE PAGE NO

ORIGINAL SCALE 1:75

APPROVED C.Howat

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

D.B.Britten/CH
ASSIST. G.M. ENG. 23-7-91

ISSUE IDENTIFICATION

DRAWN	R.J.D.
DATE	23-7-91
CH'D	D.J.Z.

11kV & 22kV PADMOUNT SUBSTATION EASEMENT LAYOUT

SUB 016665 T
SHEET No 1 OF 2 SHEETS
INDEX REF S001E

THIS ISSUE

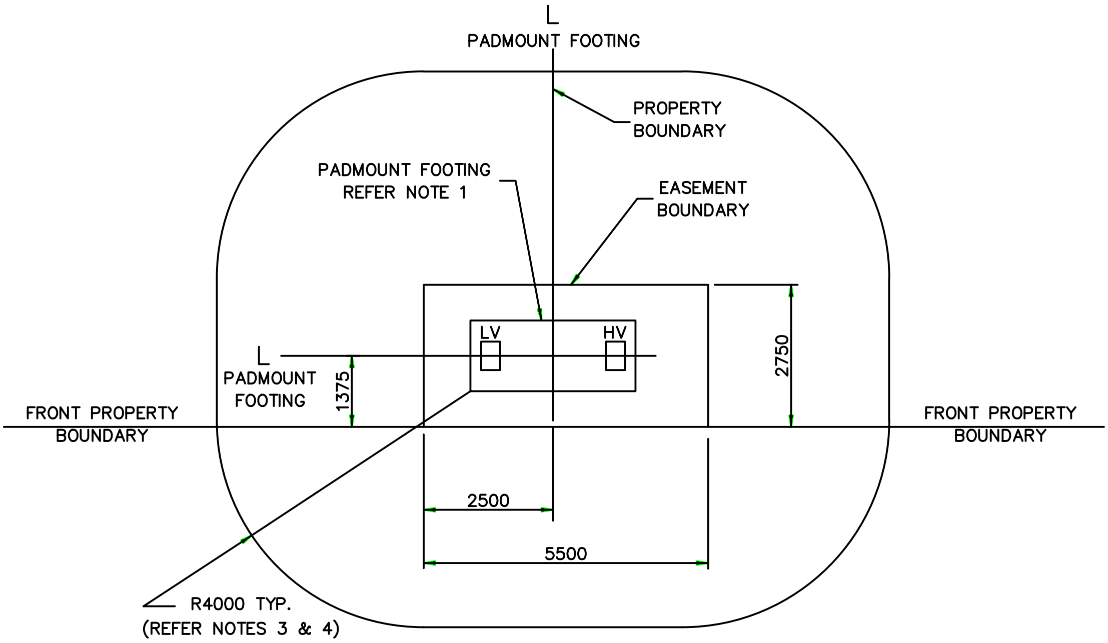
PAGE NO.

AMENDMENTS

A	ORIGINAL ISSUE; J R No. 920101
B	D'RN JMcD; CH'D S.G.P; DATE 21-8-92; JR No 920194; DIM 5000 WAS 5500 (REF. F4); S.D.E. F.M.
C	D'RN FMAIO; CH'D FM; DATE 16-9-92; JR No ..; PAGE NOS REMOVED NOTES AMENDED.; S.D.E. FM
D	DR'N C.R.T.; CH'D D.J.Z; DATE 15-7-93; JR No 930117; TITLE AMENDED. NOTE 1 AMENDED. NOTE 5 ADDED.; S.D.E. JK
E	DR'N C.R.T.; CH'D D.J.Z; DATE 28-10-93; JR No 930206; SDI 117 WAS TP9.; S.D.M. JK
F	DR'N D.J.Z; CH'D D.J.Z; DATE 25-8-95; JR No 950159; NOTE 2 REVISED. NORMAL INSTALLATION HEIGHT CLEARANCE WAS 3200mm. FOOTING REF DRGS DELETED.; M.S.S. J.K.
G	DR'N D.J.Z.; CH'D D.J.Z; DATE 05-2-96; JR No 960001; NOTE 1 REVISED. ISSUE ID SDI 104, 114 & 117 DELETED. NOTES 2,3 & 4 SDI 104 WAS SDI 105.; SEO SQ
H	DR'N R.J.H; CH'D R.J.H; DATE 04-7-96; JR No 960051; DIM 5500 WAS 5000 (F4).; SEO JK
J	DR'N B.G.H; CH'D JK; DATE 20-10-98; JR No GZ911100; EASEMENT AREA FINISH NOTE DELETED. CLAUSES REMOVED FROM NOTES 2,3 & 4.; MNSA JK
K	DR'N R.H; CH'D R.H; DATE 18-6-99; JR No WX911159; 11kV PADMOUNT FTG WAS 2970 x 1290.; MNAT JK
L	DR'N GSF; CH'D GSF; DATE 26-11-15; JR No N/A; REF TO SDI104 NOW MCI0006.; NSM Colin Crisafulli

NOTES

1. PADMOUNT FOOTING DIMENSIONS;
   11/22kV PADMOUNT – 3190mm X 1370mm
2. HEIGHT REQUIRED ABOVE PADMOUNT FOOTING FOR NORMAL INSTALLATION TO BE 5500mm. WHERE HEIGHT IS RESTRICTED BELOW 5500mm REFER TO MCI0006.
3. EXCEPT AS NOTED IN MCI0006, ANY METAL FENCING, WITHIN THE AREA DEFINED BY A LINE 4000mm FROM FOOTING EXTREMITIES & THE EASEMENT BOUNDARY, IS TO BE CONSTRUCTED SO THAT ADJACENT PANELS ARE ISOLATED FROM EACH OTHER & FROM THE GROUND.
4. EXCEPT AS NOTED IN MCI0006, ANY METAL CLAD BU1LDING SHOULD NOT ENCROACH W1THIN THE AREA DEFINED BY A L1NE 4000mm FROM THE FOOTING EXTREMITIES.



UNDERGROUND RESIDENTIAL DEVELOPMENT
WHERE BUILDING SETBACKS ARE LESS THAN 7.5 METRES

- SUBSTATION TO BE POSITIONED WHEREVER POSSIBLE ON LOW SIDE OF
@U STREET. IF SUBSTATION MUST BE POSITIONED ON HIGH SIDE, DIM 2750
@U MUST BE INCREASED TO 4000 AND DIM 1375 MUST BE INCREASED TO 2625
@U TO CLEAR WATER BOARD SEWERS.

- FOOTING MAY BE ROTATED THROUGH 180 DEGREES.
@U
- MULTIPLE PADMOUNTS NOT APPLICABLE IN THIS CASE.

Endeavour Energy

FENCE ISOLATED PANEL INST DET	061674	
REFERENCE DRAWINGS	DRG. NO.	THIS ISSUE PAGE NO

ORIGINAL SCALE 1:75 | APPROVED C.Howat | DO NOT SCALE DIMENSIONS IN MILLIMETRES | D.B.Britten/CH ASSIST. G.M. ENG. 18-5-92 | ISSUE IDENTIFICATION

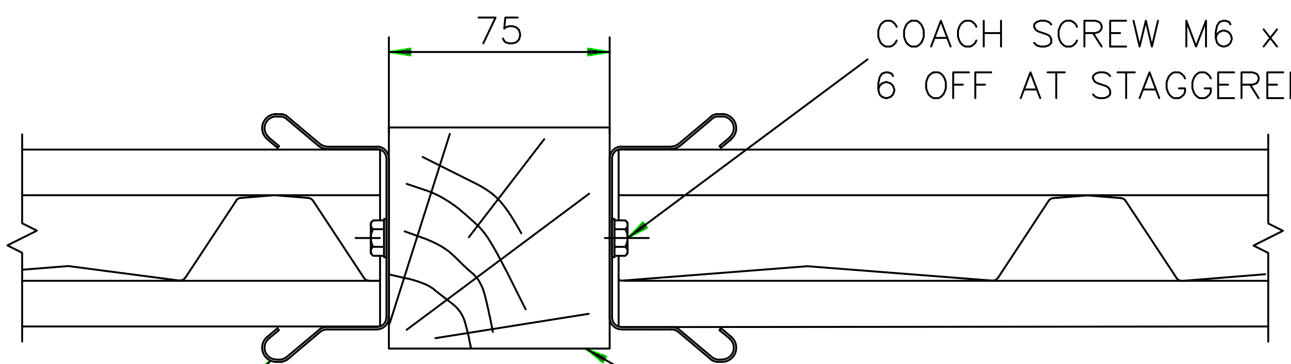
DRAWN R.M.M | DATE 18-5-92 | CH'D D.J.Z

11kV & 22kV PADMOUNT SUBSTATION EASEMENT LAYOUT

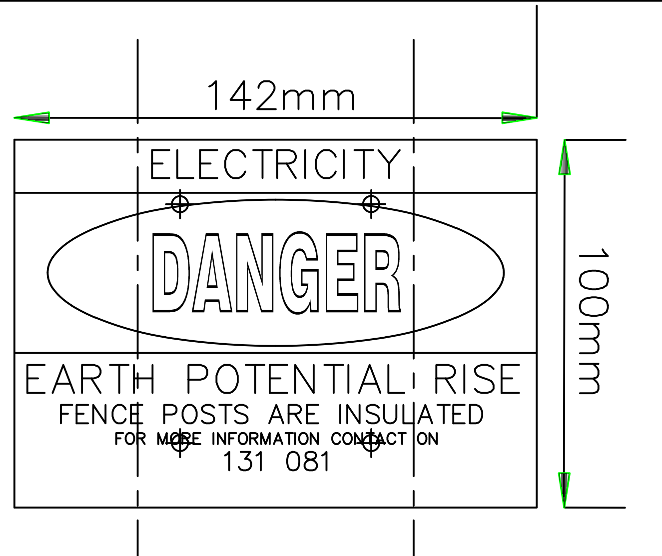
SUB 016665 L | SHEET No 2 OF 2 SHEETS | INDEX REF S001E | THIS ISSUE | PAGE NO.

NOTES

1. ARRANGEMENT AS SHOWN IS DESIGNED FOR "LYSAGHT NEETASCREEN FENCING". WHEN OTHER TYPES OF METALLIC FENCING ARE ENCOUNTERED THE SAME PRINCIPLE IS TO BE APPLIED.
2. FENCE TO BE ERECTED IN ACCORDANCE WITH MCI0006.

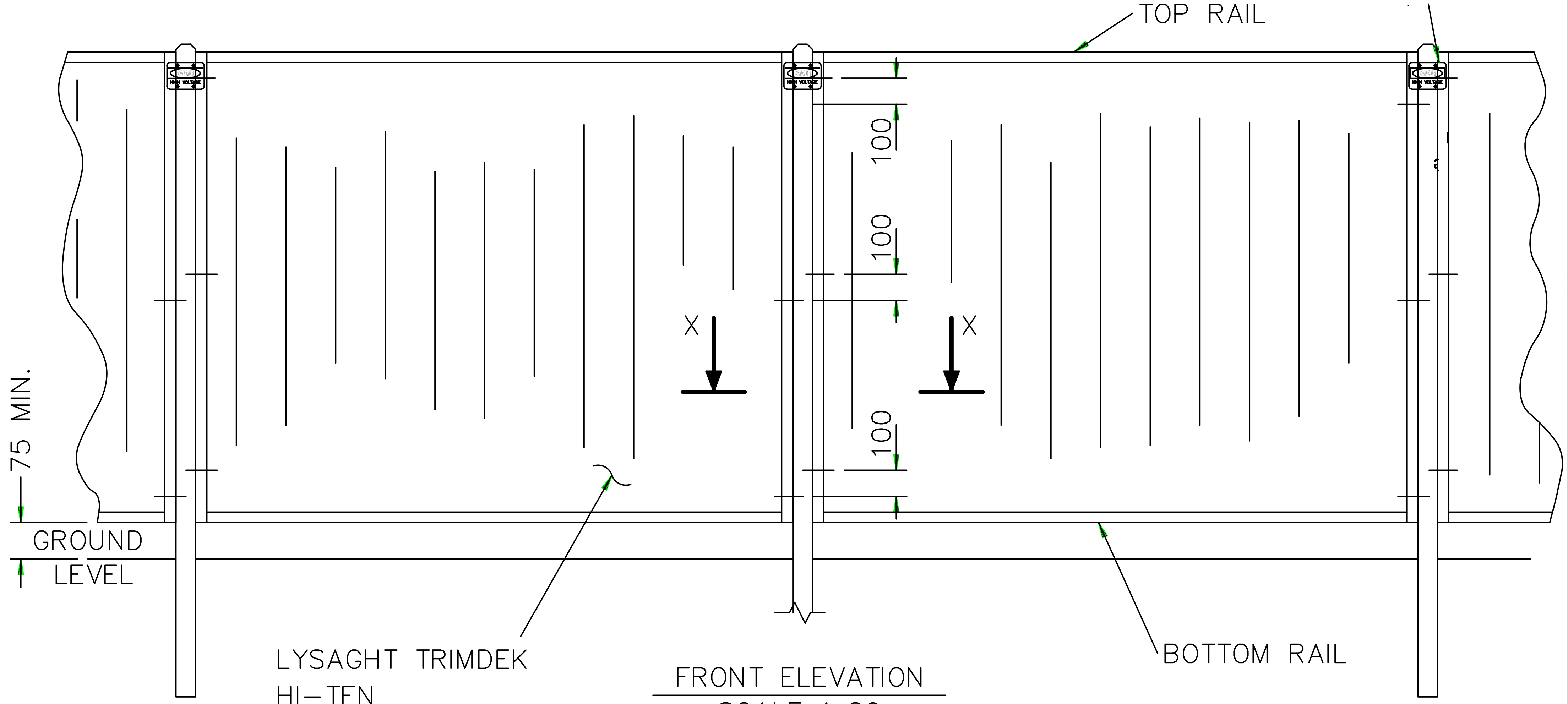


SECTION X–X
SCALE 1:2.5



EPR DANGER SIGN SPECIFICATION
SCALE 1:2

NOTES
1). 1.5MM WHITE RAVEK OR APPROVED EQUIVALENT
2). DANGER SIGN SYMBOL A/W AS1319–1994 (WHITE LETTERING ON RED OVAL ON BLACK BACKGROUND)
3). BLACK LETTERING ON WHITE BACKGROUND UNLESS STATED



FRONT ELEVATION
SCALE 1:20

AMENDMENTS			
A	ORIGINAL ISSUE	J R No.	900201
C	DR'N RJH, CH'D RJH, DATE 18–6–99, JR No WX911159	'CLAUSE 4.3' DELETED FROM NOTE 2.	MNAT JK
D	DR'N B.P.R, CH'D G.A, DATE 18.11.10, JR No .	'DANGER SIGNS ADDED	.
E	DR'N G.S.F, CH'D G.S.F, DATE 26–11–15, JR No N/A	NOTE 2 REVISED MCI0006 WAS SDI 104.	NSM C. Crisafulli

Endeavour Energy

ORIGINAL SCALE	AS SHOWN
APPROVED	C.Howat
DRAWN	B.G.H
DATE	01–3–91
CH'D	B.G.H
PARTS AND ACCESSORY LIST	
REFERENCE DRAWINGS	
DO NOT SCALE	DIMENSIONS IN MILLIMETRES
AUTHORISED	D.B.Britten/CH
ASSIST. G.M. ENG.	01–3–91

INSULATED FENCE POST AND EPR DANGER SIGN

A3 | 061674 | E

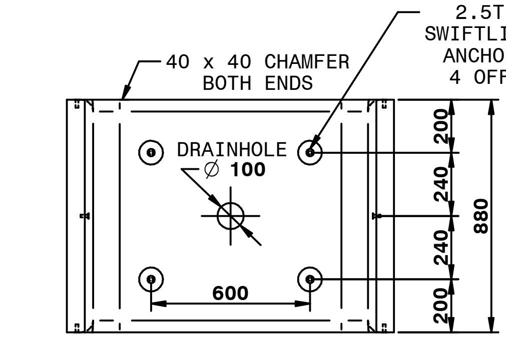
SHEET No 1 OF 1 SHEETS

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	16-03-93
	JR No	920294
DRAINHOLE WAS Ø90. DIM 1234 WAS 1240. DIM 100 WAS 250. DIM 400 WAS 250. DIM 1092 ADDED. LIFT LUGS DELETED.		
S.D.E.	D.T.G.	
C	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	13-07-93
	JR No	930125
TITLE REVISED, END SHEET DETAILS ADDED. ISSUE ID SDI104 ADDED.		
S.D.E.	D.T.G.	
D	DR'N	T.A.B.
	CH'D	T.A.B.
	DATE	27-05-94
	JR No	940063
DIM 2800 WAS 2464, DIM 1160 WAS 1163, DIM 800 WAS 750, DIM 600 WAS 515, DIM 70 WAS 80, DIM 350 WAS 400, DIM 30 WAS 28, DIM 1235 WAS 1234, DIM 110 WAS 1092, DIM 1165 WAS 1015, DIM 560 WAS 490, ANCHORS WERE 820 APART, INTERNAL FERRULES ADDED, MASS WAS 1800KG, VOCAB ADDED, 22KV ADDED TO TITLE, HOLES WERE Ø14, CHAMFER ADDED, SDI114 ADDED.		
S.D.M.	D.T.G.	
E	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	16-11-94
	JR No	940162
SDI117 WAS TP9.		
S.D.M.	JK	
F	DR'N	J.W
	CH'D	R.J.H
	DATE	18-04-95
	JR No	950077
CHANGE END SHEET DETAIL WAS LV END SHEET DETAIL QUANTITY: 2 OFF WAS 1 OFF. DELETED: HV END SHEET DETAIL.		
S.D.M.	JK	
G	DR'N	D.J.Z
	CH'D	D.J.Z.
	DATE	20-12-96
	JR No	960097
NOTE 1 ADDED. ISSUE ID'S DELETED. END SHEET COVER AND CUTOUT END SHEET DETAILS ADDED. END SHEET DETAIL DIM 1080 WAS 800.		
M.N.S.A.	JK	
H	DR'N	G.Ford
	CH'D	G.Ford
	DATE	09-12-04
	JR No	---
SWITCHING STATION CULVERT DETAILS ADDED.		
M.N.S.A.	G.Ford	
J	DR'N	G.Ford
	CH'D	G.Ford
	DATE	03-12-13
	JR No	---
SWIFTLIFT RATING 2.5T WAS 1.3T. END SHEET FIBREGLASS WAS PLASTIC. END SHEET RIBS ADDED. CUT OUT END SHEET AND NOTE 1 DELETED.		
M.P.S.	G.Ford	

NOTES

1) -

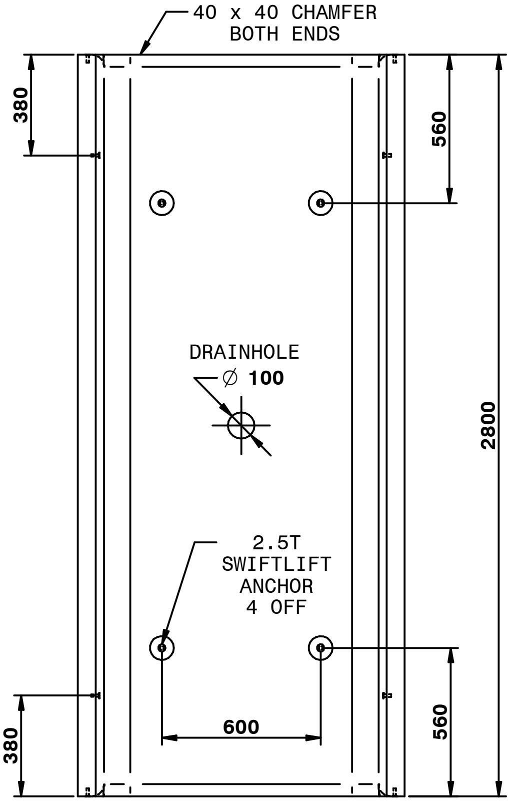
ITEM	QTY	DESCRIPTION	REMARKS



ITEM 2

INVERT CULVERT DETAIL

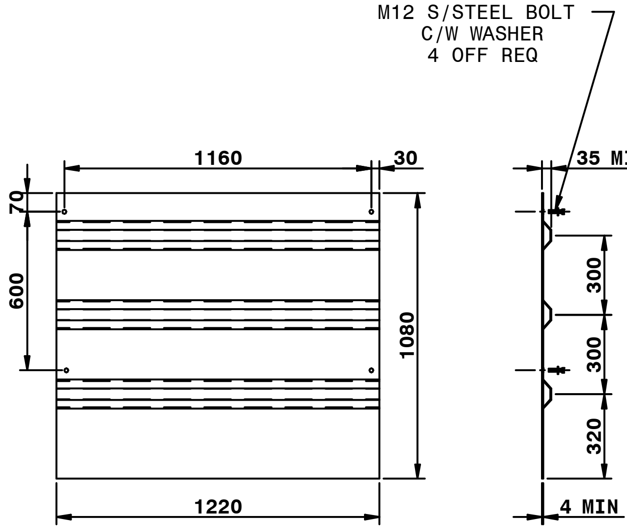
SWITCHING STATION PLAN VIEW



ITEM 1

INVERT CULVERT DETAIL

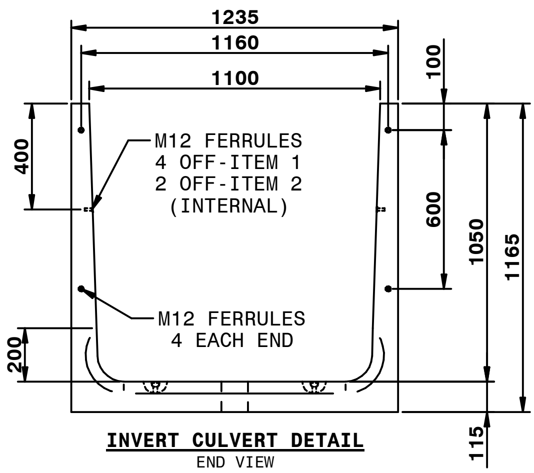
PADMOUNT PLAN VIEW



END SHEET DETAIL

MATERIAL: RIGID FIBREGLASS - MIN 4mm THICK WITH STRENGTHENING RIBS

QUANTITY: 2 OFF PER CULVERT



INVERT CULVERT DETAIL

END VIEW

	PADMOUNT	SWITCHING STATION
APPROX. MASS:	2280kg	720kg
STOCK CODE:	YT10165	1554336

ORIGINAL SCALE	APPROVED
	C.Howat

DRAWN	T.A.B.
DATE	28/10/92
CH'D	D.J.Z

INDEX REF S002A

Endeavour Energy

-	-
PM SUB INVERT CULVERT FTG INST	076665

REFERENCE DRAWINGS

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED
D.B.Britten/CH
ASSIST. G.G. ENG. 28/10/92

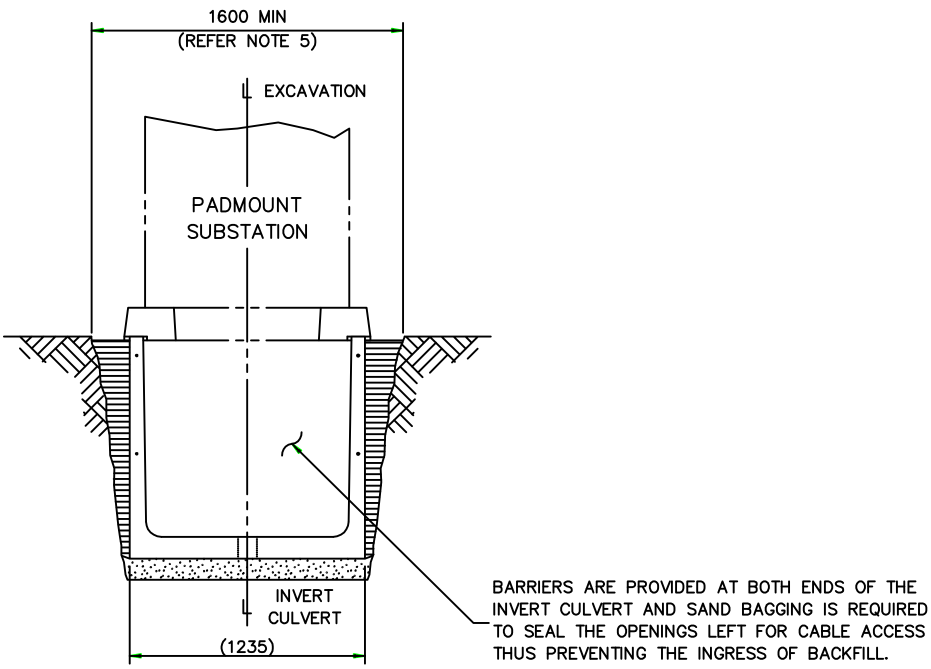
11 & 22kV PADMOUNT & SWITCHING STATION
INVERT CULVERT
CONSTRUCTION DETAILS

A4 075027 J

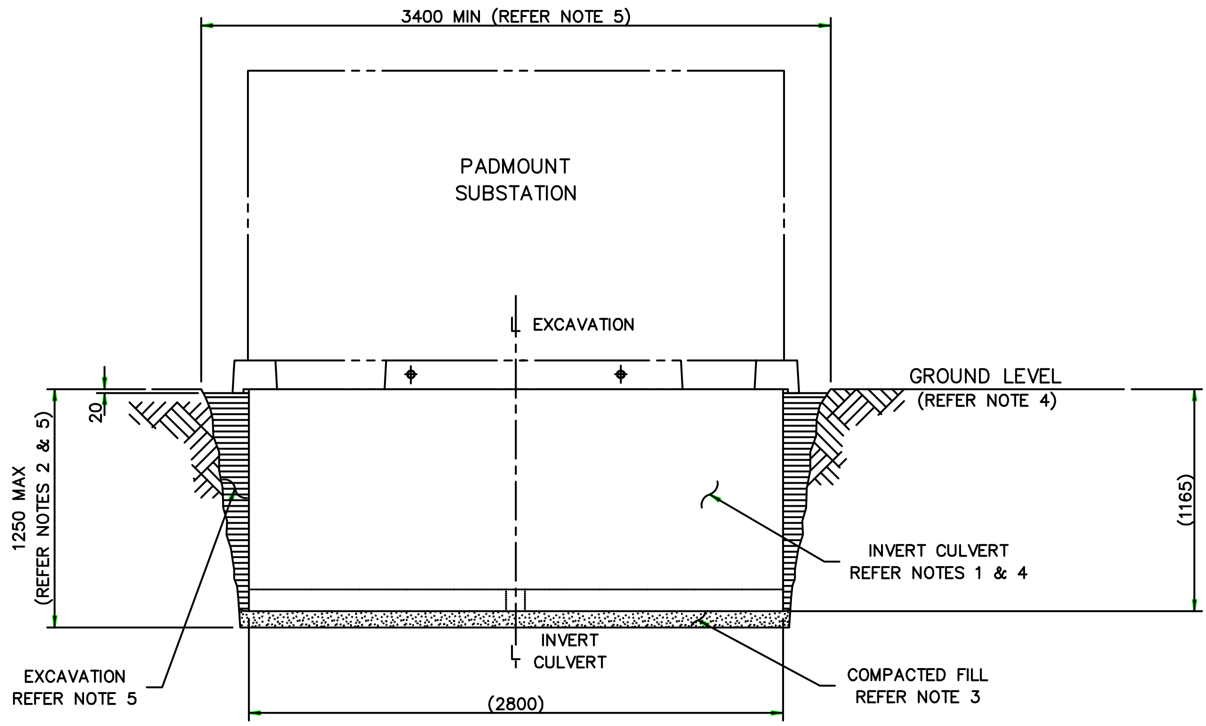
SHEET No. 1 OF 1

NOTES

1. THE INVERT CULVERT FOOTING IS SUITABLE FOR INSTALLATION ON GROUND WITH A MINIMUM BEARING CAPACITY OF 75 kPa. SOFT CLAYS, SILTS & LOOSE FINE SAND ARE EQUIVALENT TO 110 kPa.
2. FOR SOIL BEARING CAPACITIES LESS THAN 75 kPa AN EXTRA 500mm OF EXCAVATION IS REQUIRED THEN BACKFILLED IN ACCORDANCE WITH NOTE 3 TO ACHIEVE A MINIMUM OF 75 kPa SOIL BEARING CAPACITY.
3. FILLING REQUIRED FOR LEVELLING MUST BE ROAD BASE AND PLACED IN LAYERS NOT EXCEEDING 200mm THICKNESS. THIS FILLING MUST BE COMPACTED TO A DENSITY OF 98% STANDARD.
4. TOP OF CULVERT TO BE POSITIONED 50mm BELOW FINISHED GROUND LEVEL.
5. EXCAVATION TO BE 3400mm X 1600mm MINIMUM X 1250mm MAXIMUM DEPTH AND BACKFILLED WITH SAND AROUND INVERT CULVERT TO A LEVEL NOT GREATER THAN 20mm BELOW FINISHED HEIGHT OF INVERT CULVERT. ENSURE THAT NO BACKFILL IS INSIDE INVERT CULVERT.



END VIEW



ELEVATION

AMENDMENTS

A	ORIGINAL ISSUE	
	J R No.	920294
B	DR'N	C.R.T.
	CH'D	D.J.Z.
	DATE	22-7-93
	JR No	930117
22kV REMOVED FROM TITLE. CULVERT WAS 75mm BELOW GROUND LEVEL.		
	S.D.M.	D.T.G.
C	DR'N	T.A.B.
	CH'D	T.A.B.
	DATE	27-5-94
	JR No	940063
DIM 2800 WAS 2464 DIM 1250 WAS 1100 DIM 3300 WAS 3100 22KV ADDED SDI 114 ADDED NOTE 5 REVISED		
	S.D.M.	DTG
D	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	16-11-94
	JR No	940162
SDI 117 WAS TP9. DIM 1600 WAS 1400. DIM 3400 WAS 3300. REF DIM 1165 ADDED. NOTE 5 REVISED.		
	S.D.M.	JK
E	DR'N	G.P.S.
	CH'D	G.P.S.
	DATE	23-10-97
	JR No	970067
NOTE 4 WAS FLUSH WITH EXISTING GRND		
	M.N.S.A	JK

Endeavour Energy

REFERENCE DRAWINGS	DRG. NO.	THIS ISSUE PAGE NO
INVERT CULVERT DETAIL	075027	
PADMOUNT SUB EASEMENT LAYOUT	016665	

ORIGINAL SCALE	1: 20
APPROVED	J.Cook
DRAWN	D.J.Z.
DATE	24-3-93
CH'D	D.J.Z.

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

ASSIST. G.M. ENG. J.Allen/JC 24-3-93

ISSUE IDENTIFICATION: SDI 104 | SDI 114 | SDI 117

11/22kV PADMOUNT SUBSTATION
INVERT CULVERT FOOTING INSTALLATION

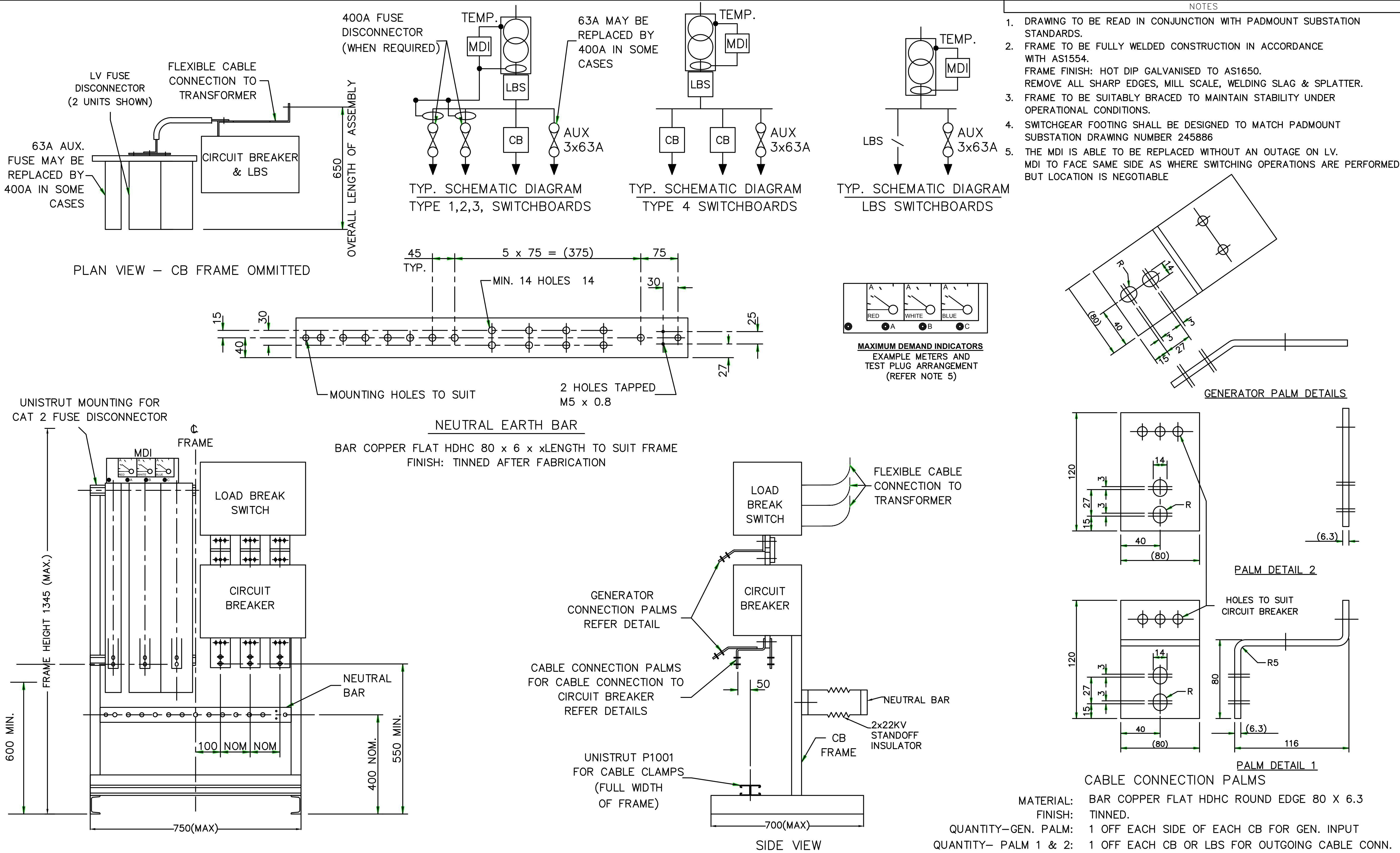
SUB 076665 E
SHEET No 1 OF 1 SHEETS
INDEX REF S002A

THIS ISSUE

PAGE NO.

NOTES

1. DRAWING TO BE READ IN CONJUNCTION WITH PADMOUNT SUBSTATION STANDARDS.
2. FRAME TO BE FULLY WELDED CONSTRUCTION IN ACCORDANCE WITH AS1554.
   FRAME FINISH: HOT DIP GALVANISED TO AS1650.
   REMOVE ALL SHARP EDGES, MILL SCALE, WELDING SLAG & SPLATTER.
3. FRAME TO BE SUITABLY BRACED TO MAINTAIN STABILITY UNDER OPERATIONAL CONDITIONS.
4. SWITCHGEAR FOOTING SHALL BE DESIGNED TO MATCH PADMOUNT SUBSTATION DRAWING NUMBER 245886
5. THE MDI IS ABLE TO BE REPLACED WITHOUT AN OUTAGE ON LV.
   MDI TO FACE SAME SIDE AS WHERE SWITCHING OPERATIONS ARE PERFORMED BUT LOCATION IS NEGOTIABLE



MATERIAL: BAR COPPER FLAT HDHC ROUND EDGE 80 X 6.3
FINISH: TINNED.
QUANTITY–GEN. PALM: 1 OFF EACH SIDE OF EACH CB FOR GEN. INPUT
QUANTITY– PALM 1 & 2: 1 OFF EACH CB OR LBS FOR OUTGOING CABLE CONN.

AMENDMENTS					
A	ORIGINAL ISSUE	Job No. 930209			
D	DR'N G.P.S.	CH'D G.P.S	DATE 23-10-97	JR No 970067	NOTE 3 WAS "LUGS TO BE FITTED TO" & 20 — M.N.S.A / J.K
E	DR'N B.G.H	CH'D JK	DATE 24-12-97	JR No GZ851126	4 OFF DOUBLE 14 HOLES ADDED. 75mm DIMS WERE 45mm. MIN. 14 HOLES WAS MIN. 10 HOLES. (G.R. B5) — MNAS / JK
F	DR'N RJH	CH'D RJH	DATE 01-11-99	JR No WX011240	MDI DIMS DELETED PLAN & FRONT VIEW. DIMS 550, 600 WERE 600, 650 FRONT VIEW. NOTES RE MAX DEMAND INDIC., LIFT HOLES & FRAME MTG HOLES DELETED. NOTE NUMBERING REVISED TO SUIT. — MNAT / JK
G	DR'N KT	CH'D VM	DATE 24.4.06	JOB No	STAND OF INSULATORS ADDED DRWWING ALTERED TO SHOW TYPES OF SWITCHBOARDS — DSM / VM
H	DR'N G.S.F.	CH'D G.S.F.	DATE 6-9-10	JR No N/A	SWITCH BETWEEN CB & TRF. ADDED TO ALL CB FRAMES. MDI DETAIL MODIFIED. AUX. FUSE CAN BE UPGRADED TO 400A FUSE STRIP ON TYPE 1, 2 & 4 FRAMES. GENERATOR CONN. PALM ADDED. — MDEB / G.S.F.
J	DR'N G.S.F	CH'D G.S.F	DATE 26-11-15	JR No N/A	NOTE 4 DRG No WAS 945 886 NOW 245886 — NSM / C. Crisafulli

Endeavour Energy

ORIGINAL SCALE	APPROVED J.Cook	DO NOT SCALE DIMENSIONS IN MILLIMETRES	REFERENCE DRAWINGS / AUTHORISED J.Cook
DRAWN	CRT		MGR TRANSMISSION CAPITAL PROJECTS 24.11.93
DATE	3.11.93		
CH'D	DJZ		

PADMOUNT SUBSTATION TYPICAL LV CIRCUIT BREAKER AND LOAD BREAK SWITCH FRAME ARRANGEMENT DETAILS

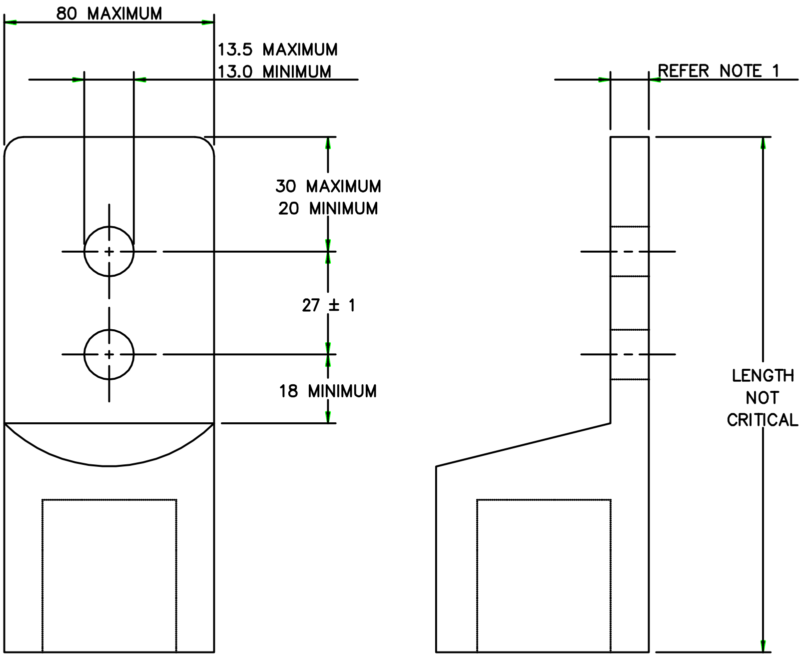
A2 077555 J

SHEET No 1 OF 1 SHEETS

AMENDMENTS		
A	ORIGINAL ISSUE	
J R No.	940145	
B	DR'N	D.J.Z.
	CH'D	J.K.
	DATE	09-1-96
	JR No	960001
NOTE 1 ADDED.		
M.S.S.	J.K.	

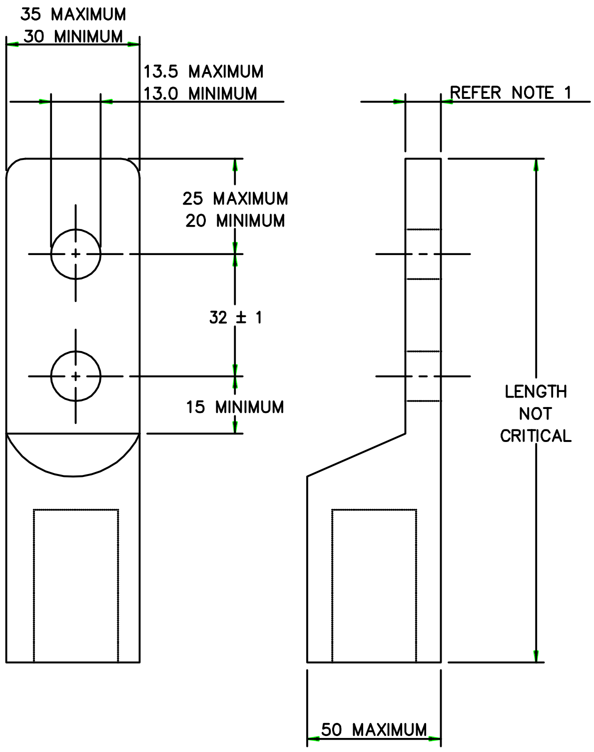
NOTES

1. THE CURRENT RATING OF THE LUG SHALL BE EQUIVALENT TO THE CURRENT RATING OF THE CABLE/S TO A MAXIMUM 1400 AMPS.
   ALL DISTRIBUTION SWITCHGEAR WILL ACCEPT BOTH ALUMINIUM OR COPPER CABLES.



CIRCUIT BREAKER CABLE LUG

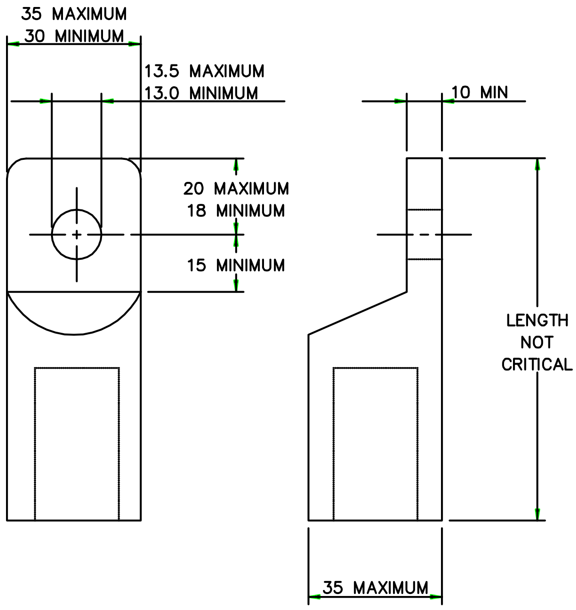
MAXIMUM SIZE CABLE – 630mm²
MAXIMUM No PER PHASE – 4 OFF



FEEDER FUSED DISCONNECTOR

CATEGORY 2 CABLE LUG

MAXIMUM SIZE CABLE – 240mm²
MAXIMUM No PER PHASE – 2 OFF



FEEDER FUSED DISCONNECTOR

CATEGORY 1 CABLE LUG

MAXIMUM SIZE CABLE – 240mm²
MAXIMUM No PER PHASE – 2 OFF

Endeavour Energy

REFERENCE DRAWINGS	DRG. NO.	THIS ISSUE PAGE NO

ORIGINAL SCALE	APPROVED
NONE	C.Howat

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

C.Howat	
SUBSTATION DEVELOPMENT MGR	12-10-94

DRAWN	D.J.Z.
DATE	27-9-94
CH'D	D.J.Z.

LOW VOLTAGE EQUIPMENT
CABLE LUG
CRITICAL DIMENSIONS

SUB 078239 B

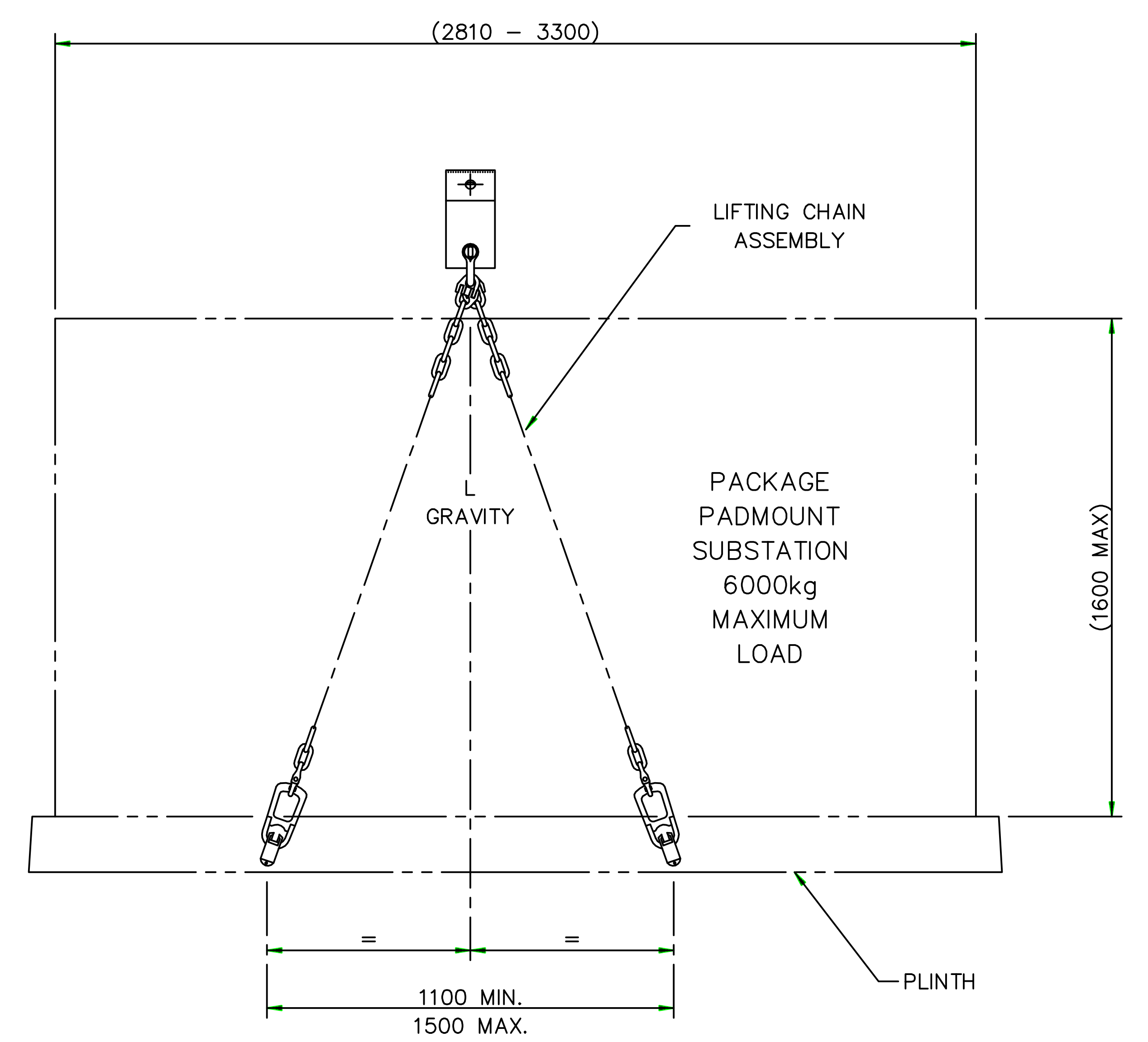
SHEET No 1 OF 1 SHEETS

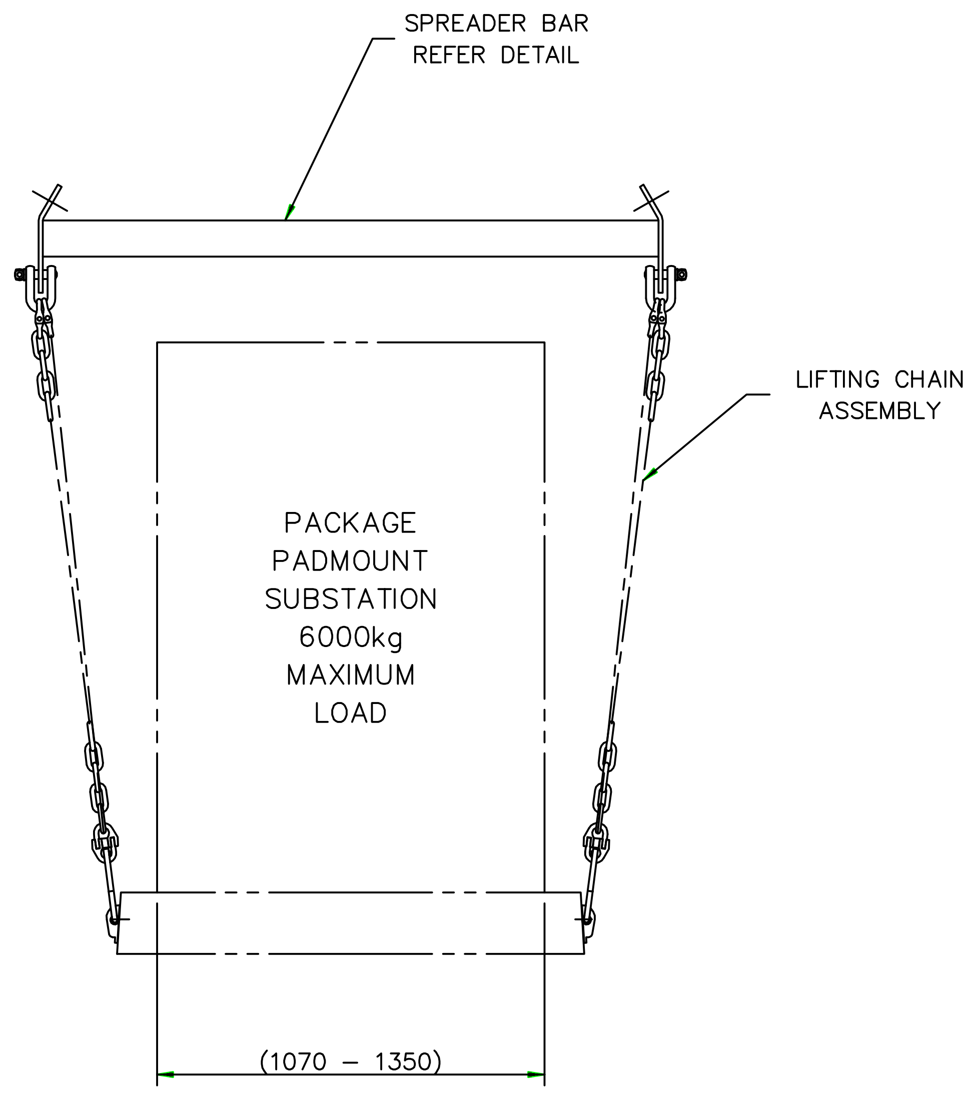
INDEX REF S008A

ISSUE IDENTIFICATION

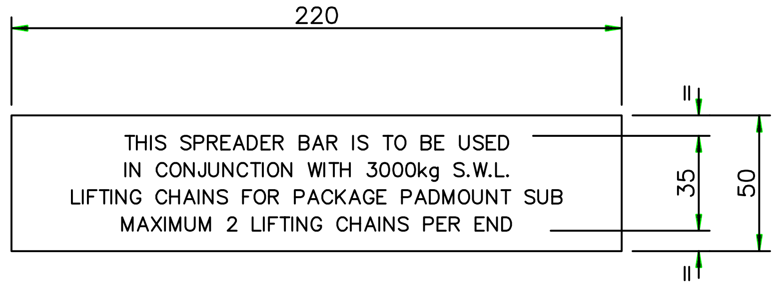
THIS ISSUE

PAGE NO.

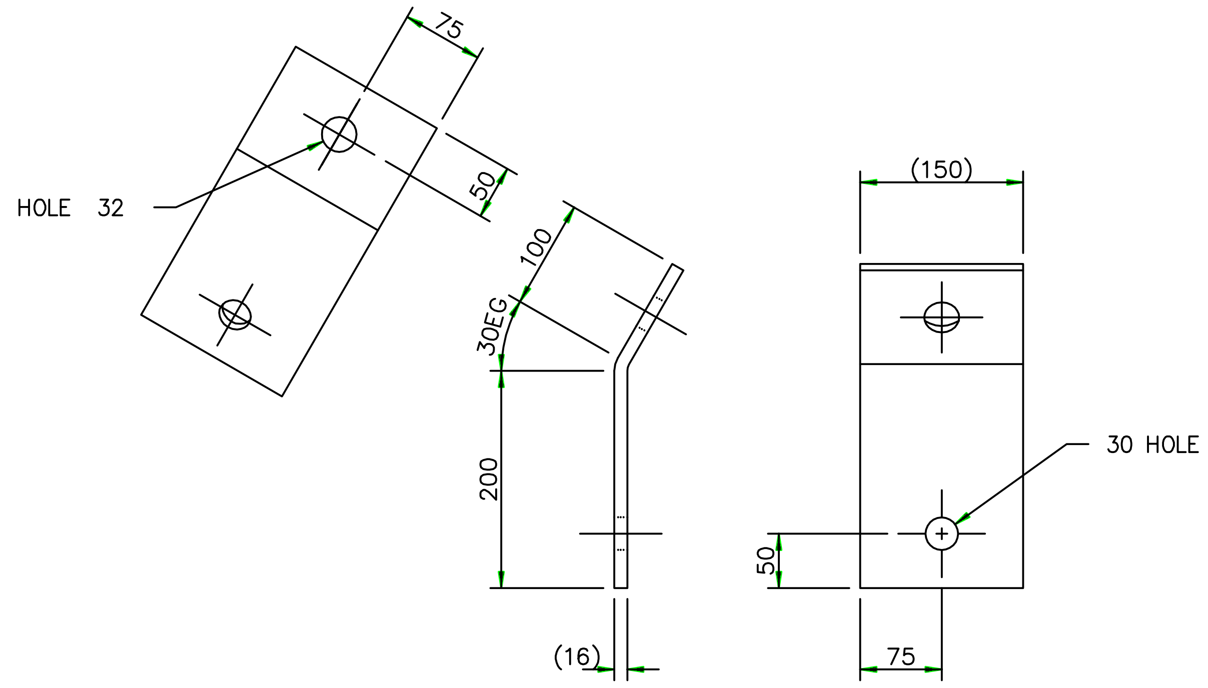




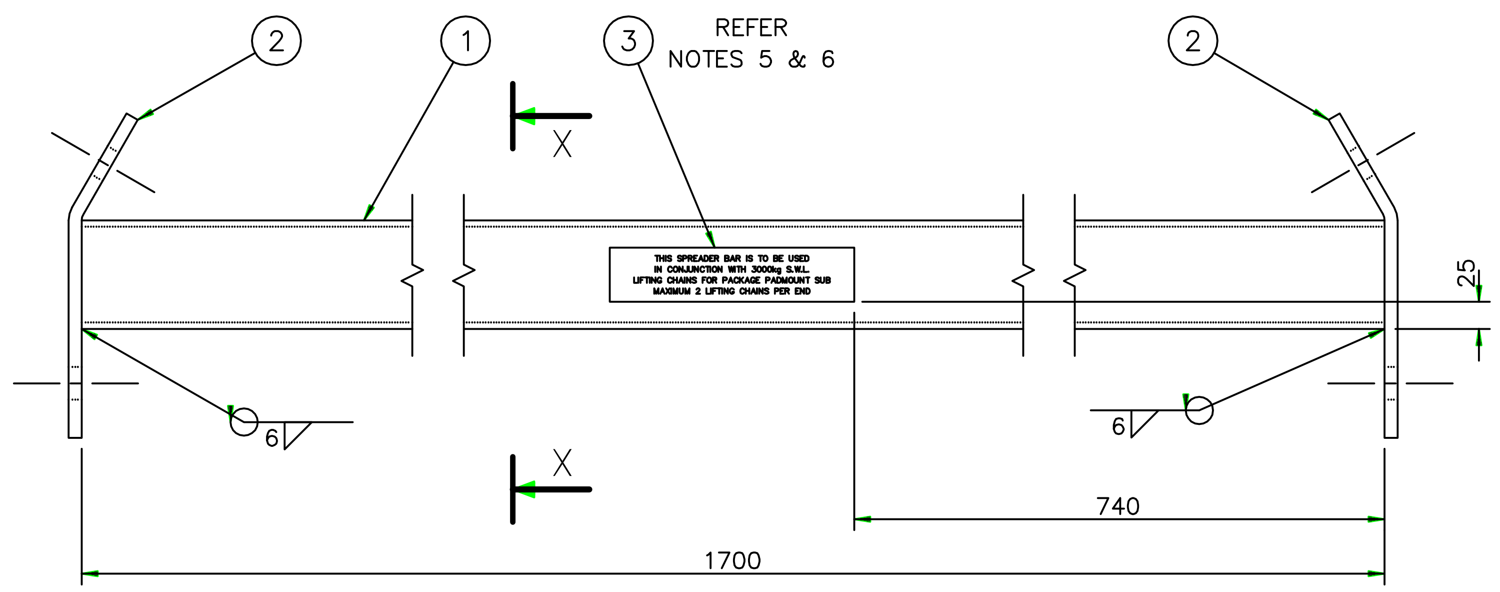
ARRANGEMENT
SCALE 1:15



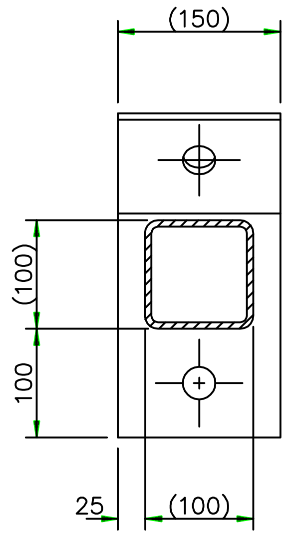
ITEM 3 DETAIL
SCALE 1:2
REFER NOTES 5 & 6



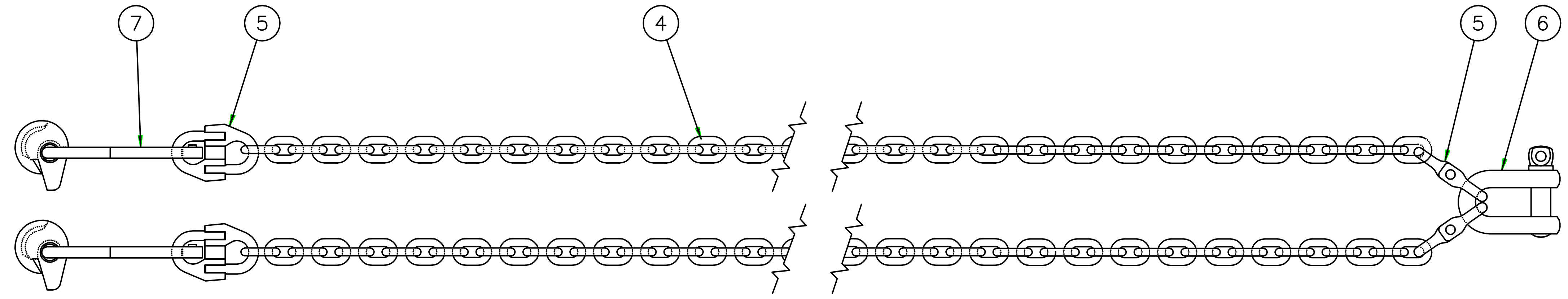
ITEM 2 DETAIL
SCALE 1:5
(2 OFF REQUIRED)



SPREADER BAR DETAIL
SCALE 1:5



SECTION "X–X"



LIFTING CHAIN ASSEMBLY
SCALE 1:5
REFER NOTE 3
(2 OFF REQUIRED)

NOTES

1. WELDING TO BE DONE IN ACCORDANCE WITH AS1554.1.
2. SYMBOLS COMPLY WITH AS1101.3.
3. LIFTING CHAINS TO HAVE "S.W.L. 3000kg" CAPACITY.
4. FINISH:
   2 COATS PRIMER/SURFACER
   (DULUX 2K "PRIMECOTE" OR EQUIV)
   2 COATS SAFETY YELLOW ACRYLIC/ENAMEL
   (DULUX 2K "ACRAN" OR EQUIV).
5. LABEL (ITEM 3) TO BE "POP" RIVETTED TO SPREADER BAR IN POSITION SHOWN AFTER PAINTING.
6. LABEL (ITEM 3) TO BE ENGRAVED AS SHOWN CHARACTERS TO BE 5mm HIGH AND PAINT FILLED (BLACK).

ITEM	PART	DRG	DESCRIPTION	QTY	REMARK
1	–	–	TUBE STEEL RHS 100 x 100 x 6 x 1700 LG	1	–
2	–	–	BAR STEEL FLAT 150 x 16 x 305 LG	2	DETAIL
3	–	–	SHEET ALUMINIUM 3 x 50 x 220 LG	1	DETAIL
4	–	–	CHAIN (GUNNEBO) SIZE 10 DIA. GRADE 80 CODE KL–10–8 (MAX. LOAD 3.2t.) 54 LINKS (1620 LG.)	4	–
5	–	–	COUPLING LINK (GUNNEBO) TYPE G CODE G–10–8 (MAX. LOAD 3.2 t.)	8	–
6	–	–	SHACKLE DEE ALLOY GRADE S NOM. SIZE 22 DIA. GALV. (WLL 6.5t.)	2	–
7	–	–	LIFTING EYE UNIVERSAL GALV. (REID SWIFTLIFT) (SWL 2.5t.)	4	–

AMENDMENTS

A	ORIGINAL ISSUE	
J R No.	950032	
B	DR'N	J.W.
	CH'D	G.P.S.
	DATE	15-1-96
	JR No	960004
TENDER SPECIFICATION FROM TITLE BLOCK DELETED		
M.S.S.	J.K.	
C	DR'N	G.P.S.
	CH'D	G.P.S.
	DATE	23-10-97
	JR No	970067
DIMS 1700, 740 WERE 1400 & 590 (F3). ITEM 4 WAS 50 LINKS. PADMOUNT WAS 4500kg MAXIMUM LOAD. 1100 MIN, 1500 MAX DIMS ADDED (D2). TITLE WAS "11kV PACKAGE "		
M.N.S.A	J.K.	
D	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	24-11-97
	JR No	970067
ITEM 1 WAS 1400LG ITEM 2 WAS 12 THK		
M.N.S.A.	J.K.	

ORIGINAL SCALE AS SHOWN

DRAWN	D.J.Z.	
DATE	04-7-95	
CH'D	D.J.Z.	

APPROVED C.Howat

Endeavour Energy

REFERENCE DRAWINGS

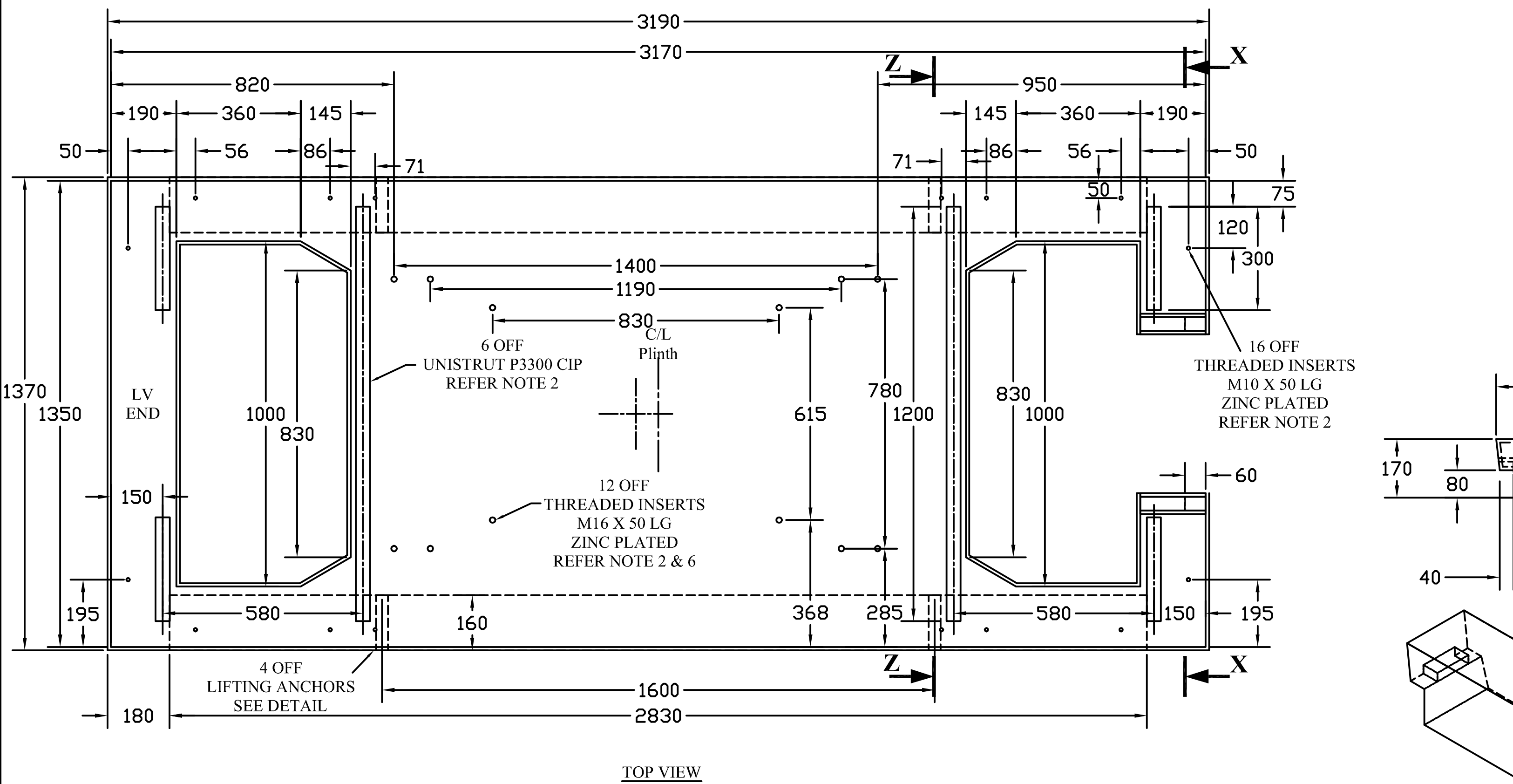
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED C.Howat
SUBSTATION DEVELOPMENT MGR 12-07-95

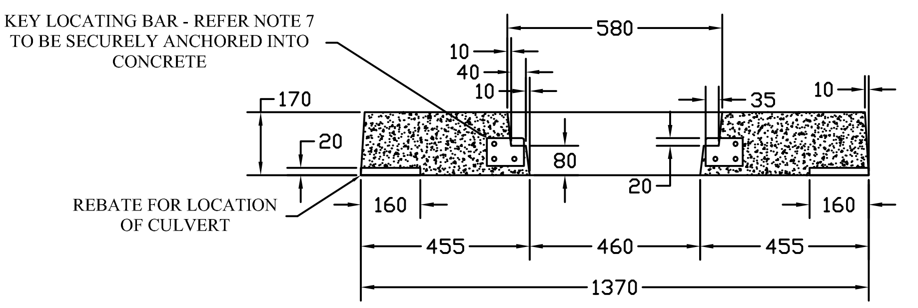
PACKAGE PADMOUNT SUBSTATION
LIFTING ARRANGEMENT & DETAILS

A1 078481 D

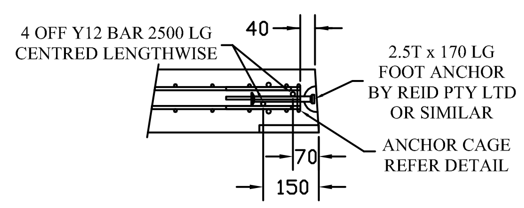
SHEET No 1 OF 1 SHEETS



TOP VIEW



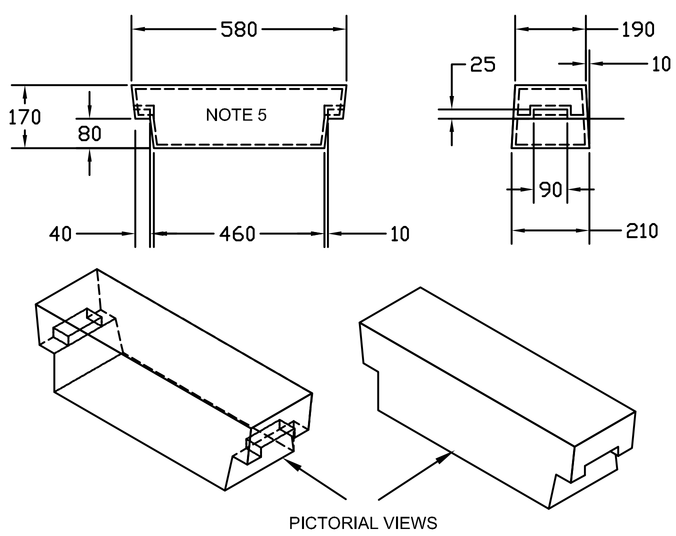
SECTION X - X



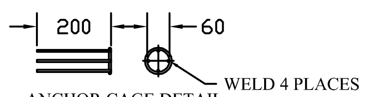
PART SECTION Z - Z

NOTES

1) CONCRETE TO HAVE MINIMUM COMPRESSIVE STRENGTH OF 32MPa AFTER 28 DAYS. MAXIMUM SLUMP 80mm.
2) UNISTRUT CHANNELS & THREADED INSERTS TO BE POSITIONED LEVEL WITH SURFACE OF CONCRETE.
3) TOP & SIDES OF PLINTH TO HAVE A STEEL TROWEL FINISH FREE FROM CRACKS & DEFECTS.
4) PLINTH TO BE DESIGNED BY AN ACCREDITED STRUCTURAL ENGINEER.
5) MATERIAL: GLASS REINFORCED CONCRETE. WALL THICKNESS = 8mm. APPROXIMATE MASS = 8kg
6) THREADED INSERTS ARE REQUIRED TO PREVENT EQUIPMENT MOVEMENT DURING TRANSPORT. THEREFORE THEY SHOULD BE FIXED INTO CONCRETE OR TO REINFORCING TO PREVENT PULL OUT.
7) MATERIAL: STAINLESS STEEL. APPROX. SIZE = 100 x 75 x 6mm THICK
8) PLINTH TO BE SUITABLE FOR LIFTING, TRANSPORTING & SUPPORTING IN SERVICE UP TO 8500kg AS FOLLOWS:
   - A TRANSFORMER UP TO 6000kg
   - HV & LV SWITCHGEAR UP TO 200kg EACH END
   - A CUBICLE UP TO 300kg



CABLE ACCESS KEY DETAIL
VOCAB No. 1548411



ANCHOR CAGE DETAIL
MATERIAL: R6 BAR
QUANTITY: 4 OFF

AMENDMENTS				
A	ORIGINAL ISSUE			
B	HV & LV PENETRATIONS & CUBICLE HOLD DOWN MODIFIED	DRFN G. FORD	CHFD G. FORD	DATE 21/06/01
C	CABLE ACCESS KEY SHAPE MODIFIED TO TAPPER SAME AS PLINTH	DRFN G. FORD	CHFD G. FORD	DATE 04/01/05

Endeavour Energy

ORIGINAL SCALE	
APPROVED	G. Ford
DRAWN	G. Ford
DATE	22/08/2001
CH'D	G. Ford

REFERENCE DRAWINGS

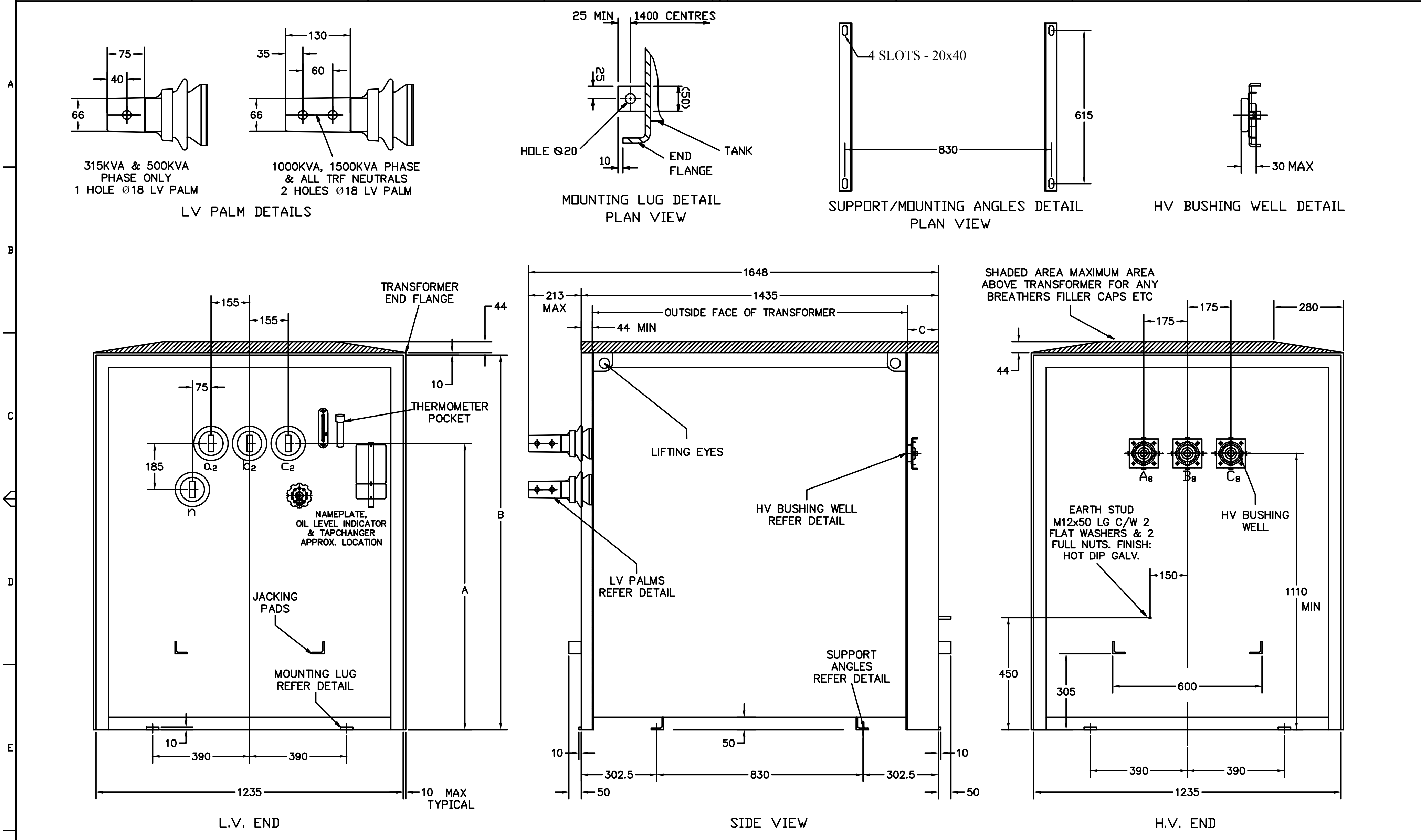
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED: W. Isley
MANAGER ASSET SERVICES 22/08/2001

SIZE 14 & 16 PADMOUNT SUBSTATION
PRECAST CONCRETE PLINTH
FOR CULVERT FOOTING
CONSTRUCTION DETAILS

A3 | 245886 | C

SHEET No 1 OF 1 SHEETS



	RATING OF TRANSFORMER		
	315 & 500kVA	1000kVA	1500kVA
DIM A	1150	1345	1345
DIM B	1275	1505	1505
DIM C	130	75	44

AMENDMENTS

A	ORIGINAL ISSUE	
B	TITLE WAS "300..."	DRN G.P.S CH'D G.P.S DATE 23-10-97
C	1600 WAS 1700 & 1350 WAS 1450 (GR A4). 465 & 1750 WAS 550 MAX (GR B3). NOTE 2 WAS HEIGHT 1560 - 1600mm.	DRN B.G.H CH'D B.G.H DATE 02-10-98 JR No GZ11100
D	LAYOUT OF LV & HV ENDS REVISED. TABLE ADDED.	DRN R.H CH'D R.H DATE 23-8-99 JR No VX011223
E	REDRAWN. TABLES AMENDED. HV BUSHING DETAILS ADDED	DRN G. Ford CH'D G. Ford DATE 25-6-2002
F	LV PALM HOLE DIAMETER CHANGED FROM 22 TO 18.	DRN CSA CH'D VM DATE 26/11/04
G	LV NEUTRAL BUSHING NOW 2 HOLE. LIFTING EYES SHOWN. THERMOPOCKET SHOWN.	DRN G. Ford CH'D G. Ford DATE 26-11-15

NSW C. Crisafulli

Endeavour Energy

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

REFERENCE DRAWINGS

ORIGINAL SCALE

APPROVED G. Ford

AUTHORISED Glen Ford
MANAGER SUBSTATION STANDARDS 03/10/1997

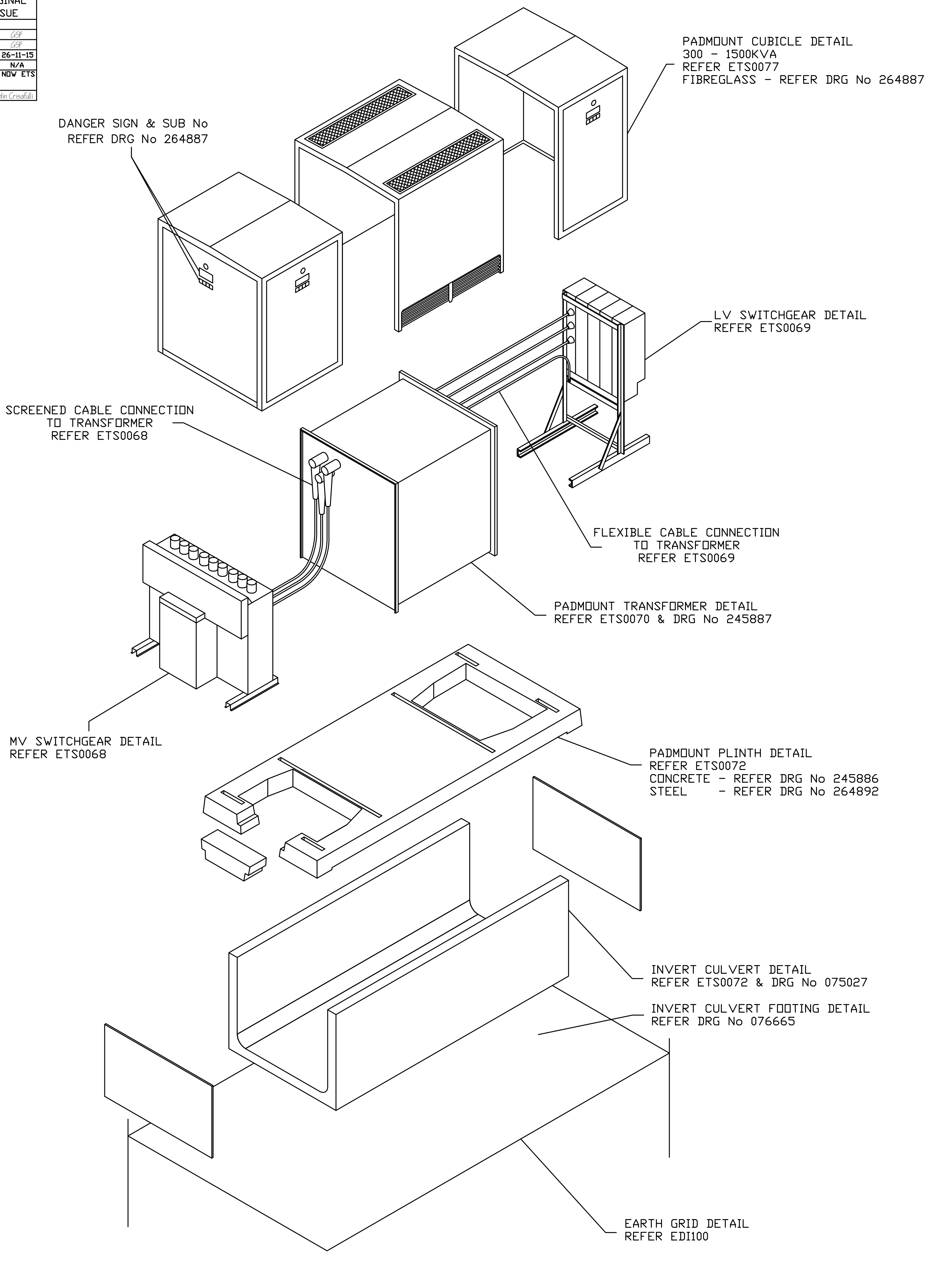
DRAWN B.G.H
DATE 03/10/1997
CH'D G.P.S
INDEX REF. S008A

SIZE 14-315,500KVA & SIZE 16-1000,1500KVA PADMOUNT & INDOOR TRANSFORMER TYPICAL REQUIREMENTS

A3 245887 G

SHEET No 1 OF 1 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
B	DR'N GSF; CH'D GSF; DATE 26-11-15; JR No N/A
	ALL SDI REF. NOW ETS REFERENCES
NSM	Colin Crisafulli



Endeavour Energy

REFERENCE DRAWINGS

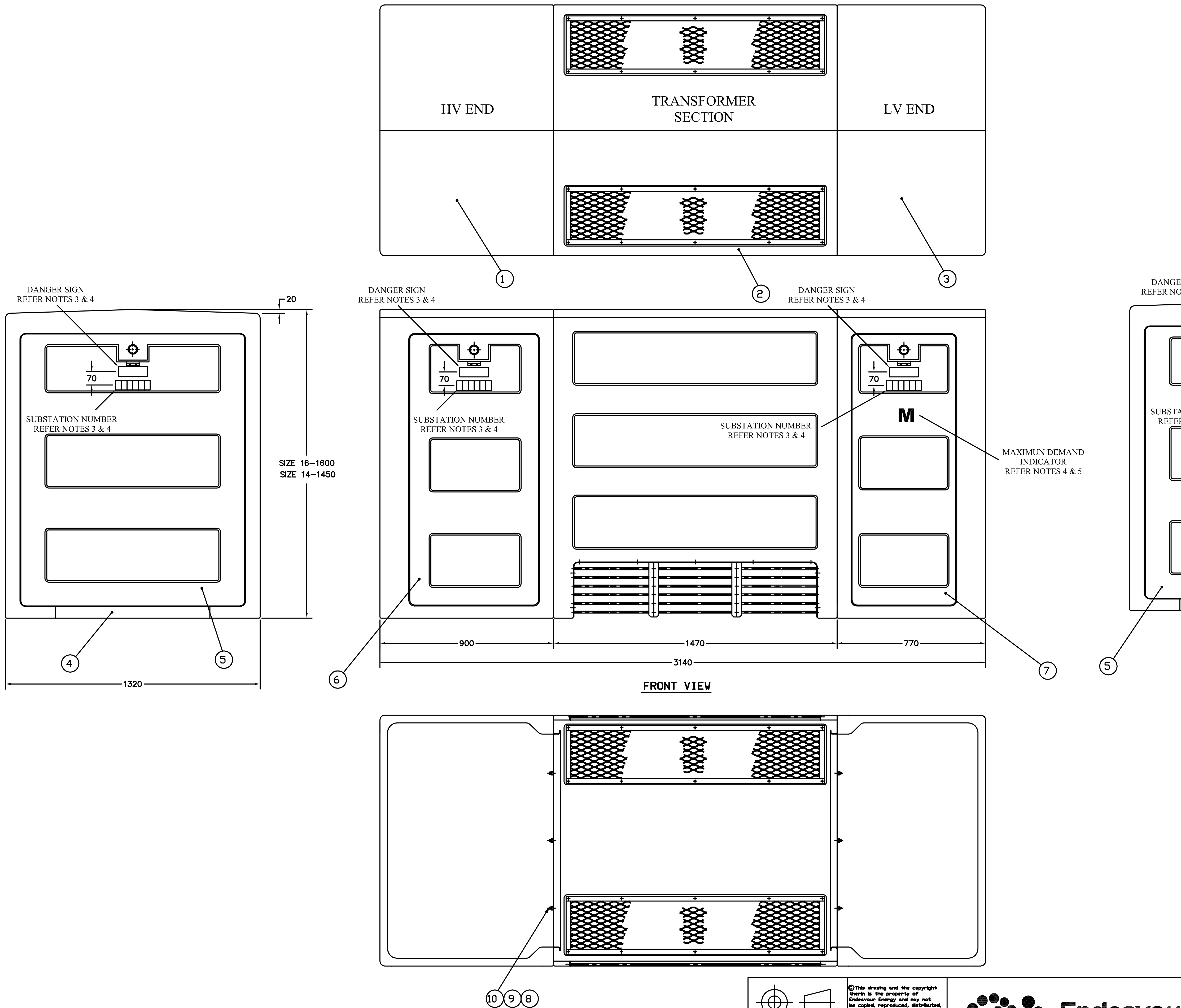
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

ORIGINAL SCALE	
APPROVED	G. Ford
AUTHORISED	W. Isley
MANAGER ASSET SERVICES	01/08/2001
DRAWN	G. Ford
DATE	01/08/2001
CH'D	G. Ford
INDEX REF.	S003A

SIZE 14 AND 16
11/22KV PADMOUNT SUBSTATION
EXPLODED VIEW

A3 264786 B

SHEET No 1 OF 1 SHEETS



NOTES

1. THIS DRAWING TO BE USED IN CONJUNCTION WITH THE RELEVENT Endeavour Energy PADMOUNT SUBSTATION CUBICLE SPECIFICATION
2. THE REAR VIEW NOT DRAWN IS A MIRROR IMAGE OF FRONT VIEW SHOWN.
3. "DANGER HIGH VOLTAGE" SIGNS AND SUBSTATION NUMBERS TO BE FITTED ON ALL DOORS AS SHOWN.
4. SIGNS & NUMBERS TO BE FITTED BY WORKSHOP STAFF PRIOR TO ISSUE.
5. LETTER "M" TO BE AFFIXED TO LOW VOLTAGE DOOR WHICH ALLOWS ACCESS FOR THE READING OF MAXIMUM DEMAND INDICATORS.

ITEM NO	VOCAB / DRG	DESCRIPTION	QTY	REFER
1	NA	HIGH VOLTAGE COMPARTMENT	1	DRG 264891
2	NA	TRANSFORMER COMPARTMENT	1	DRG 264888
3	NA	LOW VOLTAGE COMPARTMENT	1	DRG 264891
4	NA	REMOVABLE BOTTOM MULLION	2	DRG 264891
5	NA	DOOR CUBICLE END HV & LV	2	DRG 264890
6	NA	DOOR CUBICLE SIDE HIGH VOLTAGE	2	DRG 264890
7	NA	DOOR CUBICLE SIDE LOW VOLTAGE	2	DRG 264890
8	NA	WASHER ROUND FLAT GALV M10	18	–
9	NA	WASHER SPRING GALV M10	18	–
10	NA	NUT HEX HD GALV M10	18	–

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N GSF / CH'D GSF / DATE 01-10-03 / JR No --	SIZE 14 HEIGHT NOW 1450MM.
MDEB	GSF	

ORIGINAL SCALE

APPROVED G. Ford

DRAWN	G. Ford
DATE	10/08/2001
CH'D	G. Ford

Endeavour Energy

REFER MATERIAL LIST

STEELWORK DETAILS 264889

REFERENCE DRAWINGS

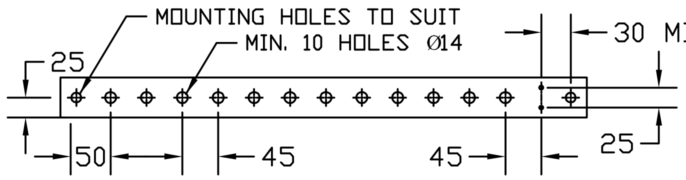
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED W. Isley
MANAGER ASSET SERVICES 10/08/2001

SIZE 14 & 16 - PADMOUNT SUBSTATION
FIBREGLASS CUBICLE
GENERAL ARRANGEMENT

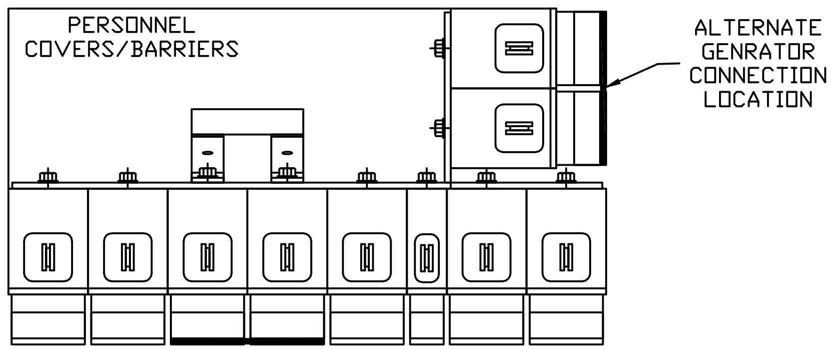
A3 264887 B

SHEET No 1 OF 1 SHEETS

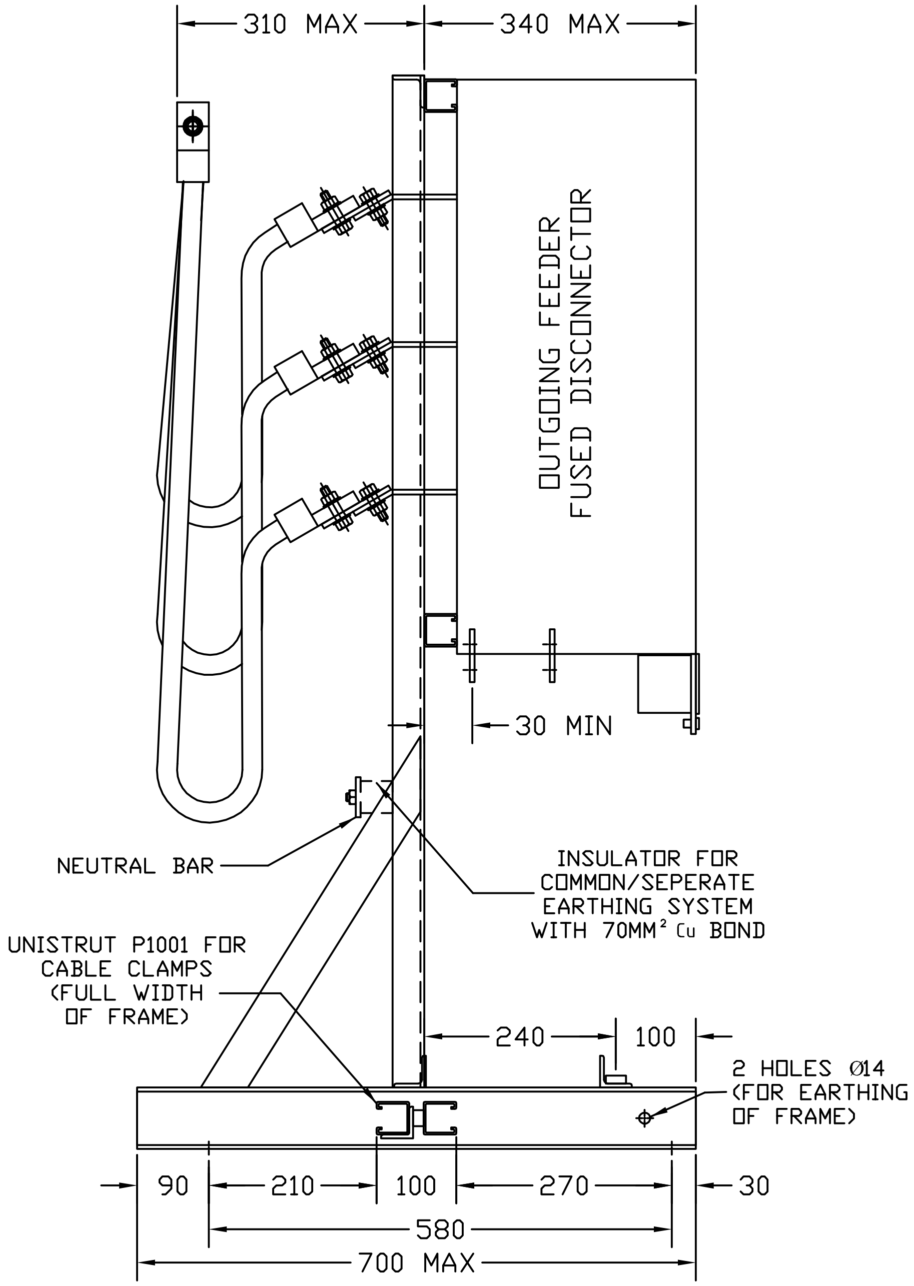


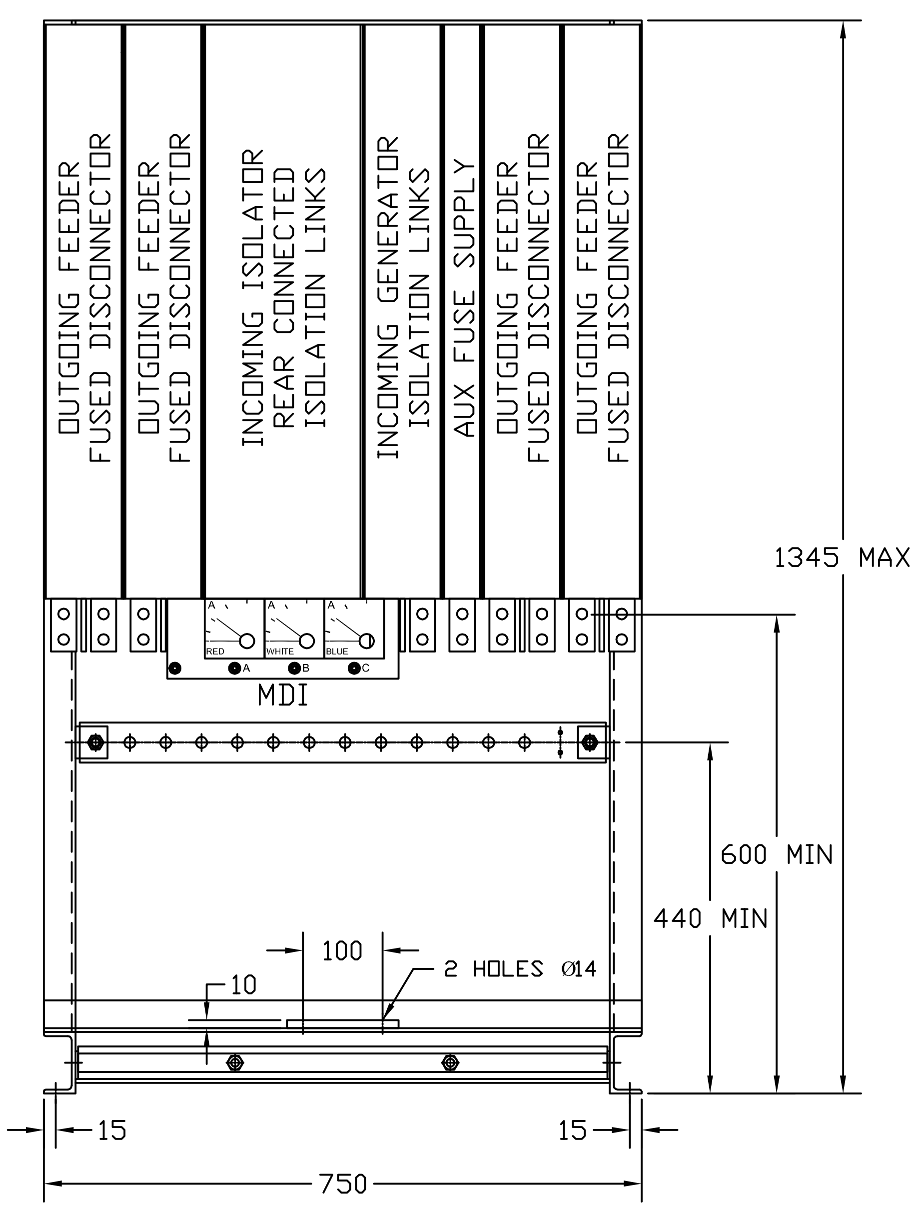
NEUTRAL EARTH BAR

BAR COPPER FLAT HDHC 50 x 6
FINISH: TINNED AFTER FABRICATION



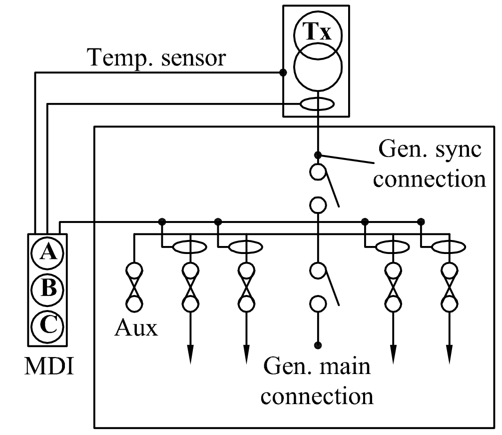
TOP VIEW OF LV WITH GENERATOR CONNECTION LOCATION OPTIONS



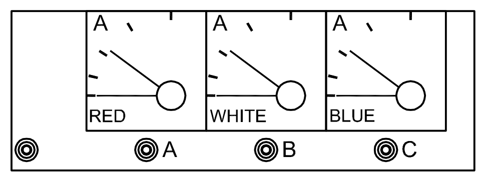


NOTES

1) DRAWING TO BE READ IN CONJUNCTION WITH THE PADMOUNT SUBSTATION STANDARDS.
2) FRAME TO BE FULLY SEAL WELDED IN ACCORDANCE WITH AS1554. REMOVE ALL SHARP EDGES, MILL SCALE, WELDING SLAG AND SPLATTER. FRAME FINISH: HOT DIP GALVANISED TO AS1650.
3) FRAME TO BE SUITABLY BRACED TO MAINTAIN STABILITY UNDER OPERATING CONDITIONS. ANY BRACING USED MUST NOT EXTEND ABOVE THE NEUTRAL EARTH BAR.
4) SWITCHGEAR FOOTING SHALL BE DESIGNED TO MATCH PADMOUNT SUBSTATION DRAWING NUMBER 245886.
5) THE MDI IS TO BE ABLE TO BE REPLACED WITHOUT AN OUTAGE ON LV. MDI TO FACE SAME SIDE AS WHERE SWITCHING OPERARTIONS ARE PERFORMED BUT LOCATION IS NEGOTIABLE.



SCHEMATIC DIAGRAM



MAXIMUM DEMAND INDICATORS

EXAMPLE METERS AND TEST PLUG ARRANGEMENT (REFER NOTE 5)

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N KT; CH'D VM; DATE 26-4-06; JR No --	STAND OFF INSUL. & Cu LINK ADDED TO NEUTRAL EARTH BAR NOTE 4 ADDED. TITLE REVISED; DSM VM
C	DR'N GSF; CH'D GSF; DATE 06-9-10; JR No --	WIDTH REDUCED FROM 965 TO 750. MDI TYPE AND LOCATION MODIFIED. ALT. GEN. LOCATION ADDED.; MDEB GSF

Endeavour Energy

ORIGINAL SCALE	APPROVED G. Ford	DO NOT SCALE DIMENSIONS IN MILLIMETRES	AUTHORISED W. Isley
DRAWN	G. Ford	REFERENCE DRAWINGS	MANAGER DISTRIBUTION SERVICES 23/10/2001
DATE	23/10/2001		
CH'D	G. Ford		

PADMOUNT SUBSTATION
LV DISTRIBUTION BOARD FRAME
TO SUIT SIZE 14 & 16 SUBSTATION
ARRANGEMENT DETAILS

A3 | 266515 | C

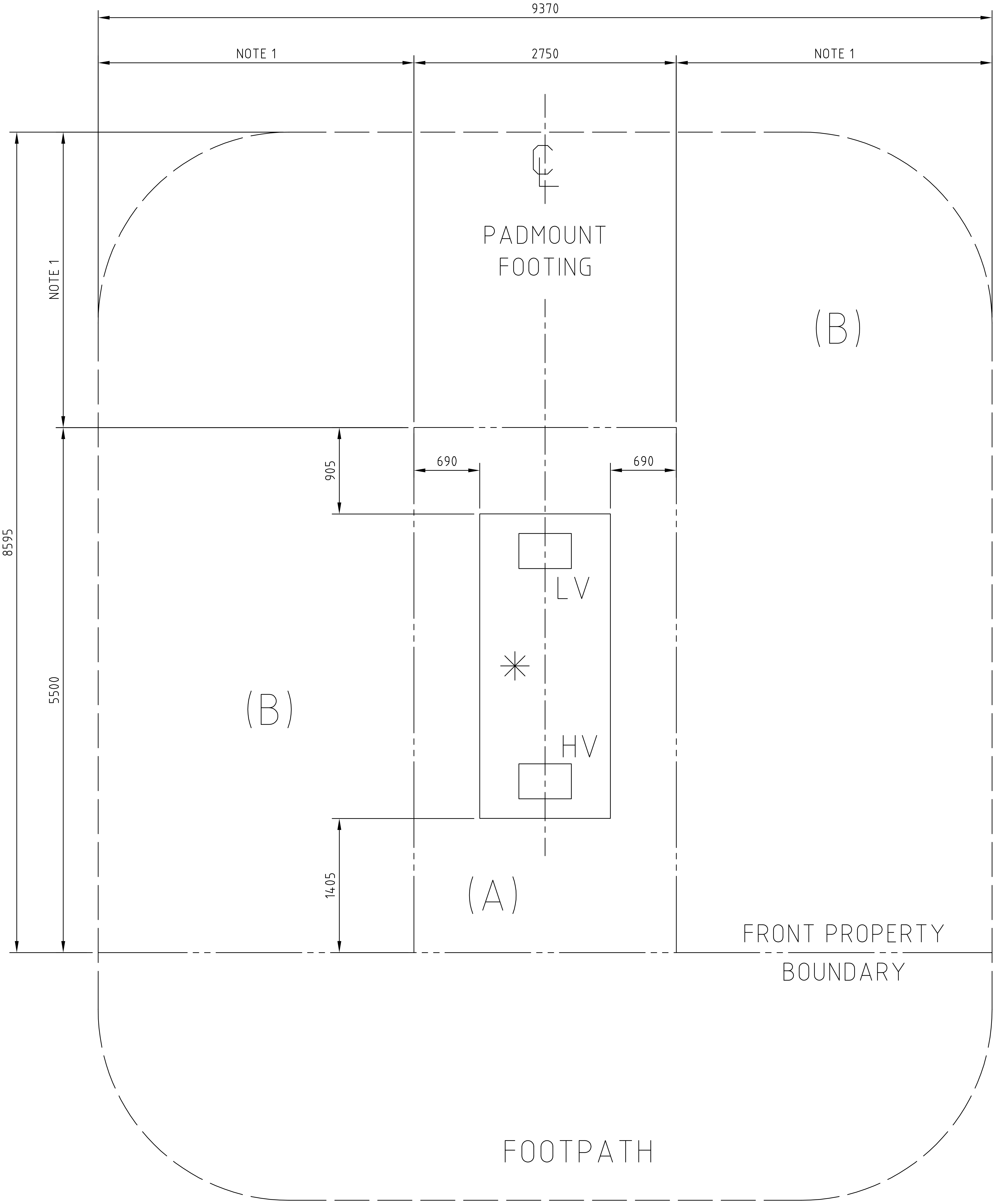
SHEET No 1 OF 1 SHEETS

AMENDMENTS

A	ORIGINAL ISSUE
Job No.	

EASEMENT PROPOSALS FOR PADMOUNT SUBSTATION

GENERAL ARRANGEMENT



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.

2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES.

3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

www.dialbeforeyoudig.com.au
DIAL 1100 BEFORE YOU DIG

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS $15.1m^2$

(B) COVENANT

Endeavour Energy

REFERENCE DRAWINGS

ORIGINAL SCALE 1:30	APPROVED D.Marshall	DO NOT SCALE DIMENSIONS IN MILLIMETRES	AUTHORISED W.Isley
DRAWN	J.H.	MANAGER ASSET ENGINEERING	26.10.05
DATE	24-08-05		
CH'D	DM		

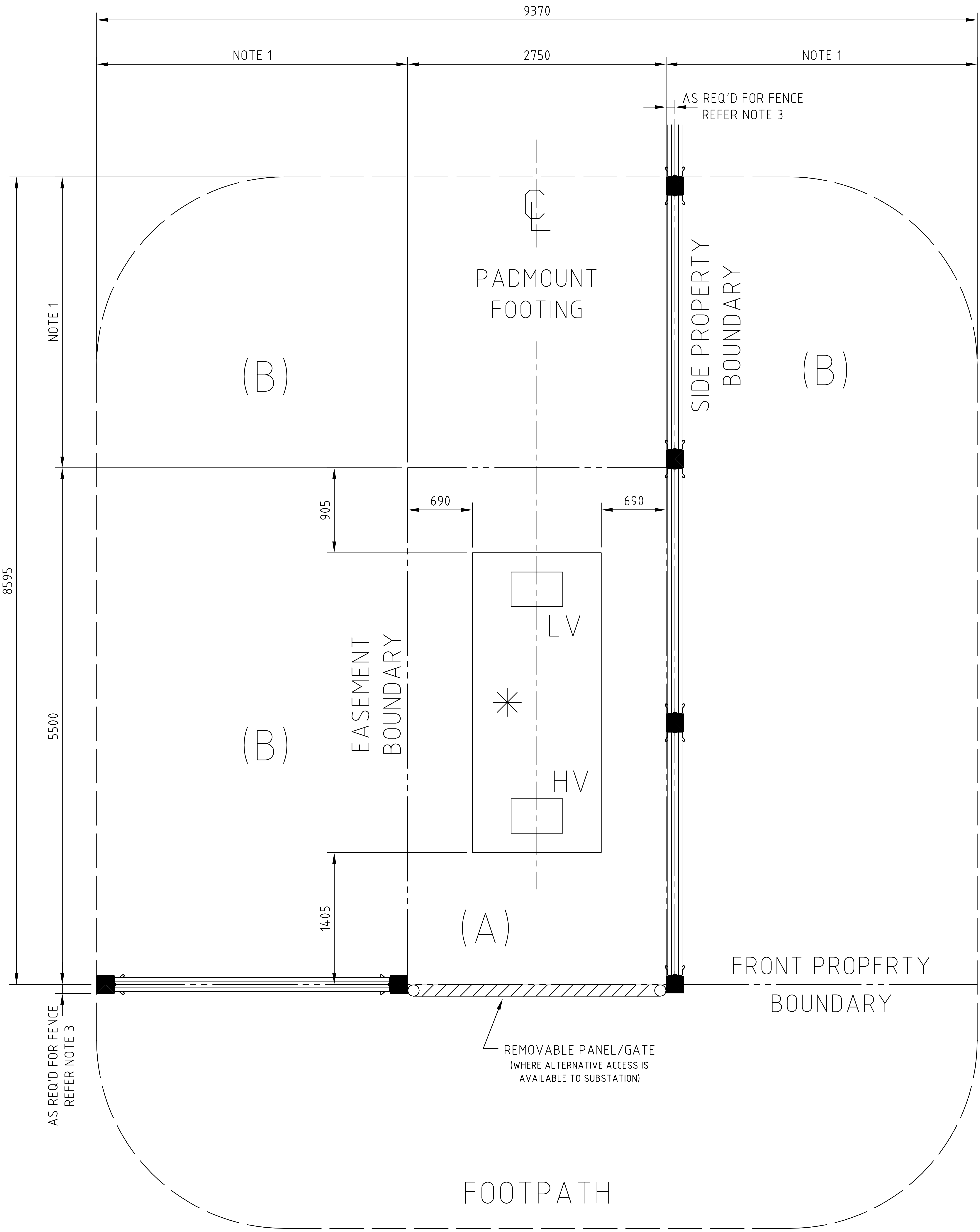
FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION (EASEMENT DETAILS)

A2P 289702 A

SHEET No 1 OF 7 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	

SCENARIO No.1



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.
2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES. IF LOCKED THEN PANEL/GATE IS TO BE FITTED WITH "IE" SERIES LOCK.
3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

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■ FOR SEPARATELY EARTHED SUBSTATIONS, INSULATED POSTS ARE REQUIRED ON ALL PANELS UP TO & INCLUDING 4m FROM SUBSTATION.

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS 15.1m^2

(B) COVENANT

FENCE

GATE/REMOVABLE FENCE PANEL

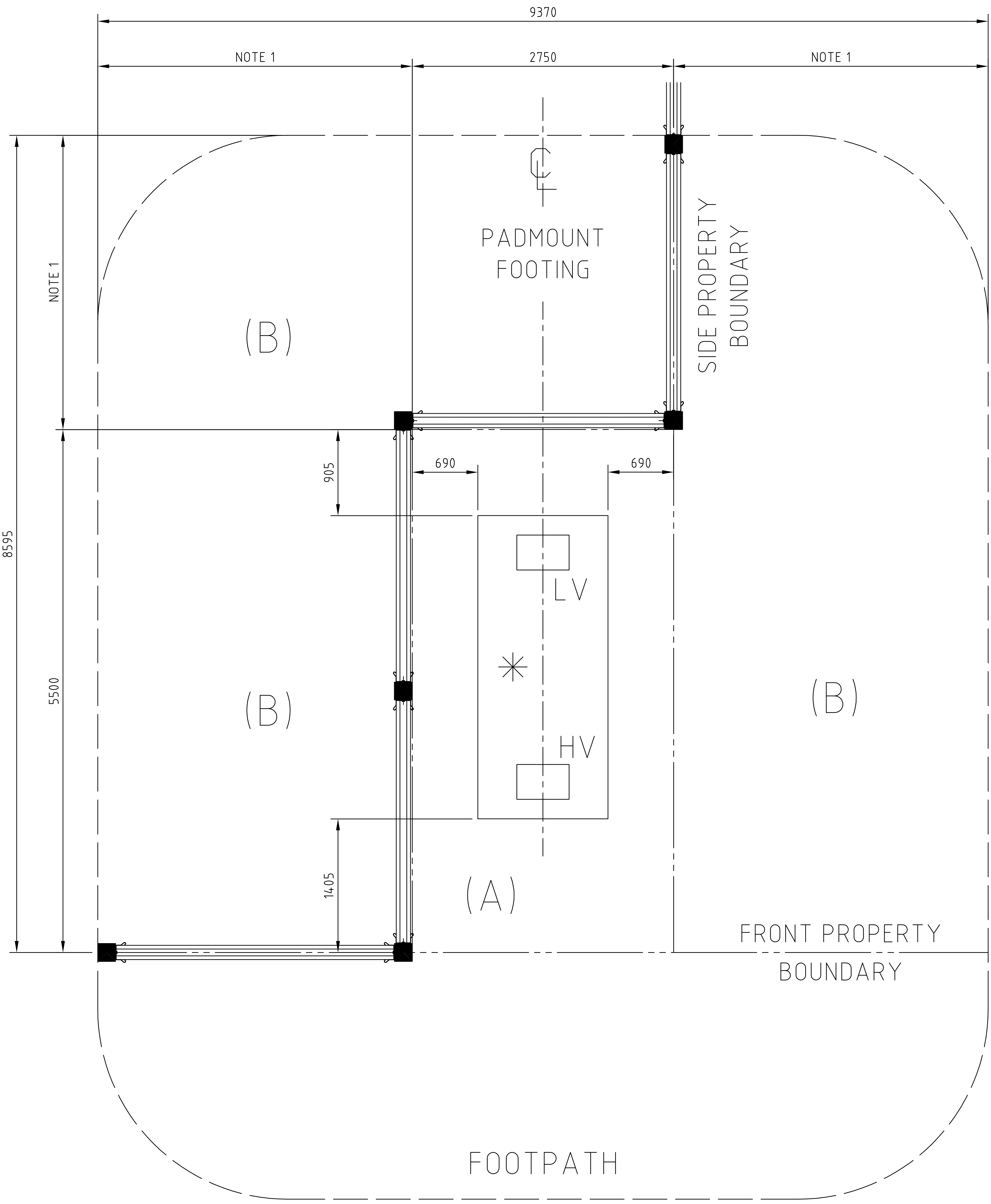
Endeavour Energy

ORIGINAL SCALE 1:30	APPROVED D.Marshall	REFERENCE DRAWINGS	
DRAWN	J.H.	DO NOT SCALE DIMENSIONS IN MILLIMETRES	AUTHORISED W.Isley
DATE	24-08-05	FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION SCENARIO No.1	MANAGER ASSET ENGINEERING 26.10.05
CH'D	DM	A2P 289702 A	SHEET No 2 OF 7 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	

SCENARIO No.2

PARTIALLY FENCED



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.
2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES.
3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

■ FOR SEPARATELY EARTHED SUBSTATIONS, INSULATED POSTS ARE REQUIRED ON ALL PANELS UP TO & INCLUDING 4m FROM SUBSTATION.

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS 15.1m²

(B) COVENANT

▤ FENCE

Endeavour Energy

ORIGINAL SCALE 1:30	APPROVED D.Marshall	
DRAWN	J.H.	
DATE	24-08-05	
CH'D	DM	

REFERENCE DRAWINGS

DO NOT SCALE
DIMENSION IN MILLIMETRES

AUTHORISED W.Isley
MANAGER ASSET ENGINEERING 26.10.05

FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION SCENARIO No.2

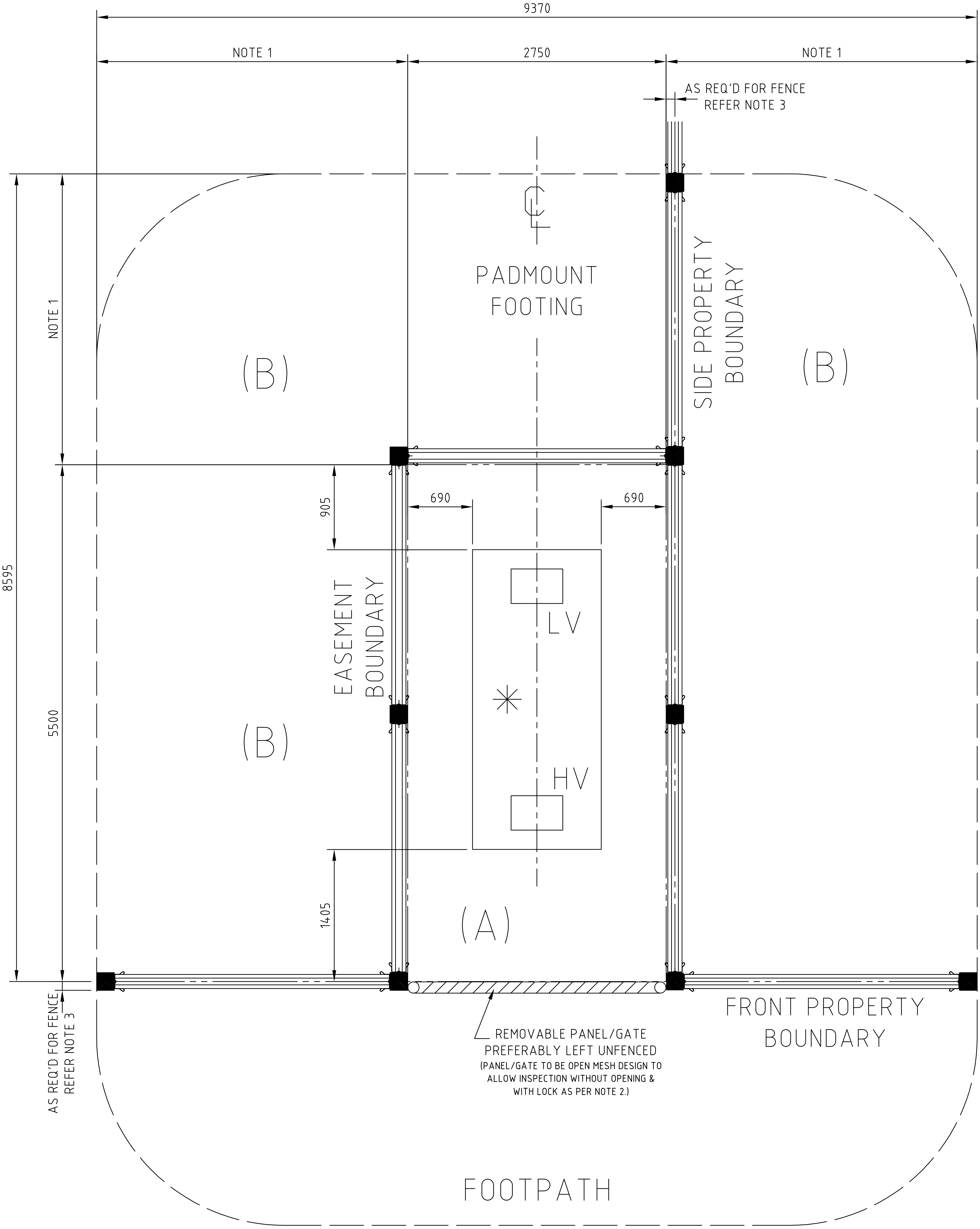
A2P 289702 A

SHEET No 3 OF 7 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	

SCENARIO No.3

FULLY FENCED OUT PADMOUNT SUBSTATION WITH OR WITHOUT REMOVABLE FRONT PANEL ON A GATE



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.

2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES. IF LOCKED THEN PANEL/GATE IS TO BE FITTED WITH "IE" SERIES LOCK.

3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

■ FOR SEPARATELY EARTHED SUBSTATIONS, INSULATED POSTS ARE REQUIRED ON ALL PANELS UP TO & INCLUDING 4m FROM SUBSTATION.

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS 15.1m^2

(B) COVENANT

▤ FENCE

▨ GATE/REMOVABLE FENCE PANEL

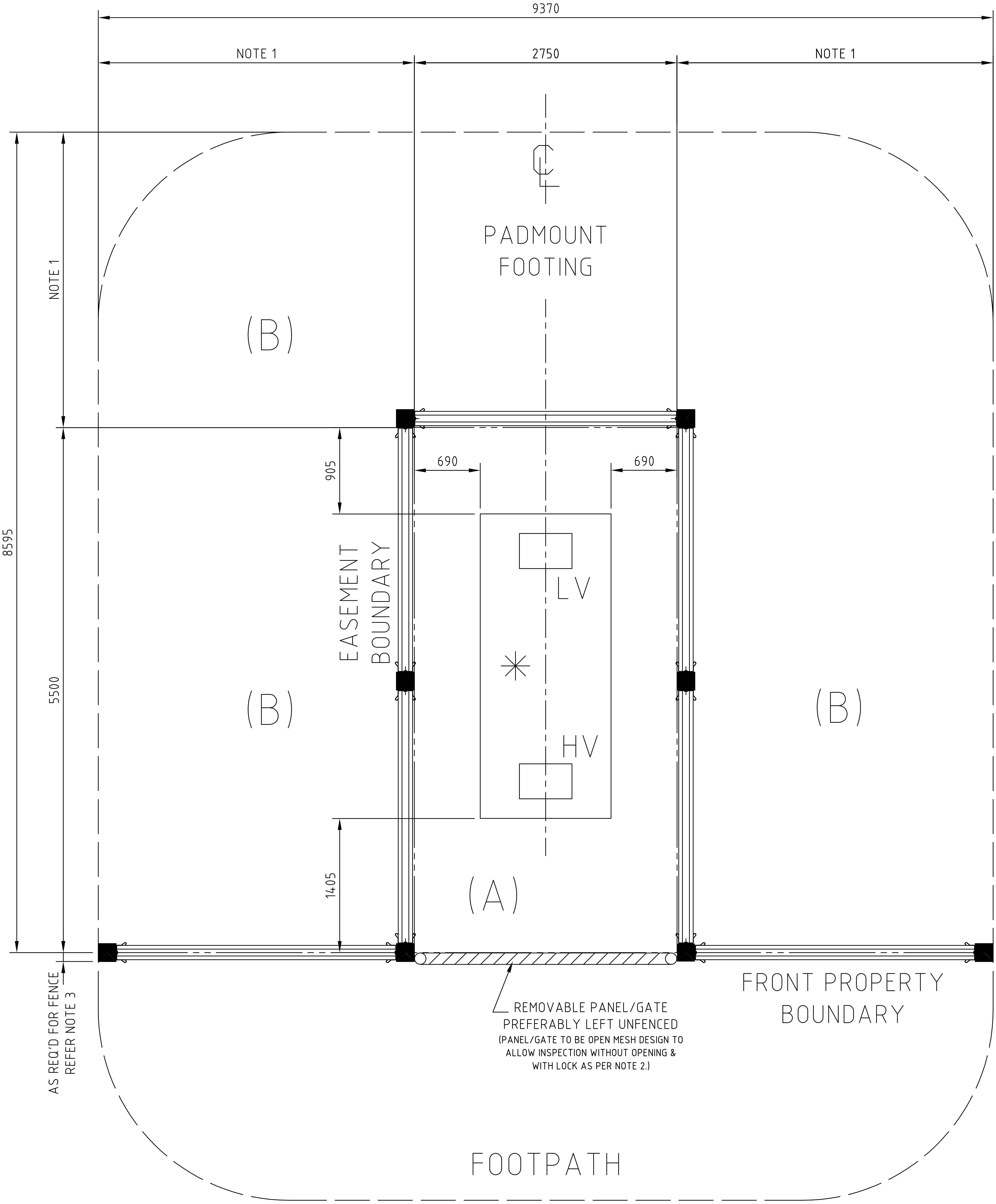
Endeavour Energy

ORIGINAL SCALE 1:30	APPROVED D.Marshall	REFERENCE DRAWINGS	
DRAWN	J.H.	DO NOT SCALE DIMENSIONS IN MILLIMETRES	AUTHORISED W.Isley
DATE	25-08-05	FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION SCENARIO No.3	MANAGER ASSET ENGINEERING 26.10.05
CH'D	DM	A2P 289702 A	SHEET No 4 OF 7 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	

SCENARIO No.4

FULLY FENCED OUT PADMOUNT SUBSTATION WITH OR WITHOUT REMOVABLE FRONT PANEL ON A GATE



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.
2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES. IF LOCKED THEN PANEL/GATE IS TO BE FITTED WITH "IE" SERIES LOCK.
3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

■ FOR SEPARATELY EARTHED SUBSTATIONS, INSULATED POSTS ARE REQUIRED ON ALL PANELS UP TO & INCLUDING 4m FROM SUBSTATION.

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS 15.1m^2

(B) COVENANT

FENCE

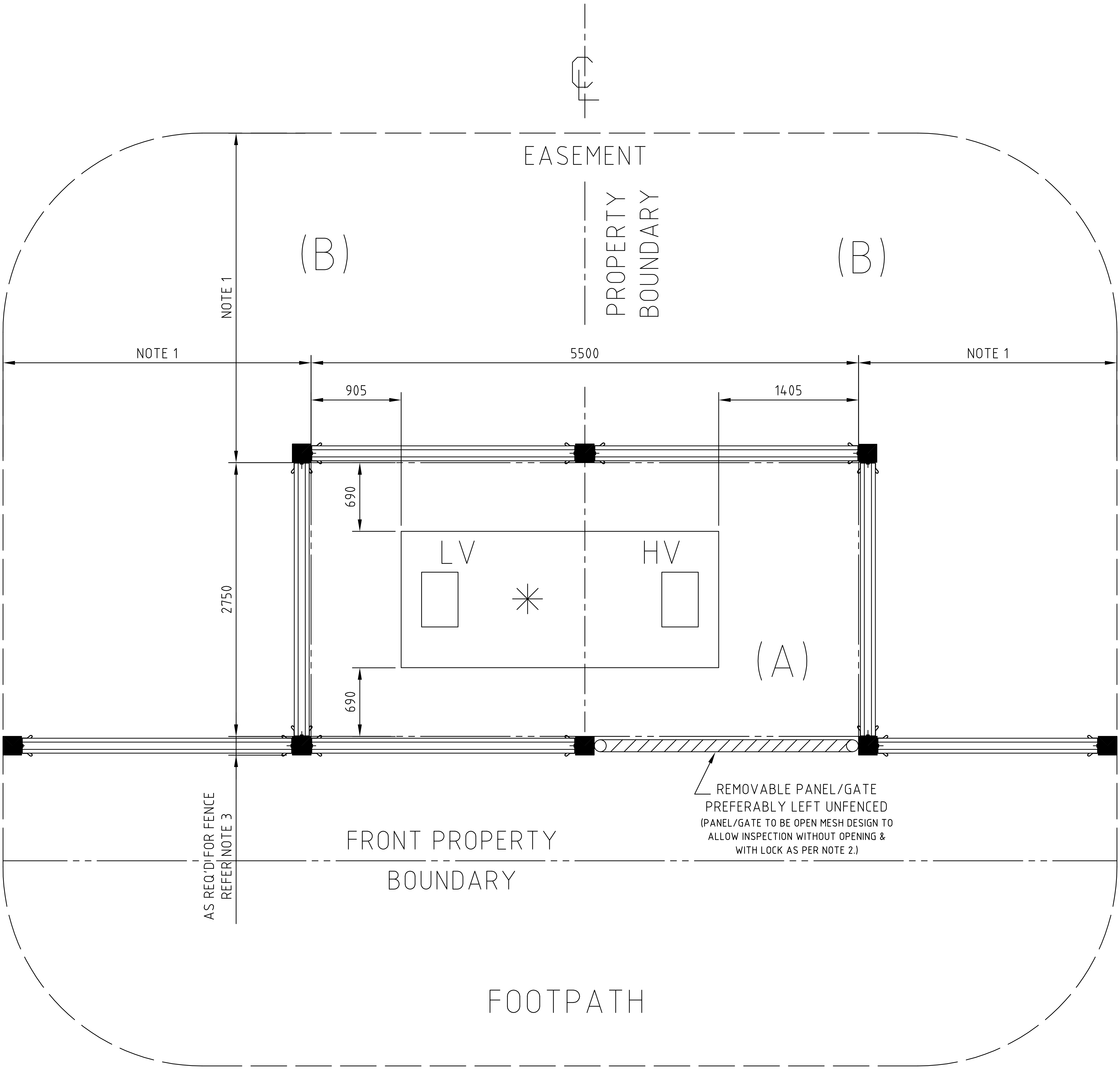
GATE/REMOVABLE FENCE PANEL

Endeavour Energy

ORIGINAL SCALE 1:30	APPROVED D.Marshall	DO NOT SCALE DIMENSIONS IN MILLIMETRES	AUTHORISED W.Isley
DRAWN	J.H.	REFERENCE DRAWINGS	MANAGER ASSET ENGINEERING 26.10.05
DATE	25-08-05	FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION SCENARIO No.4	A2P 289702 A
CH'D	DM		SHEET No 5 OF 7 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	

SCENARIO No.5



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.
2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES. IF LOCKED THEN PANEL/GATE IS TO BE FITTED WITH "IE" SERIES LOCK.
3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

■ FOR SEPARATELY EARTHED SUBSTATIONS, INSULATED POSTS ARE REQUIRED ON ALL PANELS UP TO & INCLUDING 4m FROM SUBSTATION.

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS 15.1m^2

(B) COVENANT

FENCE

GATE/REMOVABLE FENCE PANEL

ORIGINAL SCALE 1:30	APPROVED D.Marshall	Endeavour Energy
DRAWN	J.H.	
DATE	25-08-05	
CH'D	DM	

REFERENCE DRAWINGS

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED W.Isley
MANAGER ASSET ENGINEERING 26.10.05

FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION SCENARIO No.5

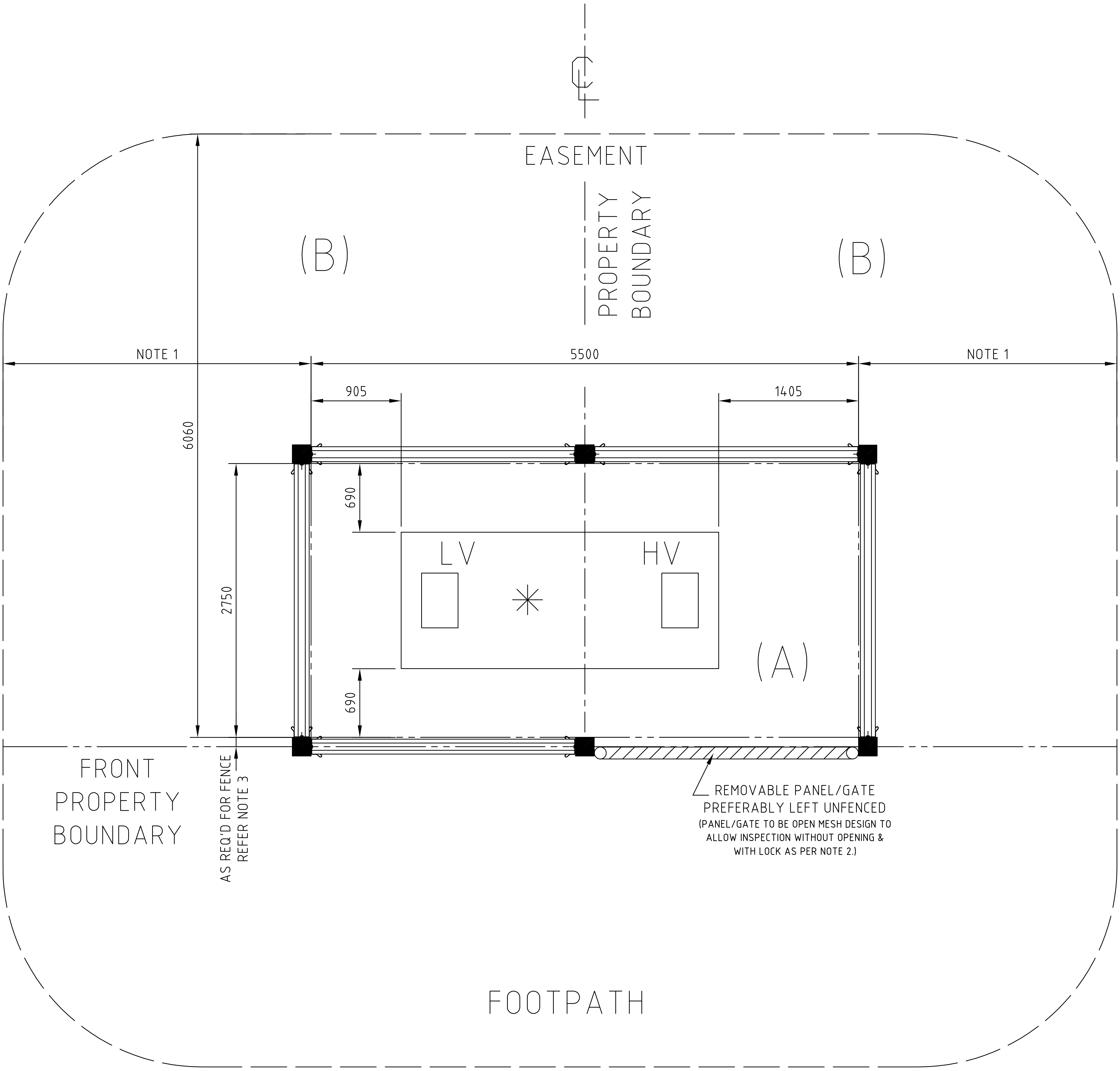
A2P 289702 A

SHEET No 6 OF 7 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	

SCENARIO No.6

LEFT UNFENCED OR REMOVABLE PANELS/GATES



NOTE

1. COVENANT DIMENSIONS SHOULD BE CHECKED TO ENSURE THEY COMPLY WITH SDI 100 AND SUBSTATION DESIGN STANDARDS.
2. UNRESTRICTED 24 HOUR ACCESS TO THE SUBSTATION IS REQUIRED, DIRECTLY FROM A PUBLIC STREET FOR PERSONNEL AND HEAVY VEHICLES. IF LOCKED THEN PANEL/GATE IS TO BE FITTED WITH "IE" SERIES LOCK.
3. EASEMENT TO BE UNENCUMBERED BY FENCING. WHERE FENCING ENCROACHES ON THE EASEMENT THE EASEMENT MUST BE MOVED.

■ FOR SEPARATELY EARTHED SUBSTATIONS, INSULATED POSTS ARE REQUIRED ON ALL PANELS UP TO & INCLUDING 4m FROM SUBSTATION.

✳ PLINTH DIMENSIONS 3.19m x 1.37m

(A) EXISTING EASEMENT AREA IS 15.1m²

(B) COVENANT

FENCE

GATE/REMOVABLE FENCE PANEL

Endeavour Energy

ORIGINAL SCALE 1:30	APPROVED D.Marshall	DO NOT SCALE DIMENSIONS IN MILLIMETRES	REFERENCE DRAWINGS
DRAWN	J.H.		AUTHORISED W.Isley
DATE	25-08-05		MANAGER ASSET ENGINEERING 26.10.05
CH'D	DM		

FENCING ARRANGEMENT FOR PADMOUNT SUBSTATION SCENARIO No.6

A2P 289702 A

SHEET No 7 OF 7 SHEETS

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7.7.2 Indoor substation – associated drawings

Drawing no.	Amendment no.	Subject
040877/1	D	Removable pulling ring and socket fabrication details
040877/2	C	Removable pulling ring and socket fabrication details
040879	E	Four tonne wall anchor fabrication and installation details
040881	F	Typical conduit details
040882	B	Suspended cable tray support details
040883/1	F	Ventilation control typical schematic (with supervisory control)
040883/2	G	Ventilation control typical schematic (without supervisory control)
053671	F	Manhole access ladder and cover detail 1200 high basement
053914	F	Std layout for HV switch room to suit single transformer chamber
054738	C	Typical cable alcove details
061736	B	ID sub cable stand 3 x 16mm″ XLPE
069526	A	Cover plate lifting handle detail
077696	F	ID sub high voltage switch room (to suit up to 4 trf) std layout
078239	B	Low voltage equipment cable lug critical dimensions
240118	C	ID sub bund wall fabrication detail
292712	A	Substation earth stake protection box
297547	A	Indoor dist. sub HV and LV floor penetration and trench detail
297555	C	Indoor dist. sub sw/gr trench cover plate detail
297556	C	Indoor dist. sub HV sw/gr trench mounting support brkt detail
297557	B	Standard layout single transformer indoor substation
297558	C	Standard layout two transformer indoor substation
317522	B	Standard layout single transformer indoor padmount style distribution substation

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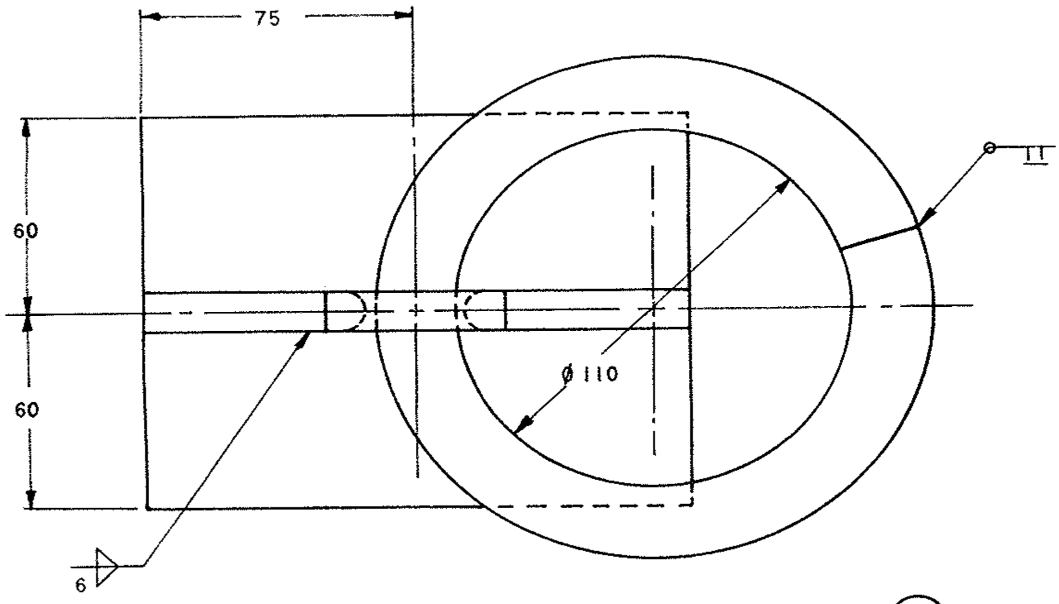


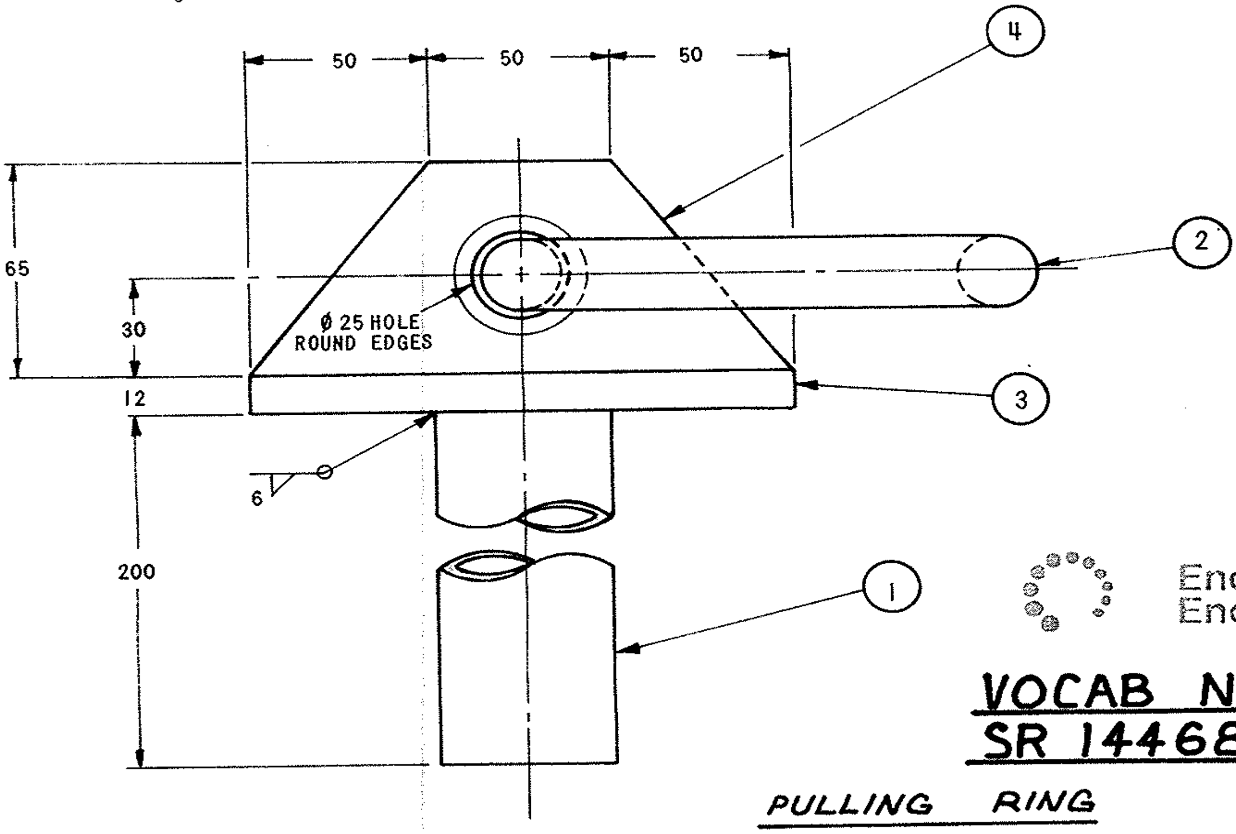
AMENDMENTS

B	DRN	W.C.H.
	CHD	SGP.
	DATE	19.12.84
	CH Nº	242

VOCAB Nº ADDED
SUBS ENG. Km.

C	DR'N	J.H.
	CH'D	FM
	DATE	27-7-05
	JOB No	

DSM FM/GAP
DRG. FRAME WAS PCC.



Endeavour Energy

VOCAB Nº SR 14468

PULLING RING

NOTES:

1. FINISH: HOT DIPPED GALVANISED AFTER FABRICATION
2. ALL WELDING TO BE IN ACCORDANCE WITH AS 1554. SYMBOLS TO AS Z6
3. TWO PULLING RINGS REQUIRED IN EACH SUBSTATION

ITEM	DESCRIPTION	QTY
4	STEEL BAR FLAT 150 x 12 x 65 LG	1
3	STEEL BAR FLAT 150 x 12 x 120 LG	1
2	STEEL BAR ROUND Ø 22 x 420 LG	1
1	PIPE STEEL MED 40 NB x 200 LG (OD 48.3)	1

SHEET 1 OF 2 SHEETS

ALL DIMENSIONS ARE IN MILLIMETRES

CONCRETE WALL ANCHOR	F 40879
REMOVABLE PULLING RING SOCKET	SHEET 2
REFERENCE DRAWINGS	

APPROVED L Engel

JOB Nº

PLAN ENG		DIST ENG		DR'N	A.P.A.
CONS ENG		MAINS ENG		CH'D	PMW / GP
		REF A4(h)		SUPV D'MAN	

DISTRIBUTION SUBSTATIONS

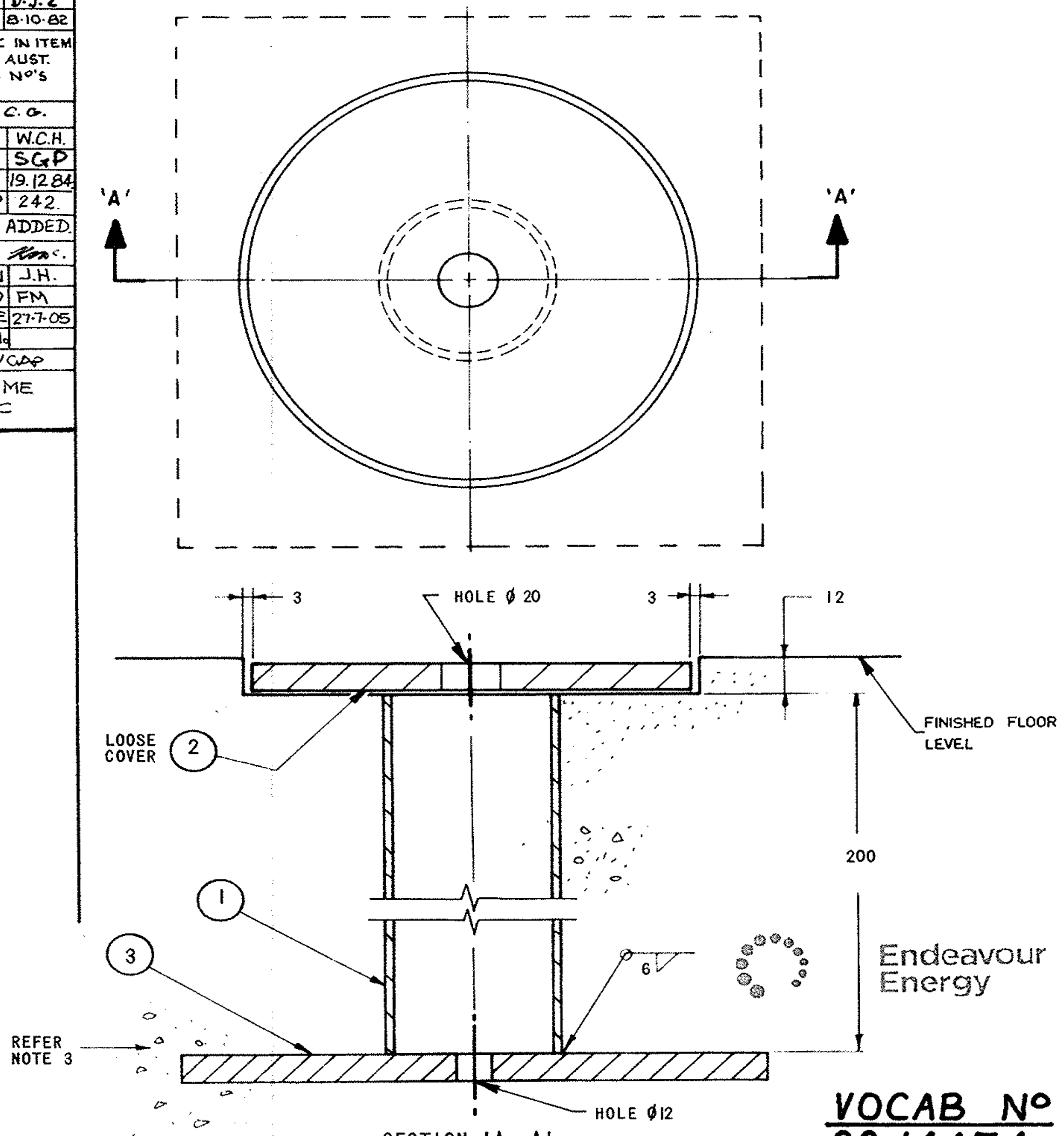
REMOVABLE PULLING RING & SOCKET FABRICATION DETAILS

A. C. Moorhead
CHIEF ELEC ENG DATE 30-7-75
SCALE 1:2

F 40877 ~~A~~ ~~B~~ C

TECH 150

Rev		
A	ORIGINAL ISSUE	
B	DR'N.	R.J.H.
	CH'D	D.J.2
	DATE	8.10.82
Ø12 HOLE IN ITEM 3 ADDED. AUST. STANDARD Nº'S UPDATED.		
SUB. ENG. C.G.		
C	DR'N	W.C.H.
	CH'D	SGP
	DATE	19.12.84
	CH Nº	242.
VOCAB Nº ADDED.		
SUBS ENG.		
D	DR'N	J.H.
	CH'D	FM
	DATE	27-7-05
	JOB Nº	
DSM	FM/GAP	
DRG. FRAME WAS PPC		



SECTION 'A - A'

VOCAB Nº SS 14474.

SOCKET

NOTES:-

1. FINISH: AFTER FABRICATION HOT DIP GALV. TO AS1650.
2. ALL WELDING TO BE IN ACCORDANCE WITH AS 1554. SYMBOLS TO AS1101 PT. 3.
3. MINIMUM OF 75 mm OF CONCRETE AROUND ITEM 3

ITEM	DESCRIPTION	QTY
3	STEEL PLATE 10 x 200 x 200	1
2	STEEL PLATE 10 x 150 DIA	1
1	PIPE STEEL MED 50 NB x 200 LG (ID 53.1)	1

DO NOT SCALE

SHEET 2 OF 2 SHEETS

ALL DIMENSIONS ARE IN MILLIMETRES

REFERENCE DRAWINGS	
CONCRETE WALL ANCHOR	F40879
REMOVABLE PULLING RING	SHEET 1

APPROVED L Engel

JOB Nº

PLAN ENG		DIST ENG	
CONS ENG		MAINS ENG	
		REF A4(h)	

DR'N A.P.A.
CH'D
SUPV D'MAN

DISTRIBUTION SUBSTATIONS

REMOVABLE PULLING RING & SOCKET FABRICATION DETAILS

A. C. Moorhead
CHIEF ELEC ENG DATE 30-7-75

ORIGINAL SCALE 1:2

F 40877 ~~A~~ ~~B~~ ~~C~~ D

NOTES

1. ANCHOR ASSEMBLY

MATERIAL: DEFORMED BAR Y28 TO AS 1302
FINISH: HOT DIP GALVANISED
CAPACITY: 4 TONNES.

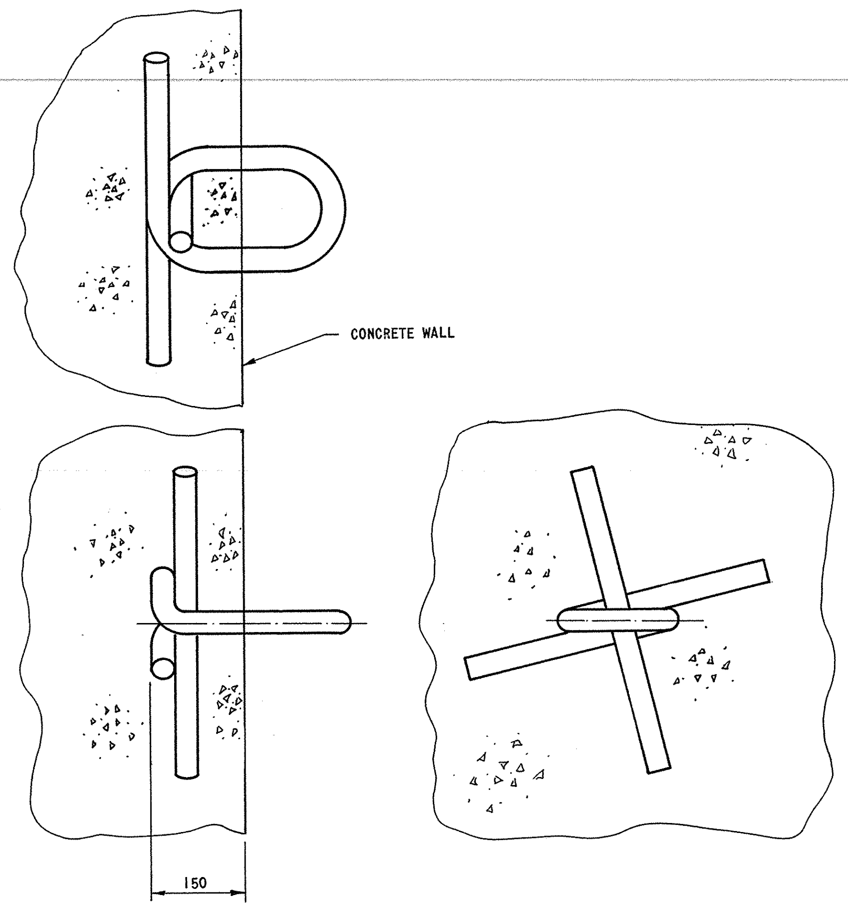
2. CONCRETE WALL DETAIL

THE WALL IN WHICH THE ANCHOR IS SET SHALL COMPLY WITH THE FOLLOWING:

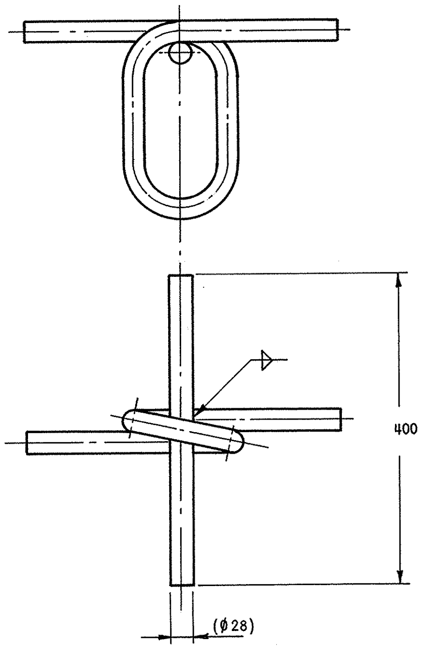
THICKNESS: 200 mm (MINIMUM)
HEIGHT: NO RESTRICTION
WIDTH: NO RESTRICTION
REINFORCING: Y12 AT 200 mm CENTRES OR Y16 AT 300 mm CENTRES. PLACED EACH WAY WITH 40 mm COVER FROM FACE THROUGH WHICH THE ANCHOR PROJECTS (THIS IS MINIMUM REINFORCING).
CONCRETE: 20 MPa (MINIMUM)
RESTRAINT: WALL SHALL BE RESTRAINED AT TOP & BOTTOM TO PREVENT MOVEMENT IN DIRECTION OF FORCE APPLIED TO ANCHOR.

3. POSITION OF ANCHOR:

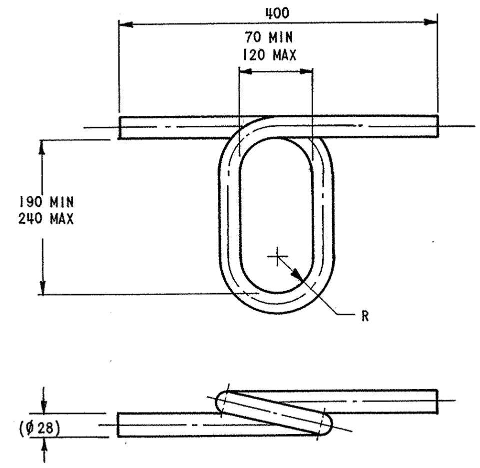
500 mm (MAXIMUM) 300 mm (PREFERRED) ABOVE FLOOR LEVEL.



MOUNTING DETAILS



ASSEMBLY



DETAIL

Endeavour Energy

~~VOCAB No SA 11616~~

(DRAWING PREPARED FROM W.H. ROSIER P.L. DRG No 84031-2.)

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

REFERENCE DRAWINGS

ORIGINAL SCALE 1:5

APPROVED L Engel

DRAWN DMcD
CH'KD D.J.Z.
CO-ORD D'SERV

CONCRETE WALL MOUNTED ANCHOR
4 TONNE CAPACITY
FABRICATION & MOUNTING DETAILS

P. Thomson
DIRECTOR ENG. DATE 22·4·85

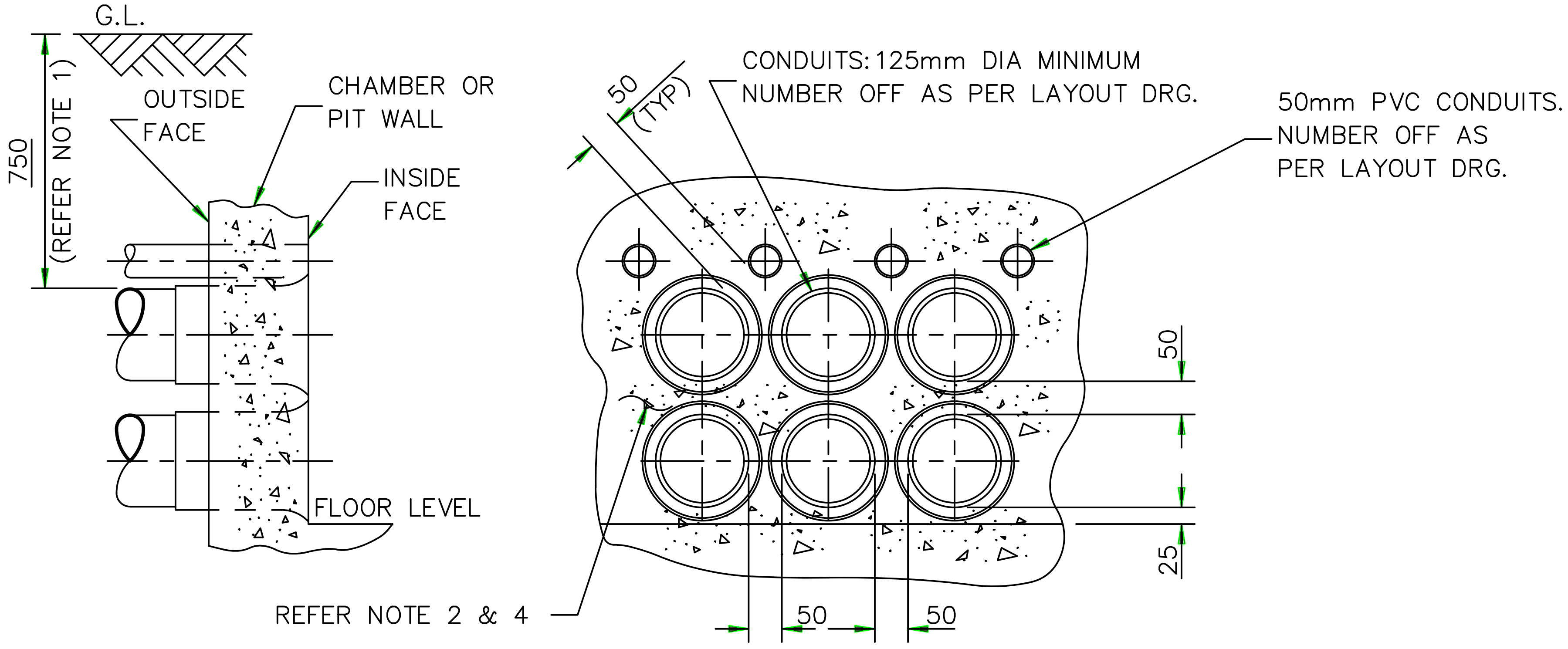
C 40879 A
SHEET No OF SHEETS
D E
INDEX REF A4 H

AMENDMENTS

A	ORIGINAL ISSUE	DR'N DMcD, CH'D D.J.Z., DATE 22.4.85, CH Nº 243	
D	REDRAWN M.S.D.	DR'N J.H., CH'D FM/GF, DATE 27-7-05, JOB No	DSM FNY CAP — DRG. FRAME WAS PCC E1. VOCAB. No. DELETED AS A STORES ITEM

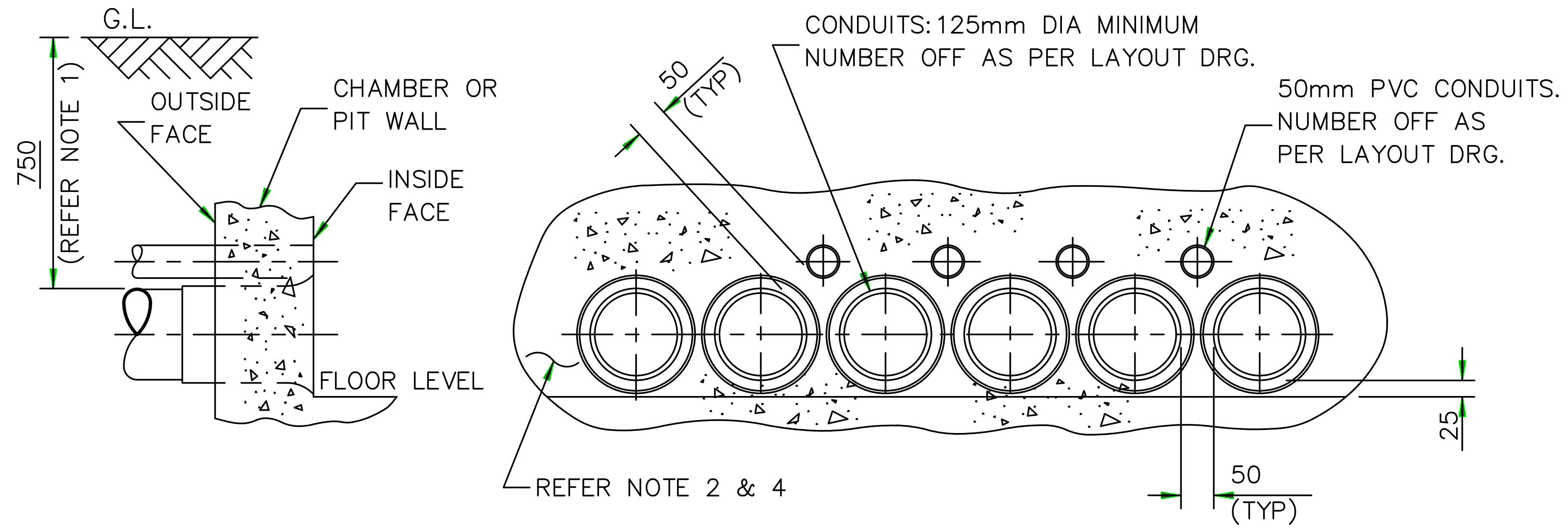
NOTES

1. MINIMUM COVER TO TOP OF CONDUITS TO BE 750mm, OTHERWISE CONCRETE ENCASE 75mm THICK.
2. CONDUITS TO BE GROUTED INTO WALL OPENING WITH WATERPROOF CEMENT RENDER TO PREVENT INGRESS OF WATER.
3. THIS DRG TO BE READ IN CONJUNCTION WITH MCI0006 & MDI0028
4. 125mm DIA CONDUIT ENDS TO BE BELLMOUTHED.



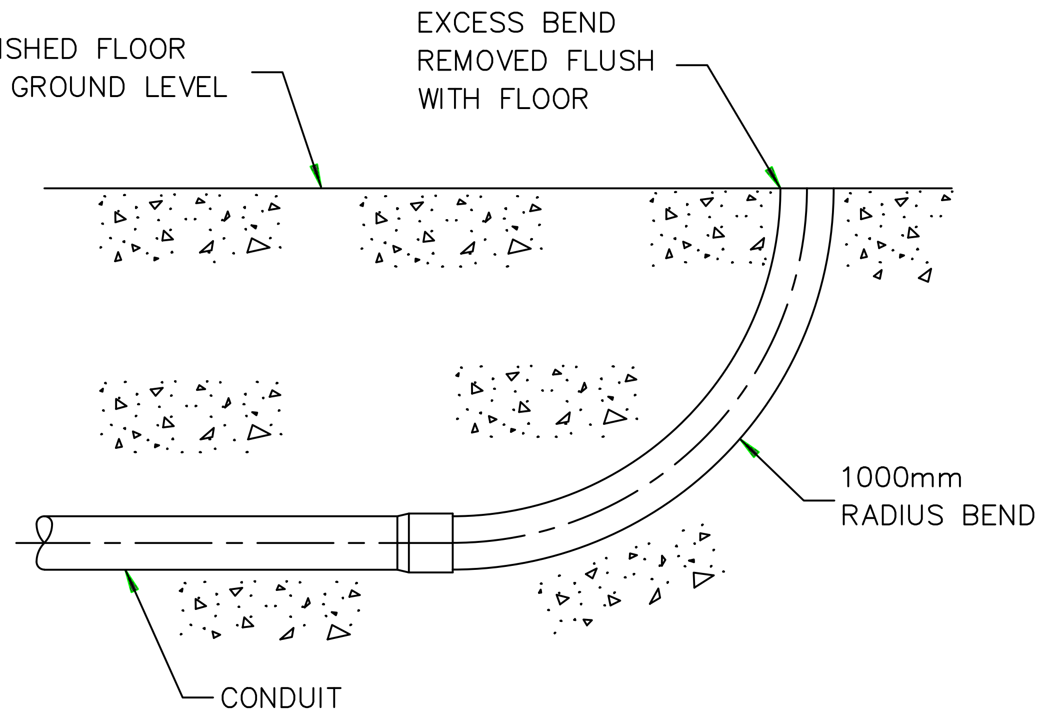
PREFERRED CONDUIT ENTRY DETAIL

SCALE 1:10



ALTERNATIVE CONDUIT ENTRY DETAIL

SCALE 1:10



CONDUIT BEND DETAIL

SCALE 1:20

AMENDMENTS							
A	ORIGINAL ISSUE	J R No. N/A	DR'N JW	CH'D DJZ	DATE 16-5-96	JR No 960035	
E	DRAWING REDRAWN NOTE 3 SDI 105 WAS 118.	S.E.O. J.K.	DR'N G.S.F	CH'D G.S.F	DATE 26-11-15	JR No N/A	NOTE 3 MCI0006 & MDI0028 WAS SDI 105 NSM C.Crisafulli
F							

Endeavour Energy

ORIGINAL SCALE AS SHOWN

APPROVED M.Tamp

DRAWN	J.W
DATE	16-5-96
CH'D	J.K.

REFERENCE DRAWINGS

DO NOT SCALE

DIMENSIONS IN MILLIMETRES

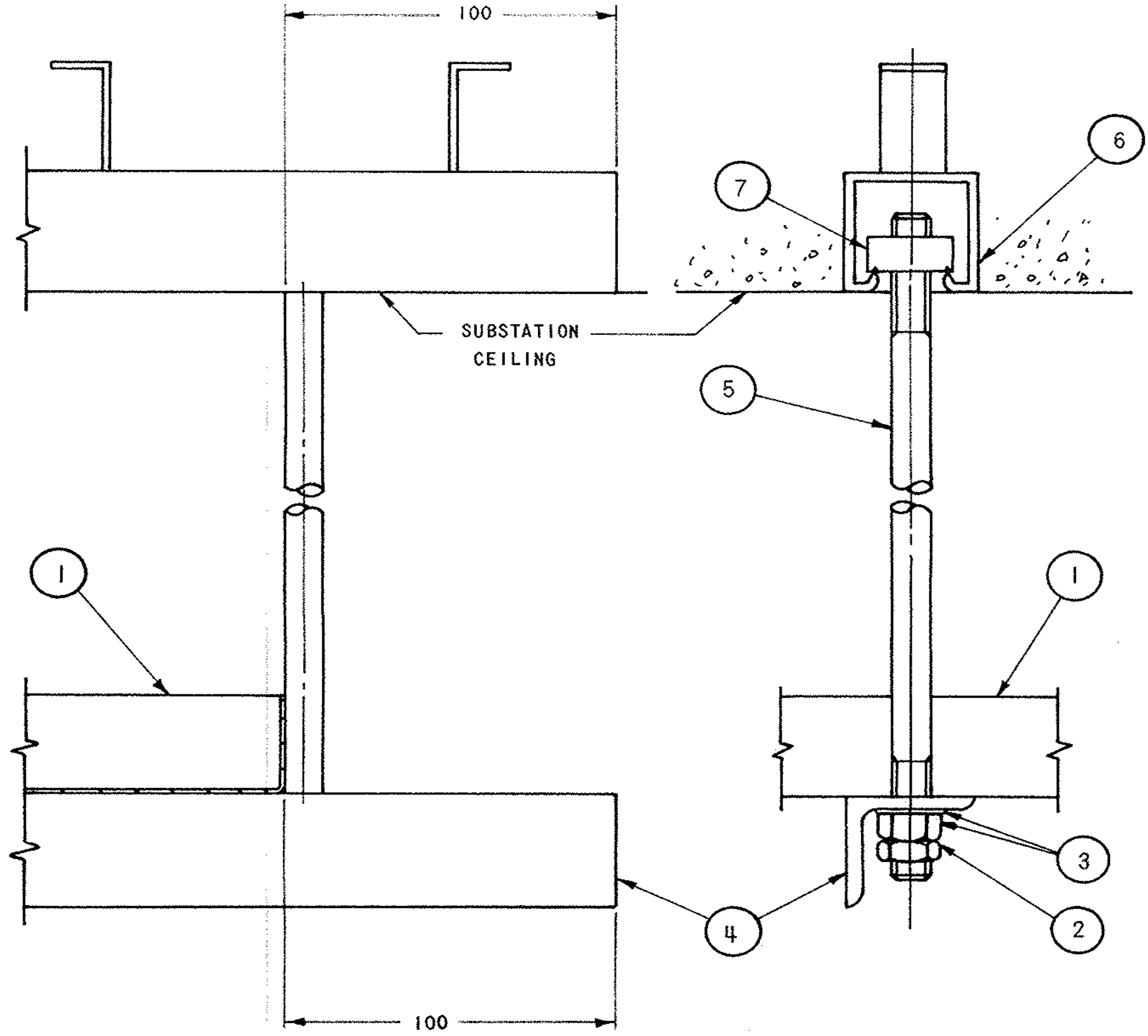
AUTHORISED M.Tamp

M.N.S.A. 17-05-96

INDOOR DISTRIBUTION SUBSTATIONS TYPICAL CONDUIT DETAILS

A3 040881 F

SHEET No 1 OF 1 SHEETS



SHOWN FOR ONE SIDE ONLY

ALL DIMENSIONS ARE IN MILLIMETRES

ITEM	DESCRIPTION
7	UNISTRUT M12 NUT AS REQ'D GALV
6	UNISTRUT TYPE M 1000 C1 (LENGTH TO SUIT) GALV
5	STEEL ROD MS ϕ12 LENGTH TO SUIT (40 mm OF THREAD BOTH ENDS)
4	STEEL ANGLE 38 x 38 x 5 (LENGTH TO SUIT)
3	NUT STEEL HEX GALV M12 & WASHER
2	NUT STEEL LOCK HEX GALV M12 AS REQ'D
1	CABLE TRAY (SIZE & LENGTH TO SUIT)

NOTE: ITEMS 1, 4 & 5 TO BE HOT DIPPED GALVANISED AFTER FABRICATION

DRAWING FRAME WAS PCC.

B | DR'N J.H. | CH'D F.M./G.F | DATE 27-7-05 | DSM FM/GAP

Endeavour Energy

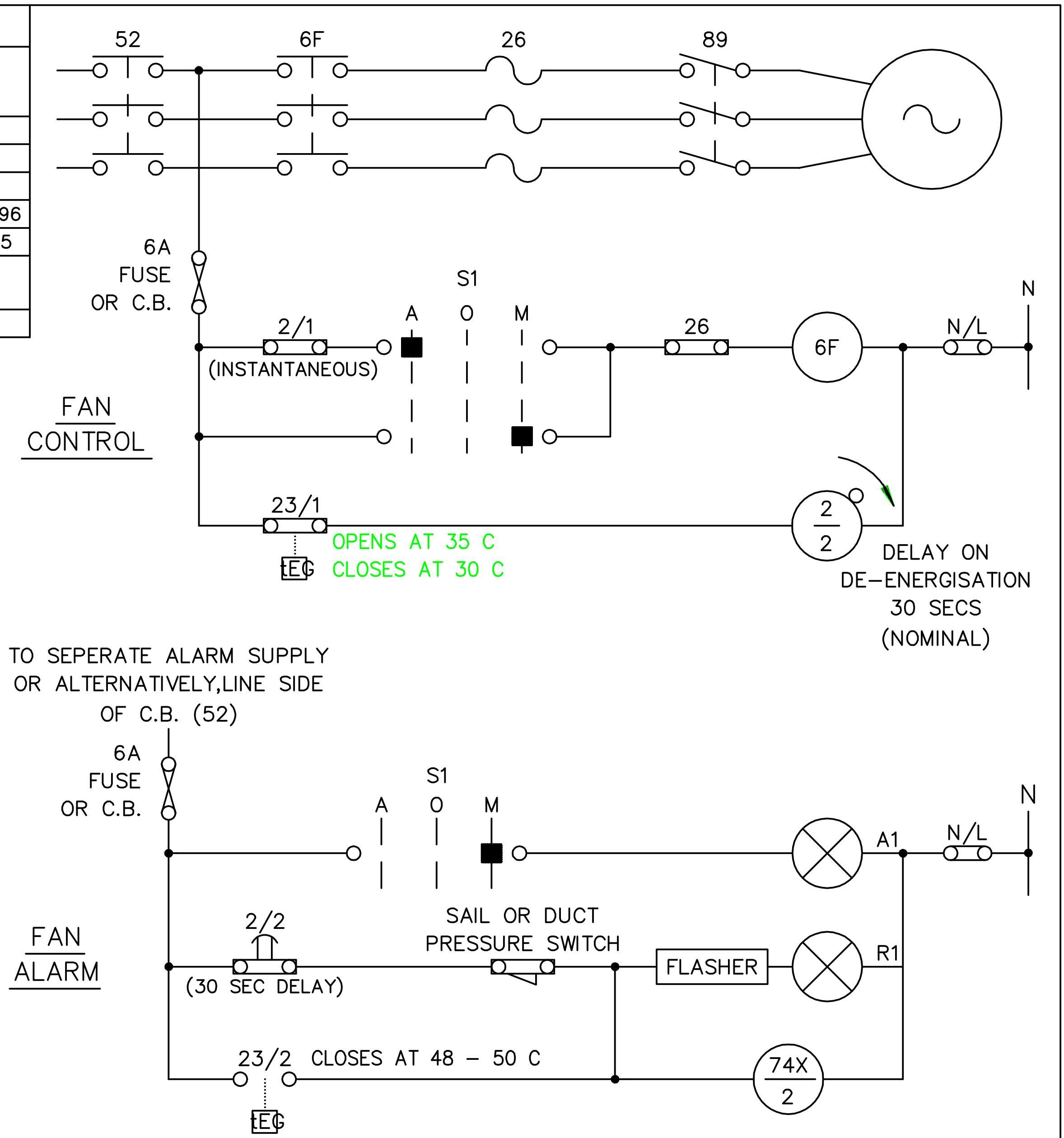
REFERENCE DRAWINGS

APPROVED	L Engel				
S O ENG		SUB ENG		DR'N	A.P.A.
PLAN ENG		DIST ENG		CH'D	PMW / R
CONS ENG		MAINS ENG		SUPV D'MAN	HD
M & P ENG		REF A4(h)			

DISTRIBUTION SUBSTATIONS
SUSPENDED CABLE TRAY
SUPPORT DETAILS

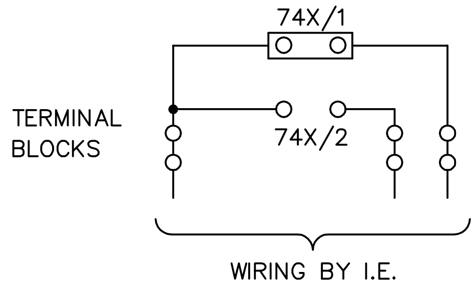
A. C. Moore
CHIEF ELEC ENG | DATE 6-8-75
SCALE 1 : 2
F 40882 A
B

AMENDMENTS	
A	ORIGINAL ISSUE
J R No.	N/A
F	DR'N: J.W
	CH'D: D.J.Z
	DATE: 16–5–96
	JR No: 960035
DRAWING REDRAWN NOTE 5 REVISED.	
S.E.O.	J.K.



LEGEND

A1 – MANUAL OPERATIONAL INDICATION LAMP (AMBER)
R1 – LOCAL VENTILATION FAILURE INDICATION LAMP (RED)
2 – AUTO CLOSE LOCKOUT TIMING RELAY
S1 – AUTO – OFF – MAN, SELECTOR SWITCH
23 – TEMPERATURE CONTROL DEVICE
26 – THERMAL OVERLOAD RELAY
52 – CIRCUIT BREAKER
89 – ISOLATOR
N/L – NEUTRAL LINK
6F – FAN CONTACTOR
74X – AUX. ALARM RELAY



NOTES

1. FAN MAY BE SINGLE PHASE.
2. ALL CONTROLS ARE TO BE LOCATED WITHIN THE SUBSTATION.
3. SAIL OR DUCT PRESSURE SWITCH TO BE LOCATED IN VENTILATION DUCT. CONTACTS OPEN WHEN VENTILATION WORKING.
4. CUSTOMER TO SUBMIT DETAILS OF PROPOSED VENTILATION SYSTEMS TO Endeavour Energy FOR APPROVAL PRIOR TO INSTALLATION.
5. CONTROL CIRCUIT FUSE/S TO BE SIEMENS TYPE 3NW 32NNSB OR SIMILAR TO SUIT 3NW NS6 FUSE CARTRIDGE.

Endeavour Energy

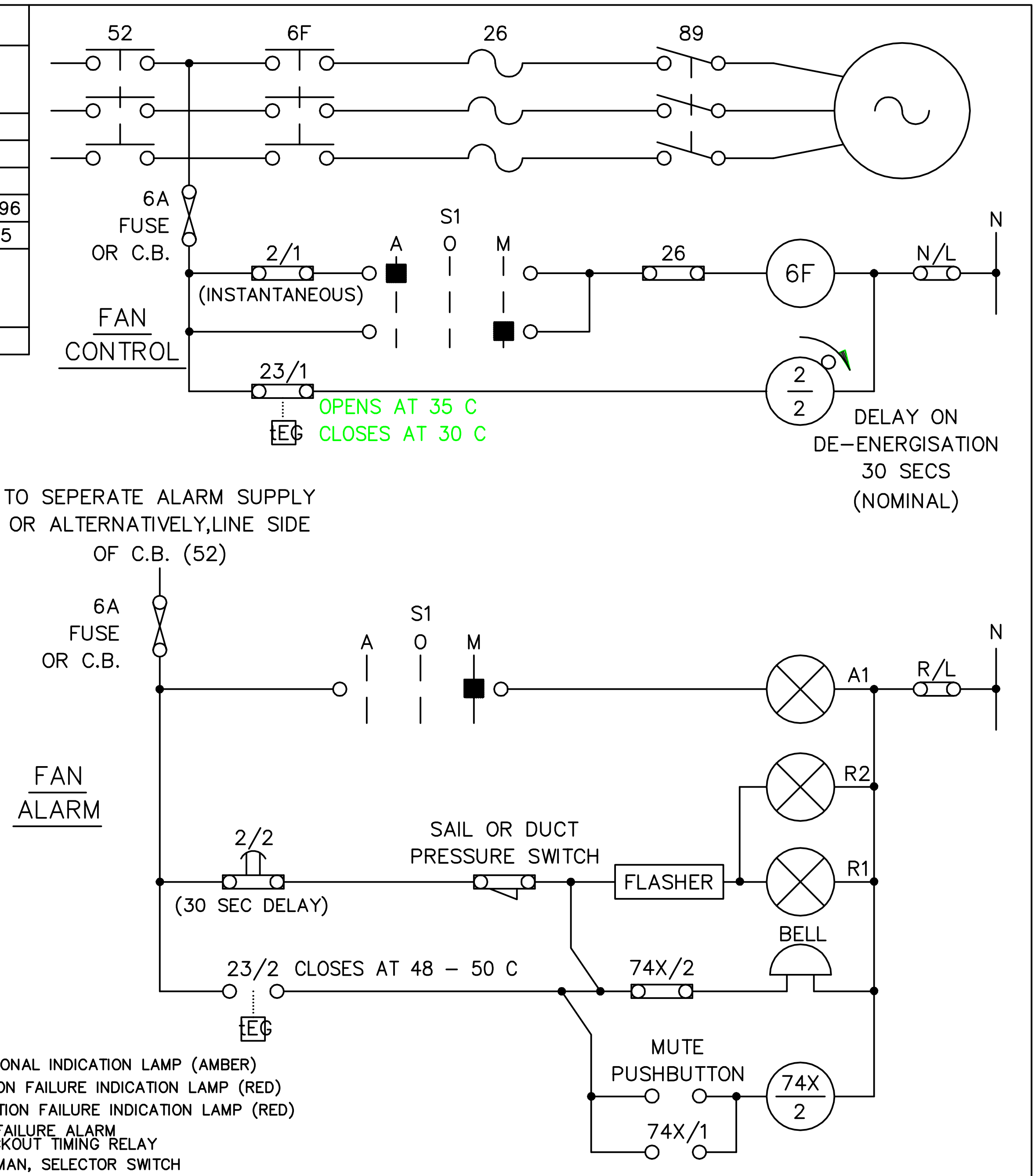
DRAWN	J.W
DATE	16–5–96
CH'D	J.K.

DISTRIBUTION SUBSTATIONS
WITH SUPERVISORY CONTROL –
VENTILATION CONTROL.
TYPICAL SCHEMATIC DIAGRAM

M.Tamp

M.N.S.A.		17–05–96
ORIGINAL SCALE	NONE	APPROVED M.Tamp
A4	040883	F
	SHEET No 1 OF 2 SHEETS	

AMENDMENTS	
A	ORIGINAL ISSUE
J R No.	N/A
G	DR'N: J.W
	CH'D: D.J.Z
	DATE: 16–5–96
	JR No: 960035
DRAWING REDRAWN NOTES 2,4 & 5 REVISED.	
S.E.O.	J.K.



LEGEND

A1 – MANUAL OPERATIONAL INDICATION LAMP (AMBER)
R1 – LOCAL VENTILATION FAILURE INDICATION LAMP (RED)
R2 – REMOTE VENTILATION FAILURE INDICATION LAMP (RED)
BELL – VENTILATION FAILURE ALARM
2 – AUTO CLOSE LOCKOUT TIMING RELAY
S1 – AUTO – OFF – MAN, SELECTOR SWITCH
23 – TEMPERATURE CONTROL DEVICE
26 – THERMAL OVERLOAD RELAY
52 – CIRCUIT BREAKER
89 – ISOLATOR
N/L – NEUTRAL LINK
6F – FAN CONTACTOR
74X – AUX. ALARM RELAY

NOTES

1. FAN MAY BE SINGLE PHASE.
2. ALL CONTROLS TO BE LOCATED WITHIN THE SUBSTATION. ONLY THE BELL,MUTE PUSHBUTTON & R2 SHOULD BE MOUNTED EXTERNALLY IN A CONTROL ROOM OR ALARM PANEL, WITH NAME PLATE SAYING "NOTIFY Endeavour Energy'S NETWORK CONTROLLER ON INITIATION OF FAULT. TELEPHONE 131081".
3. SAIL OR DUCT PRESSURE SWITCH TO BE LOCATED IN VENTILATION DUCT. CONTACTS OPEN WHEN VENTILATION WORKING.
4. CUSTOMER TO SUBMIT DETAILS OF PROPOSED VENTILATION SYSTEMS TO Endeavour Energy FOR APPROVAL PRIOR TO INSTALLATION.
5. CONTROL CIRCUIT FUSE/S TO BE SIEMENS TYPE 3NW 32NNSB OR SIMILAR TO SUIT 3NW NS6 FUSE CARTRIDGE.

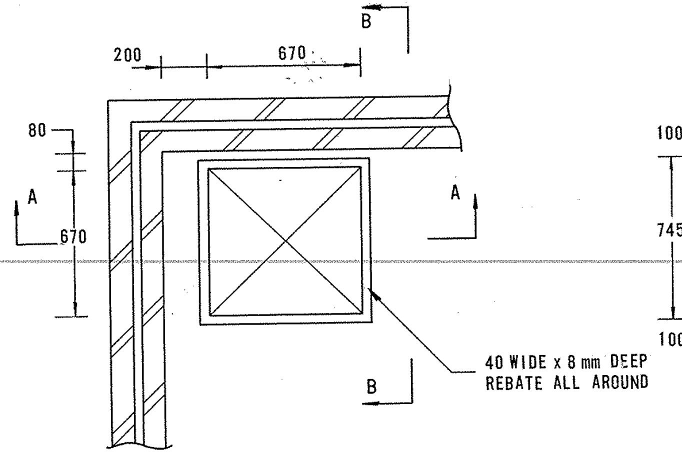
Endeavour Energy

DISTRIBUTION SUBSTATIONS WITHOUT SUPERVISORY CONTROL VENTILATION CONTROL TYPICAL SCHEMATIC DIAGRAM

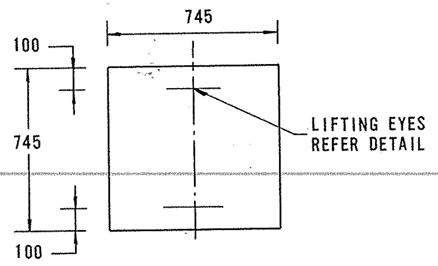
DRAWN	J.W
DATE	16–5–96
CH'D	J.K.

M.Tamp	
M.N.S.A.	17–05–96
ORIGINAL SCALE: NONE	APPROVED: M.Tamp
A4	040883 G
SHEET No 2 OF 2 SHEETS	

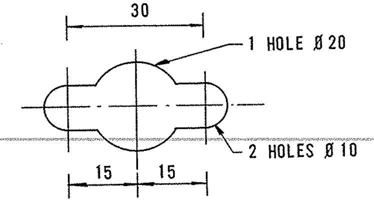
NOTES



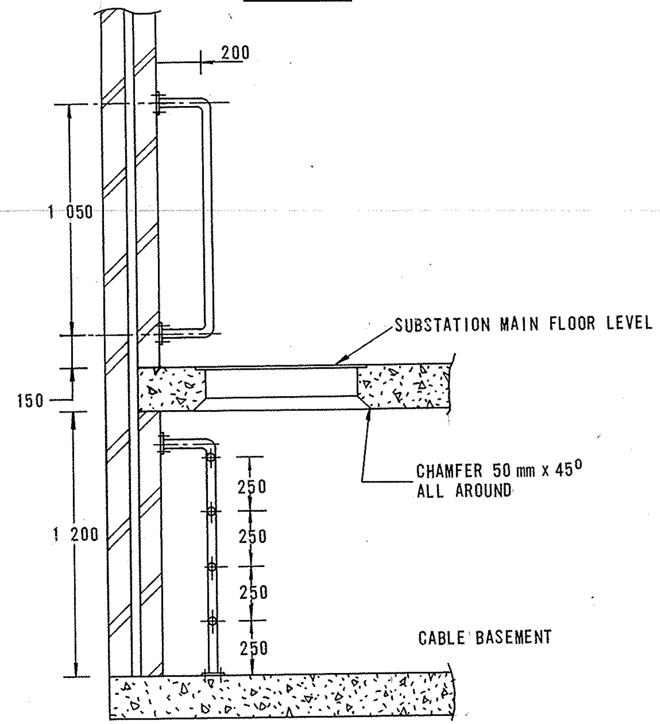
MAIN FLOOR LEVEL
SCALE 1:20



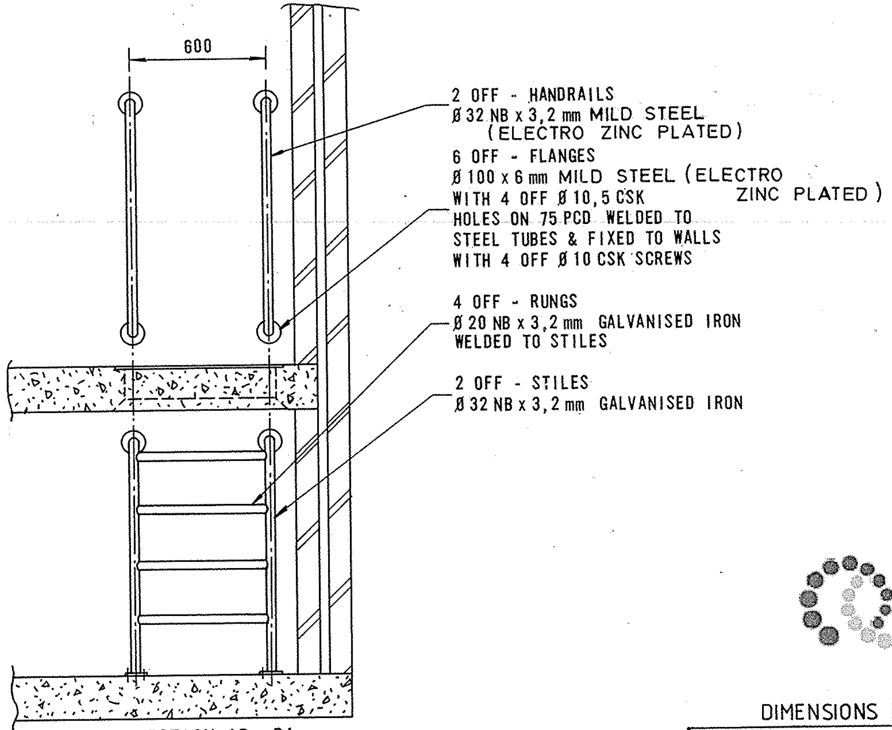
MANHOLE COVER
SCALE 1:20
MATERIAL: TREAD PLATE ALUMINIUM 6 THICK.



LIFTING EYE DETAIL
FULL SCALE



SECTION 'A - A'
SCALE 1:20



SECTION 'B - B'
SCALE 1:20

DO NOT SCALE

Endeavour Energy

DIMENSIONS IN MILLIMETRES

MANHOLE COVER LIFTING HANDLE DETAIL	069526

REFERENCE DRAWINGS

AMENDMENTS

A	ORIGINAL ISSUE		
B	DR'N GLB, CH'D S.G.P., DATE 5-7-85, CH Nº 832	MANHOLE COVER MATERIAL ADDED	MSD. K.M.
C	DR'N WCH, CH'D SGP, DATE 3-12-86, CH Nº 86/392	LIFTING HANDLE DET. ADDED. HANDRAILS WERE GALV. IRON.	MSD
D	DR'N G.M, CH'D D.J.Z., DATE 10/10/89, CH Nº 89/291	MANHOLE COVER MATERIAL WAS STEEL FLOOR PLATE. LIFTING HANDLE ALTERNATIVE MAT'L ADDED.	M.S.D. T.M.
E	DR'N G.I.T., CH'D D.J.Z., DATE 13-11-90, JR Nº 90/35	LIFTING HANDLE DETAIL DELETED	SUB ENG:
F	DR'N J.H., CH'D FM/GF, DATE 27-7-05, JOB No	DRG. FRAME WAS PCC	DSM FM/GAP

SCALE AS SHOWN
APPROVED
DRAWN PNB DESIGN K.M.
CH'KD
CO-ORD D'SERV

DISTRIBUTION SUBSTATIONS
MANHOLE, ACCESS LADDER &
COVER DETAIL
(1200mm HIGH BASEMENT)

P. Thomson
CHIEF ELECT. ENG. DATE 14-9-84

D 53671 F
SHEET No OF SHEETS
B C D E
INDEX REF A4H

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N	F.MAIO
	CH'D	J.Kirk
	DATE	15-12-93
	JR No	930250
REDRAWN. SDI118 WAS TPS1100 WAS 1000. REF DRGS ADDED		
SDM		J.Kirk
C	DR'N	F.MAIO
	CH'D	S.QUINN
	DATE	01-03-95
	JR No	940203
CONDUIT BELLMOUTH NOTE ADDED		
MNSS		S.QUINN
D	DR'N	F.MAIO
	CH'D	JK
	DATE	16-6-97
	JR No	...
SDI105 WAS SDI118. INTEGRAL WAS PROSPECT. HOLEC MD4 SWGR REFERED		
MNSA		JK
E	DR'N	RJH
	CH'D	RJH
	DATE	23-8-99
	JR No	WXD11101
"NOT TO BE USED FOR CONSTRUCTION" REMOVED. REF DRG 250173 WAS 077697. NOTE 1 REVISED.		
MNAS		G.Ford
F	DR'N	GSF
	CH'D	GSF
	DATE	26-11-15
	JR No	-
REDRAWN. ROOM SIZE NOW TO SUIT MORE 4 FUNCTION SW-GR. TRENCH NOW TO DRG 297547		
NSM		C.Grisafulli

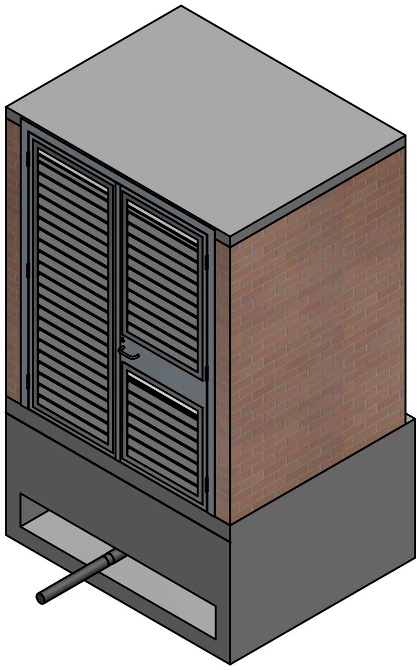
NOTES

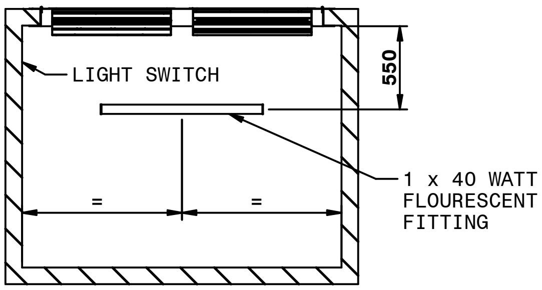
1) THIS DRAWING TO BE READ IN CONJUNCTION WITH MCI0006.

2) CABLE ALCOVE IS TO BE USED WHEN THE BUILDING ALIGNMENT (INCLUDING BELOW GROUND LEVEL FLOORS ETC) IS WITHIN 600 OF THE PROPERTY BOUNDARY. REFER DRG 54738.

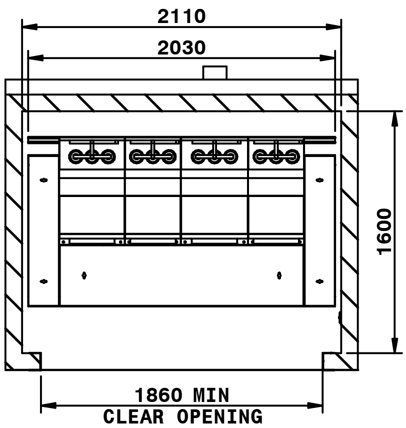
IF BUILDING ALIGNMENT IS FURTHER THAN 600 FROM THE PROPERTY BOUNDARY THEN CONDUITS ARE REQUIRED IN LIEU OF ALCOVE. SEE SECTION A-A-2.

ITEM	QTY	DESCRIPTION	REMARKS

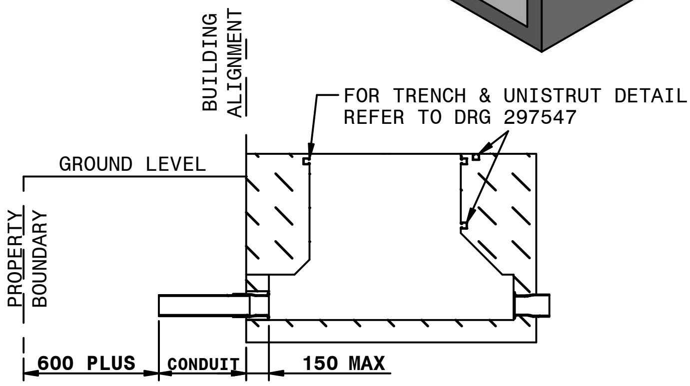




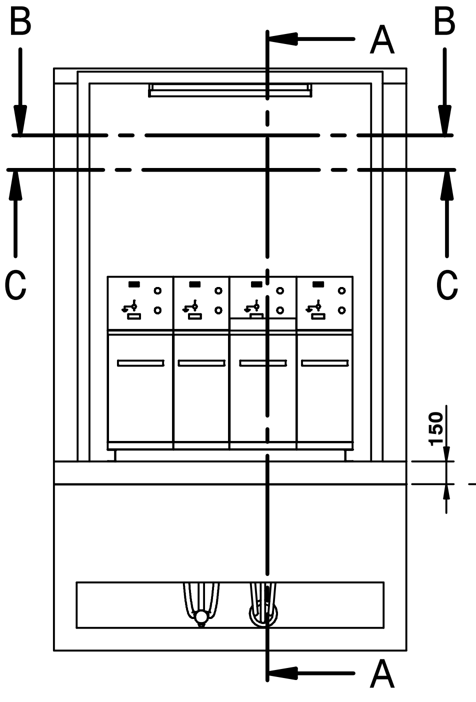
SECTION C-C
LIGHTING REQUIREMENTS



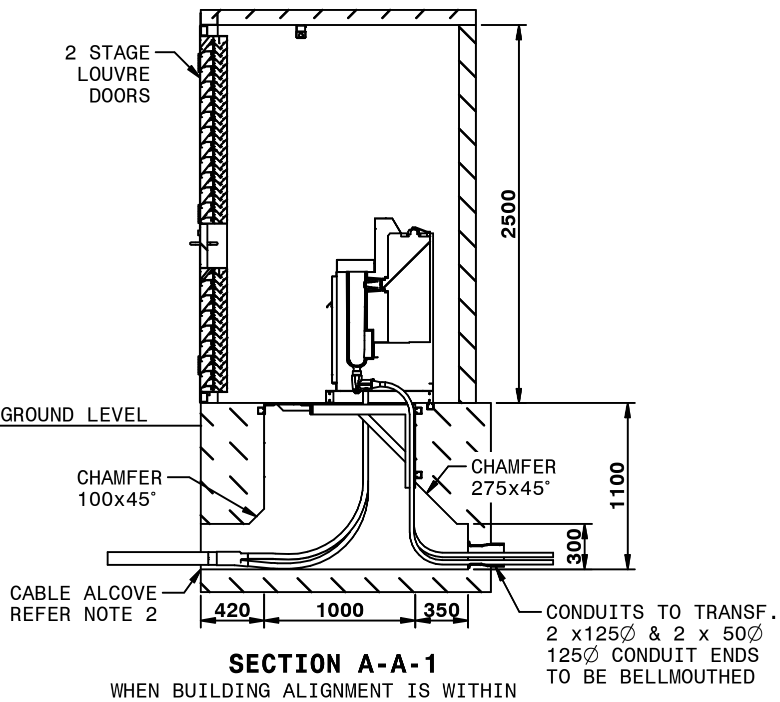
SECTION B-B



SECTION A-A-2
WHEN BUILDING ALIGNMENT IS GREATER THAN 600 FROM THE PROPERTY BOUNDARY AND CONDUITS TO BOUNDARY ARE REQUIRED



ELEVATION
(DOORS REMOVED FOR CLARITY)



SECTION A-A-1
WHEN BUILDING ALIGNMENT IS WITHIN 600 OF THE PROPERTY BOUNDARY

REFERENCE DRAWINGS	
ID DIST SUB TRENCH COVER PLATE & SUPPORT ANGLE DETAIL	297555
ID DIST SUB FLOOR PENETRATION & TRENCH DETAILS FOR HV SW-GR	297547
DIST SUB TYPICAL CABLE ALCOVE	054738

Endeavour Energy

ORIGINAL SCALE	APPROVED
	J. Cook

DRAWN	F. MAIO	
DATE	15-12-93	
CH'D	JK	

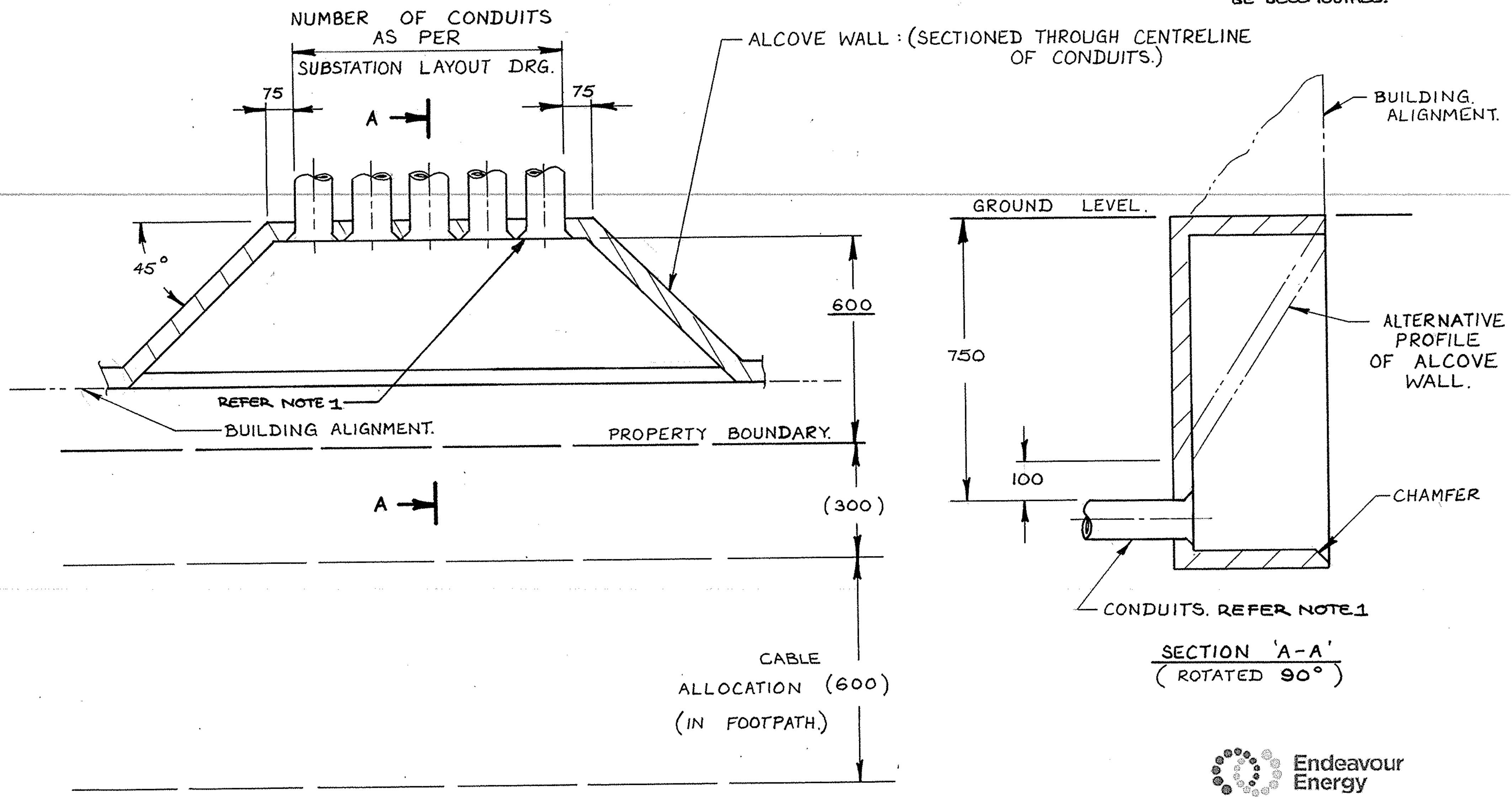
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED
J. N. Allen/JC
G.M. NETWORK 14-01-94

STANDARD LAYOUT FOR HV SWITCHROOM TO SUIT SWITCHING STATION OR SINGLE TRANSFORMER DISTRIBUTION SUBSTATION

A4 053914 F
SHEET No. 1 OF 1

NOTES
1. 125 mm DIA CONDUIT ENDS TO BE BELLMOUTHED.



Endeavour Energy

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

REFERENCE DRAWINGS

AMENDMENTS			
A	ORIGINAL ISSUE		
B	CH No 845.	DR'N P.M. CH'D JK DATE 16.1.95 JRN° 940203	
NOTE 1 ADDED	SDM JK		
C	DR'N J.H. CH'D F.M./C.F. DATE 27.7.05 JOB No	DSM F.M./C.A.P.	DRG. FRAME WAS PCC.

ORIGINAL SCALE 1:10	APPROVED	
DRAWN	W.C.H.	SUBSTN DEVEL'T
CH'KD	D.J.L.	
CO-ORD D'SERV		

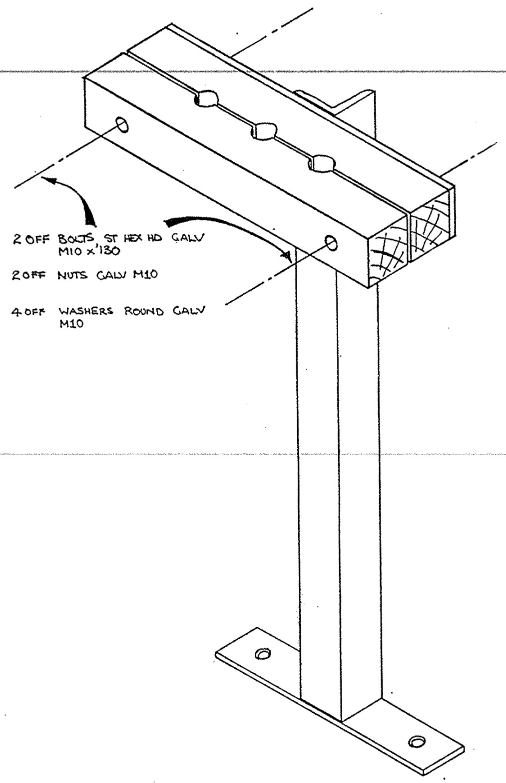
DISTRIBUTION SUBSTATION TYPICAL CABLE ALCOVE DETAIL.

P Thomson
DIRECTOR ENG DATE 20-8-85.

E 54738 A

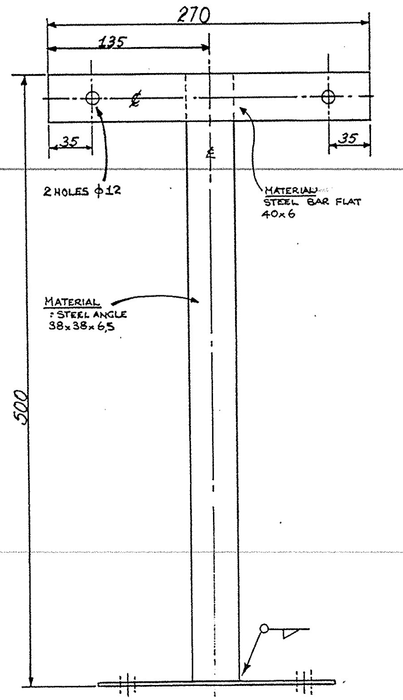
SHEET No OF SHEETS

B C INDEX REF S008A

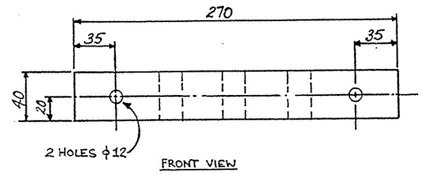


GENERAL VIEW

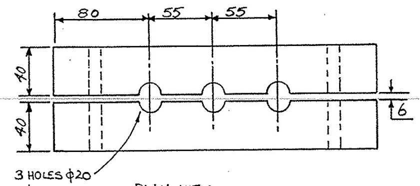
VOCAB Nº: SS17287



FRONT VIEW



FRONT VIEW



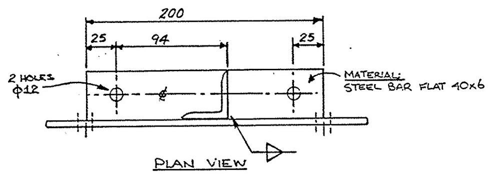
PLAN VIEW

CABLE CLEAT DETAIL

NOTES ① CABLE CLEAT TO BE MADE OF STRAIGHT GRAINED TALLOW WOOD OR APPROVED HARDWOOD FREE OF KNOTS, CRACKS OR DEFECTS OF ANY KIND.

② POSITION 6mm PACKERS IN SLOTS PRIOR TO DRILLING HOLES FOR CABLES.

③ FINISH: WOODWORK TO BE LEFT UNPAINTED



PLAN VIEW

CABLE SUPPORT STAND - ASSEMBLY

NOTE : ALL WELDING TO BE IN ACCORDANCE WITH AS.1554 USING STRUCTURAL GRADE ELECTRODES.
: ASSEMBLY IS TO BE GALVANISED IN ACCORDANCE WITH A.S.1650 AFTER FABRICATION.

Endeavour Energy

NOTES

061736

DO NOT SCALE	DIMENSIONS IN MILLIMETRES
REFERENCE DRAWINGS	
ORIGINAL SCALE	N.T.S
APPROVED	C. Howat
DRAWN	F.M.
CH'D	RSD
SUP D'MAN	
D.B. Britten per cd	
ASSIST. G M ENG.	DATE 16-1-90
A2	61736 A
SHEET No 1 OF 1 SHEETS	
B	INDEX REF S008A

Endeavour Energy

STANDARD DISTRIBUTION SUBSTATION
CABLE STAND 3 x 16 mm^2 X.L.P.E
CONSTRUCTION DETAIL.

AMENDMENTS		J R No.	D'RN	CH'D	DATE	JR No	DSM
A	ORIGINAL ISSUE		J.H.	EJN/GF	27-7-05		FM/GAP
B							

DRG. FRAME WAS PCC.

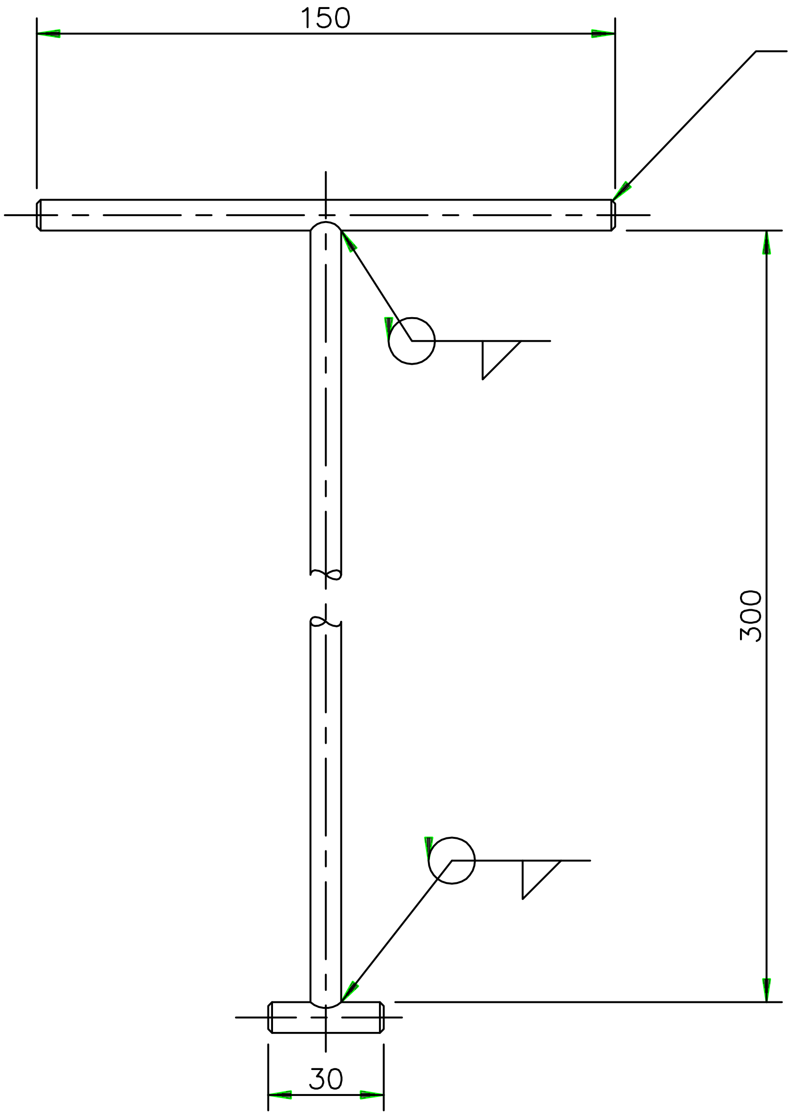
AMENDMENTS	
A	ORIGINAL ISSUE
J R No.	900035

NOTES

1. MATERIAL: BAR STEEL ROUND 8.
   FINISH: HOT DIP GALVANISED AFTER FABRICATION.
   OR
   MATERIAL: BAR ALUMINIUM ROUND 8.
   FINISH: NATURAL.

2. QUANTITY: 2 OFF REQUIRED PER INSTALLATION

3. A SUITABLE CONDUIT SADDLE 38mm (OR SIMILAR) TO BE FITTED TO WALL IN CLOSE PROXIMITY TO MANHOLE OR TRENCH COVER PLATES AT A HEIGHT 1350mm ABOVE FLOOR LEVEL FOR STORAGE OF LIFTING HANDLES.



Endeavour Energy

DRAWN	GIT
DATE	06-12-90
CH'D	D.J.Z

INDOOR DISTRIBUTION SUBSTATION
TRENCH & FLOOR COVER PLATE
LIFTING HANDLE
DETAIL

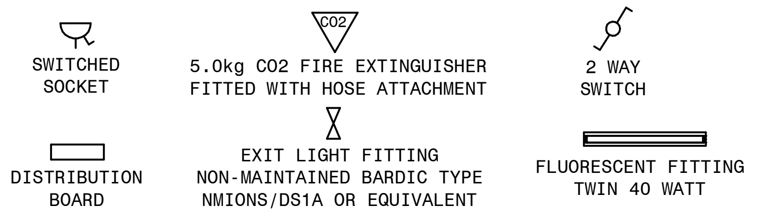
D.B.Britten/CH			
ASSIST. G.M. ENG.		06-12-90	
ORIGINAL SCALE	1:2	APPROVED	C.Howat
A4	069526		A
	SHEET No 1 OF 1 SHEETS		

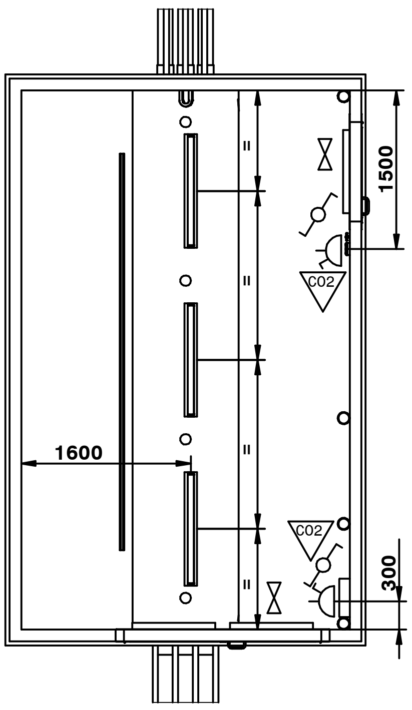
AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N	F.Maio
	CH'D	SQ
	DATE	24-1-96
	JR No	9402303
DIM.S A & B REV. TO SUIT SM6 HV SWGR. NOTE 2 ADDED. REF DRG'S REV. HV TRENCH DTLS REVISED. 1 GPO ADDED. ROOM WAS 3000 WIDE. EXIT LIGHT WAS CIN200NM		
MNSA		SQ
C	DR'N	F.Maio
	CH'D	JK
	DATE	16-6-97
	JR No	...
SDI105 WAS SDI118. INTEGRAL WAS PROSPECT		
MNSA		JK
D	DR'N	RJH
	CH'D	RJH
	DATE	23-8-99
	JR No	WX011223
NOTE 1 & REF DRG No's REVISED. NOTE 3 ADDED. REF DRG 078301 DELETED.		
T.A.M.		G.Ford
E	DR'N	F.Maio
	CH'D	V.M.
	DATE	09/09/03
	JR No	WD4SUBS
DIMENSIONS A&B REVISED. HV SWGR MASS WAS 1500kG.		
DEP		G.F/V.M.
F	DR'N	G.Ford
	CH'D	G.Ford
	DATE	26/11/15
	JR No	..
TRENCH DETAIL NOW TO DRG 297547. NOTE 1 WAS SDI105 NOW MCI0006. REF DRGS UPDATED. DIM 'A' & 'B' REVISED		
NSM		C.Crisafulli

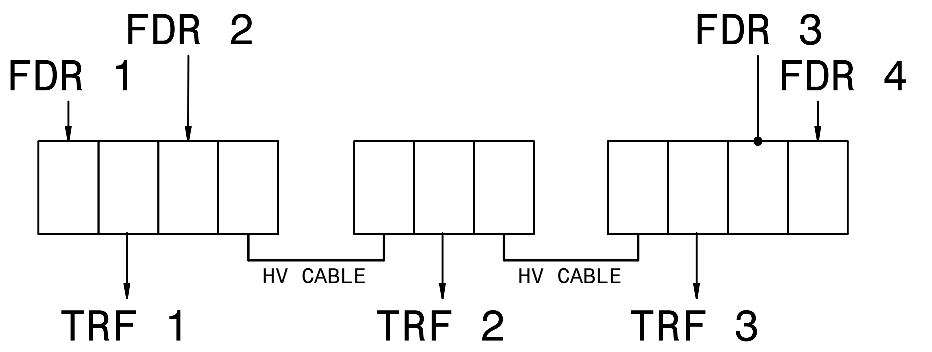
NOTES

1) THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DISTRIBUTION STANDARDS MDI0028 & MCI0006.
2) BUILDER TO GIVE 14 DAYS NOTICE PRIOR TO POURING FLOOR OR BASEMENT SLAB TO ALLOW FOR INSTALLATION OF EARTH GRID.
3) REFER TO INDIVIDUAL HV SWITCHGEAR SUBSTATION DESIGN INSTRUCTION FOR DETAILS OF INSTALLING SWITCHGEAR MOUNTING STEELWORK.
4) ALL CONDUITS TO BE SEALED BY FIRE PROOF SEALANT AT ALL TIMES. CONDUITS TO RUN TO PROPERTY BOUNDARY.
5) SWITCHGEAR BASED ON MAX OF 4 INCOMING FEEDERS FOR 2,3 AND 4 TRF SUBS AND 3 FDRS FOR 1 TRF SUB. A 500mm GAP SHOULD BE MAINTAINED BETWEEN EACH HV SWITCHGEAR TO ALLOW FOR CABBLING AND INSTALLATION.

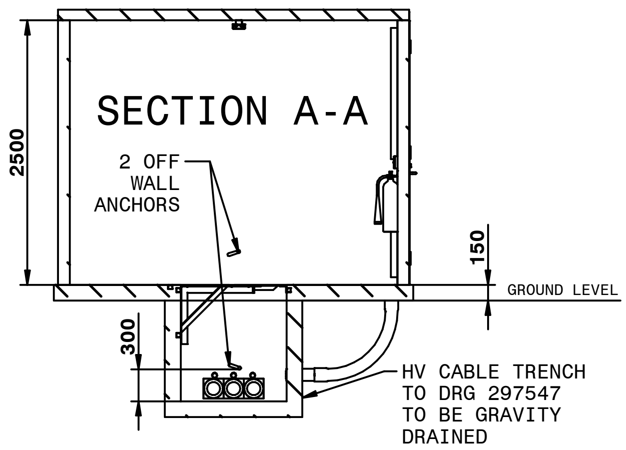
ITEM	QTY	DESCRIPTION	REMARKS







TYPICAL SW/GEAR MODULES FOR 3 TRF SUB



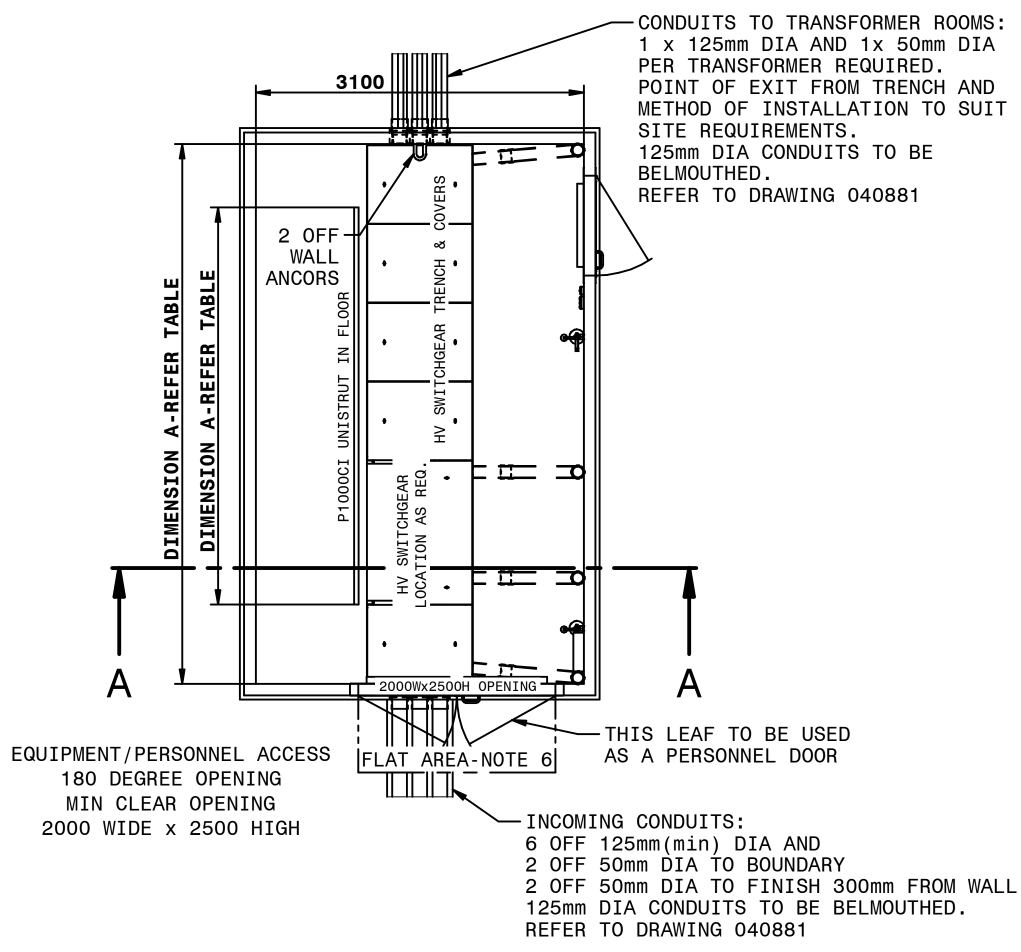


TABLE FOR CALCULATION OF HV SWITCHROOM LENGTH				
MAX NO OF TRF'S TO BE SUPPLIED	ONE	TWO	THREE	FOUR
DIMENSION 'A'	3000	3750	5350	7150
DIMENSION 'B'	4350	5100	6700	8500

MAJOR EQUIPMENT MASS		
HV SWITCHGEAR MODULES	500kg EACH	2500kg MAX

REFERENCE DRAWINGS	
HV SW/GR TRENCH FABR. DETAIL	297556
COVER PLATE & ANGLE FABR. DTL- HV & LV SW/GR	297555
FLOOR PENETRATION & TRENCH DTL - HV & LV SW/GR	297547
CONCRETE WALL ANCHOR FABRICATION DETAIL	040879
REMOVABLE PULLING RING & SOCKET FABR. DTL	040877
INDOOR DIST SUB TYPICAL CONDUIT DETAILS	040881
-	-
-	-

Endeavour Energy

ORIGINAL SCALE	APPROVED J Cook		
DRAWN	F.Maio		
DATE	11/1/94		
CH'D	JKirk		INDEX REF.

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED J.N.Allen/JC
G.M.Network 19/1/94

STANDARD LAYOUT FOR INDOOR HIGH VOLTAGE SWITCHROOM TO SUIT DISTRIBUTION SUBSTATION CONTAINING UP TO FOUR TRANSFORMERS

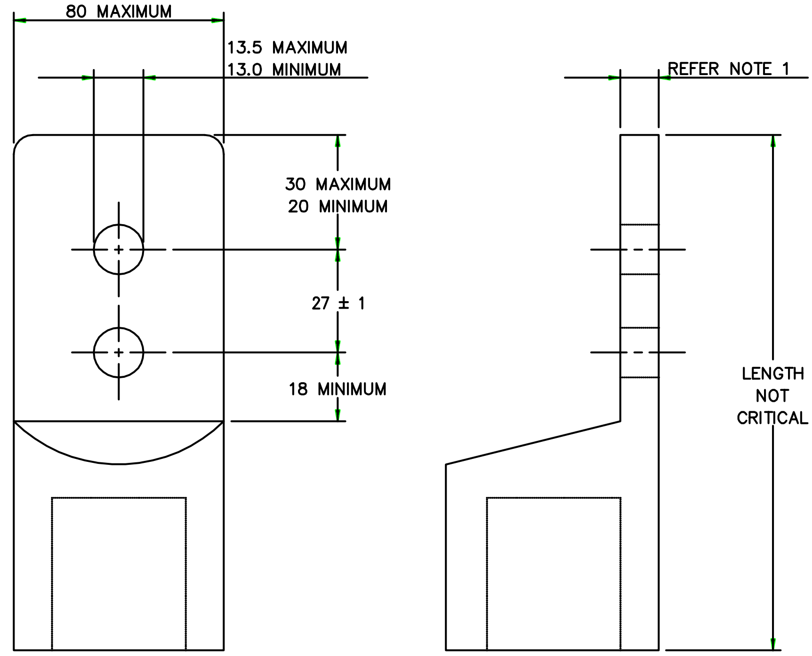
A3 077696 F

SHEET No. 1 OF 1

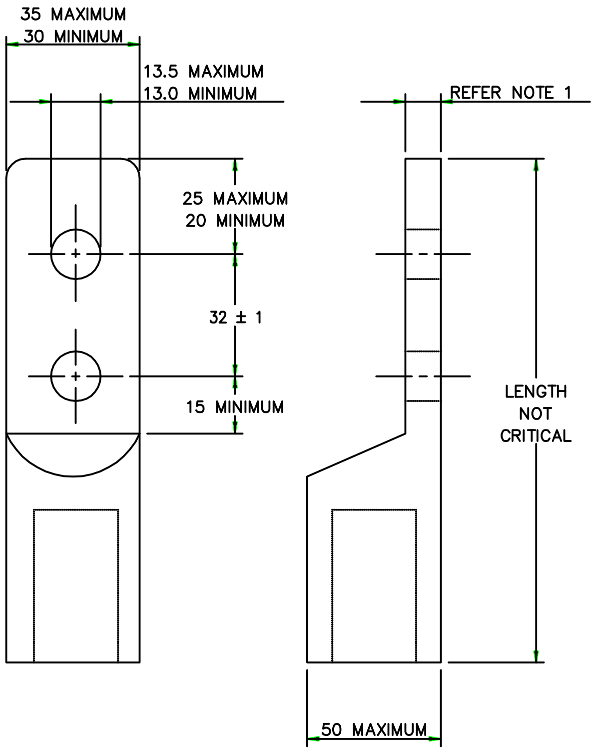
AMENDMENTS		
A	ORIGINAL ISSUE	
J R No.	940145	
B	DR'N	D.J.Z.
	CH'D	J.K.
	DATE	09-1-96
	JR No	960001
NOTE 1 ADDED.		
M.S.S.	J.K.	

NOTES

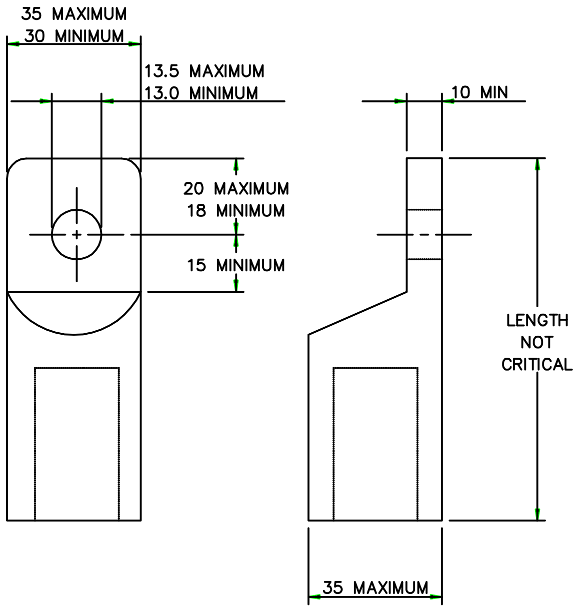
1. THE CURRENT RATING OF THE LUG SHALL BE EQUIVALENT TO THE CURRENT RATING OF THE CABLE/S TO A MAXIMUM 1400 AMPS.
ALL DISTRIBUTION SWITCHGEAR WILL ACCEPT BOTH ALUMINIUM OR COPPER CABLES.



CIRCUIT BREAKER CABLE LUG
MAXIMUM SIZE CABLE – 630mm²
MAXIMUM No PER PHASE – 4 OFF



FEEDER FUSED DISCONNECTOR
CATEGORY 2 CABLE LUG
MAXIMUM SIZE CABLE – 240mm²
MAXIMUM No PER PHASE – 2 OFF



FEEDER FUSED DISCONNECTOR
CATEGORY 1 CABLE LUG
MAXIMUM SIZE CABLE – 240mm²
MAXIMUM No PER PHASE – 2 OFF

Endeavour Energy

REFERENCE DRAWINGS	DRG. NO.	THIS ISSUE PAGE NO

ORIGINAL SCALE	NONE	
APPROVED	C.Howat	
DRAWN	D.J.Z.	
DATE	27-9-94	
CH'D	D.J.Z.	

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

C.Howat
SUBSTATION DEVELOPMENT MGR 12-10-94

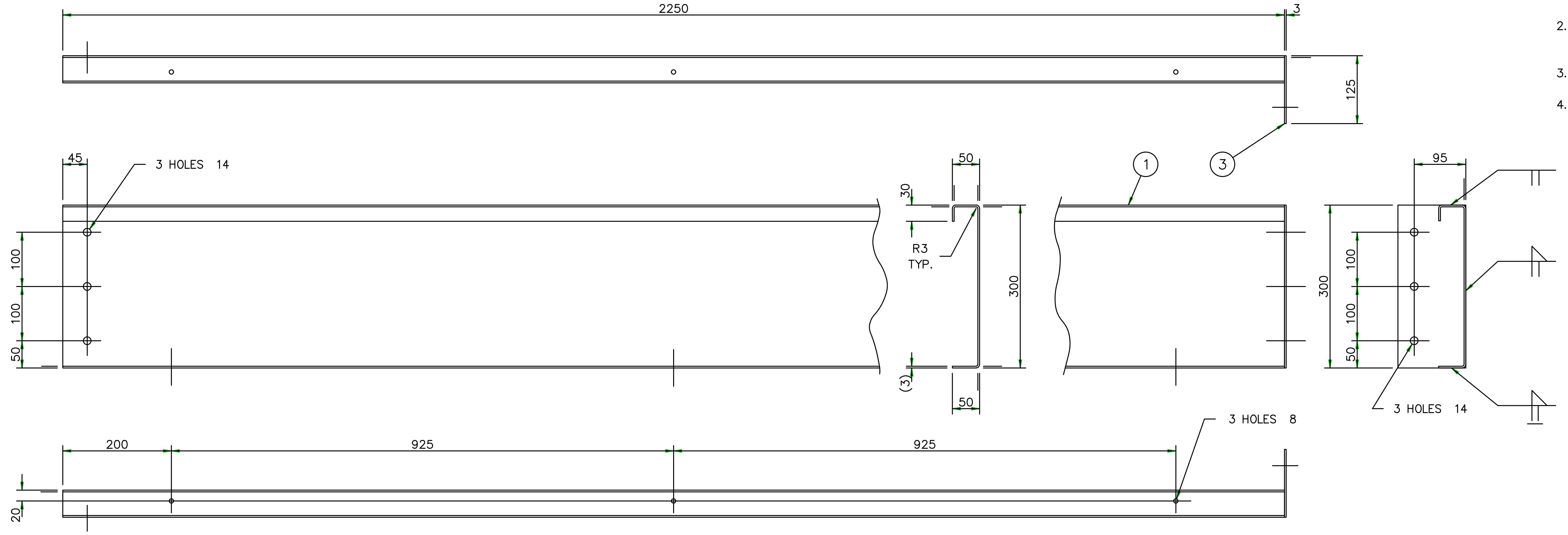
LOW VOLTAGE EQUIPMENT
CABLE LUG
CRITICAL DIMENSIONS

SUB 078239 B
SHEET No 1 OF 1 SHEETS
INDEX REF S008A

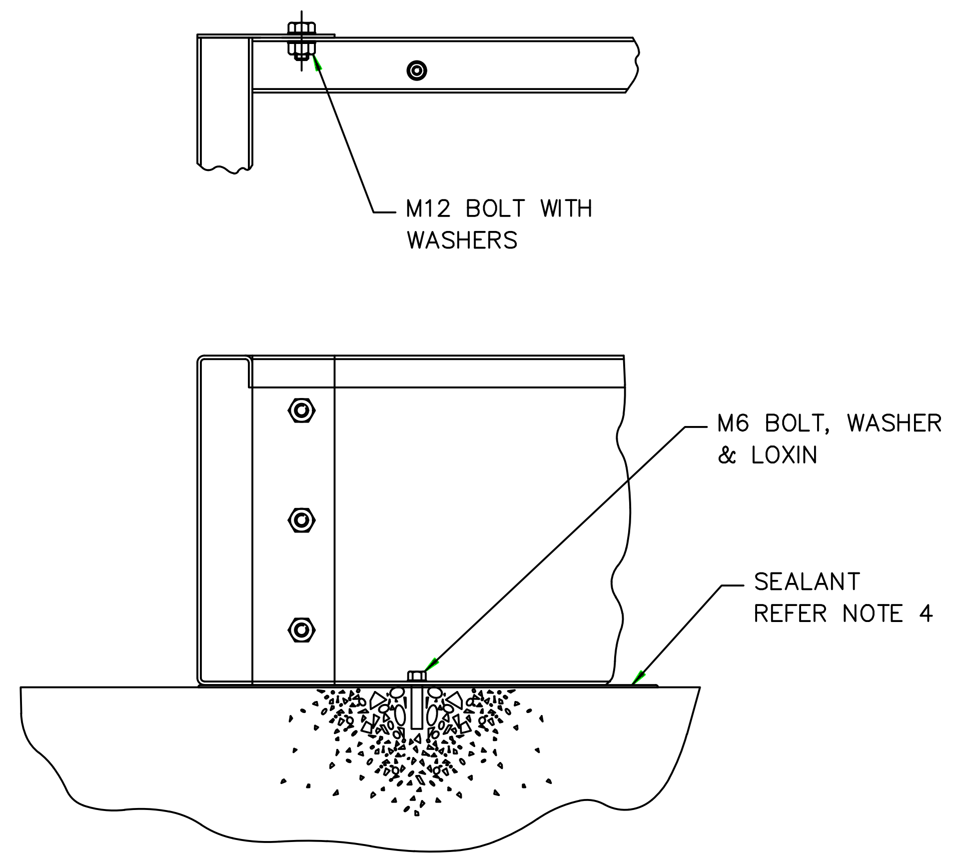
ISSUE IDENTIFICATION
THIS ISSUE
PAGE NO.

NOTES

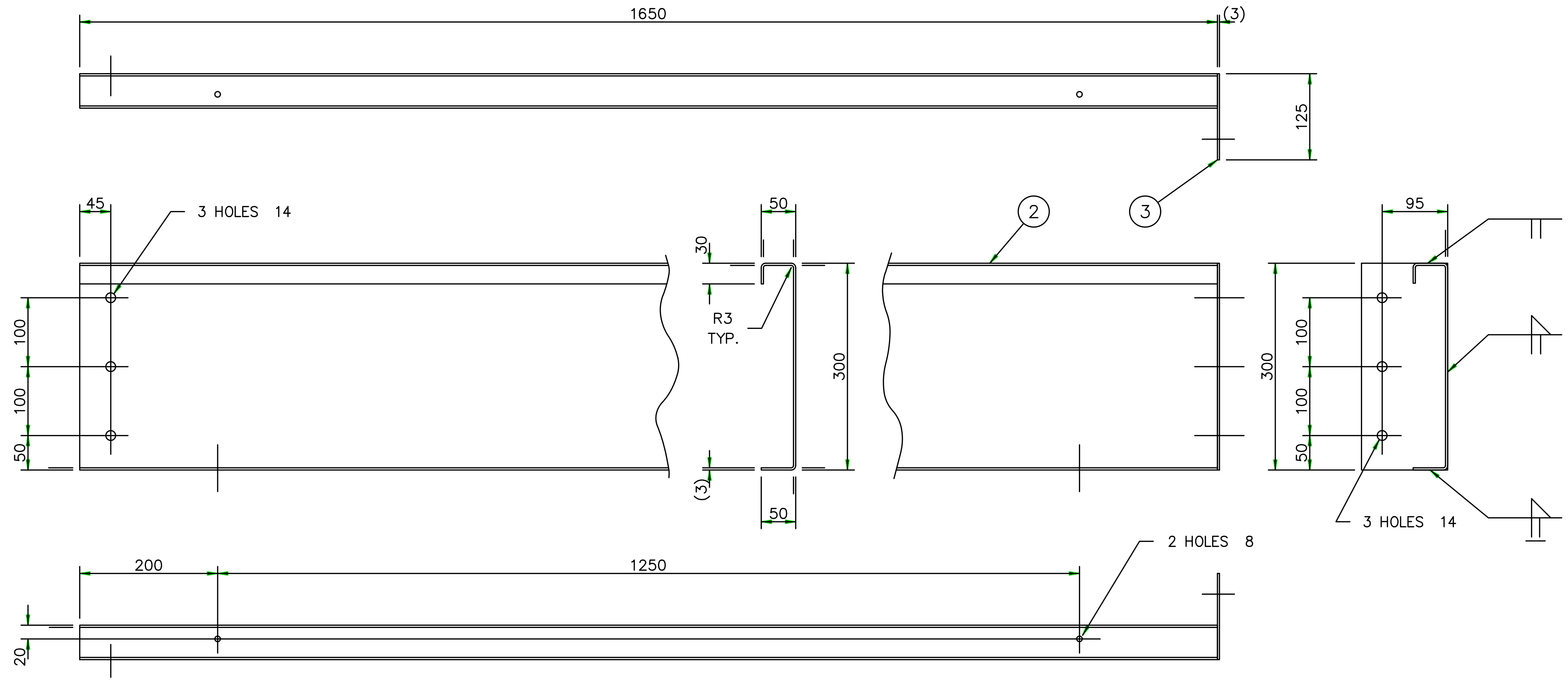
1. TOLERANCES UNLESS OTHERWISE STATED:
   - HOLE DIMENSIONS ± 0.5mm.
   - LINEAR DIMENSIONS UP TO 50mm ± 1.5mm.
   - LINEAR DIMENSIONS OVER 50mm ± 5% UP TO A MAXIMUM OF 5mm.
2. WELDING SYMBOLS COMPLY WITH AS1101 PART 3 1987.
   WELDING TO BE IN ACCORDANCE WITH AS1554 PART 1 1991.
3. PAINT ALL BARE METAL SURFACES WITH COLD GALVANISING PAINT.
4. INSTALLATION INSTRUCTIONS:
   REFER TO THE INDOOR DISTRIBUTION SUBSTATION BUND INSTALLATION INSTRUCTION FOR THE SEALANT TYPE AND METHOD OF INSTALLING THIS BUND.



BARRIER L DETAIL
SCALE: 1:5



BUNDWALL CORNER ASSEMBLY
SCALE: 1:5



BARRIER S DETAIL
SCALE: 1:5

ITEM	PART	DRG	DESCRIPTION	QTY	REMARK
1	–	–	SHEET STEEL GALVABOND 3 x 425 x 2250 LG.	2	–
2	–	–	SHEET STEEL GALVABOND 3 x 425 x 1650 LG.	2	–
3	–	–	SHEET STEEL GALVABOND 3 x 125 x 300 LG.	4	–

AMENDMENTS

A	ORIGINAL ISSUE	J R No. NA				
B	DR'N B.G.H	CH'D JK	DATE 20-10-98	JR No GZ911100	2500 WAS 1550 GR-E4 2100 WAS 1050 GR-G4 2950 WAS 2050 GR-A4 3 HOLES AT 1275 CTRS WAS 2 HOLES AT 1650 CTRS GR-C4	MNSA JK
C	DR'N RJH	CH'D RJH	DATE 14-8-99	JR No WX011223	DIM 2250 WAS 2950. DIM 1650 WAS 2500.	MNAT JK

Endeavour Energy

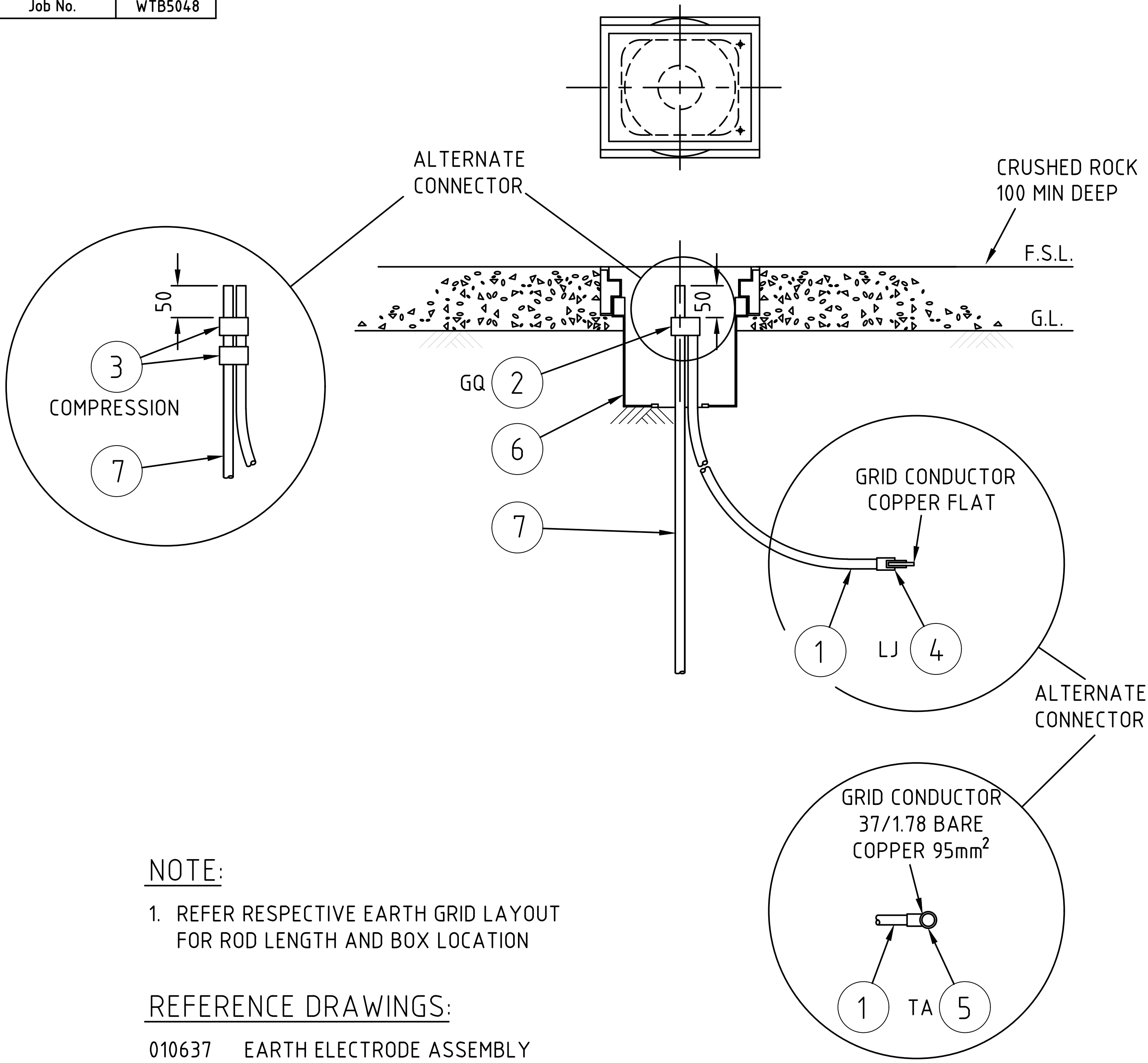
ORIGINAL SCALE AS NOTED	APPROVED J.Kirk	DO NOT SCALE DIMENSIONS IN MILLIMETRES	AUTHORISED Michael Tamp/JC
DRAWN	B.G.H	REFERENCE DRAWINGS	MGR NETWORK SUBS ASSETS 02-01-97
DATE	30-12-96		
CH'D	G.P.S.		

INDOOR DISTRIBUTION SUBSTATION
DEMOUNTABLE BUNDWALL
FABRICATION DETAIL

A1 240118 C

SHEET No 1 OF 1 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE
Job No.	WTB5048



NOTE:

1. REFER RESPECTIVE EARTH GRID LAYOUT FOR ROD LENGTH AND BOX LOCATION

REFERENCE DRAWINGS:

010637 EARTH ELECTRODE ASSEMBLY

ITEM	DESCRIPTION
1	CONDUCTOR – 37/1.78 BARE OR COVERED COPPER 95mm²
2	CADWELD – ERICO TYPE GQ
3	COMPRESSION CONNECTOR – BURNDY STYLE YGHC
4	CADWELD – ERICO TYPE LJ
5	CADWELD – ERICO TYPE TA
6	INSPECTION PIT – ERICO PIT03
7	EARTH ELECTRODE – Ø15 x LENGTH INDICATED ON RESPECTIVE EARTH GRID DRG

Endeavour Energy

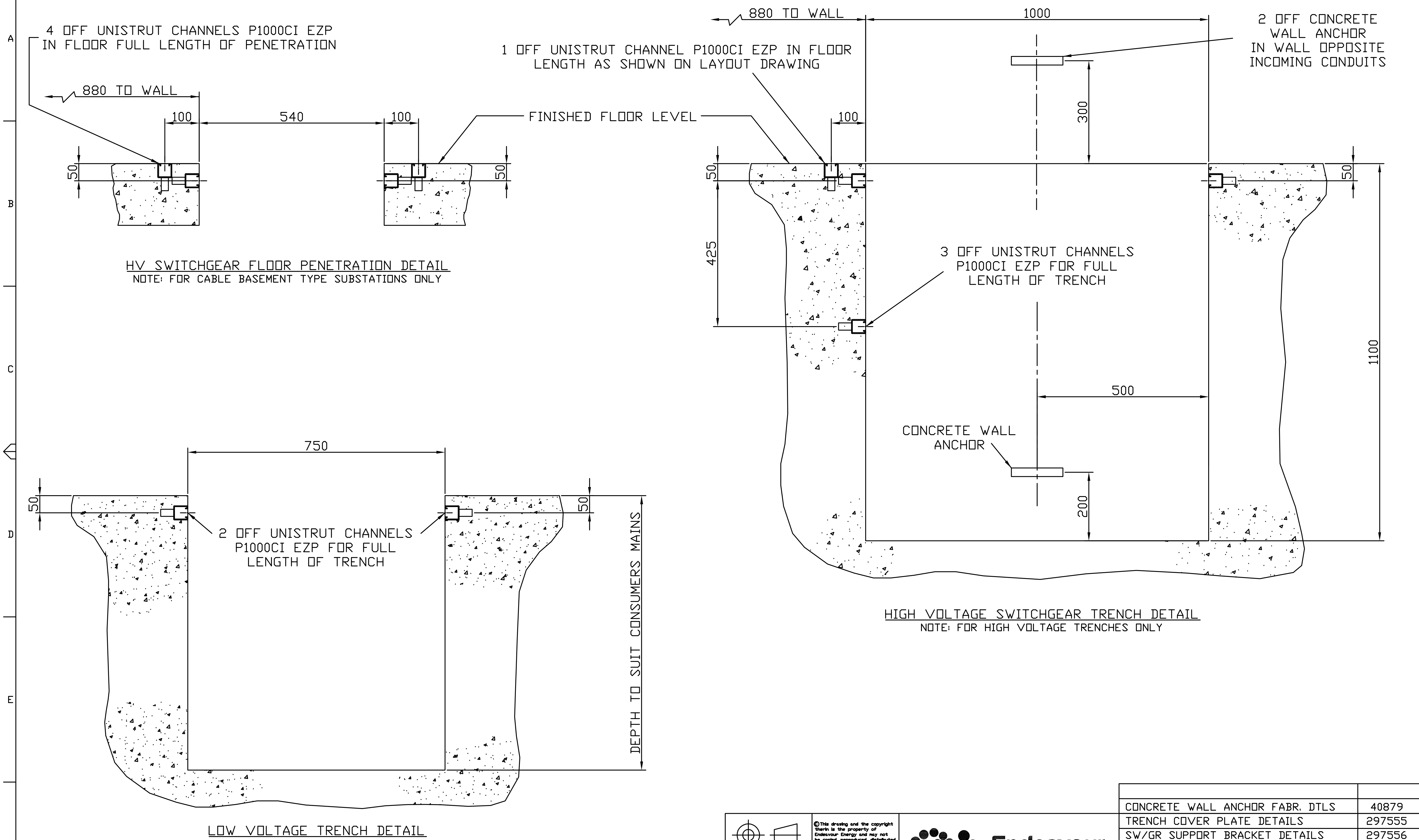
DRAWN	BF
DATE	08.12.04
CH'D	JMcD

SUBSTATION
EARTH STAKE PROTECTION BOX
15mm ROD
ARRANGEMENT

ORIGINAL SCALE NTS	APPROVED D.Asvestas/GST
MGR TRANSMISSION CAP PROJECTS	14.04.05

A4 | 292712 | A

SHEET No 1 OF 1 SHEETS



REFERENCE DRAWINGS	
CONCRETE WALL ANCHOR FABR. DTLS	40879
TRENCH COVER PLATE DETAILS	297555
SW/GR SUPPORT BRACKET DETAILS	297556

AMENDMENTS: A ORIGINAL ISSUE

ORIGINAL SCALE

APPROVED: G. Ford

DRAWN	G. Ford		
DATE	20-07-2005		
CH'D	G. Ford		INDEX REF. S002A

Endeavour Energy

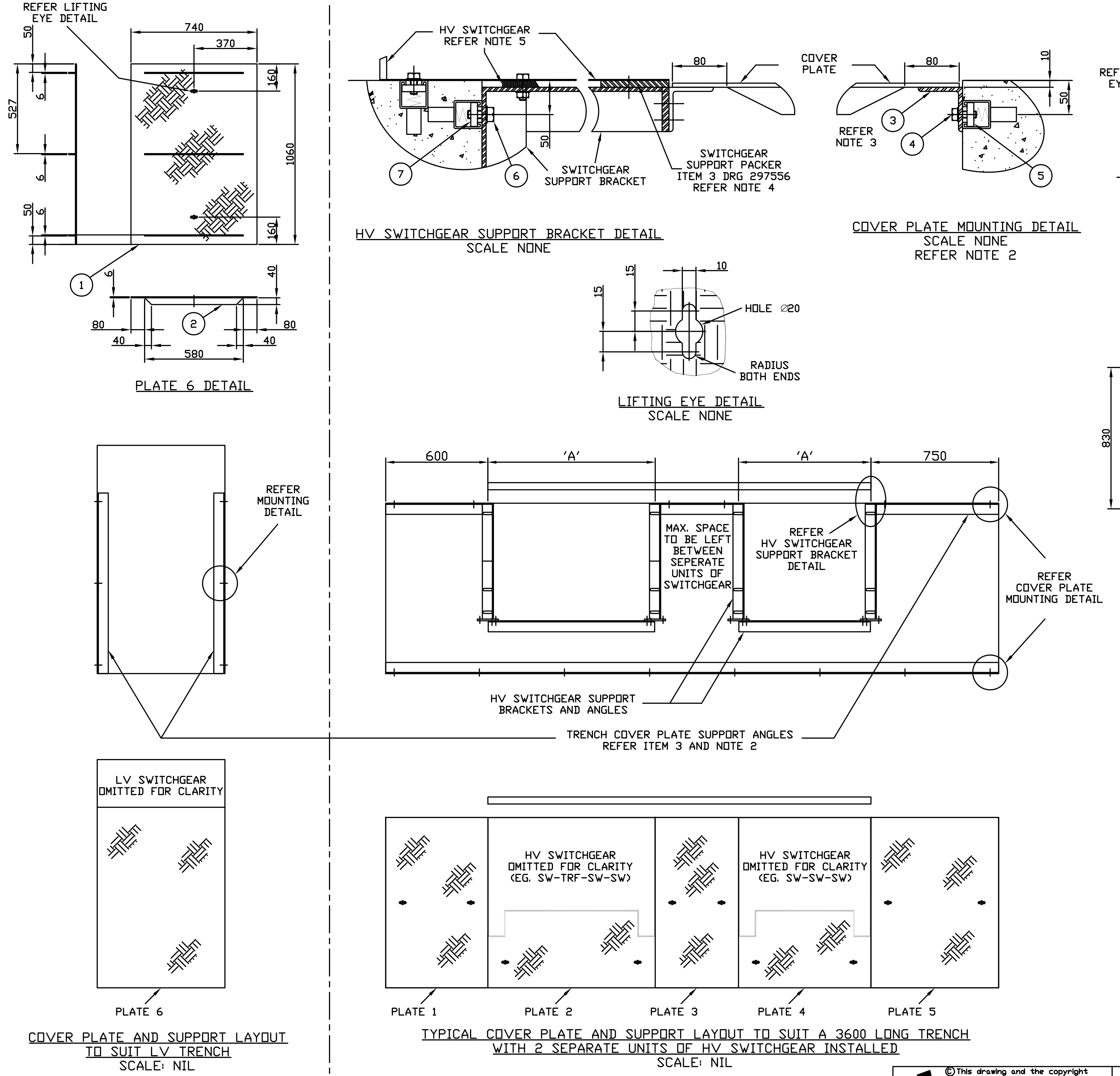
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

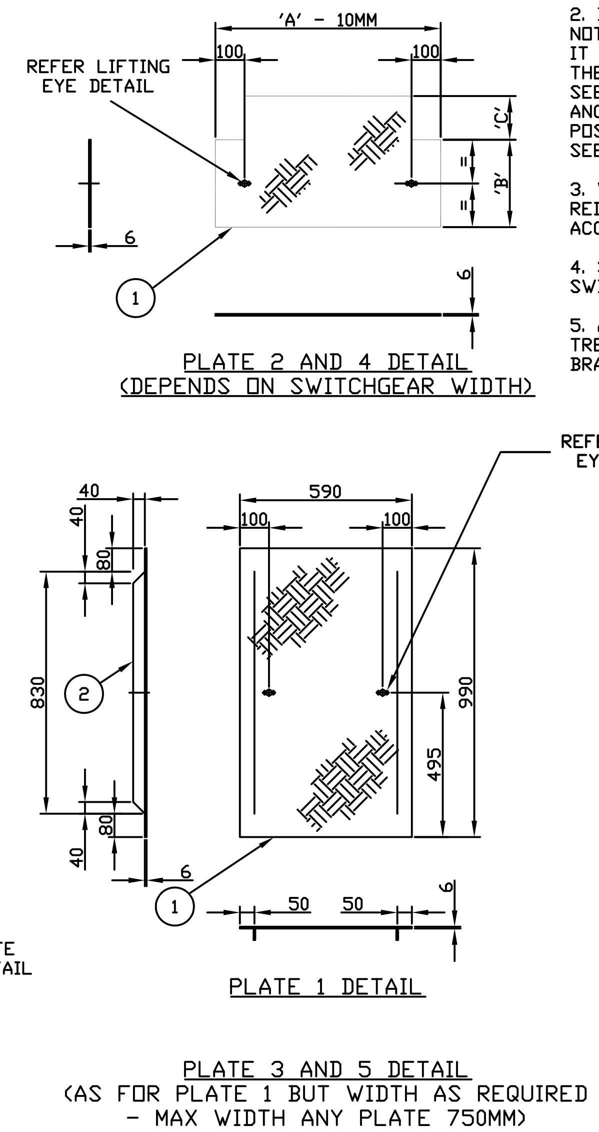
AUTHORISED: W. Isley
MANAGER ASSET ENGINEERING 20-07-2005

INDOOR DISTRIBUTION SUBSTATION
FLOOR PENETRATION AND TRENCH DETAILS
FOR HV AND LV SWITCHGEAR

A3 297547 A

SHEET No 1 OF 1 SHEETS





NOTES

1. ALL WELDED CONSTRUCTION TO BE USED IN ACCORDANCE WITH AS1665.

2. ITEM 3 TO BE HOT DIP GALVANISED AFTER FABRICATION. NOTE, THIS ITEM IS REQUIRED ON BOTH SIDES OF TRENCH. IT IS NOT REQUIRED FOR THE SECTION OF TRENCH WHERE THE SWITCHGEAR IS TO BE MOUNTED. SEE EXAMPLE. ANGLES TO BE BOLTED AT 500mm CENTRES MAXIMUM WHERE POSSIBLE. SEE MOUNTING DETAIL DELOW.

3. WHERE FEWER UNITS OF SWITCHGEAR ARE REQUIRED REDUCE QUANTITY OF PLATE 2 AND ADD PLATE 3 ACCORDINGLY.

4. SWITCHGEAR SUPPORT PACKER ONLY REQUIRED WHEN SWITCHGEAR SITS ON CONCRETE AT REAR OF TRENCH.

5. ALL SWICHGEAR TO SIT ON CONCRETE AT REAR OF TRENCH EXCEPT SAFELINK WHICH SITS FULLY ON SUPPORT BRACKETS.

QUANTITIES	
PLATE 1	
PLATE 2	
PLATE 3	
PLATE 4	
PLATE 5	
PLATE 6	

TYP. SW/GEAR DIMENSIONS			
BRAND	'A'	'B'	'C'
SM6	375	300	0
SVS	420	430	0
SAFELINK 3 FUNCTION	775	320	150
SAFELINK 4 FUNCTION	980	320	150
RM6 3 FUNCT.	1186	410	0
RM6 4 FUNCT.	1619	410	0
8DJH-SFS	1050	410	0
8DJH-SFSS	1360	410	0
8DJH-SSS	930	410	0
8DJH-SSSS	1240	410	0
-	-	-	-

MARKED UP FOR PROPOSED SUBSTATION AT:

ITEM NO	VOCAB /DRG	DESCRIPTION	QTY	REFER
1	N/A	TREADPLATE ALUMINIUM 6mm x WIDTH & LENGTH TO SUIT	AR	-
2	N/A	BAR ALUMINIUM FLAT 40 x 6 x LENGTH TO SUIT	AR	-
3	N/A	ANGLE STEEL 65 x 65 x 6 x LENGTH TO SUIT	AR	NOTE 2
4	N/A	BOLT STEEL HEX HD GALV M10 x 35 LG	AR	-
5	N/A	NUT UNISTRUT SPRING LOADED P1008 M10	AR	-
6	N/A	BOLT STEEL HEX HD GALV M12 x 35 LG	AR	-
7	N/A	NUT UNISTRUT SPRING LOADED P1008 M12	AR	-

REFERENCE DRAWINGS	
COVER PLATE LIFTING HANDLE DETAIL	69526
SW/GR SUPPORT DRACKET DETAIL	297556
HV AND LV SW/GR TRENCH DETAIL	297547

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

ORIGINAL SCALE

		APPROVED
DRAWN	G. Ford	G. Ford
DATE	08/07/2005	
CH'D	G. Ford	INDEX REF. S008A

INTEGRAL ENERGY

INDOOR DISTRIBUTION SUBSTATION
STANDARD SWITCHGEAR TRENCH
COVER PLATE AND SUPPORT ANGLE FABRICATION
WITH INSTALLATION DETAILS

AUTHORISED
W. Isley
MANAGER ASSET ENGINEERING 08/07/2005

A3 297555 C

SHEET No 1 OF 1 SHEETS

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N G5F; CH'D G5F; DATE 14-04-07; JR No --	REDRAWN TO ACCOMODATE PADMOUNT STYLE HV SWITCHGEAR. DSM
C	DR'N G5F; CH'D G5F; DATE 14-07-15; JR No --	SIEMENS 8DJH DETAIL ADDED. NSM C.Crisafulli

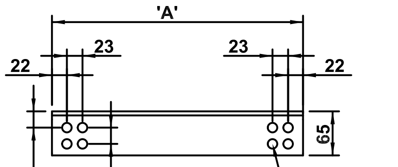
AMENDMENTS	
A	ORIGINAL ISSUE
B	DR'N G.S.F. / CH'D G.S.F. / DATE 14-04-07 / JR No N/A
MODIFIED TO ALLOW STD PADMOUNT SWITCHGEAR TO BE USED ON ID SUBS.	
DSM	GSF
C	DR'N G.S.F. / CH'D G.S.F. / DATE 06-07-15 / JR No N/A
NOTE 4 ADDED. SW/GR BRANDS INCREASED. TOP VIEW DIMENSIONS REVISED.	
NSM	C.Crisafulli

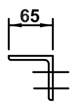
NOTES
1) ALL DIMENSIONS IN MILLIMETRES.
2) WELDED CONSTRUCTION THROUGHOUT. ALL WELDS TO COMPLY WITH AS1554.1.
3) COMPLETE ITEMS TO BE HOT DIP GALVANISED AFTER FABRICATION.
4) CHECK SWITCHGEAR AND DIMENSION 'A' BEFORE FABRICATION. SWITCHGEAR TO SIT ON HALF THE WIDTH OF THE FRAME WITH THE CHECKERPLATE (OR NEXT SWITCH) TO SIT ON THE OTHER HALF.

ITEM	QTY	DESCRIPTION	REMARKS

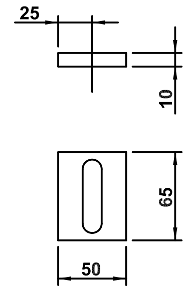
MARKED UP FOR PROPOSED SUBSTATION AT:

QUANTITIES	
ITEM 1	
ITEM 2	
ITEM 3	

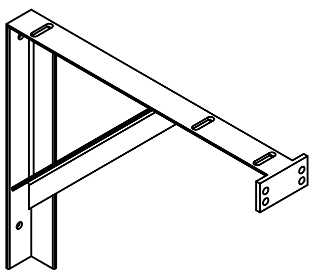


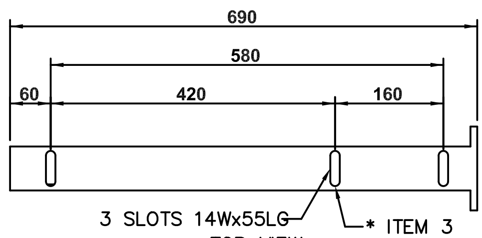


ITEM 2
MATERIAL: 65x65x6.5 STEEL ANGLE
8 OFF HOLES MAY BE SLOTS OF SAME SIZE

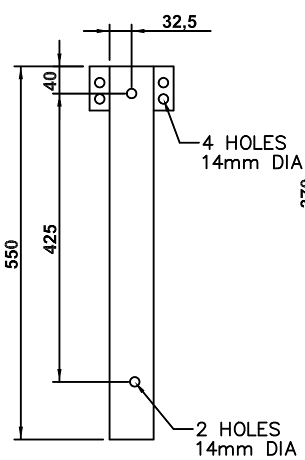


ITEM 3
MATERIAL: 50x65x6.5 MILD STEEL
*–SPACER MOUNTS HERE WHEN SWITCHGEAR
SITS ON CONCRETE AT REAR

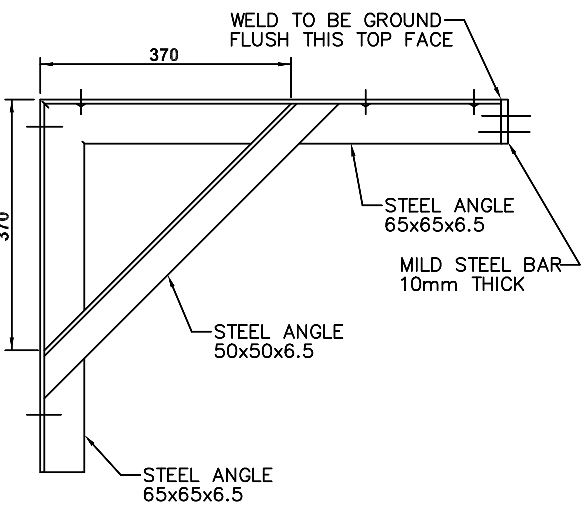




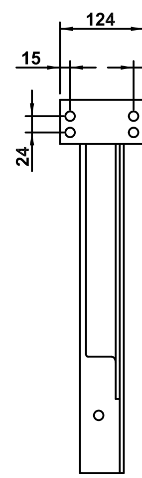
TOP VIEW



REAR VIEW



SIDE VIEW



FRONT VIEW

ITEM 1

SWITCHGEAR (REFER NOTE 4)	
BRAND	'A'
SM6	370
SVS	370
SAFELINK 3 FUNCT.	772
SAFELINK 4 FUNCT.	969
RM6 3 FUNCT.	1170
RM6 4 FUNCT.	1605
8DJH-SFS	1046
8DJH-SFSS	1360
8DJH-SSS	930
8DJH-SSSS	1240

Endeavour Energy

REFERENCE DRAWINGS	
~~HV & LV SW/GR TRENCH DETAIL~~	297547
~~COVER PLATE & SUPPORT ANGLE DT~~	297555

ORIGINAL SCALE — APPROVED: G. Ford

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED: W. Isley — MANAGER ASSET ENGINEERING 08/07/05

DRAWN	G. Ford
DATE	08/07/05
CH'D	G. Ford

INDEX REF. S008A

INDOOR DISTRIBUTION SUBSTATION
STANDARD 11/22KV SWITCHGEAR
TRENCH MOUNTING SUPPORT BRACKET
FABRICATION DETAIL

A4 297556 C

SHEET No. 1 OF 1

AMENDMENTS	
A	ORIGINAL ISSUE
B	DR'N G.S.F; CH'D G.S.F; DATE 04-01-16; JR No --
NOTE 1 WAS SDI105 NOW MDI0028. NOTE 3 AMENDED NOTE 5&6 ADDED.	
NSM	C.Crisafulli

NOTES

1) THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DISTRIBUTION STANDARDS MDI0028 & MCI0006.

2) BUND WALLS TO BE ERECTED AS PER STANDARD AFTER INSTALLATION OF OIL/FLUID FILLED TRANSFORMERS.

3) VENTILATORS ARE SHOWN IN TYPICAL LOCATIONS ONLY. VENTILATORS IN WALLS ADJACENT TO HV SWITCHGEAR SHALL BE INSTALLED 2000mm ABOVE FLOOR LEVEL.

4) REFER TO INDIVIDUAL HV SWITCHGEAR SUBSTATION DESIGN INSTRUCTION FOR DETAILS OF INSTALLING SWITCHGEAR MOUNTING STEELWORK.

5) ALL CONDUITS TO BE SEALED BY FIRE PROOF SEALANT AT ALL TIMES. CONDUITS TO RUN TO PROPERTY BOUNDARY.

6) A FLAT AREA AT LEAST 1.5m DEEP x 1.5m WIDE TO SUPPORT 5 TONNES IS REQUIRED IN FRONT OF EQUIPMENT LOADING DOORS TO ALLOW THE TRANSFORMER TO BE SET DOWN AFTER UNLOADING FROM THE TRUCK.

ITEM	QTY	DESCRIPTION	REMARKS

SWITCHED SOCKET

C02 5.0kg CO2 FIRE EXTINGUISHER FITTED WITH HOSE ATTACHMENT

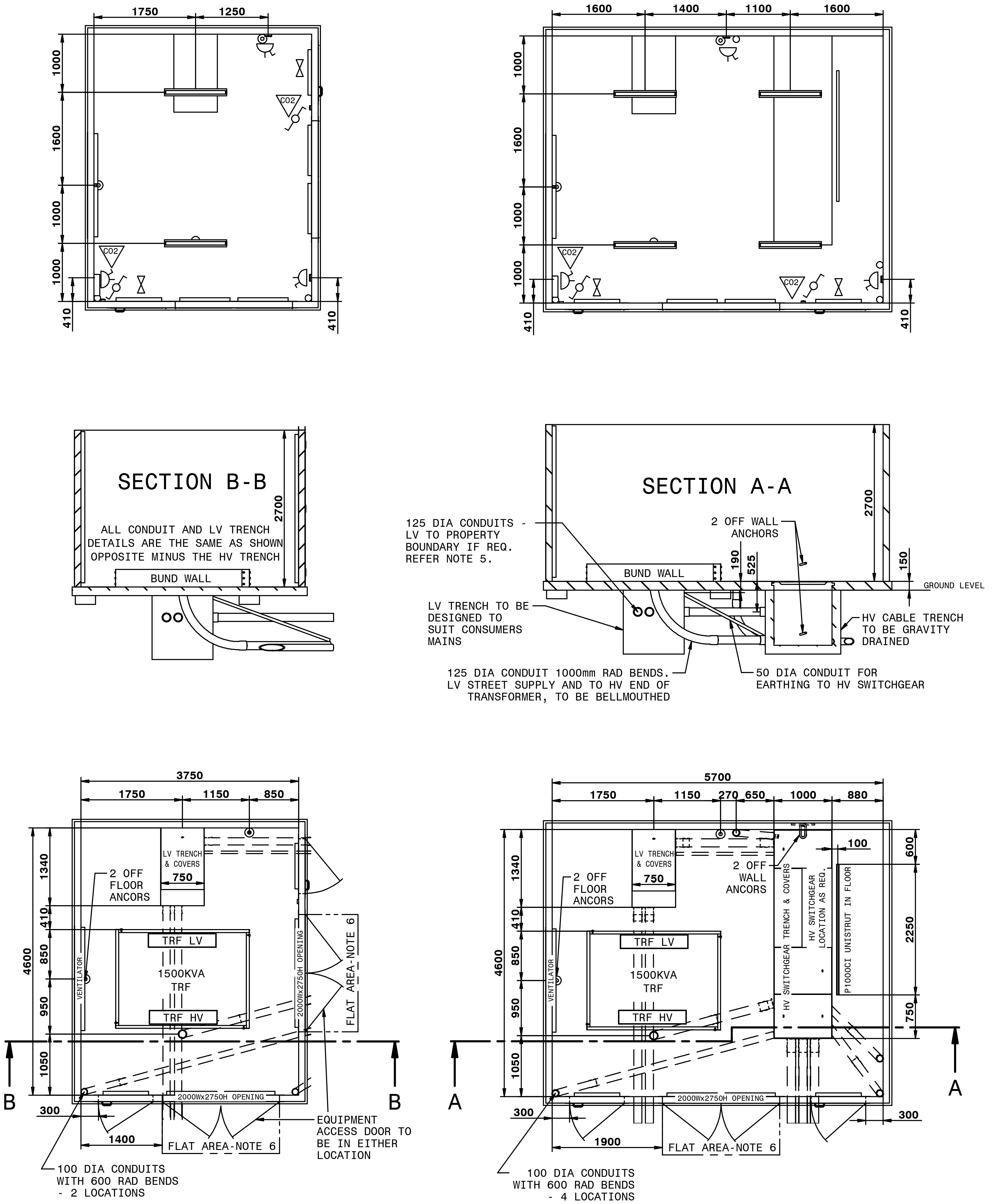
2 WAY SWITCH

PULLING RING

DISTRIBUTION BOARD

EXIT LIGHT FITTING NON-MAINTAINED BARDIC TYPE NMIONS/DS1A OR EQUIVALENT

FLUORESCENT FITTING TWIN 40 WATT



MAJOR EQUIPMENT MASS	
HV SWITCHGEAR MODULES	500kg EACH
POWER TRANSFORMER	5000kg EACH

REFERENCE DRAWINGS	
HV SW/GR TRENCH FABR. DETAIL	297556
COVER PLATE & ANGLE FABR. DTL- HV & LV SW/GR	297555
FLOOR PENETRATION & TRENCH DTL - HV & LV SW/GR	297547
CONCRETE WALL ANCHOR FABRICATION DETAIL	040879
REMOVABLE PULLING RING & SOCKET FABR. DTL	040877
INDOOR DIST SUB TYPICAL CONDUIT DETAILS	040881
-	-

Endeavour Energy

ORIGINAL SCALE	APPROVED G. Ford
DRAWN	G. Ford
DATE	20/07/05
CH'D	G. Ford

INDEX REF S001A

STANDARD LAYOUT FOR A SINGLE TRANSFORMER INDOOR DISTRIBUTION SUBSTATION WITH & WITHOUT HV AND LV TRENCHES TO SUIT UPTO 1500KVA DRY OR OIL FILLED TRANSFORMERS

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED W. Isley
MANAGER ASSET ENGINEERING 20/07/05

A3 297557 B

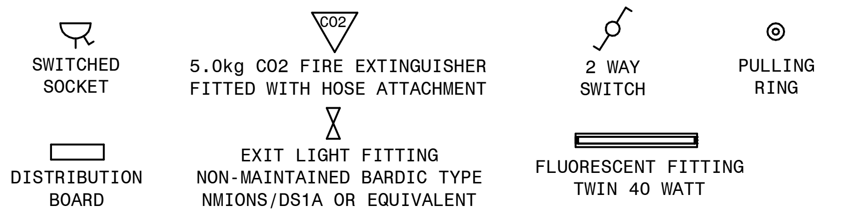
SHEET No. 1 OF 1

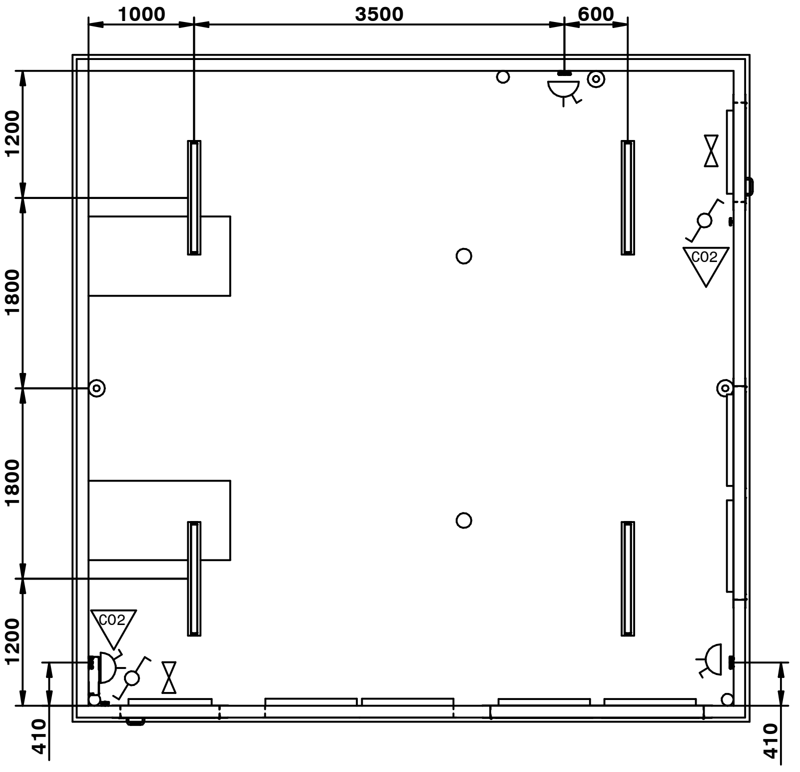
AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N	G.S.F
	CH'D	G.S.F
	DATE	30-11-05
	JR No	--
WIDTH OF ROOM WITHOUT SW/GEAR WAS 7600 NOW 6100		
DSM	G.S.F	
C	DR'N	G.S.F
	CH'D	G.S.F
	DATE	04-01-16
	JR No	--
NOTE 1 WAS SDI105 NOW MDI0028. NOTE 3 AMENDED NOTE 5&6 ADDED.		
NSM	C.Crisafulli	

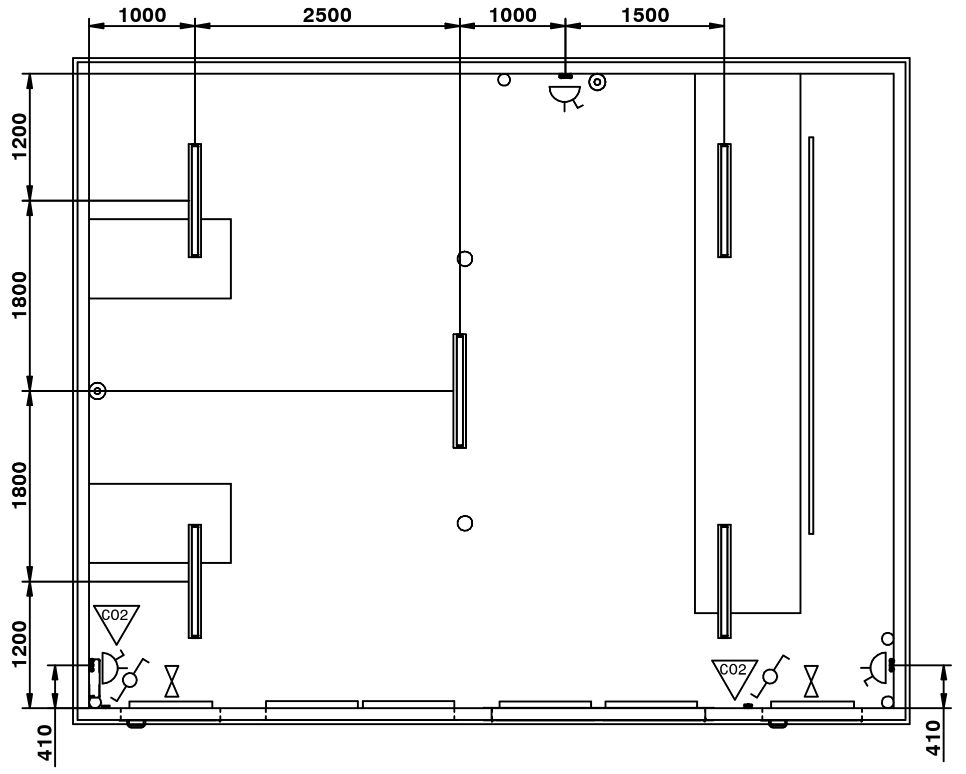
NOTES

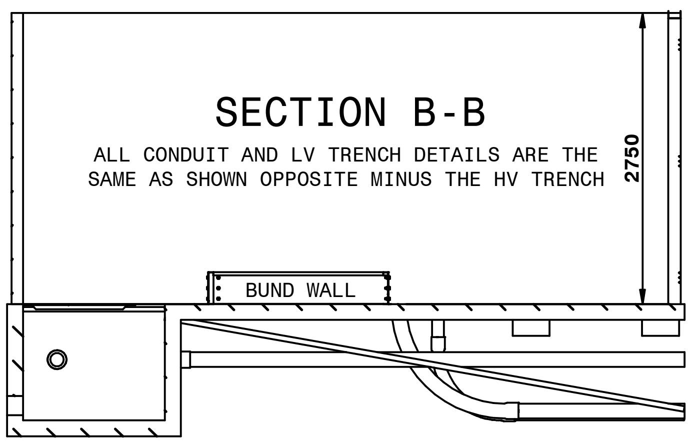
1) THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DISTRIBUTION STANDARDS MDI0028 & MCI0006.
2) BUND WALLS TO BE ERECTED AS PER STANDARD AFTER INSTALLATION OF OIL/FLUID FILLED TRANSFORMERS.
3) VENTILATORS ARE SHOWN IN TYPICAL LOCATIONS ONLY. VENTILATORS IN WALLS ADJACENT TO HV SWITCHGEAR SHALL BE INSTALLED 2000mm ABOVE FLOOR LEVEL.
4) REFER TO INDIVIDUAL HV SWITCHGEAR SUBSTATION DESIGN INSTRUCTION FOR DETAILS OF INSTALLING SWITCHGEAR MOUNTING STEELWORK.
5) ALL CONDUITS TO BE SEALED BY FIRE PROOF SEALANT AT ALL TIMES. CONDUITS TO RUN TO PROPERTY BOUNDARY.
6) A FLAT AREA AT LEAST 1.5m DEEP x 1.5m WIDE TO SUPPORT 5 TONNES IS REQUIRED IN FRONT OF EQUIPMENT LOADING DOORS TO ALLOW THE TRANSFORMER TO BE SET DOWN AFTER UNLOADING FROM THE TRUCK.

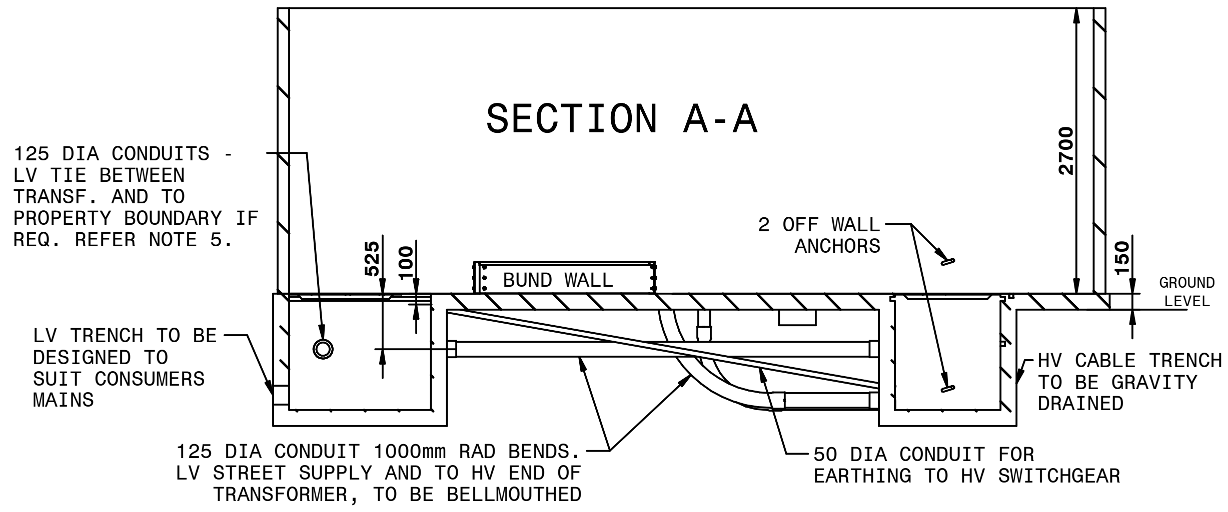
ITEM	QTY	DESCRIPTION	REMARKS

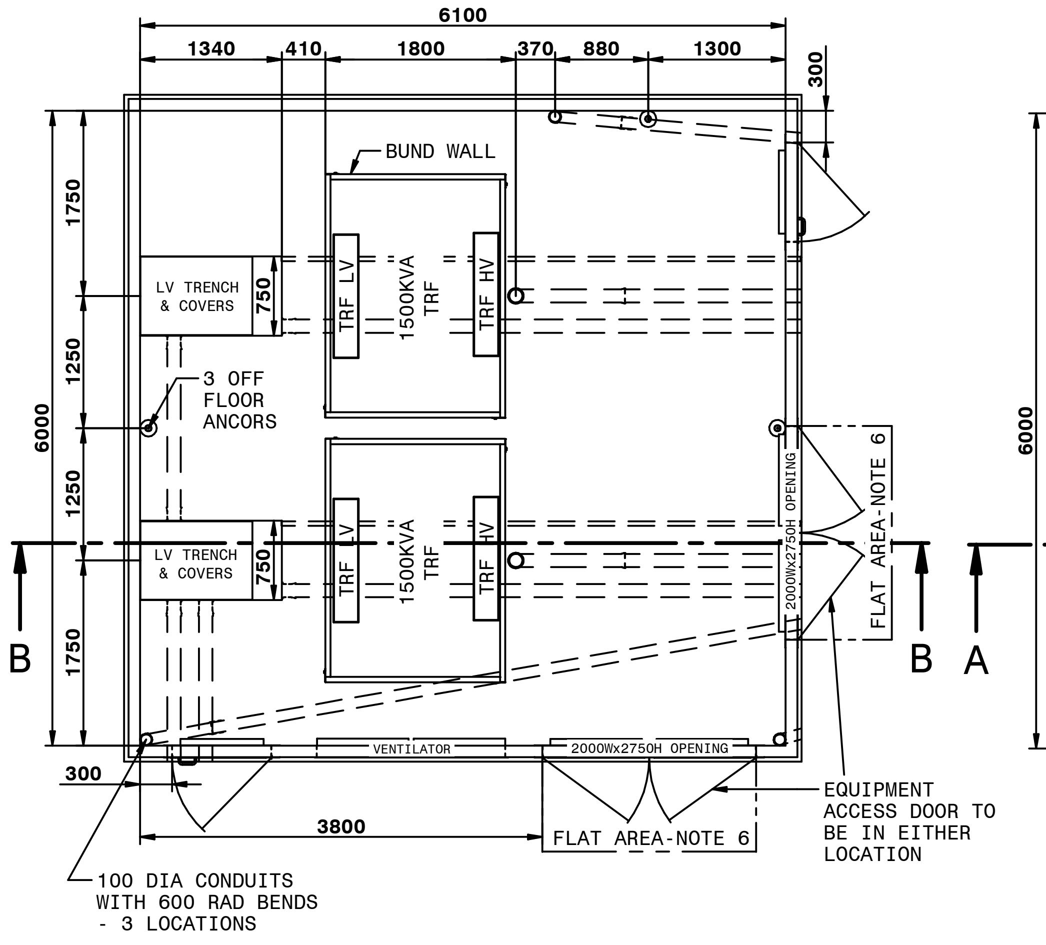


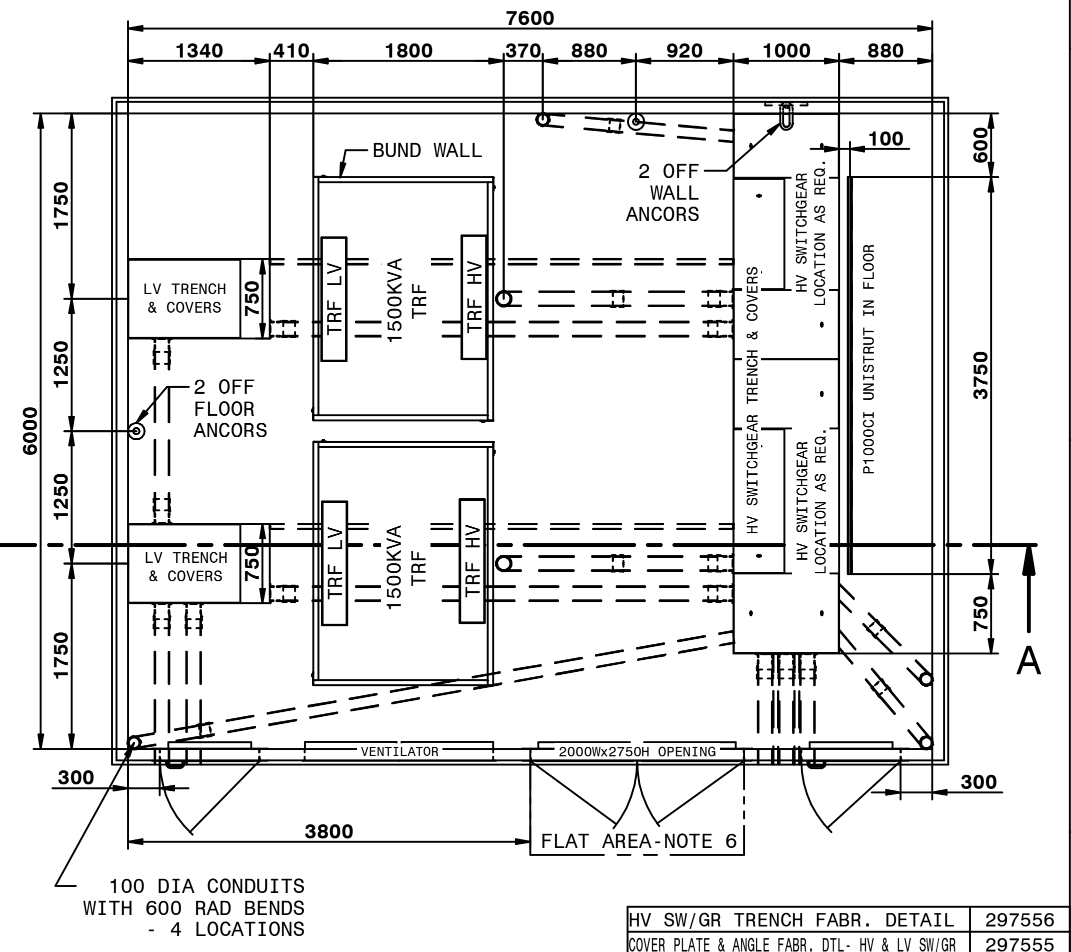












MAJOR EQUIPMENT MASS	
HV SWITCHGEAR MODULES	500kg EACH
POWER TRANSFORMER	5000kg EACH

REFERENCE DRAWINGS	
HV SW/GR TRENCH FABR. DETAIL	297556
COVER PLATE & ANGLE FABR. DTL- HV & LV SW/GR	297555
FLOOR PENETRATION & TRENCH DTL - HV & LV SW/GR	297547
CONCRETE WALL ANCHOR FABRICATION DETAIL	040879
REMOVABLE PULLING RING & SOCKET FABR. DTL	040877
INDOOR DIST SUB TYPICAL CONDUIT DETAILS	040881
-	-

Endeavour Energy

ORIGINAL SCALE

APPROVED: G. Ford

DRAWN: G. Ford

DATE: 08/07/05

CH'D: G. Ford

INDEX REF S001A

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED: W. Isley
MANAGER ASSET ENGINEERING 08/07/05

STANDARD LAYOUT FOR A TWO TRANSFORMER INDOOR DISTRIBUTION SUBSTATION WITH & WITHOUT HV AND LV TRENCHES TO SUIT UPTO 1500KVA DRY OR OIL FILLED TRANSFORMERS

A3 297558 C

SHEET No. 1 OF 1

AMENDMENTS	
A	ORIGINAL ISSUE
B	DR'N G.S.F.; CH'D G.S.F.; DATE 26-11-15; JR No N/A; REDRAWN. HV TRENCH EXTENDED; NSM C.Crisafulli

NOTES

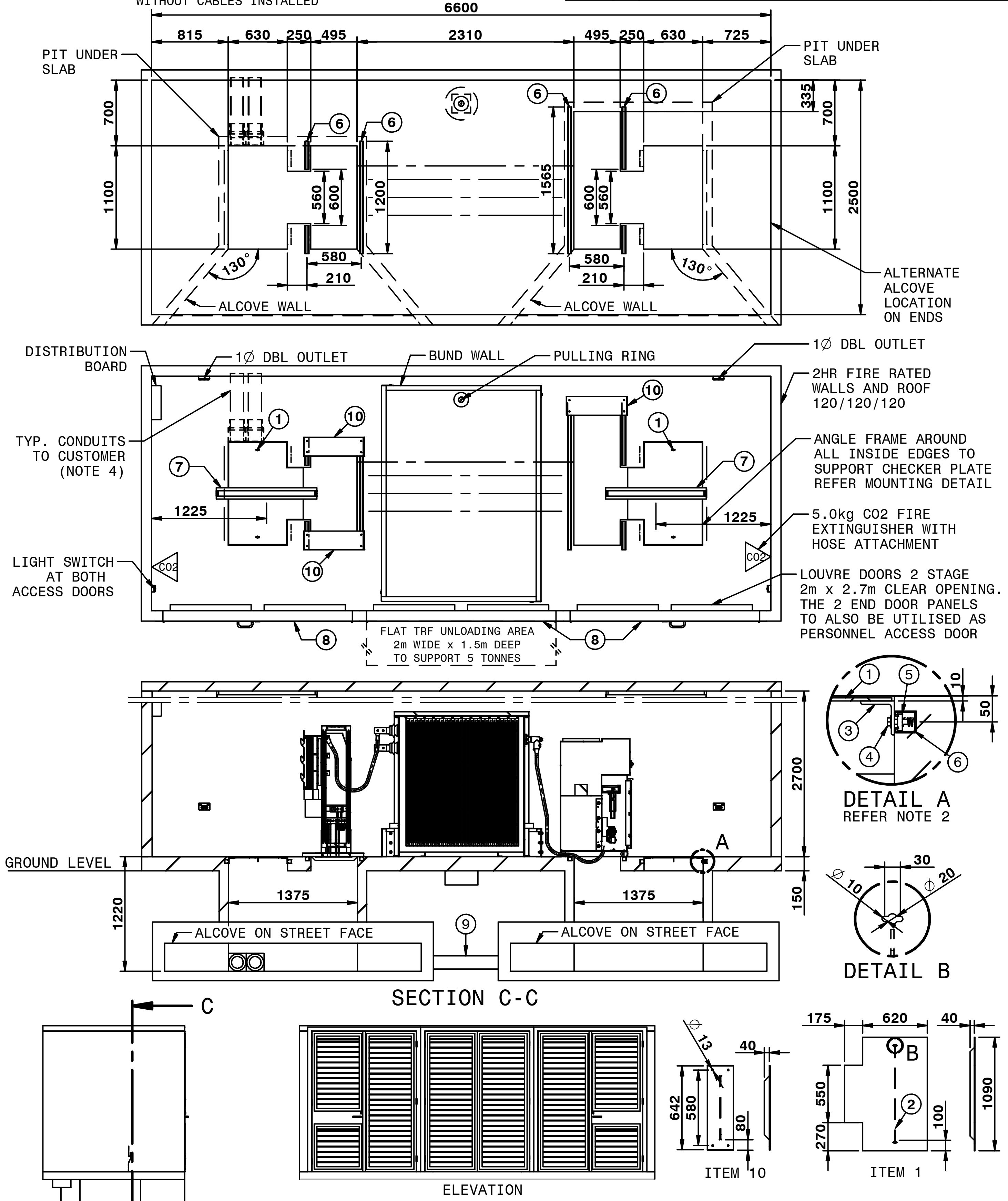
1) ALL WELDED CONSTRUCTION TO BE IN ACCORDANCE WITH AS1665.

2) ITEM 3 TO BE HOT DIP GALVANISED AFTER FABRICATION. NOTE: THIS ITEM IS REQUIRED ON ALL SIDES OF PENETRATION. ANGLE IRON TO BE BOLTED AT 400mm CENTRES MAX WHERE POSSIBLE. SEE MOUNTING DETAIL BELOW.

3) ALL HV & LV CABLES TO BE HORIZONTAL & LEVEL WITH SUB FLOOR BEFORE ENTERING SUB TO FACILITATE CABLE TERM.

4) CONDUITS TO BE SEALED FOR 2HR FIRE RATING WITH OR WITHOUT CABLES INSTALLED

ITEM	QTY	DESCRIPTION	REMARKS
1	2	TREADPLATE ALUM. 6mm x W & L TO SUIT	
2	A/R	BARE ALUMINIUMFLAT 40x6 LEN TO SUIT	
3	A/R	ANGLE STEEL 65x65x6x LEN TO SUIT	NOTE 2
4	A/R	BOLT STEEL HEX HD GALV. M10x35 LG	
5	A/R	NUT UNISTRUT SPRING LOADED P1000 M10	
6	A/R	UNISTRUT CHANNEL P1000CI EZP	
7	2	FLUORECENT FITTING TWIN 40 WATT	
8	3	LOUVRE DOOR 2 STAGE 2mWx2.7mH CLEAR	
9	A/R	CONDUITS 3x125mm + 1x50mm HV TO LV	NOTE 4
10	A/R	TREADPLATE ALUM. 6mm x W & L TO SUIT	



ORIGINAL SCALE	APPROVED G. Ford
DRAWN	G. Ford
DATE	06/09/07
CH'D	G. Ford

Endeavour Energy

REFERENCE DRAWINGS
-
-

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED W. Isley
MANAGER ASSET ENGINEERING 06/09/07

STANDARD LAYOUT FOR A SINGLE TRANSFORMER INDOOR PADMOUNT STYLE DISTRIBUTION SUBSTATION WITH MINIMAL HV SWITCHING TO SUIT UP TO 1500kVA OIL OR DRY TRANSFORMER

A4 317522 B

SHEET No. 1 OF 1

7.7.3 Padmount switching station – associated drawings

Drawing no.	Amendment no.	Subject
075027	J	11/22kV padmount and switching station invert culvert construction details
078559	B	11kV switching station heater and thermostat mounting detail
264890	B	Size 14 and 16 padmount substation fibreglass cubicle door
264891	C	Size 14 and 16 padmount substation fibreglass cubicle HV and LV compartment
282539	A	11 and 22kV HV switching station two and four pier footing details
282540	A	Size 16 switching station fibreglass cubicle HV compartment
282551	B	Size 16 switching station easement layout
292827	A	Size 14 and 16 HV switching station precast concrete plinth construction detail

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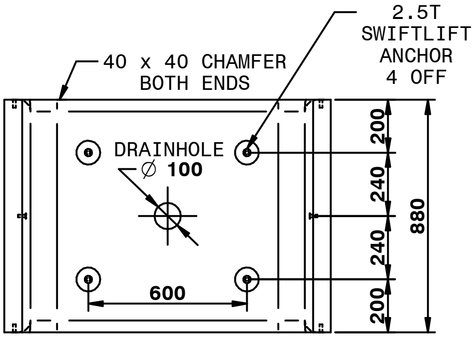
AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	16-03-93
	JR No	920294
DRAINHOLE WAS Ø90. DIM 1234 WAS 1240. DIM 100 WAS 250. DIM 400 WAS 250. DIM 1092 ADDED. LIFT LUGS DELETED.		
S.D.E.	D.T.G.	
C	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	13-07-93
	JR No	930125
TITLE REVISED, END SHEET DETAILS ADDED. ISSUE ID SDI104 ADDED.		
S.D.E.	D.T.G.	
D	DR'N	T.A.B.
	CH'D	T.A.B.
	DATE	27-05-94
	JR No	940063
DIM 2800 WAS 2464, DIM 1160 WAS 1163, DIM 800 WAS 750, DIM 600 WAS 515, DIM 70 WAS 80, DIM 350 WAS 400, DIM 30 WAS 28, DIM 1235 WAS 1234, DIM 110 WAS 1092, DIM 1165 WAS 1015, DIM 560 WAS 490, ANCHORS WERE 820 APART, INTERNAL FERRULES ADDED, MASS WAS 1800KG, VOCAB ADDED, 22KV ADDED TO TITLE, HOLES WERE Ø14, CHAMFER ADDED, SDI114 ADDED.		
S.D.M.	D.T.G.	
E	DR'N	D.J.Z.
	CH'D	D.J.Z.
	DATE	16-11-94
	JR No	940162
SDI117 WAS TP9.		
S.D.M.	JK	
F	DR'N	J.W
	CH'D	R.J.H
	DATE	18-04-95
	JR No	950077
CHANGE END SHEET DETAIL WAS LV END SHEET DETAIL QUANTITY: 2 OFF WAS 1 OFF. DELETED: HV END SHEET DETAIL.		
S.D.M.	JK	
G	DR'N	D.J.Z
	CH'D	D.J.Z.
	DATE	20-12-96
	JR No	960097
NOTE 1 ADDED. ISSUE ID'S DELETED. END SHEET COVER AND CUTOUT END SHEET DETAILS ADDED. END SHEET DETAIL DIM 1080 WAS 800.		
M.N.S.A.	JK	
H	DR'N	G.Ford
	CH'D	G.Ford
	DATE	09-12-04
	JR No	---
SWITCHING STATION CULVERT DETAILS ADDED.		
M.N.S.A.	G.Ford	
J	DR'N	G.Ford
	CH'D	G.Ford
	DATE	03-12-13
	JR No	---
SWIFTLIFT RATING 2.5T WAS 1.3T. END SHEET FIBREGLASS WAS PLASTIC. END SHEET RIBS ADDED. CUT OUT END SHEET AND NOTE 1 DELETED.		
M.P.S.	G.Ford	

NOTES

1) -

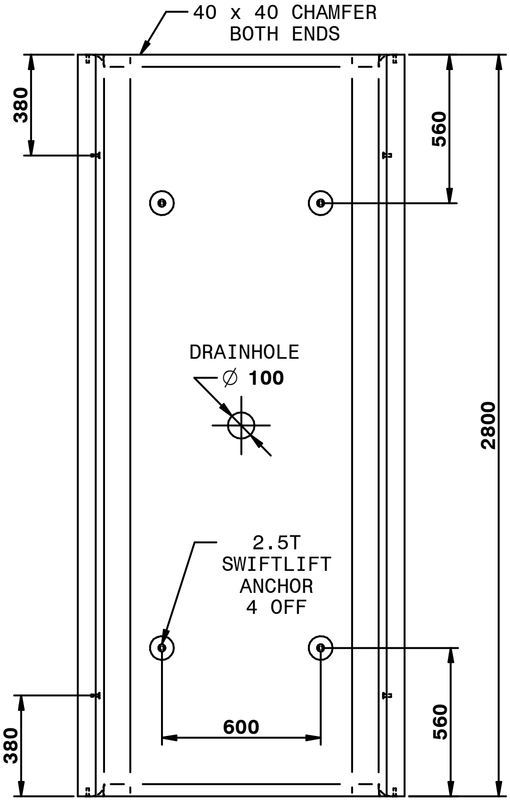
ITEM	QTY	DESCRIPTION	REMARKS



ITEM 2

INVERT CULVERT DETAIL

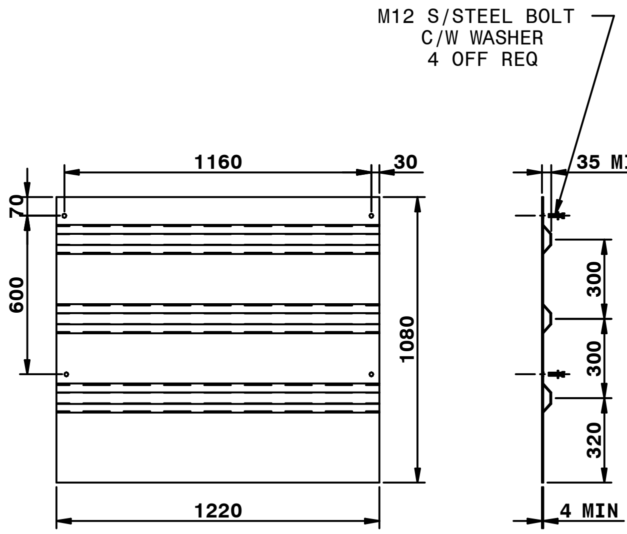
SWITCHING STATION PLAN VIEW



ITEM 1

INVERT CULVERT DETAIL

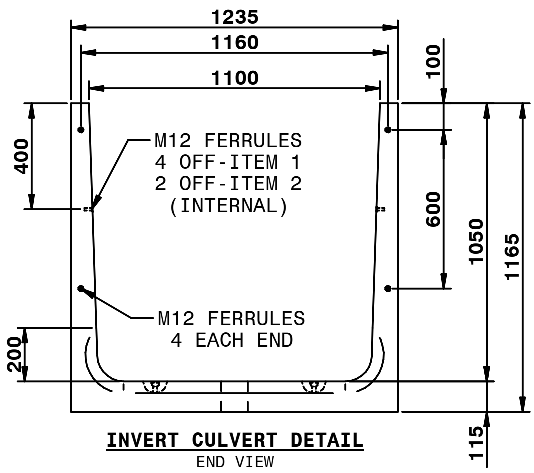
PADMOUNT PLAN VIEW



END SHEET DETAIL

MATERIAL: RIGID FIBREGLASS - MIN 4mm THICK WITH STRENGTHENING RIBS

QUANTITY: 2 OFF PER CULVERT



INVERT CULVERT DETAIL

END VIEW

	PADMOUNT	SWITCHING STATION
APPROX. MASS:	2280kg	720kg
STOCK CODE:	YT10165	1554336

	ORIGINAL SCALE	APPROVED	
		C.Howat	
DRAWN	T.A.B.		
DATE	28/10/92		
CH'D	D.J.Z		INDEX REF S002A

Endeavour Energy

-	-
PM SUB INVERT CULVERT FTG INST	076665
REFERENCE DRAWINGS	

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

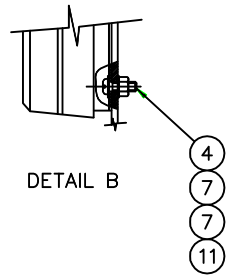
AUTHORISED: D.B.Britten/CH, ASSIST. G.G. ENG. 28/10/92

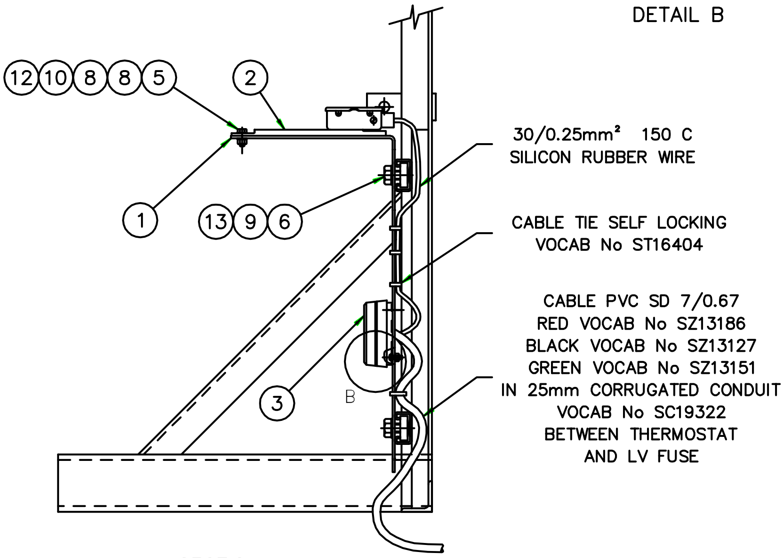
11 & 22kV PADMOUNT & SWITCHING STATION
INVERT CULVERT
CONSTRUCTION DETAILS

A4 075027 J

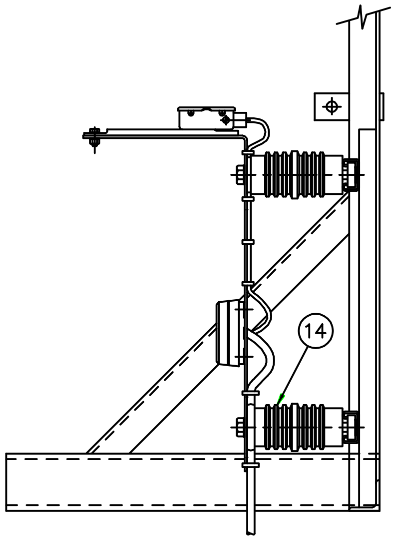
SHEET No. 1 OF 1

AMENDMENTS	
A	ORIGINAL ISSUE
J R No.	940199
B	DR'N C.R.T. / CH'D C.R.T. / DATE 31-10-95 / JR No 950179
HV SWITCH STATION ADDED TO TITLE.	
MNSS	S.Q.

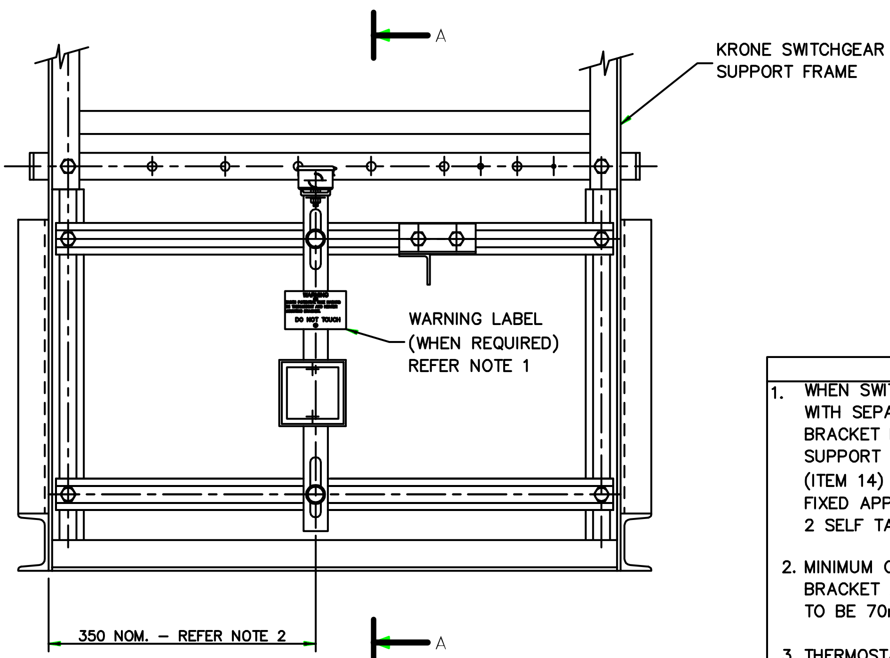




SECTION A–A

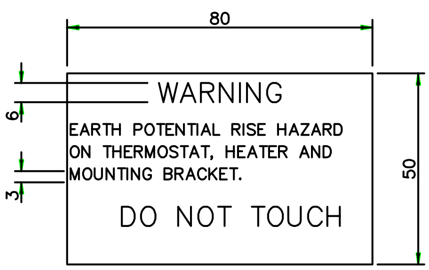


ALTERNATIVE MOUNTING ARRANGEMENT
WITH STANDOFF INSULATORS
REFER NOTE 1



NOTES

1. WHEN SWITCHGEAR IS LOCATED IN AN AREA WITH SEPARATE EARTHING THE MOUNTING BRACKET IS TO BE INSULATED FROM THE SUPPORT FRAME USING POST INSULATORS (ITEM 14) AND THE WARNING LABEL BE FIXED APPROXIMATELY WHERE SHOWN VIA 2 SELF TAPPING SCREWS.
2. MINIMUM CLEARANCE BETWEEN MOUNTING BRACKET AND UNSCREENED HV CABLE IS TO BE 70mm.
3. THERMOSTAT IS TO BE SET AT 20 C.



WARNING LABEL DETAIL
SCALE 1:1
MATERIAL: GRAVOPLY – WHITE LETTERING
ON RED BACKGROUND.

ITM NO	VOCAB /DRG	DESCRIPTION	QTY	REFER
1	078558	BRACKET HEATER AND THERMOSTAT MTG	1	NOTE 2
2	SH10220	HEATER ANTI–CONDENSATION 50W	1	–
3	ST10708	THERMOSTAT (SUNVIC TLM2453)	1	NOTE 3
4	NA	SCREW STEEL PAN HD Z/P M4 X 16 LG	2	–
5	SS19816	SCREW S/STEEL HEX HD M6 X 20 LG	1	–
6	SS19581	SCREW S/STEEL HEX HD M12 X 25 LG	2	–
7	NA	WASHER STEEL FLAT RND Z/P 4	4	–
8	SW11341	WASHER S/STEEL FLAT RND 6	2	–
9	SW10159	WASHER S/STEEL FLAT RND 12	2	–
10	SW11465	WASHER STEEL SPRING Z/P 6	1	–
11	NA	NUT STEEL HEX Z/P M4	2	–
12	SN12491	NUT S/STEEL HEX M6	1	–
13	SN12564	NUT SPRING M12 UNISTRUT No P4010/M12	2	–
14	SY10204	INSULATOR POST WITH M12 STUD	2	NOTE 1

Endeavour Energy

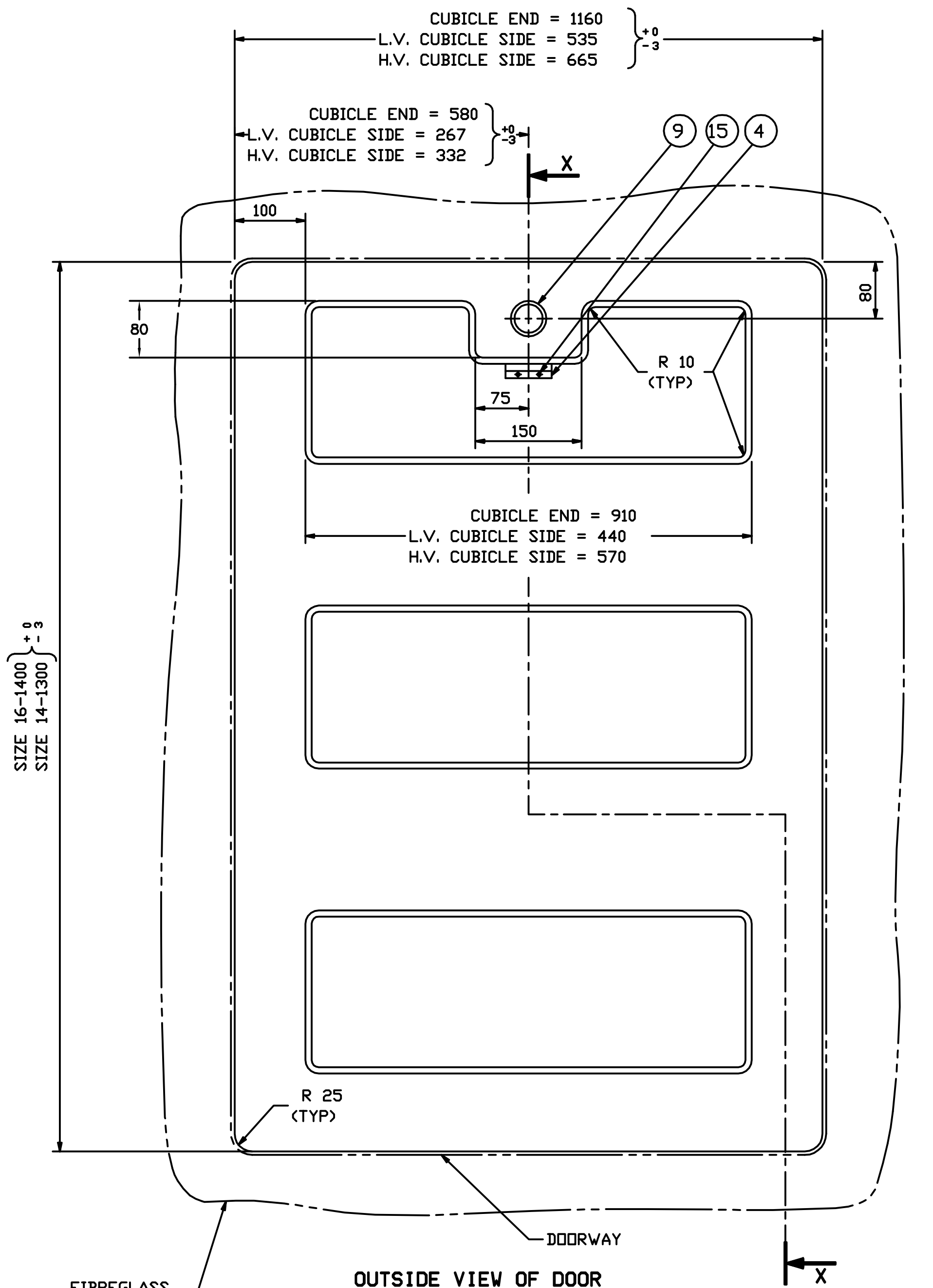
REFERENCE DRAWINGS	DRG. NO.	THIS ISSUE PAGE NO

ORIGINAL SCALE 1:5 & 1:1
APPROVED C.Howat
DO NOT SCALE
DIMENSIONS IN MILLIMETRES
SUBSTATION DEVELOPMENT MGR C.Howat 21–04–95
ISSUE IDENTIFICATION SDI 100

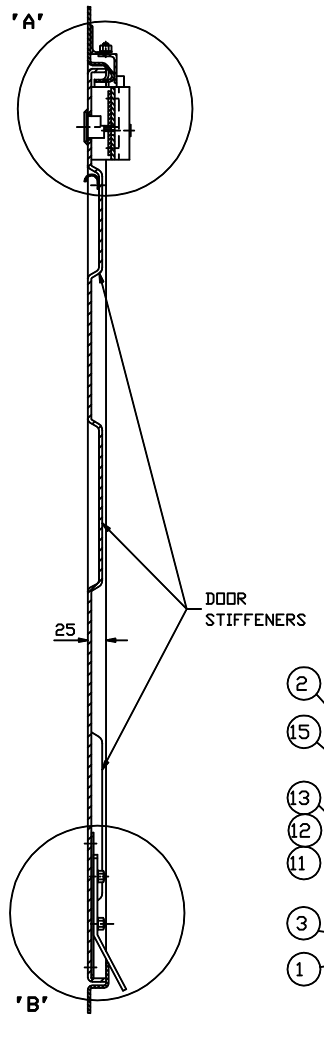
DRAWN J.W
DATE 21-4-95
CH'D R.J.H

11kV PADMOUNT SUB/HV SWITCH STATION KRONE SWITCHGEAR HEATER & THERMOSTAT MOUNTING DETAIL

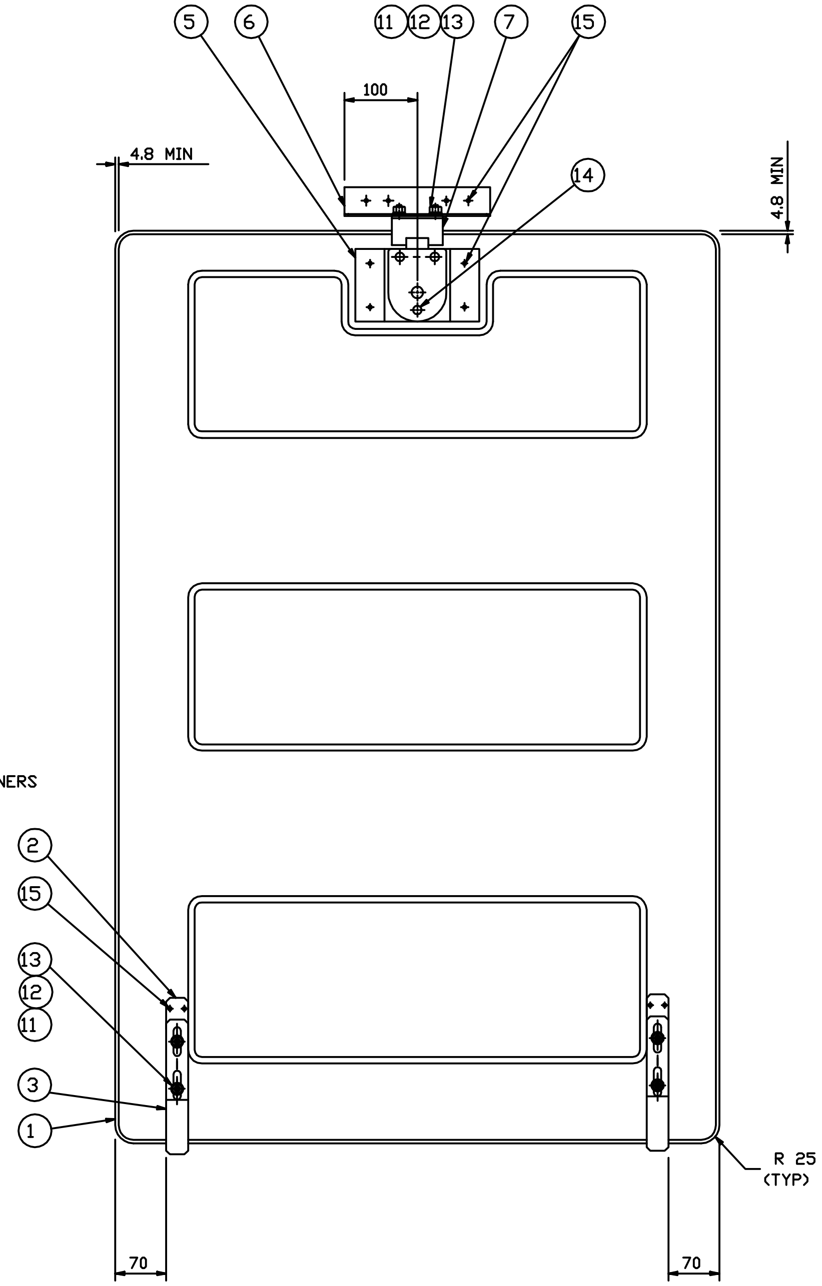
SUB 078559 B
SHEET No 1 OF 1 SHEETS
INDEX REF S008A
THIS ISSUE
PAGE NO.



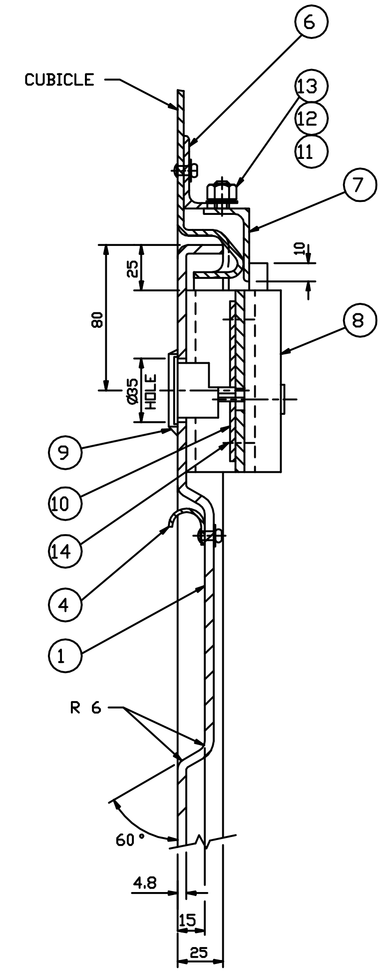
OUTSIDE VIEW OF DOOR
SCALE 1:5
DOOR SHOWN IN DOORWAY
ALL HIDDEN DETAILS OMITTED



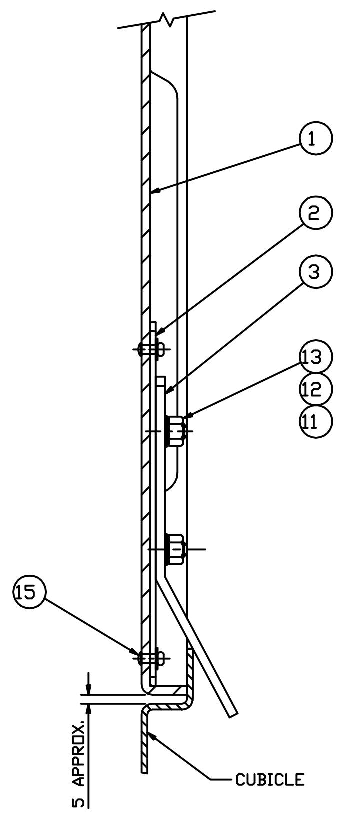
SECTION X-X
SCALE 1:5



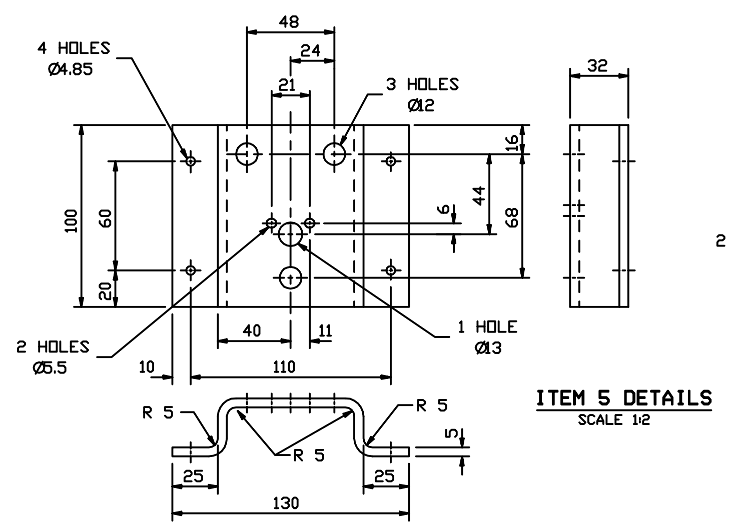
INSIDE VIEW OF DOOR
SCALE 1:5
DOORWAY OMITTED FOR CLARITY



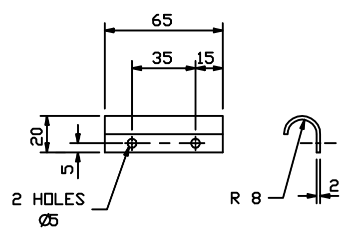
DETAIL 'A'
SCALE 1:2



DETAIL 'B'
SCALE 1:2



ITEM 5 DETAILS
SCALE 1:2



ITEM 4 HANDLE DETAILS
SCALE 1:2

NOTES

1. THIS DRAWING TO BE USED IN CONJUNCTION WITH THE RELEVANT Endeavour Energy PADMOUNT SUBSTATION CUBICLE SPECIFICATION. THE INTERNAL AND EXTERNAL CUBICLE FINISH IS ALSO DETAILED IN THIS SPECIFICATION.
2. TOLERANCE - UP TO AND INCLUDING 300 ±0
   OVER 300 ±2.0
   UNLESS OTHERWISE NOTED.
3. ALL UNSPECIFIED RADII TO BE R6 MIN.
4. ITEM 1 (FIBREGLASS DOOR SKIN) TO HAVE A MINIMUM WALL THICKNESS OF 4.8mm (EXCLUDING GELCOAT).
5. ITEMS SHOWN IN MATERIAL LIST ARE SUFFICIENT FOR 1 DOOR ONLY.
6. BACKSET CASE (ITEM 8) TO BE SUPPLIED WITHOUT THUMB TURN. SUITABLE LOCK TYPES ARE: - LOCKWOOD TYPE 100 CASE WITH TYPE 213 DEAD BOLT ASSEMBLY OR LANE CAT. No. 606 ELECTRIC SC (372099).
7. DRILL 18 HOLES Ø4.85 (No.11 DRILL) IN ITEM 1 (FIBREGLASS DOOR) TO SUIT ITEMS 2,4,5 & 6.
8. SUITABLE WASHER TO BE FITTED TO ITEM 15 (POP RIVET) ON INSIDE OF DOOR PRIOR TO FIXING RIVET IN PLACE. HEAD OF POP RIVET TO BE ON OUTSIDE OF DOOR.

ITM NO	VOCAB /DRG	DESCRIPTION	QTY	REFER
1	NA	FIBREGLASS DOOR SKIN	1	NOTE 1&2&7
2	NA	DOOR LOWER SECURITY PLATE	2	DRG 264889
3	NA	DOOR SECURITY BRACKET	2	DRG 264889
4	NA	STEEL HANDLE GALV	1	DETAIL
5	NA	RETAINING BRACKET LOCK - FIBREGLASS	1	DETAIL
6	NA	DOOR LATCH STRIKER PLATE RETAINING BRACKET	1	DRG 264889
7	NA	DOOR LATCH STRIKER PLATE	1	DRG 264889
8	NA	BACKSET CASE	1	NOTE 6
9	NA	LOCK CYLINDER - YALE (SUPPLIED BY INTEGRAL)	1	-
10	NA	RETAINING PLATE STEEL BACKSET CASE	1	DRG 264889
11	NA	WASHER STEEL FLAT RND GALV 8	6	-
12	NA	WASHER STEEL SPRING Z/P 8	6	-
13	NA	NUT STEEL HEX HD GALV M8	6	-
14	NA	SCREW STEEL C'SUNK HD GALV M5 x 25 LG	3	-
15	NA	POP RIVET AL DIA 4.8 (AD612)	18	NOTE 8

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N GSF; CH'D GSF; DATE 01-10-03; JR No --; SIZE 14 DOOR NOW TALLER BY 100MM TO 1300MM.	MDEB GSF

REFERENCE DRAWINGS	
STEELWORK DETAIL	264889
FIBREGLASS CUBICLE ARRGT	264887

ORIGINAL SCALE

APPROVED: G. Ford

DRAWN: G. Ford

DATE: 13/08/2001

CH'D: G. Ford

Endeavour Energy

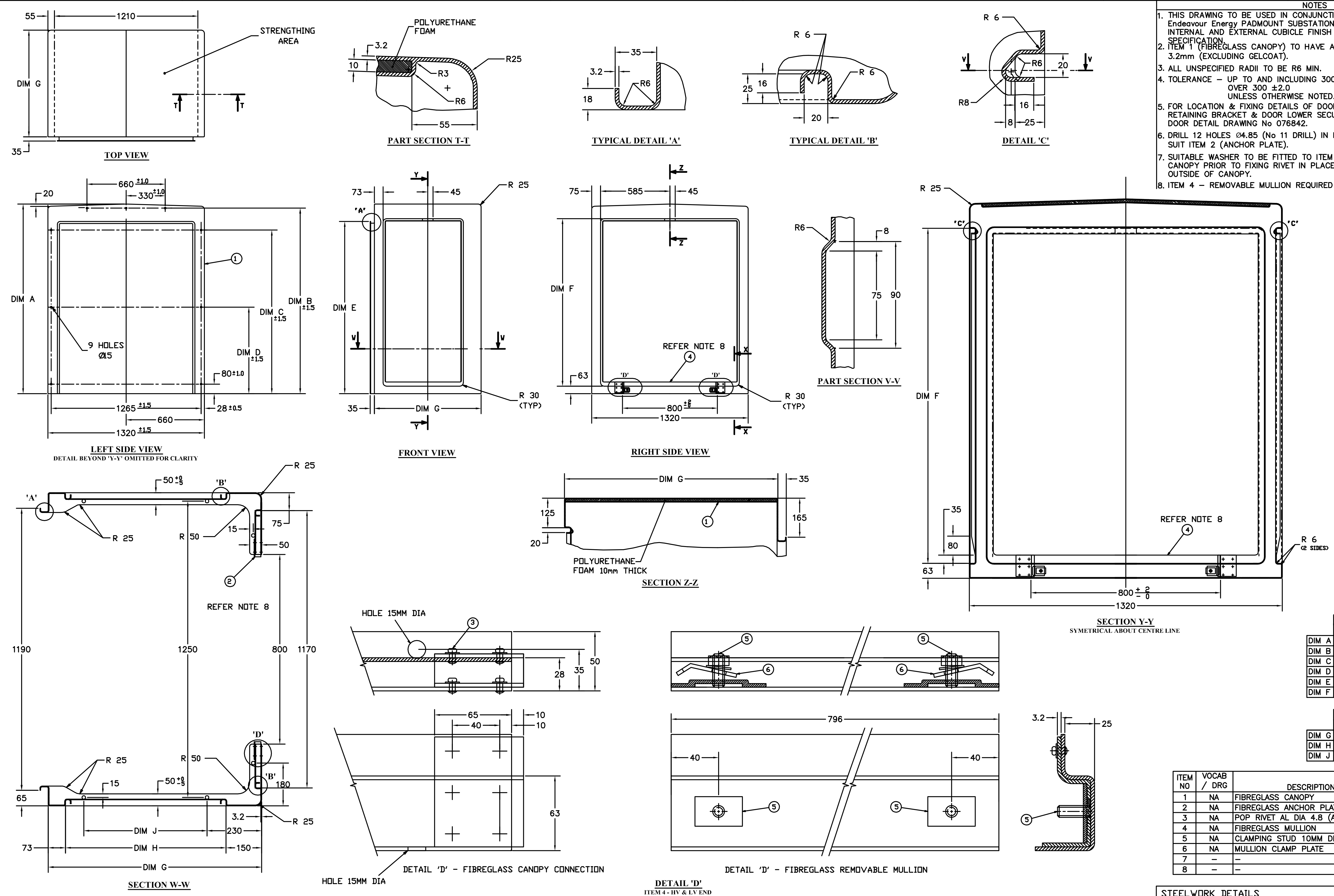
DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED: W. Isley
MANAGER ASSET SERVICES 13/08/2001

SIZE 14 & 16 - PADMOUNT SUBSTATION
FIBREGLASS CUBICLE
DOOR DETAILS

A3 264890 B

SHEET No 1 OF 1 SHEETS



NOTES

1. THIS DRAWING TO BE USED IN CONJUNCTION WITH THE RELEVANT Endeavour Energy PADMOUNT SUBSTATION CUBICLE SPECIFICATION THE INTERNAL AND EXTERNAL CUBICLE FINISH IS ALSO DETAILED IN THIS SPECIFICATION.
2. ITEM 1 (FIBREGLASS CANOPY) TO HAVE A MINIMUM WALL THICKNESS OF 3.2mm (EXCLUDING GELCOAT).
3. ALL UNSPECIFIED RADII TO BE R6 MIN.
4. TOLERANCE – UP TO AND INCLUDING 300 ±1.0
   OVER 300 ±2.0
   UNLESS OTHERWISE NOTED.
5. FOR LOCATION & FIXING DETAILS OF DOOR LATCH STRIKER PLATE RETAINING BRACKET & DOOR LOWER SECURITY PLATE & BRACKET REFER DOOR DETAIL DRAWING No 076842.
6. DRILL 12 HOLES Ø4.85 (No 11 DRILL) IN ITEM 1 (FIBREGLASS CUBICLE) TO SUIT ITEM 2 (ANCHOR PLATE).
7. SUITABLE WASHER TO BE FITTED TO ITEM 3 (POP RIVET) ON INSIDE OF CANOPY PRIOR TO FIXING RIVET IN PLACE. HEAD OF POP RIVET TO BE ON OUTSIDE OF CANOPY.
8. ITEM 4 – REMOVABLE MULLION REQUIRED ON HV AND LV END

	CUBICLE HEIGHT DIMENSIONS	
	SIZE 14	SIZE 16
DIM A	1450	1600
DIM B	1415	1565
DIM C	1230	1380
DIM D	630	730
DIM E	1253	1453
DIM F	1313	1413

	CUBICLE LENGTH DIMENSIONS	
	HV END	LV END
DIM G	900	770
DIM H	677	547
DIM J	520	390

ITEM NO	VOCAB / DRG	DESCRIPTION	QTY	REFER
1	NA	FIBREGLASS CANOPY	1	NOTE 2
2	NA	FIBREGLASS ANCHOR PLATE	2	–
3	NA	POP RIVET AL DIA 4.8 (AD612)	12	–
4	NA	FIBREGLASS MULLION	2	–
5	NA	CLAMPING STUD 10MM DIA	2	–
6	NA	MULLION CLAMP PLATE	2	–
7	–	–	–	–
8	–	–	–	–

REFERENCE DRAWINGS	
STEELWORK DETAILS	264889
DOOR DETAILS	264890
FIBREGLASS CUBICLE ARRGT	264887

AMENDMENTS		
A	ORIGINAL ISSUE	
B	DR'N GSF; CH'D GSF; DATE 01-10-03; JR No --	SIZE 14 DIM F, G, H & J CHANGED. HEIGHT NOW 1450MM. DOOR 100MM HIGHER. MULLION CLAMP CHANGED. MDEB GSF
C	DR'N GSF; CH'D GSF; DATE 27-02-04; JR No --	REMOVABLE MULLION ADDED TO LV END. NOTE 8 MODIFIED. MDEB GSF

Endeavour Energy

ORIGINAL SCALE NONE

APPROVED G. Ford

DRAWN G. Ford
DATE 10/08/2001
CH'D G. Ford

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

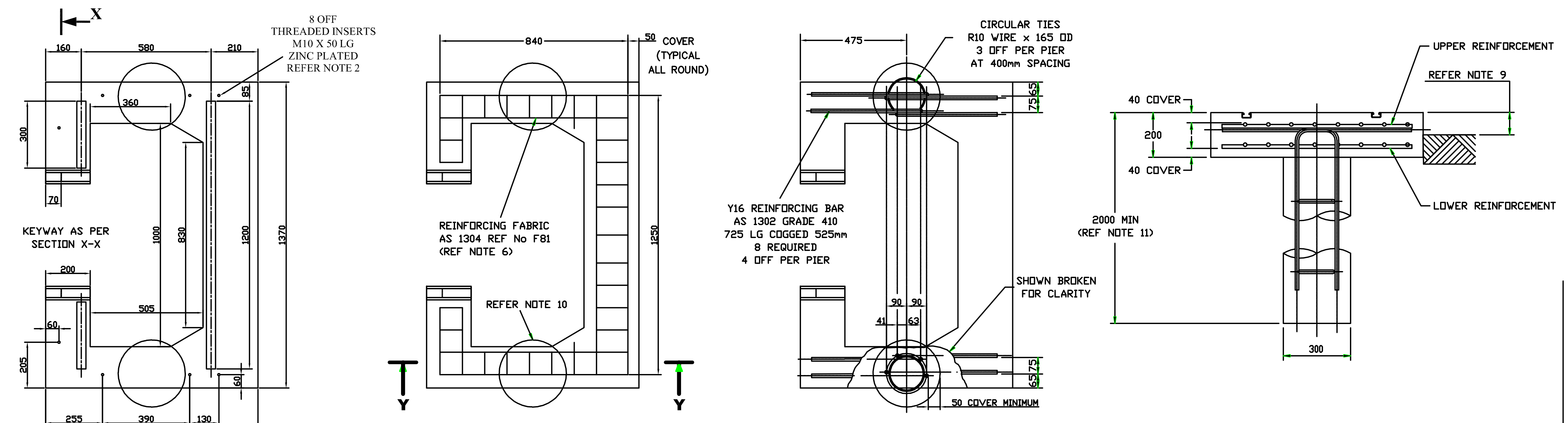
AUTHORISED W. Isley
MANAGER ASSET SERVICES 10/08/2001

SIZE 14 & 16 PADMOUNT SUBSTATION FIBREGLASS CUBICLE HV & LV COMPARTMENTS

A3 264891 C

SHEET No 1 OF 1 SHEETS

TWO PIER CONSTRUCTION DETAIL



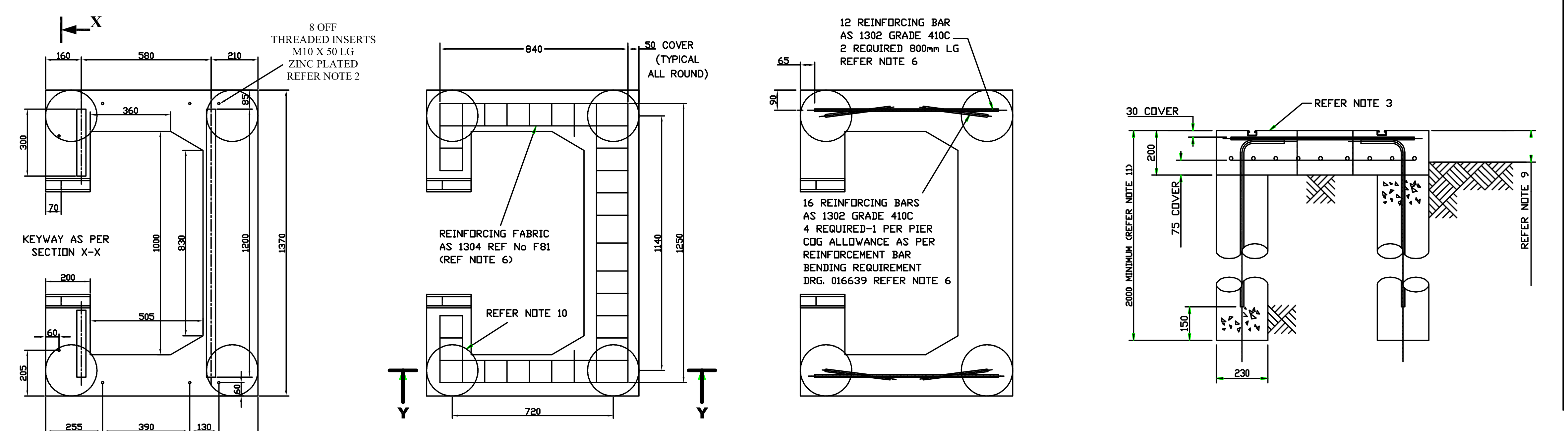
OVERALL DIMENSIONS & UNISTRUT LOCATION

UPPER & LOWER REINFORCING DETAIL

PIER REINFORCING DETAIL

SECTION Y - Y

FOUR PIER CONSTRUCTION DETAIL



OVERALL DIMENSIONS & UNISTRUT LOCATION

UPPER & LOWER REINFORCING DETAIL

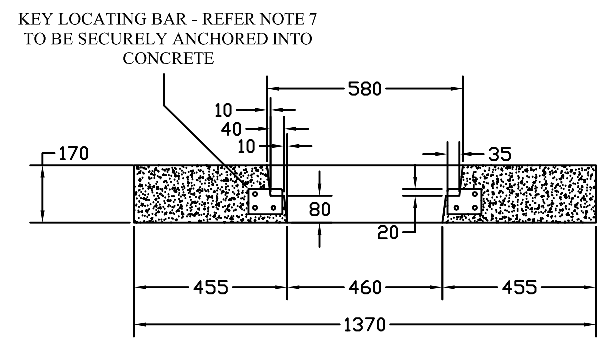
PIER REINFORCING DETAIL

SECTION Y - Y

NOTES

1) CONCRETE TO HAVE MINIMUM COMPRESSIVE STRENGTH OF 25MPa AFTER 28 DAYS. MAXIMUM SLUMP 80mm.
2) UNISTRUT CHANNELS & THREADED INSERTS TO BE POSITIONED LEVEL WITH SURFACE OF CONCRETE.
3) TOP & SIDES OF PLINTH TO BE FLAT & LEVEL & HAVE A STEEL TROWEL FINISH FREE FROM CRACKS & DEFECTS.
4) ALL MATERIAL AND WORKMANSHIP TO BE ACCURATELY LOCATED & TIED PRIOR TO POURING CONCRETE.
5) MATERIAL: GLASS REINFORCED CONCRETE. WALL THICKNESS = 8mm. APPROXIMATE MASS = 8kg
6) REINFORCEMENT & UNISTRUT CHANNEL TO BE ACCURATELY LOCATED AND TIED PRIOR TO POURING CONCRETE.
7) MATERIAL: STAINLESS STEEL. APPROX. SIZE = 100 x 75 x 6mm THICK
8) ALL MATERIAL & WORKMANSHIP TO BE IN ACCORDANCE WITH SAA CONCRETE STRUCTURES CODE (AS 3600).
9) TOP OF SLAB TO BE 100mm ABOVE HIGHEST POINT OF FINISHED GROUND LEVEL ADJACENT TO FOOTING.
10) TOP OF PIER TO FINISH LEVEL WITH BOTTOM OF SLAB.
11) 2000mm DIMENSION IS A MINIMUM & IS TO BE INCREASED IF NECESSARY TO NCLUDE 600mm OF VIRGIN SOIL.
12) QTY OF CONCRETE IS APPROX. 0.5 Cu METRES.

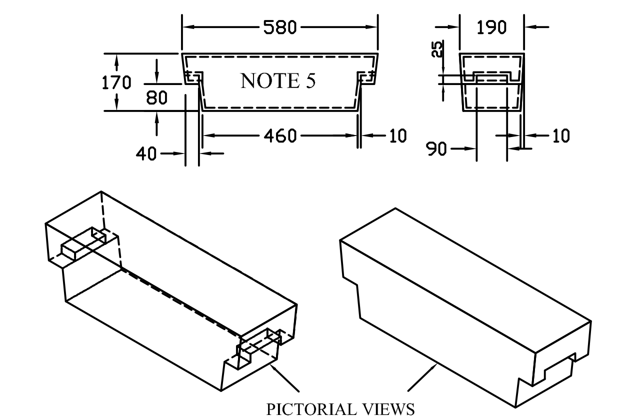
KEYWAY CONSTRUCTION DETAIL



SECTION X - X

CABLE ACCESS KEY DETAIL

VOCAB No. 1548411



PICTORIAL VIEWS

AMENDMENTS	A	ORIGINAL ISSUE	
ORIGINAL SCALE	APPROVED G. Ford		
DRAWN	G. Ford		
DATE	11/09/2003		
CH'D	G. Ford		INDEX REF S002A

Endeavour Energy

REFERENCE DRAWINGS

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

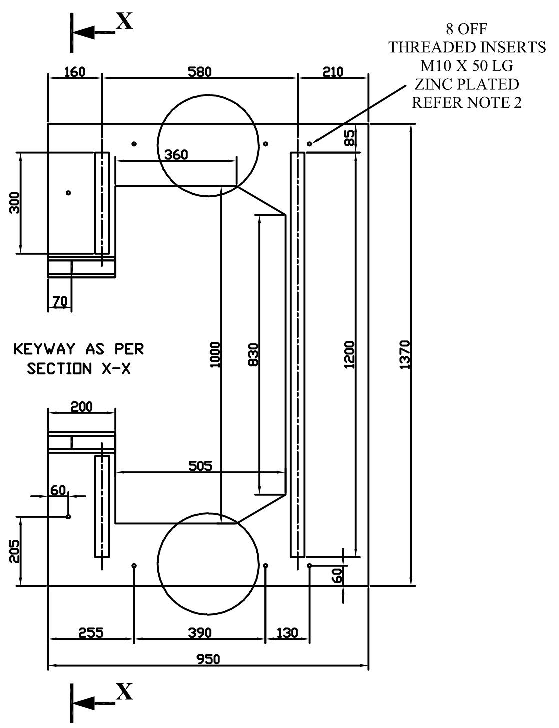
AUTHORISED W. Isley
MANAGER ASSET ENGINEERING 11/09/2004

11 & 22 KV HV SWITCHING STATION
TWO & FOUR PIER CONCRETE PLINTH
CONSTRUCTION DETAILS

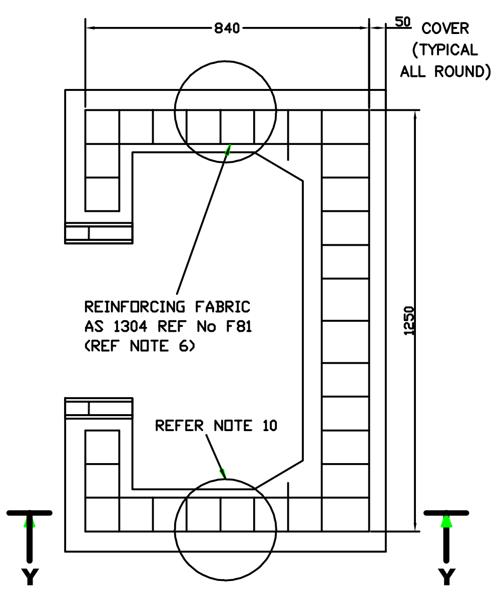
A3 282539 A

SHEET No 1 OF 1 SHEETS

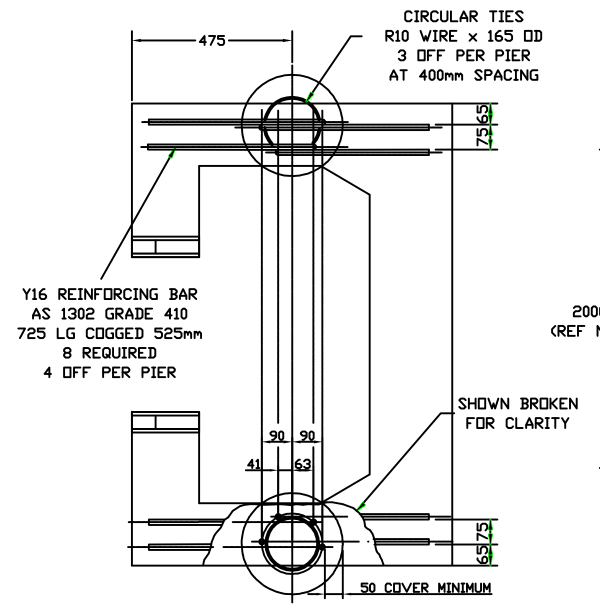
TWO PIER CONSTRUCTION DETAIL



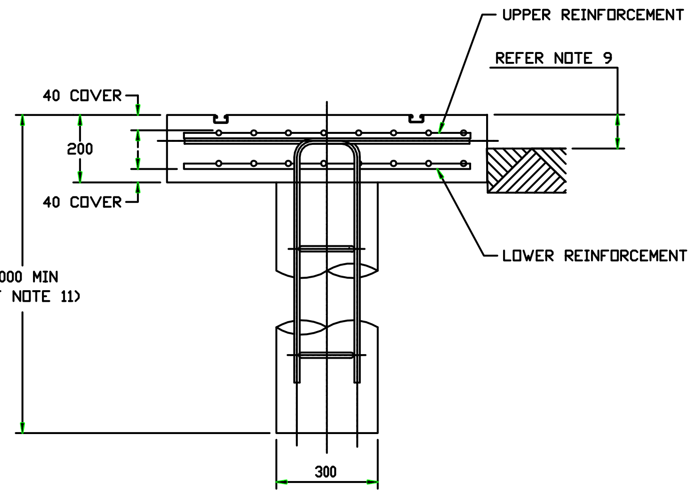
OVERALL DIMENSIONS & UNISTRUT LOCATION



UPPER & LOWER REINFORCING DETAIL

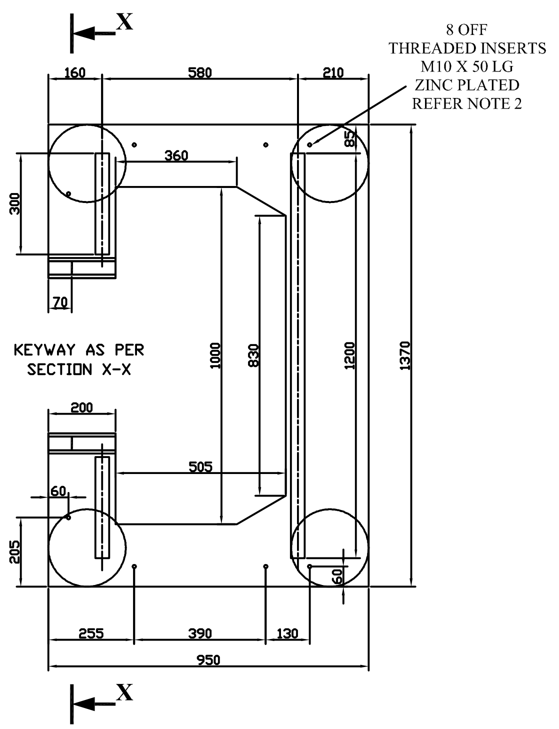


PIER REINFORCING DETAIL

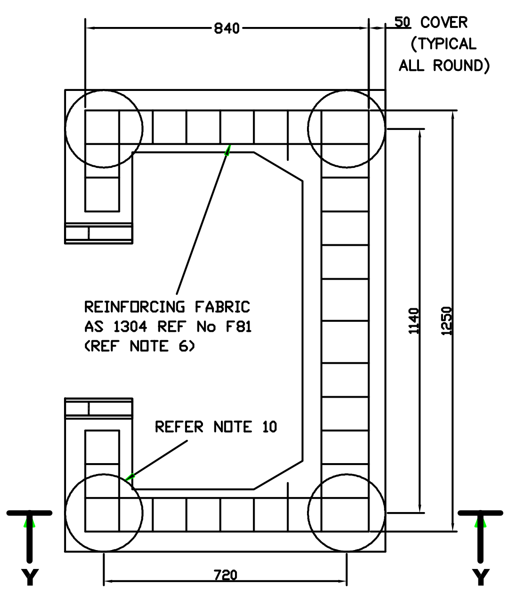


SECTION Y - Y

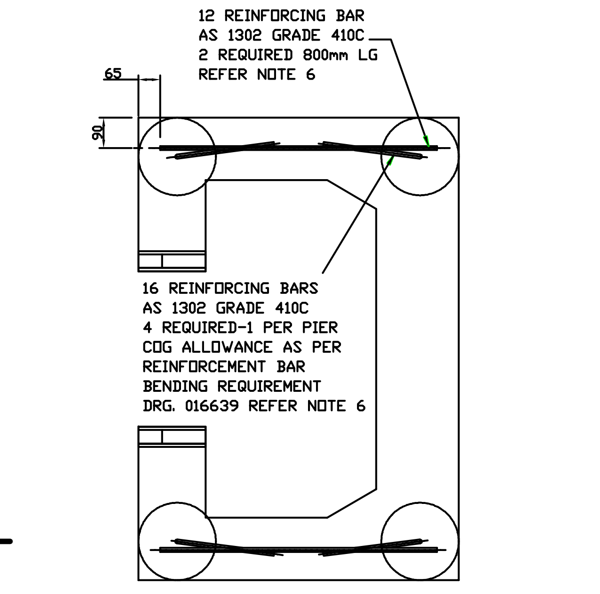
FOUR PIER CONSTRUCTION DETAIL



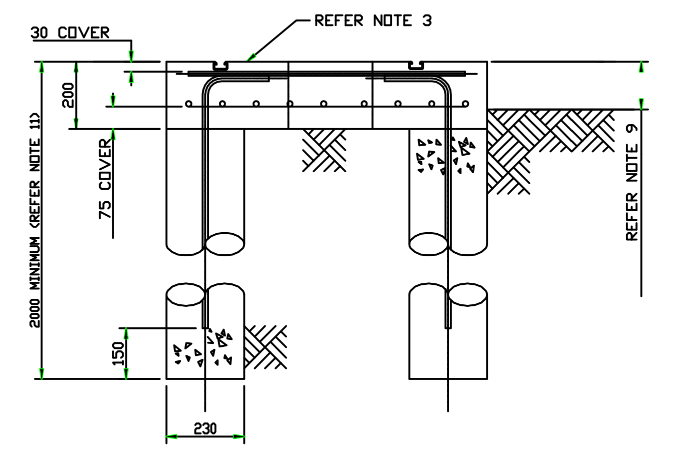
OVERALL DIMENSIONS & UNISTRUT LOCATION



UPPER & LOWER REINFORCING DETAIL



PIER REINFORCING DETAIL

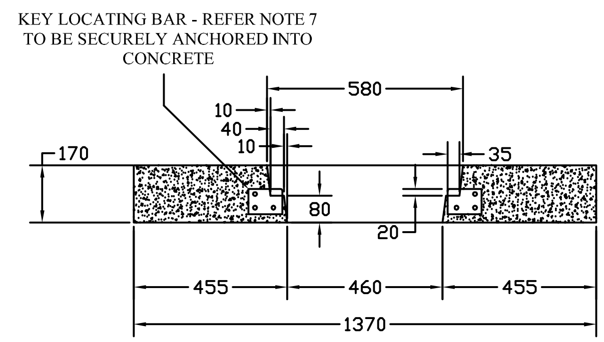


SECTION Y - Y

NOTES

1) CONCRETE TO HAVE MINIMUM COMPRESSIVE STRENGTH OF 25MPa AFTER 28 DAYS. MAXIMUM SLUMP 80mm.
2) UNISTRUT CHANNELS & THREADED INSERTS TO BE POSITIONED LEVEL WITH SURFACE OF CONCRETE.
3) TOP & SIDES OF PLINTH TO BE FLAT & LEVEL & HAVE A STEEL TROWEL FINISH FREE FROM CRACKS & DEFECTS.
4) ALL MATERIAL AND WORKMANSHIP TO BE ACCURATELY LOCATED & TIED PRIOR TO POURING CONCRETE.
5) MATERIAL: GLASS REINFORCED CONCRETE. WALL THICKNESS = 8mm. APPROXIMATE MASS = 8kg
6) REINFORCEMENT & UNISTRUT CHANNEL TO BE ACCURATELY LOCATED AND TIED PRIOR TO POURING CONCRETE.
7) MATERIAL: STAINLESS STEEL. APPROX. SIZE = 100 x 75 x 6mm THICK
8) ALL MATERIAL & WORKMANSHIP TO BE IN ACCORDANCE WITH SAA CONCRETE STRUCTURES CODE (AS 3600).
9) TOP OF SLAB TO BE 100mm ABOVE HIGHEST POINT OF FINISHED GROUND LEVEL ADJACENT TO FOOTING.
10) TOP OF PIER TO FINISH LEVEL WITH BOTTOM OF SLAB.
11) 2000mm DIMENSION IS A MINIMUM & IS TO BE INCREASED IF NECESSARY TO NCLUDE 600mm OF VIRGIN SOIL.
12) QTY OF CONCRETE IS APPROX. 0.5 Cu METRES.

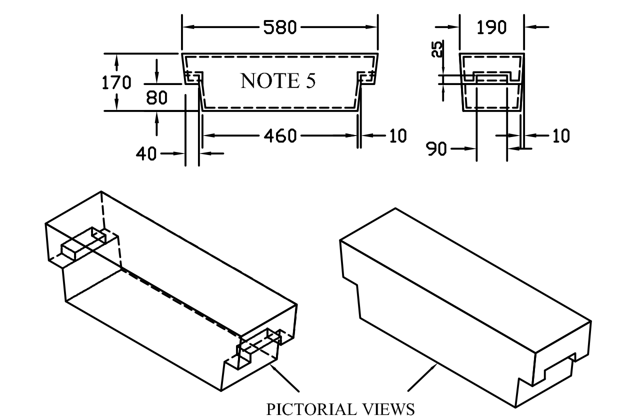
KEYWAY CONSTRUCTION DETAIL



SECTION X - X

CABLE ACCESS KEY DETAIL

VOCAB No. 1548411



PICTORIAL VIEWS

AMENDMENTS	
A	ORIGINAL ISSUE

Endeavour Energy

ORIGINAL SCALE		APPROVED	G. Ford
DRAWN	G. Ford		
DATE	11/09/2003		
CH'D	G. Ford	INDEX REF	S002A

REFERENCE DRAWINGS

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED
W. Isley
MANAGER ASSET ENGINEERING 11/09/2004

11 & 22 KV HV SWITCHING STATION
TWO & FOUR PIER CONCRETE PLINTH
CONSTRUCTION DETAILS

A3 | 282539 | A

SHEET No 1 OF 1 SHEETS

AMENDMENTS

A	ORIGINAL ISSUE
B	DR'N GSF CH'D GSF DATE 24-10-14 UR No --

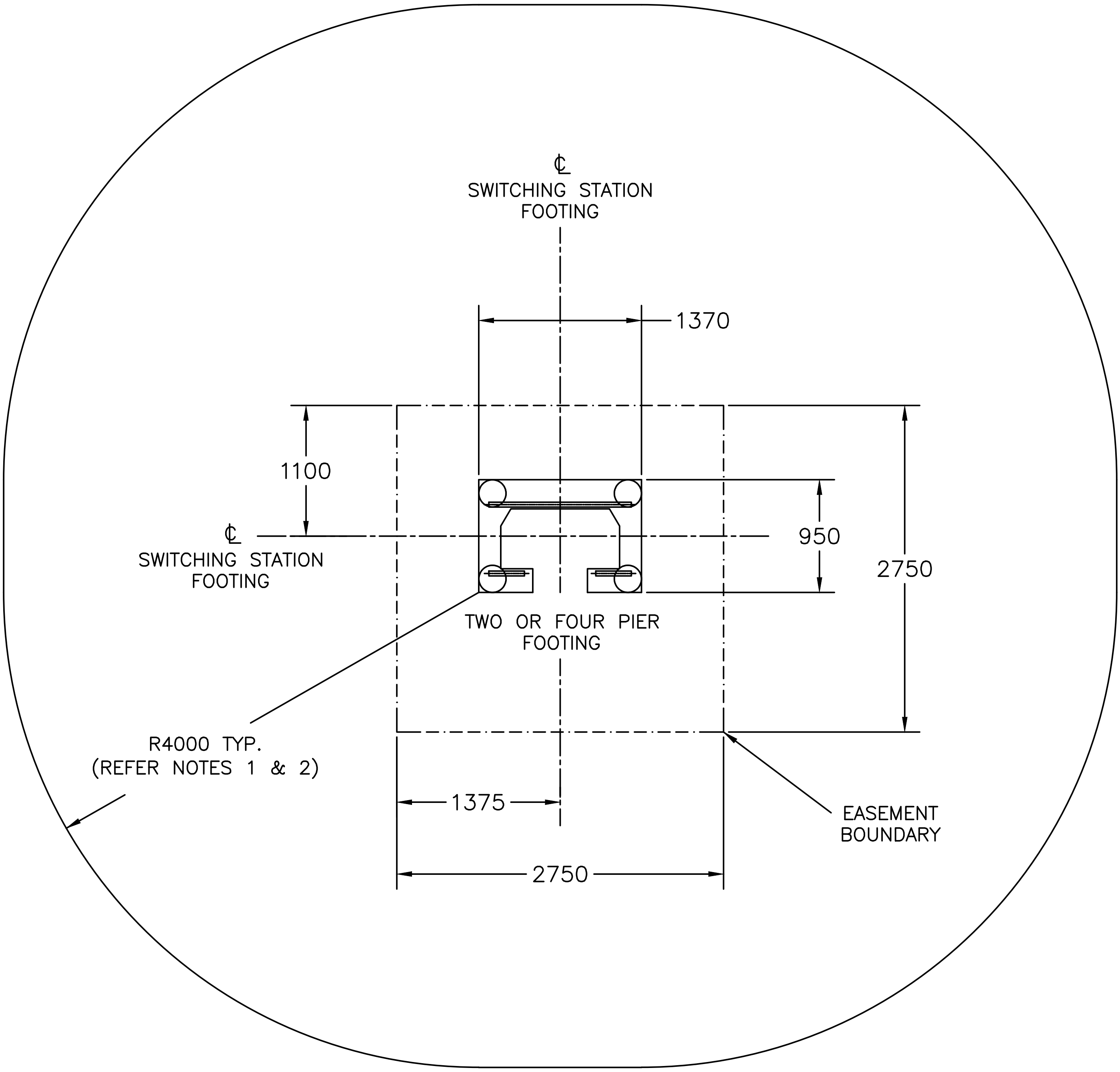
NOTE 1 & 2 WAS SDI104 NOW REFER TO RELEVANT STANDARDS

NSM C.Crisafulli

NOTES

1. EXCEPT AS NOTED IN THE RELEVANT EARTHING AND CONSTRUCTION STANDARDS ANY METAL FENCING BETWEEN THE AREA DEFINED BY A LINE 4000mm FROM THE FOOTING EXTREMITIES & THE EASEMENT BOUNDARY SHOULD BY CONSTRUCTED SO THAT THE POSTS INSULATE ADJACENT PANELS FROM EACH OTHER & THE GROUND.

2. EXCEPT AS NOTED IN THE RELEVANT EARTHING AND CONSTRUCTION STANDARDS ANY METAL CLAD BUILDING SHOULD NOT ENCROACH WITHIN THE AREA DEFINED BY A LINE 4000mm FROM THE FOOTING EXTRMITIES.



Endeavour Energy

11 & 22KV HV SW / STN 2 & 4 PIER FTG	282539
REFERENCE DRAWINGS	

ORIGINAL SCALE

APPROVED G. Ford

DO NOT SCALE
DIMENSIONS IN MILLIMETRES

AUTHORISED W. Isley

MANAGER ASSET ENGINEERING 15/09/2003

DRAWN	G. Ford
DATE	15/09/2003
CH'D	G. Ford

INDEX REF S002A

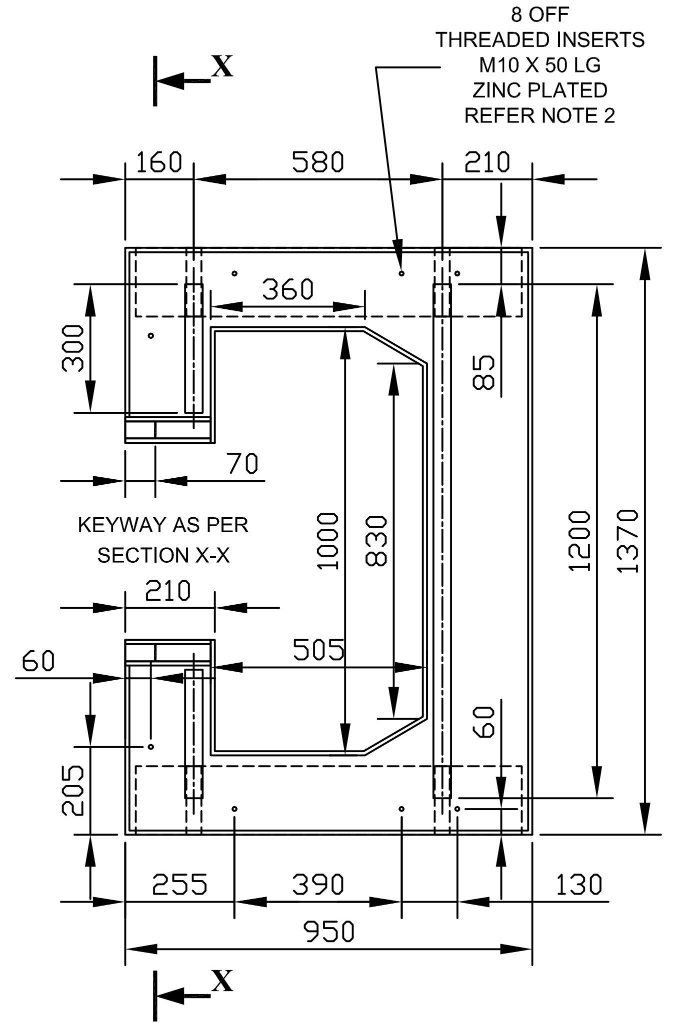
SIZE 16 SWITCHING STATION
EASEMENT LAYOUT

A3 282551 B

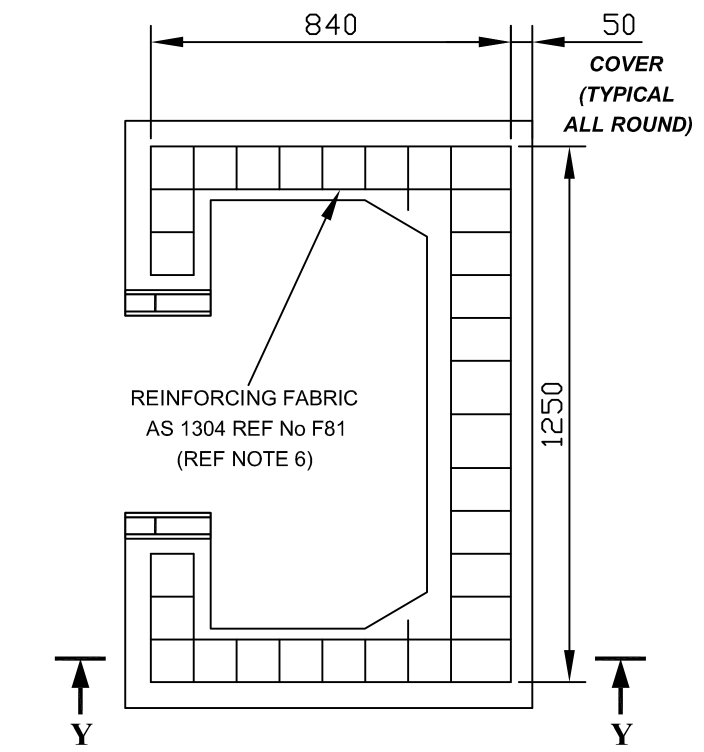
SHEET No 1 OF 1 SHEETS

AMENDMENTS	
A	ORIGINAL ISSUE

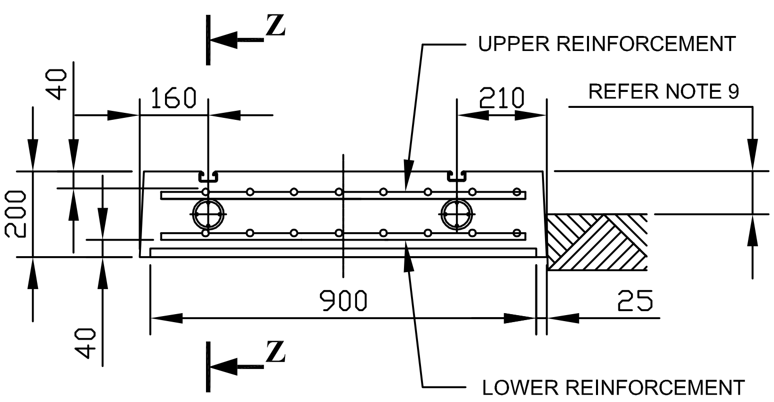
PLINTH DETAIL



OVERALL DIMENSIONS & UNISTRUT LOCATION



UPPER & LOWER REINFORCING DETAIL



SECTION Y - Y

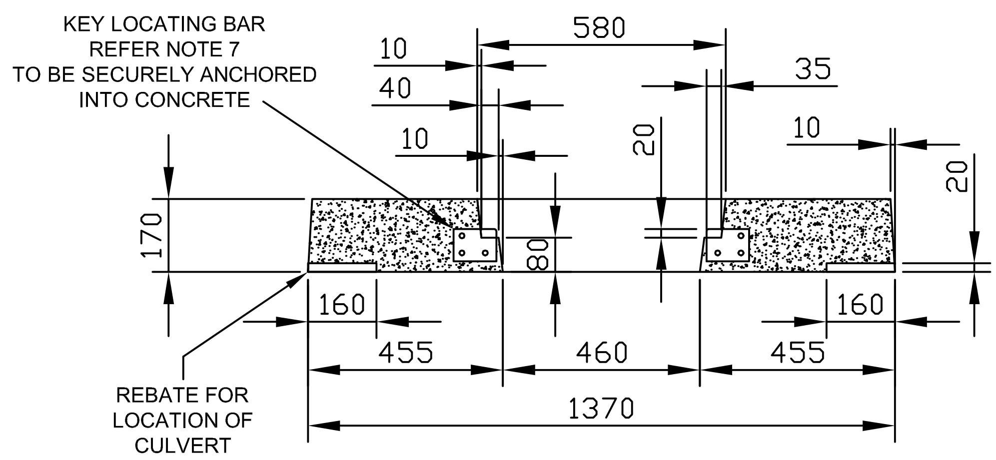
APPROX. MASS : 290kg

VOCAB No. : To be advised

NOTES

1) CONCRETE TO HAVE MINIMUM COMPRESSIVE STRENGTH OF 25MPa AFTER 28 DAYS. MAXIMUM SLUMP 80mm.
2) UNISTRUT CHANNELS & THREADED INSERTS TO BE POSITIONED LEVEL WITH SURFACE OF CONCRETE.
3) TOP & SIDES OF PLINTH TO BE FLAT & LEVEL & HAVE A STEEL TROWEL FINISH FREE FROM CRACKS & DEFECTS.
4) ALL MATERIAL AND WORKMANSHIP TO BE ACCURATELY LOCATED & TIED PRIOR TO POURING CONCRETE.
5) MATERIAL: GLASS REINFORCED CONCRETE. WALL THICKNESS = 8mm. APPROXIMATE MASS = 8kg
6) REINFORCEMENT & UNISTRUT CHANNEL TO BE ACCURATELY LOCATED AND TIED PRIOR TO POURING CONCRETE.
7) MATERIAL: STAINLESS STEEL. APPROX. SIZE = 100 x 75 x 6mm THICK
8) ALL MATERIAL & WORKMANSHIP TO BE IN ACCORDANCE WITH SAA CONCRETE STRUCTURES CODE (AS 3600).
9) TOP OF SLAB TO BE 100mm ABOVE HIGHEST POINT OF FINISHED GROUND LEVEL ADJACENT TO FOOTING.
9) PLINTH TO BE SUITABLE FOR LIFTING, TRANSPORTING & SUPPORTING IN SERVICE UP TO 500kg AS FOLLOWS:
 - HV SWITCHGEAR UP TO 400kg, A CUBICLE UP TO 100kg

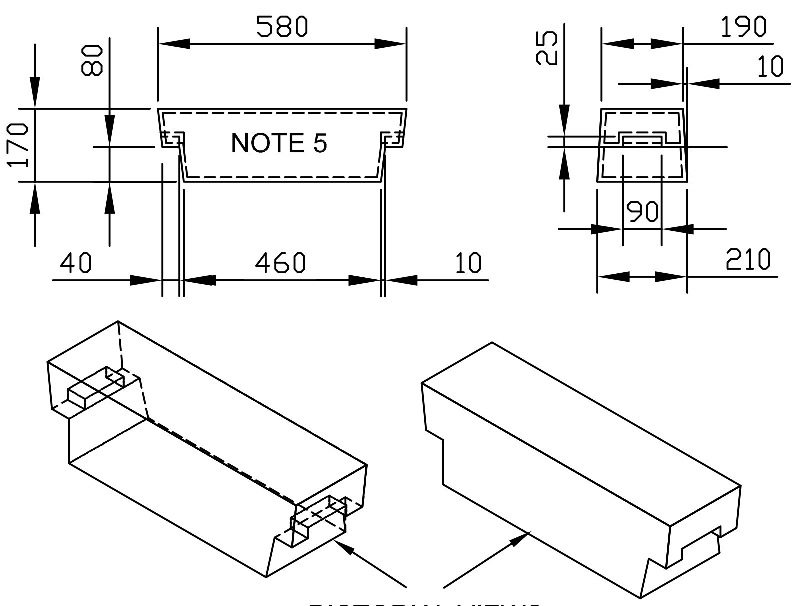
KEYWAY CONSTRUCTION DETAIL



SECTION X - X

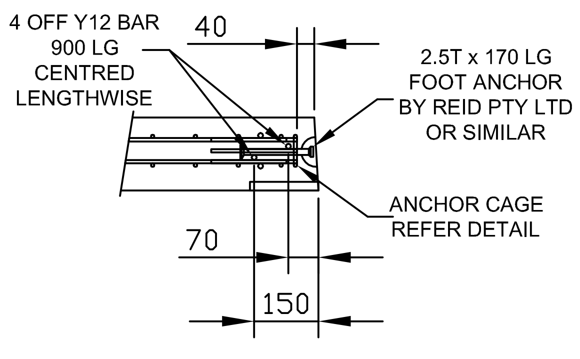
CABLE ACCESS KEY DETAIL

VOCAB No. 1548411

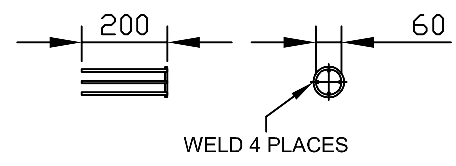


PICTORIAL VIEWS

LIFTING ANCHOR DETAIL



PART SECTION Z - Z



ANCHOR CAGE DETAIL

MATERIAL: R6 BAR
QUANTITY: 4 OFF

Endeavour Energy

ORIGINAL SCALE	APPROVED G. Ford	DO NOT SCALE DIMENSIONS IN MILLIMETRES	REFERENCE DRAWINGS
DRAWN	G. Ford		AUTHORISED W. Isley
DATE	07/12/2004		MANAGER ASSET ENGINEERING 07/12/2004
CH'D	G. Ford	INDEX REF S002A	

SIZE 14 & 16 HV SWITCHING STATION
PRECAST CONCRETE PLINTH
CONSTRUCTION DETAILS

A3 | 292827 | A

SHEET No 1 OF 1 SHEETS

ELECTRICAL SAFETY

FOR BUILDING AND CONSTRUCTION WORKERS

WORKPLACE FACT SHEET

KNOW THE DANGERS

Employees and contractors in the building and construction industry may run the risk of receiving an electric shock and causing substantial damage to plant and equipment when operating plant near overhead power lines or when excavating. This fact sheet has been developed to help you understand why you may be at risk and what you can do to work safely.

THINGS YOU SHOULD DO BEFORE STARTING WORK

- Complete a risk assessment. This should identify hazards (including work practices and procedures) and help you implement appropriate control measures.
- Find out the location of underground and overhead power lines and their proximity to your work activities and transit routes before commencing digging or other activities by phoning **131 081**.
- Know the location of underground and overhead power lines and their proximity to your work activities and transit routes before commencing digging or other activities.
- Dial **1100** or visit **www.1100.com.au** when planning underground work.
- Visually inspect points of attachment, at both ends, before commencing work as gutters and metal roofs may become "alive" due to deteriorating insulation on electrical wiring.
- Use a safety switch to reduce the risk of shock from portable tools.
- Before commencing work, install eye level visual markers in any area where overhead power lines are identified.
- Carefully monitor weather conditions – power lines can sway in the wind, sag as temperatures increase and are difficult to see at dawn and dusk.
- Ensure operators are aware of the height and reach of their machinery in their travel, stowed and working positions to ensure that minimum approach distances to power lines are maintained. For more information refer to *Work Near Overhead Power Lines Code of Practice 2006*, WorkCover NSW.
- Determine electricity asset safety clearances and whether an isolation needs to occur by referring to *Where to draw the line on safety clearances from electricity assets*, available at www.endeavourenergy.com.au
- Ask the occupant if they have experienced any minor electrical shocks from plumbing or appliances.

Call 131 081 and put safety first.
www.endeavourenergy.com.au

Endeavour Energy

BEFORE YOU DIG

- Apply for Dial Before You Dig plans for each location where you intend to dig.
- Use cable location services and technologies such as Global Positioning Systems (GPS) and Ground Penetrating Radar (GPR) to accurately identify the location of underground utilities.
- Pothole once you reach the applicable approach distance – for more information on approach distances for underground assets refer to *Work Near Underground Assets Guide 2007*, WorkCover NSW.

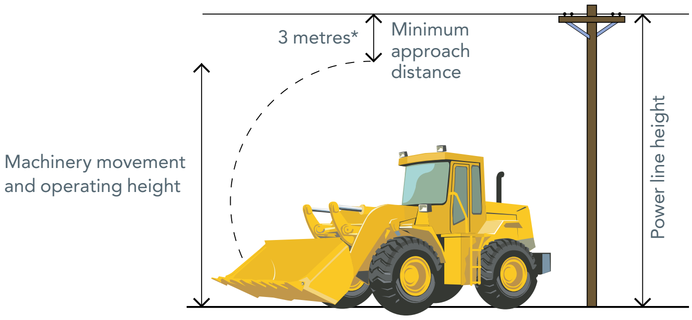
SAFE WORK HABITS

- Look up and locate overhead power lines and maintain at least the minimum approach distance from them.

Minimum safe approach distances when working near power lines
Workers and their equipment should not approach overhead power lines any closer than the following, when machinery is being operated:

Power lines with voltages up to 132,000 volts	e.g. low voltage distribution and subtransmission lines, usually on poles	3 metres
Between 132,000 and 330,000 volts	e.g. subtransmission and transmission lines, usually on either poles or towers	6 metres
More than 330,000 volts	e.g. transmission lines usually on towers	8 metres

The distance that must be assessed prior to work



*Voltages up to 132,000 volts.

- Remember that WorkCover requires a minimum approach distance of at least three metres from overhead power lines (up to 132,000 volts).
- Exercise extreme caution when working near the point of attachment of the electrical service line to the house/building.
- Look for cables and the signs of underground assets whenever digging, such as changes in grass, depressions or mounds and pipe work.
- Look out for electrical arcs. If identified, do not commence work and contact Endeavour Energy immediately on **131 003**.
- To eliminate the possibility of making contact with power lines on a job site, plan and communicate safe traffic paths by providing diagrams of plant and vehicle travel paths away from overhead power lines.
- Assign a spotter to each operator of high machinery and excavators to guide movements near overhead power lines and underground cables and ensure that minimum approach distances are maintained.
- Before every relocation, lower all machinery into the transport position.
- Use proximity sensor technologies on plant while you dig.

PERMIT TO WORK SYSTEMS

Using a permit to work (PTW) system can be an effective way to be sure preventative measures have been taken before any digging commences. It acts as a checklist that can only enable digging work to commence (usually with supervisor sign off) once all preventative actions have been taken *first*.

A typical permit to work checklist should ask/specify the following:

01 Has Dial Before You Dig been undertaken?

02 Have cable location services/technologies been used and their results compared with the DBYD plans?

03 Have the plans been marked up to reflect any new information/changes?

04 Has the safest plant suitable for the job been selected and ordered?

05 Has a spotter been allocated to this job to observe hand, mechanical or powered digging?

06 Is potholing included in the safe work procedure?

07 Has the job been assessed to use non-destructive digging?

08 Have overhead power lines been identified as a risk? If so, has this risk been managed as low as reasonably practicable?

09 Have all persons who may face/are affected by the risk of hitting underground utilities been consulted/made aware of the safe work procedures?

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WORKCOVER
NEW SOUTH WALES

WORK NEAR UNDERGROUND ASSETS

GUIDE 2007

making a difference

New South Wales Government

INDUSTRY REFERENCE GROUP
UTILITIES

This is a Utilities Industry Reference Group (IRG) project in partnership with WorkCover and Industry.

The Utilities IRG working party consisted of representatives from the following organisations:

- Alinta
- Australian Workers Union – Technical Administrative Professional Staff Branch
- Civil Contractors Federation
- Department Energy, Utilities and Sustainability
- EnergyAustralia
- Integral Energy
- Local Government Engineer's Association
- Local Government and Shires Association
- Roads and Traffic Authority
- Sydney Water
- Telstra
- WorkCover.

ACKNOWLEDGEMENT

The Working Party wishes to acknowledge that some references in this document are sourced from the WorkSafe Victoria *Guide for Undertaking Work Near Underground Assets,* the Utility Providers *Code of Practice for Western Australia* and the NSW Streets Opening Conference *Guide to Codes and Practices for Streets Opening.*

CONTENTS

PREFACE

This Guideline is for employers, employees, contractors, subcontractors and other parties involved in construction work near underground assets. Note: This Guideline is not designed to impact on mining legislation.

The aim of this Guideline is to assist employers in deciding appropriate measures to eliminate or control risks to workers and other people on construction sites. It provides practical advice on implementing the requirements of the *Occupational Health and Safety Act 2000* (OHS Act) and the *Occupational Health and Safety Regulation 2001* (OHS Regulation).

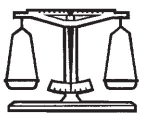
At times, construction work may be carried out near underground assets on greenfield construction sites as well as on or near public roads and pedestrians. Where construction and maintenance work is carried out on or near public roads, work should be carried out in accordance with the AS 1742 set of Standards – *Manual of uniform traffic control devices.* These Standards are supported by a set of field guides (HB 81) *Field guide for traffic control at works on roads.*

Use this Guideline to assess the effectiveness of your present arrangements for dealing with safety issues associated with working near underground assets, and to check that sources of risk have been identified and dealt with. If you are setting up a new business, this Guideline can serve as your step-by-step guide to establishing a program to manage the hazards arising from work near underground assets.

Work on, near or adjacent to gas and electricity services are deemed to be high risk construction work. Also water and sewerage assets may be deemed to be high risk construction work.

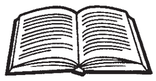
What do the symbols in the Guideline mean?

To help you work out what you require, a number of symbols are used to highlight things you need to take into account and tools to help you undertake the activity.



Assess the risks in your workplace

Processes of finding things that cause harm, work out how serious the problems are and then to fix them



Legal obligations that must be followed

The process of finding things that cause harm, working out how big a problem they are and fixing them

1. ESTABLISHMENT

1.1 TITLE

This is the Work Near Underground Assets Guideline.

1.2 PURPOSE

This Guideline provides practical guidance to prevent injury to people and damage to underground assets.

1.3 SCOPE

This Guideline informs asset owners, contractors, employers, workers and industry as to their obligations to:

- accurately install and record the location of the asset
- operate and maintain utility assets
- foster co-operation between underground utility owners and industry so as to eliminate or control the risk to individuals and the community, as well as damage to underground assets
- manage the risks involving underground assets at a workplace
- provide safe systems of work for individuals dealing with works near underground assets
- encourage the use of agreed practices for such work
- carry out JSA/Risk assessment and develop safe work method statements prior to commencing high risk construction work.

Note: This Guideline relates to underground utility assets on public land, within easements and on private property. While the principles may be similar, this Guideline does not specifically relate to underground assets on private property.

1.3.1 Encouraging compliance

All worksite controllers within NSW have a duty of care to persons within their worksite or those who may be affected by actions or omissions arising from their work activities.

The adoption of this Guideline when dealing with underground assets should help ensure that this duty of care is met.

All persons working near underground assets are encouraged to adopt this Guideline.

All asset owners must promote and encourage the adoption of this Guideline, not only within their own workplaces but to sub-contractors and all persons performing work near underground assets.

1.4 COMMENCEMENT

This Guideline takes effect on 05/07.

1.5 INTERPRETATION

1.5.1 Recommended practices

Words such as ‘should’ indicate recommended courses of action. ‘Consider’ indicates a possible course of action that the Guideline is indicating the duty holder should think about. However, you may choose an alternative method of achieving a safe system of work.

1.5.2 Legal requirements

Words such as ‘must’, ‘requires’ or ‘mandatory’ indicate that legal requirements exist which must be complied with.

1.6 DEFINITIONS

access authority	a written authorisation, issued by an asset owner, which allows persons to work within a specified proximity of the asset.
accredited person	a person who has successfully completed a recognised training course relating to the specific job, the training having been conducted by a registered or accredited training organisation.
approach distance	the minimum separation in air from an exposed conductor that shall be maintained by a person, or any object held by or in contact with that person.
approved	having appropriate endorsement in writing for a specific activity.
asset owner	the owner, controller or operator of an underground asset. For the purpose of this Guideline an underground asset includes electrical, water, sewage and drainage, gas, telecommunications, petrochemicals and hazardous substances.
authorised person	a person with technical knowledge or sufficient experience who has been approved, or has the delegated authority to act on behalf of the organisation, to perform the duty concerned.
cable	an insulated conductor or two or more such conductors laid together, whether with or without fillings, reinforcements or protective coverings.
competent person	a person who has acquired through training, qualification or experience, or a combination of them, the knowledge and skills to carry out the task.
confined space	confined space as defined in Australian Standard AS 2865 *Safe working in a confined space.*
construction work	means any of the following: • excavation, including the excavation or filling of trenches, ditches, shafts, wells, tunnels and pier holes, and the use of caissons and cofferdams • building, construction (including the manufacturing of prefabricated elements of a building at the place of work concerned), alteration, renovation, repair, maintenance and demolition of all types of buildings • civil engineering, including the construction, structural alteration, repair, maintenance and demolition of – for example, airports, docks, harbours, inland waterways, dams, rivers, avalanche and sea defence works, roads and highways, railways, bridges and tunnels, viaducts – and works related to the provision of services such as communications, drainage, sewerage, water and energy supplies.

consumer services	the supply to individual houses or premises, as opposed to "mains" which form part of the utility's distribution system.
– water	the cold water supply pipework from the water main up to and including the outlet valves at fixtures and appliances. The water service is owned by the consumer.
– electricity	consumer services means the conductors from the supply authorities' distribution mains (overhead or underground) to the customers' premises.
– gas	the pipe used to supply gas to the property, which runs from the distribution main to the meter position. the Network Operator, also known as the Asset Owner, owns the section of the pipe between the distribution main and the property. The property owner owns the section of pipe between the property line and the meter.
– telecommunications	the conduit and cabling controlled by the Carrier from the Network Point of Presence to the Network Boundary Point (NBP). Cabling beyond the NBP is customer owned cabling.
contaminated ground	a contaminated site that poses a significant risk of harm to human health or the environment and is regulated by the EPA (NSW) under *Contaminated Land Management Act 1997.* Refer to http://www.epa.nsw.gov.au/clm/searchregister.aspx
control measures	measures taken to minimise a risk to the lowest level reasonably practicable.
crane	an appliance intended for raising or lowering a load and moving it horizontally. Includes the supporting structure of the crane and its foundations, but does not include industrial lift trucks, earth moving machinery, amusement devices, tractors, industrial robots, conveyors, building maintenance equipment, suspended scaffolds or lifts.
earthed	direct electrical connection to the general mass of earth so as to ensure and maintain the effective dissipation of electrical energy.
earth moving machinery	an operator controlled item of plant used to excavate, load or transport, compact or spread earth, overburden, rubble, spoil, aggregate or similar material, but does not include a tractor or industrial lift truck.
electrical apparatus	any electrical equipment, including overhead power lines and underground cables, the conductors of which are live or can be made live.
electricity network	transmission and distribution systems consisting of electrical apparatus which are used to convey or control the conveyance of electricity between generators' points of connection and customers' points of connection.
emergency work	work to rectify or prevent imminent danger to human life or physical injury. work to rectify or prevent imminent or continuing damage to, or destruction of, property or the environment. work to rectify or prevent an unscheduled outage which has or is likely to have a significant impact on the Distribution Network or the Carrier's network.
employee	an individual who works under a contract of employment or apprenticeship.
employer	a person who employs persons under contracts of employment or apprenticeship.
energised	connected to any source of energy.

excavating	the movement or placement of soil or other surface materials by removing, boring or forcing objects into the ground or surface of the earth.
exposed conductor	an electrical conductor, approach to which is not prevented by a barrier of rigid material or by insulation that is adequate under a relevant Australian Standard specification for the voltage concerned.
extra high voltage (EHV)	in NSW, means a transmission system cable with a nominal voltage of 132,000V a.c. (132kV) or above.
hazard	anything (including work practices and procedures) that has the potential to harm the health and safety of a person.
high pressure gas (HP)	210kPa – 1050kPa. **Note:** Transmission Pressure gas is equal to or greater than 1050kPa.
high-risk construction work	means any of the following construction work: • involving structural alterations that require temporary support • at a height above 3 metres • involving excavation to a depth greater than 1.5 metres • demolition work for which a licence is not required • in tunnels • involving the use of explosives • near traffic or mobile plant • in or around gas or electrical installations • over or adjacent to water where there is a risk of drowning.
high voltage (HV)	a nominal voltage exceeding 1000V a.c. or exceeding 1500V d.c.
insulated	separated from adjoining conducting material by a non-conducting substance which provides resistance to the passage of current, or to disruptive discharges through or over the surface of the substance at the operating voltage, and to mitigate the danger of shock or injurious leakage of current.
instructed person	a person adequately advised or supervised by an Authorised Person to enable them to avoid the dangers which electricity may create.
isolated	disconnected from all possible sources of energy by means that prevent unintentional energisation of the apparatus.
lancing	using water or air aided by vacuum extraction to achieve non-destructive excavation.
live	energised.
low pressure gas (LP)	pressure less than or equal to 7kPa.
low voltage (LV)	a nominal voltage exceeding 50V a.c. or 120V d.c. but not exceeding 1000V a.c. or 1500V d.c.
mains	part of the utility's distribution system as opposed to "services" which are the take-offs for individual properties.
– water/sewerage	a conduit or pipeline controlled and maintained by a network utility operator or water authority.
– electricity	aerial or underground wires or cables from 400/230V to 330kV a.c
– gas	a pipe installed in a street to convey gas to individual services.
– telecommunications	any facility owned by the carrier – typical underground plant consists of conduits, cables, pits and manholes linking exchanges, or exchanges to distribution points.

medium pressure gas (MP)	pressures greater than 7kPa and up to 210kPa.
mobile plant	includes plant that: • moves either under its own power or is pulled or pushed by other mobile plant • moves on or around the worksite, enters or leaves the site, or moves past the site • includes road vehicles operating at a worksite. **Note:** This definition has been adopted for the purposes of this Guideline. This includes items such as earthmoving machinery, concrete boom pumps and tipper trucks operating at a worksite.
network operator	also known as the asset owner.
nominal voltage (U)	the a.c. or d.c. voltage by which a system of supply is designated.
OHS act	the Occupational Health and Safety Act 2000.
OHS regulation	the Occupational Health and Safety Regulation 2001.
overhead power line	any bare or covered aerial conductors and other associated electrical parts that make up an aerial line for the distribution and transmission of electrical energy.
other cable systems	telecommunications cables, optic fibre cables, control cables, earth cables or electrolysis drainage cables.
personal protective equipment (PPE)	items that workers can use to protect themselves against hazards. PPE includes insulating gloves, mats or sheeting, glasses and face protection. **Note:** A number of items of PPE are made and tested to Australian Standards. PPE that is not designated as meeting a recognised Standard may be unreliable in service, as its performance is unknown.
place of work	premises where people work.
plant	any machinery, equipment or appliance. **Note:** For the purposes of this Guideline the definition includes a broad range of machinery and equipment, but not limited to, cranes, mobile plant, scaffolding, load shifting equipment, industrial lift trucks, earth moving machinery, amusement devices, tractors, rural machinery, vehicles, conveyors, building maintenance equipment, suspended scaffolds or lifts, implements or tools and any component or fitting of those things.
polymeric	made from polymers otherwise known as plastics.
pot-holing	excavating with hand tools to a pre-determined depth to establish if assets exist in the immediate location.
premises	includes any place, and particularly includes: • any land, building or part of a building • any vehicle, vessel or aircraft • any installation on land, on the bed of any waters or floating on any waters • any tent or movable structure.
permit conditions	permission conditions stipulated by asset owner.
pressurised	a constrained flow of a substance in a pipeline which may be of varying diameters and thicknesses, the flow of which may or may not be directly controlled by an asset owner.
procedure	the documentation of a systematic series of actions (or activities) directed to achieve a desired result.

property line	the boundary line between the road reserve and the adjacent property.
railway assets	electrical, signalling and communications infrastructure owned and maintained by the rail entity. Assets also included but are not limited to, drainage lines and compressed air line.
safety observer	a competent person who has been specifically assigned the duty of observing and warning against unsafe approach to the asset.
supervisor	a representative of the principal for a worksite, who has the delegated responsibility for a task or range of tasks being undertaken at the worksite.
underground assets	part of an underground network such as water/drainage/sewerage, electricity, gas or communications etc.
underground services	the supply to individual houses or premises as opposed to underground assets which form part of the utility's distribution system.
works planned or programmed	any work which has followed the normal planning process prior to work commencing ie where the worksite has been physically inspected and assessed in advance of the work crew arriving on site.

2. PLANNING AND PREPARATION

The OHS Act and the OHS Regulation require employers to address workplace health and safety through a process of risk management and consultation.

Under the OHS Act and the OHS Regulation, employers have an obligation to ensure the health, safety and welfare of employees at work and that other people are not exposed to risks to their health and safety. When contracting out work, employers must ensure that contractors are planning and carrying out work in a safe manner. The work should be conducted according to this Guideline.

To effectively implement this Guideline, employers need to be aware of these requirements and have procedures in place to apply them. Employees, self-employed persons, subcontractors and controllers of premises, plant and substances also have responsibilities under OHS legislation. Each individual should ensure that they work safely and that their work does not expose others to health and safety risks.

The way to systematically plan and manage health and safety in the workplace is to build risk management and consultation into all those activities that may have OHS implications. This will involve activities such as purchasing, work methods or procedures, using contractors, reporting OHS problems, investigating incidents and planning emergency procedures.

2.1 UNDERSTANDING RESPONSIBILITIES

2.1.1 Clients

The client's responsibilities under the OHS Act and OHS Regulation will depend on their role in the design and construction. They are usually a "controller of premises" at least to some extent and may also have other roles such as designer, principal contractor or an employer in relation to the project.

The client is also in the best position to influence others to consider that constructability and maintainability are included in the design and thus to reduce construction and ongoing maintenance risks at the design stage. Setting realistic timeframes for tendering, planning and project execution can also assist planning and execution of construction work.

However, the client is not always aware of all the complexities, such as the range of construction techniques, ground conditions and their effect on safety. It is therefore often appropriate for consultation between the client and other parties at an early stage to take advantage of the opportunity to identify the best concept design.

2.1.2 Controllers of work premises, plant or substances

Controllers of work premises, plant or substances also have health and safety legal responsibilities. They must make sure that the premises used as a place of work are safe and without risks to health and that the plant and substances used in the work process are safe and without risks to health when properly used. For persons who have only limited control of the premises, plant or substances, their responsibilities apply only to the matters over which they have control.

Designers should ensure that:

- to the extent that they have control over the design work, the structure (or plant) can be safely constructed, used, repaired, cleaned, maintained, and demolished, such that the health and safety of any person is not put at risk by the design
- information is provided to the client about the health and safety aspects of the design.

Designers should also ensure that, as far as practicable, hazards associated with the following are identified before commencement of the construction work:

- the design of the structure (whether permanent or temporary)
- systems of work required to construct, repair and maintain the structure
- the intended use of the structure
- materials required to be used in the construction of the structure
- the demolition (or abandonment) of the structure.

Note: In relation to the design of plant, the OHS Regulation contains more detailed risk control requirements on designers, manufacturers and suppliers.

Where there is more than one designer, critical aspects of the project should be documented and liaison should occur between the principal contractor and relevant designers so that the work can be coordinated to ensure the safe interaction of the different design aspects. When risks remain in the design work, information should be included with the design to alert others to the risks.

2.1.3 Principal contractors

The principal contractor, whether as an employer or as the person in control of the workplace, must provide and maintain in relation to those matters over which he or she has control, a workplace that is safe and without risks to health for their employees and other persons present at the workplace or affected by the work. To fulfil these obligations the principal contractor must plan for the work to be done safely.

The principal contractor must ensure that a site specific OHS management plan is prepared and documented for each place of work where construction work is to be carried out, before the work commences. This plan must be developed in consultation with the contractor/s and their employees or representatives. The plan must include safe work method statements (SWMS), provided by the contractors where they are used, for all work activities assessed as having risks. It must also include the following details:

- arrangements for OHS induction training
- arrangements for managing OHS incidents including response persons
- site safety rules and arrangements for informing persons affected
- details where persons have specific site OHS responsibilities.

The health and safety management plan must be monitored to ensure that work is carried out safely, according to that plan and that the plan is effective. The plan must be maintained and up to date during the course of the construction work and must be made available for inspection. The principal contractor must stop work immediately, or as soon as it is safe to do so, where there is a risk to the health or safety of a person.

2.1.4 Contractors

The contractor(s) doing the work, whether the principal contractor themselves or sub-contractors, must provide and maintain a workplace that is safe and without risks to health for their employees in relation to those matters over which they have control.

In addition to consultation with the principal contractor in the overall job planning, the contractor must develop written SWMS including an assessment of the risks and the controls used to carry out the work safely.

2.1.5 Employees

Employees must take reasonable care of the health and safety of themselves and others. Employees must cooperate with employers in their efforts to comply with OHS requirements. This means that employees must notify their employer of safety and security hazards, risks and incidents in line with the requirements of the OHS Act. These requirements should be outlined by the employer's OHS policy, procedures and safety related instructions.

Employees must not be required to pay for anything done or provided to meet specific requirements made under the OHS Act or OHS Regulation.

2.1.6 Self-employed persons

Self-employed persons must ensure that their undertakings do not expose others to health or safety risks.

2.2 COORDINATION OF RESPONSIBILITIES

There may be a number of parties involved in a project, such as:

- the client
- the principal contractor
- controllers of premises, plant or substances
- designers
- employers (contractor or subcontractors) who employ persons at the site, including labour hire agencies providing persons to the site
- self-employed persons
- suppliers of plant, materials or prefabricated components.

Where more than one party has responsibilities at a specific workplace, each party retains their legal responsibilities and must discharge their responsibilities in a coordinated manner.

3. CONSULTATION AND RISK MANAGEMENT

The OHS Act and the OHS Regulation require employers to address workplace health and safety through a process of risk management and consultation.

To effectively implement this Guideline, employers need to be aware of these requirements and have procedures in place to apply them.

Employers are advised to consult the OHS Act and the OHS Regulation as well as the *Code of Practice: Occupational Health and Safety Consultation* and the *Code of Practice: Risk Assessment* for details of these requirements and how they can be met. The following information is designed to provide an overview of legislative requirements.

3.1 CONSULTATION AT THE WORKPLACE

Employers must consult with employees when taking steps to assess and control workplace risks.

In order to consult with employees, employers are required to set up consultation arrangements and develop consultation procedures.

3.1.1 Consultation arrangements

The OHS Act provides three options for consultation arrangements:

Arrangement	Workplace	Requirement
OHS Committee	20 or more employees	requested by a majority of employees or direction by WorkCover
OHS Representative	any size	at least one employee requests an election or directed by WorkCover
Other agreed arrangements	any size	agreed to by both the employer and employees (in a small workplace it may be a regular safety meeting with employees)

Before using this Guideline, an employer should ensure that consultation arrangements are in place. An employer may initiate the establishment of an OHS Committee or the election of an OHS Representative if the employees have not made such a request. When the consultation arrangements have been decided, clause 27 of the OHS Regulation requires employers to record them and advise all existing and new employees.

3.1.2 Consultation procedures

After setting up the consultation arrangements employers need to consider when and how these consultation arrangements need to be applied.

3.1.3 When should consultation be undertaken?

Under section 13 of the OHS Act, employers have the general duty to consult employees when decisions are being considered that may affect their employees' health and safety. Therefore, employers are required to consult with their OHS Committee, OHS Representative or other agreed arrangement when such decisions are being considered. Decisions which could affect health and safety include:

- planning for new premises or modifying existing premises
- purchasing new plant, equipment or substances
- planning, designing or changing work tasks or jobs
- using contractors in the workplace
- investigating incidents or accidents
- developing emergency procedures
- determining or reviewing workplace amenities
- determining or reviewing consultation arrangements.

Note: Any procedures that are developed to encompass these activities should incorporate consultation.

It may not be practical or reasonable to involve the OHS Committee or the OHS Representative in every purchase decision or task change. However, the employers and committee or representative should agree on what process is needed to ensure that affected employees are consulted.

3.1.4 How should consultation be undertaken?

When engaged in consultation, the OHS Act requires employers to:

- **share all relevant information with employees.** For example, if an employer is going to change a work task, employees need to be told of any risk to health and safety that may arise and what will be done to eliminate or control these risks.
- **give employees reasonable time to express their views.** Employees need adequate time to assess the information given to them, obtain relevant safety information and consult with fellow employees to enable them to form their views.
- **value the views of employees and take them into account when the decision is made to resolve the matter.** In many cases, agreement will be reached on how the safety issues are to be addressed. When agreement cannot be reached, the employer should explain how the employees' concerns have been addressed.

3.2 RISK MANAGEMENT AT THE WORKPLACE

Employers and self-employed persons must identify any foreseeable hazards, assess their risks and take action to eliminate or control them.

When addressing health and safety issues, besides consulting employees, employers must adopt the process of risk management. This process requires employers to:

3.2.1 Identify hazards

To ensure a safe and healthy workplace, employers must identify all the foreseeable health and safety hazards, which could harm their employees or other persons in the workplace. Hazards may arise from the work process, the equipment and materials in use, the work environment, or other people involved.

3.2.2 Assess risks

Once hazards have been identified the risk they pose to health and safety needs to be assessed. Some hazards pose a greater risk than others do, and the frequency and duration of exposure can also affect the risk. Risk assessment involves considering the likelihood and severity of injury or illness being caused by exposure to the risk. Therefore the factors that need to be considered in a risk assessment should include the:

- harm that can be caused by exposure to the hazard
- number of people and the duration and frequency of exposure to the hazard
- capability, skill and experience of people exposed to the hazard.

The risk assessment process provides information on the factors which contribute to the risk. This information will assist in determining what needs to be done to eliminate or control the hazard.

3.2.3 Eliminate or control the risk

The first responsibility is to investigate how the risk can be eliminated. Before implementing the control measures described in this Guideline, an employer should investigate possible strategies for eliminating the hazard from the work system.

If it is not reasonably practicable to do so, the risks associated with the hazard must then be controlled. This Guideline has been developed to provide advice on the most effective control measures.

3.2.4 Review risk assessment and control measures

Control measures should be reviewed on a regular basis. The frequency of their review should be determined by considering the significance of the risks associated with the hazard. However, a review should be undertaken in the following circumstances:

- new information is made available about the risks associated with the hazard
- an accident or incident occurs
- significant changes are proposed to the workplace or work system.

3.2.5 When must employers undertake risk management?

The OHS Regulation requires employers to incorporate the process of risk management into procedures.

These are the same activities for which employers are required to consult with employees.

3.2.6 Strategies for developing effective risk management procedures

When risk management activities are undertaken the following strategies should be considered to inform the process:

- visual checks through workplace inspections
- analysing the types of work being performed and the way work is performed
- inspections of plant and equipment
- analysing workplace records on accidents, incidents or 'near misses'
- risk management information provided by suppliers or manufacturers of equipment or, in the case of hazardous substances, Material Safety Data Sheets (MSDS)
- industry codes of practice for particular hazards or work processes
- Australian Standards, which set safety standards for a range of equipment products and materials
- guidance material from WorkCover NSW or industry or professional organisations.

Further advice is provided in the *Code of Practice: Risk Assessment.*

3.2.7 Personal protective equipment (PPE)

The use of PPE to control risks is lowest on the hierarchy of control measures. The measures at the lower levels are less effective and they require more frequent reviews of the hazards and systems of work. They should only be used when other control measures are impracticable or when, after implementing other controls, a residual risk remains.

- *PPE selection and suitability*

  Where PPE is to be used it should be appropriate for the risk and comply with the relevant Australian Standard or WorkCover approval. Employees should be competent in the proper selection, use and maintenance of the PPE. There should be sufficient supervision and monitoring conducted to ensure PPE is used and employees are competent in its use. PPE should be regularly inspected, maintained and replaced as necessary.

- *Eye protection*

  Dust, flying objects and sunlight are the most common sources of eye damage in excavation work.

  Where persons are carrying out cutting, grinding or chipping of concrete or metal, or welding they must be provided with eye protection complying with AS/NZS 1337:1992 – *Eye protectors for industrial applications.* Eye protection complying with AS/NZS 1337 should also be provided where persons carry out other work, such as carpentry or handling of chemicals, where there is a risk of eye injury. Selection, use and management systems should comply with AS/NZS 1336:1997 – *Recommended practices for occupational eye protection.*

- *Hearing protection*

  Where personal hearing protection is provided it should conform with AS 1270:1988 – *Acoustics – Hearing protectors.* Control measures including training should comply with AS/NZS 1269.3:1998 – *Occupational noise management – Hearing protector program.*

- *High visibility garments/safety reflective vests*

  Persons working underground or near traffic, mobile plant or equipment under operator control, should be provided with and use high visibility garments. Such garments should be selected, used and maintained in accordance with AS/NZS 4602:1999 – *High Visibility Safety Garments.* Other clothing not covered by the high visibility garment should be light coloured and all garments should be selected for best contrast with the surrounding background.

- *Safety helmets*

  The use of safety helmets may prevent or lessen a head injury from falling objects or a person hitting their head against something. Where there is a likelihood of persons being injured by falling objects and overhead protection is not provided, persons must be provided with and must use an appropriate safety helmet. Appropriate safety helmets should also be provided and used where a person may strike their head against a fixed or protruding object or where there is a risk of accidental head contact with electrical hazards.

  All persons on excavation sites should wear head protection that conforms to AS/NZS 1801:1997 – *Occupational protective helmets* and be used in accordance with AS/NZS 1800:1998 – *Occupational protective helmets – Selection, care and use.*

- *Safety gloves*

  Where there is a risk of hand injury, such as exposure to a harmful substance, excessive heat or cold, or to a mechanical device, hand protection appropriate to the risk and that complies with AS/NZS 2161:1998 – *Occupational protective gloves* should be provided and used.

- *Waterproof clothing*

  Waterproof clothing provided as a system of work relating to weather or site conditions should be effective and suitable for the task. Waterproof clothing should also incorporate light reflective features in accordance with the requirements of the section above.

3.2.8 Incident reporting

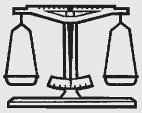
Hazards and OHS problems should be reported as soon as they are noticed so that the risks can be assessed and addressed as quickly as possible. Records of reported hazards should be kept and should include details of the action taken to remove the hazard or control the risk arising from the hazard.

The OHS Regulation also prescribes a number of workers compensation and OHS legal requirements concerning incident and injury reporting.

3.2.9 First aid

The OHS Regulation requires that employers must provide first aid facilities that are adequate for the immediate treatment of injuries and illnesses that may arise at the place of work and, if more than 25 people are employed, trained first aid personnel.

To ensure adequate first aid provisions, employers must identify their potential problems, assess their requirements and consult with employees in the process.



When determining the nature, number and location of first aid facilities and the number of trained first aid personnel, employers must take into account the location and type of work being undertaken. The type of work performed will influence the hazards and the possible harmful consequences for employees. For example, office workers will have different first aid requirements from construction workers. Workplaces using hazardous substances may require specialised first aid facilities, such as eyewash stations and emergency showers. The risk assessment process will assist in identifying the particular needs of the workplace.

Further information regarding such matters as contents of first aid kits, who qualifies as 'trained first aid personnel', and other requirements relating to first aid rooms, consult the OHS Regulation or the *First Aid in the Workplace Guide.*

3.2.10 Emergency response

The OHS Regulation specifies that an employer must ensure that, in the event of an emergency at the workplace, arrangements have been made for:

- the safe and rapid evacuation of persons from the place of work
- emergency communications
- appropriate medical treatment of injured persons
- appointment of appropriately trained persons to oversee any such evacuation and, if appropriate, the use of on-site fire fighting equipment.

3.2.11 Record keeping

The OHS Regulation requires records to be kept in the following areas:

- induction training
- hazardous substances
- confined spaces
- plant
- electricity
- asbestos
- atmospheric monitoring
- notification of accidents.

Refer to the relevant chapters of the OHS Regulation for further information.

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- All major utilities are members including Energy Australia, Integral Energy, Telstra, Optus, Alinta and Sydney Water.
- Digging without maps means exposing yourself and your contractors to danger.
- Unexpected cable strikes can slow your job down.
- Damage to underground utilities can affect your insurance.

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Fax 1300 652 077 anytime

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4. ACCURATE INSTALLATION AND INFORMATION

4.1 INTRODUCTION

Asset owners are required to capture and maintain accurate and up-to-date (as built) records of their underground assets.

When planning a job requiring excavation, a complete record search must be undertaken by lodging an enquiry with the central call service 'Dial Before You Dig'. Asset owners who are not members of this service must also be contacted. When an asset location is requested, asset owners may provide information on the recommended practices for work near that location or asset.

Lodging an enquiry with 'Dial Before You Dig' is as simple as visiting www.dialbeforeyoudig.com.au, phoning 1100 or faxing an enquiry to 1300 652 077. Once the records are obtained, they should remain in the work area and be accessible to all. When carrying out emergency work, every effort should be made to obtain records as soon as possible. If work must commence prior to the records being obtained, it should be carried out on the basis that underground assets are present even if an Electronic Service Detector gives the 'all clear'.

It should be also remembered that as technologies and work practices change over time, features such as the presence of warning tape may not be where you expect (see Table A). For example, the majority of telecommunication assets at joint locations are now housed in pits or manholes. However, the line between these may not be straight if obstructions were encountered during installation. Direct buried cable in rural areas may be identified by pits/manholes and marker posts. However, it cannot be assumed that a cable follows a direct path between these items.

WARNING: Asset owners' plans may not show the presence of all cables, pipes and plant. They may only show their position relative to road boundaries, property fences etc at the time of installation and the asset owners do not guarantee that such plans are accurate thereafter due to changes that may occur over time.

Do not assume depth or alignment of cables as these vary significantly. For example, road and building alignments and levels may change.

4.2 ENSURING ACCURACY OF PLANS AND RECORDS

Asset owners shall have a system of work which ensures the accuracy of plans. The system of work should be included in the asset owners' audit processes.

Improving the accuracy of existing asset plans relies on cooperation between asset owners and contractors. If during work activities, underground assets are found to be not on the plans or are in a different location, contact should be made with the source of the plans to notify of the missing information.

4.3 UNDERGROUND ASSET OWNERS INCLUDE:

- electricity generation, transmission and distribution
- rail
- Roads and Traffic Authority
- local authorities
- telecommunications
- private (eg privately owned water pipelines)
- gas transmission and distribution
- petrochemical (oil, petrol, LPG etc)
- oil
- water
- drainage
- sewerage.

(See Table A).

4.4 ELECTRICITY CABLES

4.4.1 Cable records

Cable records are in the form of plans drawn to scale or on computer based Geographic Information Systems (GIS).

The detail of the records will vary with the type of installation. For cable installed in a standard allocation, the records may provide only general cross sectional arrangements of cable and conduits together with road crossing and street lighting information.

It is common practice to negotiate a special alignment on the roadway for high voltage transmission cables. For this type of installation, the records are more detailed with reduced level and offset information provided. The details of local area distribution and of transmission cables are typically shown on separate plans.

Older installations may not be accurately recorded or reference details may have changed.

4.4.2 Cable installation

The cover for underground electricity cables and underground control cables may vary in depth. Always assume a cable may be present. See Table B.

Note: Underground electrical cables are not necessarily covered with slabs, marker tapes or other indicators of their presence and are frequently not enclosed in conduits. Some underground electrical cables may have been encased in bitumen. Hence a full risk assessment must be undertaken prior to carrying out any excavation work so as to accurately establish the exact locations of underground electrical cables.

4.4.3 Cable ancillary equipment

Associated with many cable installations are ancillary assets and pits. These may include cable joint pits, cable link pits, oil or gas pits, inspection pits and other ancillary pits. These pits will have cables or pipes that connect them to the main cables and care should be exercised when excavating between the cables and the ancillary pits. The presence of ancillary pits shall be confirmed with the electricity asset owner prior to any work.

4.5 GAS PIPES

4.5.1 Gas reticulation systems

Several methods of gas reticulation are used, from low-pressure services through to transmission systems. These systems have been constructed from materials including coated welded steel, cast iron, and a variety of plastics. In most areas, the systems are buried directly in a suitable stone-free backfill. The systems are not designed to resist the impact of tools or mechanical plant or to be left unsupported over any great distance. The operating pressures range from as low as 2kPa up to as high as 15MPa for a transmission pipeline system.

4.5.2 Pipe records

The records for all high and low pressure gas distribution mains are maintained in the form of plans drawn using Computer Aided Design system (CAD). The detail of the records will show the size of pipe and the type of material, changes in direction. Please note gas consumer services are generally not shown on plans. High-pressure transmission pipelines are generally located within a pipeline easement, therefore records of these pipelines are in the form of alignment sheets specific to the individual pipeline.

The location of high and low-pressure distribution mains on the plans are shown at a nominal distance from the building line. The actual pipe alignment will be shown in text as an offset distance in metres from the Building Line (MBL) – also could be known as the 'property boundary'. When locating gas distribution pipes always reference the offset distance from the building line as minor changes in alignment will not be shown graphically.

4.5.3 Pipe installation

Most pipes laid in recent years may have a marking tape or polymeric plastic slab laid above the pipes for identification when excavating. However, these tapes or slabs may have been damaged by other excavations in the area since the initial construction and not replaced. For location purposes, plastic pipe may have been laid with a trace wire to enable the main to be located using a cable locator. Again, it is important these tracer wires are not interfered with or broken, as it makes future location of these pipes very difficult. If you do break the trace wire, please ensure that the wire is rejoined and coated with electrical tape. Steel mains and pipelines will not have a trace wire as they are metallic and can be detected. Other structures, such as siphon points, valve pits, regulator pits and other varied components may be installed in the pipeline. Care needs to be taken to locate these before excavation.

While the plans may show the expected location of underground distribution mains, consumer services are not shown. Properties should be checked to ascertain whether gas meters are present. If so, the services normally run at right angles to the distribution main to the service connection at the meter. However, it cannot be assumed that a pipe follows a direct path between these items. Be aware the consumer service may receive its supply from a distribution main on the opposite side of the road. The installed depth of consumer services varies – refer to Table B. In circumstances where the correct depth of cover has not been achievable, mains and services may be encased in concrete or laid in copper pipe.

All high-pressure steel distribution mains and transmission pipelines have corrosion protection systems. These systems form part of the pipeline and incorporate the protective coating, test points and galvanic anodes at various points along its length. If these are broken or damaged, it should be reported to the gas utility immediately. They are easily rectified but can be extremely difficult to locate if the damage is not reported.

4.6 WATER AND SEWER PIPES

4.6.1 Pipeline types

Cast iron and steel pipes are often joined with lead. These and asbestos pipes are easily disturbed and brittle. Mild steel and ductile cast iron pipes have external protective coatings which, when damaged, significantly reduce the life of the pipes. Copper pipes are very soft and easily compressed or bent without necessarily breaking, but their flow capacity can be significantly reduced. Recycled water areas have dual pipe and service systems.

The water supply system in residential areas has traditionally formed part of the multiple earth neutral (MEN) system of the electricity distribution network. More recent use of PVC and polypropylene materials may adversely impact the MEN system. Refer to Section 5 for more information.

4.6.2 Depth and location

Water authorities, developers and local councils maintain records of pipeline locations.

As with other assets, there can be great variations in pipeline depths, depending on their age and the amount of surface reconstruction over the years. More recently, some water assets have been co-located with other assets in shared trenches. This raises the potential problem of simultaneous damage to several assets.

Some pipes may be encased in concrete to provide added support and protection.

4.7 TELECOMMUNICATION CABLES

Telecommunications cables developed for underground installations have changed in line with technology requirements.

Plans provided by Telstra are circuit diagrams only and indicate the presence of telecommunications plant in the general vicinity of the area shown. Due to the nature of the Telstra plant and the age of some cables and records, it is impossible to ascertain the location of all Telstra plant from plans. Telecommunications plant seldom follow straight lines and careful on site investigation is essential to uncover and reveal its exact position.

4.8 ABANDONED AND RETIRED UNDERGROUND ASSETS LEFT IN-SITU

In cases where assets are no longer to be utilised and are to be left in-situ, they are to be disconnected and/or filled, capped, plugged or otherwise rendered safe to avoid any future problems.

All such assets shall be consistent with the following points:

- treated as in-service unless otherwise positively proven out of service
- marked accordingly on the appropriate asset record
- if out of service retired or abandoned assets etc are to be interfered with, the owner of the asset should be contacted and arrangements made to locate the asset
- an asset shall not be used by others without prior agreement with the asset owner. This is so that both organisations' records can be updated
- where an asset is inserted inside an out of service, retired or abandoned conduit, pipe or duct, the records shall show this information
- if assets are sold or disposed of to another owner, then both organisations records should show such information.

4.9 TABLE A: THE INSTALLATION OF VARIOUS TYPES OF UNDERGROUND ASSETS

Assets have been installed underground over the last 150 years. Therefore you may come across a large range of pipe and cable materials, their installation technologies and protection barrier methods. The table below gives an overview of these different techniques. It is not a complete list and it should be remembered that you may come across underground assets that have no barrier protection or other indication of their presence, for example underbores.

Utility/Industry	Asset	Traditional Techniques	Current Techniques	New Technologies
Electrical cables (power, rail and tram)	Transmission: Extra High Voltage (EHV) Distribution: High Voltage (HV) and Low Voltage (LV) Supervisory and signalling cables	Buried direct, conduits (orange PVC), ductlines, concrete encased, fibro asbestos cement, steel, earthenware or encased in bitumen Protective covers bricks/tiles, terracotta, concrete, polymeric Marker tapes – polymeric	Direct burial in trench, ducts Some thrust boring across roads Marker tape – polymeric Protective covers – polymeric and concrete Surface markers	Trench-less technology including directional drilling Conduits installed by directional drilling. Variations in alignment and depth may occur. Multiple conduits can be installed using this method
	Cathodic protection	May be direct buried	Nil	
	Earthing rods and conductors	Direct buried	Direct buried	
	Conduits and ducts	Orange PVC	Orange PVC	
	Power poles and lattice towers	Risk assess to ensure that 1) structure will not be undermined and 2) cable is not coiled around base of pole		
Gas pipelines	Transmission	Coal tar enamel (warning contains asbestos) coated steel pipe Blue polyethylene coated steel pipe	Yellow polyethylene coated steel pipe Red fusion bonded epoxy coated steel pipe Construction techniques included trenching, cased boring, horizontal directional drilling	

Utility/Industry	Asset	Traditional Techniques	Current Techniques	New Technologies
	Distribution High Pressure	Blue polyethylene coated steel pipe Yellow polyethylene coated steel pipe	Yellow polyethylene coated steel pipe Construction techniques included trenching, cased boring, horizontal directional drilling	High density polyethylene yellow stripe/black pipe
	Distribution Low Pressure	Tar coated wooden pipe Cast iron pipe Blue PVC pipe	Yellow nylon pipe Medium density yellow polyethylene pipe High density polyethylene black and yellow stripe pipe Insertion of disused cast iron pipe with nylon or polyethylene pipe Construction techniques included trenching, cased boring, horizontal directional drilling	
	Consumer services	Cast iron pipe Galvanised steel pipe	Yellow nylon pipe Medium density yellow polyethylene pipe High density polyethylene yellow stripe/black pipe Insertion of disused cast iron or galvernised pipe with nylon or polyethylene pipe Construction techniques included trenching, grundamat boring, horizontal directional drilling	

Utility/Industry	Asset	Traditional Techniques	Current Techniques	New Technologies
Water mains and services	Pipes 15 mm to 3000 mm, valves, hydrants, chambers	Cast iron, steel, cement coated steel, asbestos cement, copper, glass reinforced plastic ductile iron, polyethylene, PVC or concrete encased steel or ductile iron	Pipes usually installed by trenching Pipe cracking and slip lining renewal technique also used Some directional drilling Some thrust boring across roads Surface fittings for access and operation Chambers for valve access	Dual supply mains and services in recycled water areas
	Property connections	Service connections to properties are usually copper in smaller sizes and iron or steel in larger sizes (fire services and industrial)		Dual supply mains and services in recycled water areas
Sewerage mains and services	Pits pipes 15 mm to 1800 mm, tunnels, valves, connections	Cast iron, mild steel, cement lined steel, asbestos cement, copper, glass reinforced plastic, ductile cast iron or PVC, vitreous clay	Pipes installed by trenching Sewer re-lining or replacement using trenchless technologies (eg pipe cracking and slip lining)	On site treatment and reuse systems Jointless systems
Stormwater, grey water and drainage pipelines and services	Pits pipes 15 mm to 1800 mm, tunnels, shafts	Cast iron, mild steel, cement lined steel, asbestos cement, copper, ductile cast iron or PVC reinforced concrete	Installation generally by trenching	

Utility/Industry	Asset	Traditional Techniques	Current Techniques	New Technologies
Communications cables	Phone lines	Fibro asbestos cement (FAC) pipes and ducting. Galvanised iron (GI) pipe – various diameters Rocla concrete pipes Earthenware pipe Tunnels – Sydney CBD and servicing some other major telephone exchanges White PVC pipe 10 mm to 100 mm internal diameter Black PVC Directly buried cables PVC or armored steel sheath Polyethylene	Because of the long operational life of conduits, cables providing new technology services are often hauled into existing conduits All new standard conduit installations are white PVC of internal diameter 20 mm – 100 mm. Galvanised iron (GI) conduits are used for special purpose applications Conduits installed by directional drilling. Variations in alignment and depth may occur. Multiple conduits can be installed using this method Direct drilling technologies	Conduits installed by directional drilling. Variations in alignment and depth may occur. Multiple ducts can be installed using this method
	Co-axial, data and signalling cables	As above	As above	
	Broadband, copper and fibre optic cables	As above	As above Directly buried fibre optic cables will generally have been installed with marker tape above the cable containing a metallic wire Fibre Optic cables in conduits are installed by directional drilling technologies. They do not have marking tapes installed above the cable. In this case there may be no metal marking tapes installed	

Utility/Industry	Asset	Traditional Techniques	Current Techniques	New Technologies
	Conduits and ducts	As above	As above	
Oil transmission pipelines and valves	High Pressure (above 1050 kPa) Regularly signposted	Coal tar enamel (warning contains asbestos) coated steel pipe AS 2885-1997. *Pipelines for Gas & Liquefied Petroleum*	Yellow polyethylene coated steel pipe	
Privately owned pipelines	Chemical	Mostly similar to oil and gas transmission pipelines above (WorkCover Dangerous goods pipelines) Regularly signposted.		

Note: It is essential to treat a cable or pipe as high voltage or high pressure until it has been positively identified as being otherwise.

5. HAZARD IDENTIFICATION

5.1 SAFETY INFORMATION

Consideration must be given to the safety of individuals and the community, especially to provide adequate safety barriers and safe pedestrian access around the worksite. Additionally, PPE applicable to the particular operation must be used.

Excavation within the zone of influence may destabilise the underground asset or supporting structures resulting in damage to the asset.

5.1.1 Some of the dangers when working near underground assets

- *Gas*

  Damage to gas assets can cause gas escapes which may lead to fires or explosions if an ignition source is present. There are two types of leaks following damage to the asset:

  - damage which causes an immediate escape. In this case, there is a risk to those working at the site
  - damage which causes an escape some time after the incident. This may be through damage which weakens the asset casing or the result of poor reinstatement practice. In this instance, the public is mainly at risk.

- *Electricity*

  - an injury resulting from damage to live electricity cables is usually caused by electric shock or the explosive effects of arcing current and by the fire or flames which may follow when the sheath of a cable is penetrated by an object. Damage and injury may also occur if the cable is crushed or contact is made between the individual phases of a cable. The presence of gas or a mixture of gases in a trench could be ignited by an electrical charge or an electrical arc resulting in a fire or explosion, the severity of which depends on the gaseous mixture
  - gas can be present in the ground due to gas pipe damage or leakage, sewage pits, chemical reactions or leaching and the accumulation of airborne gases in low lying areas. Gas can also be introduced by the nature of the work being undertaken such as oxy-acetylene cutting or chemical grouting
  - consideration should be given to conducting a risk assessment to determine if a trench or the work constitutes a confined space.

- *Petroleum or oil pipelines*

  - the result of damaging these assets is similar to that of gas assets. However, there is the additional risk of significant environmental issues such as contamination of waterways.

- *Water pipes and sewers*

  - some pipelines transport water under high pressure. Some older water pipes are also made from asbestos cement. Damaged water pipes have great potential to affect other assets and structures, either directly or by washing away their supports ie thrust blocks

- the main danger from sewer damage is the contamination of a broken water main or asset, damage to the environment or disease from exposure to sewage. Some sewer lines are high pressure. Toxic and explosive gases may also be present in both sewer lines and stormwater drains
- persons working on metallic water pipes are at risk of electric shock due to an electrical fault near a customer's premises or a mains neutral fault in the street. Metallic water pipes are usually bonded to the electrical earthing system and are a path of low resistance. Stray electrical current will often flow through the bonded metallic water pipe. When the pipe is cut or disconnected, either side of the pipe could become live causing a person to receive a serious or fatal electric shock. The consumer is also at risk of an electric shock under the same circumstances.

- *Telecommunications*
  - consequences could be the isolation of whole communities, disruption of interstate and international telecommunications, inability to contact emergency services, loss of telephone, mobile phone, data and television services
  - cables containing optical fibres carry light signals generated by Class 3B lasers that can cause injury to the eye. This infra-red beam is invisible to the naked eye and exposure to it should be avoided. Small optic fibre particles are capable of entering the bloodstream causing injury or death.
- *Pipelines containing hazardous substances and dangerous goods.*

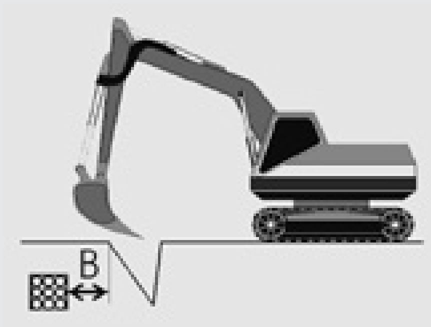
5.1.2 Safety considerations for Low, High or Extra High Voltage electrical cables

- High voltage (HV): same as for low voltage except the approach distances are variable. For more information refer to Table B.
- Extra high voltage cables (EHV): all work in the vicinity of extra high voltage cables must be undertaken with the consent and under the supervision of the asset owner. Contact with extra high voltage electric current will result in serious burns and/or death. For more information refer to Table B.
- Notwithstanding any guidance on the use of blasting as a means of excavation, where blasting is to take place within 200 m of an underground asset, the asset owner should be contacted for any special requirements.

5.1.3 Electrical earthing of metallic pipes

Prior to the removal or the repair/replacement of metallic piping, workers must ensure that an effective electrical bond across the break is maintained at all times.

5.2 TABLE B: TYPES OF ASSETS AND LIMITS OF UNDERGROUND APPROACH

Assets	Clearances	No Go Zone For Powered Excavation	Controls	Typical Depths
Types of underground assets **(Note:** The owners of assets registered with the Dial Before You Dig service and covered by this Guideline require an enquiry through this free service and the compliance with any directive issued with information regarding the asset)	The minimum approach distance for individuals carrying out work near underground assets	Distance 'B' is the minimum approach distance for powered excavating machines  For directional boring across the line of an asset a minimum clearance of **300 mm** from the asset shall be maintained For directional boring parallel to the asset and at the level of the asset, a clearance of **500 mm** shall be maintained from the edge of the nearest asset. It may be necessary to dig trial holes to prove the location of the nearest asset at points along the route. See Section 6.10	If the risk assessment identifies a potential risk of making contact with both underground and overhead assets, two safety observers would be required. One observer to ensure that the machinery maintains a safe distance from underground assets, the other observer to ensure a safe distance from the overhead powerlines In the case of gas or electricity assets, an appropriate fire extinguishing system must be at the worksite If the width and/or depth of the excavation will expose the asset, the asset owner must be contacted prior to commencing work	

Assets	Clearances	No Go Zone For Powered Excavation	Controls	Typical Depths
Low and Medium Pressure services and Low pressure mains	N/A	**300 mm**	Pot-hole to confirm location of service The position of the asset will not appear on the maps	**300 – 450 mm**
Medium Pressure mains	N/A	**300 mm**	Pot-hole to confirm location of asset The code of practice for shafts, tunnels and trenches, and the guide to dangers of poorly ventilated workplaces Only one individual at a time should be excavating if hand excavation is being undertaken in a confined space. Another should act as an observer and be able to operate any breathing, escape or fire equipment required The elimination of an ignition source in the event of an escape Excavation below underground assets should not be undertaken within a distance of **300 mm** below the asset located at the lowest level **Note:** All transmission pipelines involving gas, oil and petrochemical have separate requirements and the asset owners should be contacted.	**450 – 750 mm**

Assets	Clearances	No Go Zone For Powered Excavation	Controls	Typical Depths
High Pressure services, mains and pipelines	**300 mm** with hand tools and supervision from Network Authority	**1000 mm**	Powered excavation within 300 – 1000 mm is only permitted under supervision and with a Permit to Work from Asset Owner Also see **Controls** for medium pressure mains immediately above	**750 – 1200 mm**
Low Voltage Electricity cables – voltages less than or equal to 1000V (1kV)	Close proximity with use of hand tools	**300 mm**	Must contact asset owner for specific conditions	**450 – 750 mm**
Electricity conductors from 11,000V (11kV) up to 33,000V (33kV)	Close proximity with use of hand tools	**600 mm**	Must contact asset owner for specific conditions	**900 mm**
Underground sub-transmission cables 33,000V up to 132,000V (132kV)	Must contact asset owner	Must contact asset owner	Must be carried out under the supervision of the asset owner	**900 mm**
High Voltage Electricity cables – voltages from 1000V (1kV) up to 33kV	Close proximity with use of hand tools	Must contact asset owner	Must contact asset owner for specific conditions	**600 – 1000 mm**
Extra High Voltage Electricity Transmission cables – voltages above (132kV) and 330,000V (330kV)	Must contact asset owner	Must contact asset owner	Work must be carried out under the supervision of the asset owner	**800 – 1200 mm**
Telecommunications cables	Contact asset owner for specific conditions	Contact asset owner for specific conditions	Must contact the asset owner for specific conditions	Typically **450 – 600 mm**, other assets to **1200 mm**
Water pipelines	N/A	**300 mm** (if pipeline is **200 mm** or greater in diameter)	Pot-hole to confirm location of asset	Min **450 mm**
Sewerage pipelines	N/A	**300 mm** (if pipeline is **200 mm** or greater in diameter)	Pot-hole to confirm location of asset	Between **600 mm** to **10 (ten) metres**

5.3 ON-SITE CHECKING

Prior to any excavation work, check at least 100 m along the footpath in each direction and around nearby corners for indications of existing assets. These include:

- indicators or markers for underground assets, drainage pits and manhole covers
- damaged footpaths, driveways or depressions which may indicate the presence of a trench
- cables running up a pole
- overhead cables near the worksite
- control cabinets
- no overhead wires to a building or premise
- above ground connection cabinets
- transformers for cathodic protection on power poles
- light poles without an overhead service
- service pits for gas, water, electricity, communications, sewerage and drainage connections
- down pipes or vent poles
- underground storage tank fill points and venting systems
- kerb markings
- water valves
- fire hydrants and plugs
- sprinkler systems
- road repairs
- trap doors or access-covers for:
    - access to underground electricity substations
    - access to cable jointing pits or tunnels
    - access to sewerage or stormwater trunks
    - access underground gas regulators, siphons and valve assemblies
    - access to shafts
    - link box pits, oil tank pits and other ancillary underground pits.
- domestic service pits
- gas or water meters
- electricity pillars and meter boxes
- any other signs out of character with the surrounding area such as a clearing for an easement.

If such indications exist, the asset must be located by hand or another approved method.

5.4 PLAN OR DRAWING READING

Although each asset owner may have their own type of plan, with special notations and legends, the basic principle of map reading can be applied.

Telecommunications plans, and in some cases electrical plans, may provide a detailed representation of the asset or network. When reviewing the information:

- identify the streets or buildings nearby and position yourself so the streets correspond with the plan/s
- use the scale and measurements indicated on the plan/s to pinpoint your exact location
- remember, drawings may NOT be to scale
- many plans reference the asset location from an adjacent property alignment
- determine if measurements are metric or imperial, or a combination of both
- identify nearby pipes or cables and mark their recorded location
- cross-reference any supplementary plans or details
- identify any of the items listed below and assess their relationship to each other to determine if a measurement has altered:
  - building lines
  - pits and poles
  - offsets
  - turning points.

Note: Inaccuracies can and do occur, both on plans and in the ground. If in doubt, check with the asset owner. Never guess or assume!

Asset owners' plans show only the presence of some cables, pipes and plant. They only show their position relative to road boundaries, property fences etc at the time of installation and the utilities do not warrant or hold out that such plans are accurate thereafter due to changes that may occur over time. DO NOT ASSUME DEPTH OR ALIGNMENT of cables or pipes as these vary significantly. For example, road and building alignments and levels may change.

6. MANAGING THE RISKS

6.1 MANAGING RISKS IN THE WORKPLACE

Employers and self-employed persons must identify any foreseeable hazards, assess their risks and take action to eliminate or control them.

A hazard identification and risk assessment process must be carried out at the planning and preparation stage by the employer/contractor doing the work to determine what risks may arise when the work is being carried out. Safe systems of work must then be put in place to eliminate or control these risks. For tunnel construction work the safe system of work must also be documented in a Safe Work Method Statement (SWMS).

6.1.1 Monitor and review risk assessments and control measures

The OHS Regulation states that employers must review risk assessments and measures adopted to control risks whenever:

- there is evidence that the risk assessment is no longer valid
- an injury or illness results from exposure to a hazard to which the risk assessment relates
- a significant change is planned to the place of work, work practices or work procedures.

6.1.2 Safe work method statements (SWMS)

The OHS Regulation requires SWMS where the cost of the work undertaken exceeds $250,000 or for defined high risk construction work. Construction work in tunnels is defined as high risk construction work, so tunnelling work requires a SWMS.

The SWMS:

- describes how the work is to be carried out
- identifies the work activities assessed as having safety risks
- identifies the safety risks
- describes the control measures that will be applied to the work activities. It also includes a description of the equipment used in the work, the standards or codes to be complied with, the qualifications of the personnel doing the work and the training required to do the work.

A SWMS requires the work method to be presented in a logical sequence. The hazards associated with each process are to be identified and the measures for controlling these hazards specified.

Break down each job into a series of basic job steps to identify the hazards and potential accidents in each part of the job. The description of the process should not be so broad that it leaves out activities with the potential to cause accidents and prevents proper identification of the hazards.

Employees of the workforce should be involved/consulted in the development and implementation of any SWMS.

All persons involved in carrying out the work should understand the SWMS before commencing the work.

6.1.3 Consultation with relevant parties prior to commencing work

The planning before the start of work, which may affect a utility asset, must include but not limited to:

- consultation with local councils
- consultation with asset owners to obtain agreement on the use of out of service, retired or unused assets
- advising affected residents/occupants
- obtaining permit requirements and conditions for undertaking the works
- identifying and determining exact location of assets
- establishing methods to be adopted to protect existing assets
- further consultation as required by the scope of works
- consultation with 'Dial Before You Dig' and the asset registers of other infrastructure owners not registered with 'Dial Before You Dig'
- consultation with roads authority (eg RTA, local council or private body)
- consultation with local councils in terms of storm water assets and work in council owned roads.

Where underground assets exist, the precise location of the assets shall be established in conjunction with the asset owner by pot-holing (or equivalent non-destructive asset location techniques) prior to the principal excavation commencing.

Consideration must be given to the presence of private property assets eg telecommunications, gas, stormwater, sewerage and water assets. These private property assets are unlikely to be found on any plans and are best identified by a visual on-site inspection.

The use of an Electronic Service Detection Device to survey the ground for buried pipes and cables, before commencing excavation, should be considered.

The close out process of the project or scope of work may typically involve recording the 'as constructed' diagram of the asset and providing this record to the appropriate agency with details of:

- finished surface level
- depth of asset
- alignments from property boundary and/or kerb etc
- type of cover or warning device installed eg warning tape, concrete slab, mechanical polymeric protection strip etc
- new ownership details of the asset
- assets retired, removed, declared out of service etc
- type, size, location and installation method of assets

- surface and underground markings installed
- advice to any authorities, agencies etc on the completion of the project or scope of works
- cancellation of any permits, authorities etc
- the provision of a copy of the asset plans to the new owner.

For more information on how to safely dig near an asset, specific information is provided on the Telstra website via the following link www.telstra.com.au/dialb4udig/digging.htm Excavation with hand tools shall be carried out carefully up to but not closer than the minimum distances specified in Table B.

6.1.4 Planning and liaising with other authorities

When planning, it is important to discuss and consider the following areas:

- existing utility assets
- duration of the project and scope of works
- future planned assets
- opportunities for coordination of works
- shared trenching opportunities
- thermal impacts on EHV electricity assets
- changing ground surface levels
- installing heat sources (eg other electricity assets)
- creating underground voids (eg stormwater assets)
- changing backfill materials
- possible limitations in information available
- opportunities to improve information availability
- effect on traffic
- opportunities to isolate or relocate existing assets
- provision of visual identification devices
- asset owner and other authorities' concerns, conditions and expected working procedures
- any requirement/s for the worksite involving:
  - access to assets
  - permit conditions
  - recording of infrastructure, assets locations or relocations
  - financial costs
  - individual, asset or community safety
  - worksite and traffic management requirements and railway safety management requirements
  - reinstatement requirements (this liaison is in addition to the statutory notification required by legislation).

Consideration must be given to the operation of heavy plant over potentially fragile underground assets.

6.2 RAILWAY ASSETS

Rail easements have numerous electrical power, signalling, communication cables, compressed air and drainage lines that are owned and maintained by the Rail Authority. These assets vary in type of construction and are documented to various degrees of accuracy.

Numerous utility service providers and other private parties also jointly use the rail easement. Access to the rail easement is strictly regulated by the requirements of AS 4292.1: 2006 and AS 4799: 2000.

Access to information relating to the location of the various rail assets is issued on application.

6.3 SERVICE TUNNELS

Many utilities own or share service tunnels. These will have shafts plus manholes at the surface or other surface infrastructure supporting the tunnel environment.

6.4 EXCAVATION AND TRENCHING

To maintain essential structural support and the protection of other existing assets, excavations in the vicinity must not disturb the embedment around each asset (see Table B for minimum approach distances and to identify if the asset owner must be contacted for specific approach conditions). This information should be supplied by the asset owner through a 'Dial Before You Dig' request. Where this is not possible, the relevant asset owners must be consulted and their permission first obtained.

- If a cable or pipe is exposed, the contractor must ensure that any angular material such as rock or gravel does not mix into the embedment material
- Excavations in any easement must be backfilled, compacted and re-sealed to the appropriate Authority's standard at the completion of excavation
- Temporary restorations in roads and footways must be of sufficient quality to ensure the safety of pedestrians and vehicles until the final restoration is undertaken. Temporary restorations must be regularly checked by the responsible party to confirm their integrity
- Refer to NSW Code of Practice, *Excavation*
- Refer to:

  AUS-SPEC 306U *Road Openings and Restoration* (2004 and earlier additions)

  AUS-SPEC 7200 C0219 *Construction – Roadways – Road openings and restorations for utilities* (2007).

6.5 ASSETS NEAR BRIDGE APPROACHES

Often underground assets will be congested at the approach to bridges. Assets' typical depths may vary substantially, rising and falling sharply and at much shallower depths than elsewhere as they are channelled into shared allocated spaces on the bridge. Road safety barriers are often very close to heavily congested services at the approaches to bridges. Construction staging and footing design for such barriers should consider impacts on assets and, where possible, construct barriers prior to constructing the assets.

6.6 ASSETS AROUND POLES

Unless otherwise agreed, underground assets and other obstructions around poles are to be kept a minimum distance of 300 mm from the periphery of the pole, to allow inspections by asset owner staff.

No excavation within 10 metres of a Single Wire Earth Return (SWER) transformer pole is to occur without the approval of the local electricity asset owner.

It should be noted that the NSW Service and Installation Rules require a sketch of the underground service/consumers mains to be marked inside the switchboard.

6.7 TRAFFIC CONTROLS

All work carried out on RTA NSW controlled roads must be done in accordance with the RTA's *Traffic Control at Work Sites Manual.* As this manual is considered to be the benchmark for traffic control in NSW, **all** works carried out within the road corridor or on adjacent pathways should be conducted in accordance with this manual.

6.8 EMERGENCY WORK

While there will be times when, due to pressing requirements, the timeframe for starting work will prevent some of the normal controls from being completed, this will not diminish the responsibility of worksite controllers to do everything that is reasonable and practical that is within their power to ensure the health, safety and welfare of persons affected by their actions.

6.9 VERTICAL BORING

For any boring within 500 mm of an underground asset, the location of the asset/s shall first be proved by careful hand digging (pot-holing) or equivalent asset location techniques and:

- a minimum clearance of 300 mm from the edge of the underground asset shall be maintained for pole hole boring
- lead in excavations shall be used.

Note: All transmission assets including EHV electricity cables, pipelines involving gas, oil and petrochemicals have separate requirements and the asset owners should be contacted.

6.10 DIRECTIONAL BORING

- When boring across the line of an underground asset, the location of the asset/s shall be positively proven by hand digging (pot-holing) or proven by another approved method.
- All transmission pipelines involving gas, oil and petrochemicals have separate requirements and the asset owners should be contacted.
- For boring under electricity cables, it is necessary to excavate a slit trench beside the cables to confirm the depth of the cables and ensure the drill is not within the minimum approach distance of the cable specified in Table B.

- Additional precautions and clearances are required for directional boring near or beneath sub-transmission cables, normally located in roadways. If the bore is to pass within 2 metres of any electrical cable or conduit the asset owner must be notified as the clearances for HV and EHV may be significantly greater.

  See Table B for further information on clearances.

6.11 MECHANICAL EXCAVATING PLANT

Reference should be made to WorkCover's *Moving Plant on Construction* Sites code of practice.

Mechanical excavating plant may be used with care up to, but not closer than, the minimum distances as specified in Table B.

- Where the excavation is being carried out parallel to or across underground asset/s, location of the asset/s must be proven by careful hand tool excavation (pot-holing) or another endorsed method used to positively locate the asset prior to mechanical excavation.
- If an excavation must exceed the depth of the asset and will disturb the protective cover, slab, other asset/s or the bedding material around the asset/s, the asset owner/s must be contacted to determine if the asset/s is to be relocated.
- Excavations must be reinstated to comply with the asset owner's requirements.
- **Where plant is required to operate over underground assets, such as in major road reconstruction, the clearances as specified in Table B must be maintained. Alternatively, if Table B cannot be complied with, the asset can be mechanically protected by an engineered structure agreed to by the asset owner.**

Note: All transmission cables, pipelines and petrochemical networks may have separate requirements and the asset owners should be contacted before commencing work.

6.12 EXPLOSIVES

The use of explosives by licensed operators must only be used after a comprehensive risk assessment has been undertaken in consultation with all owners of assets in the vicinity and must be consistent with the requirements of the *Explosives Regulation 2005.*

6.13 PILE DRIVING

Pile driving adjacent to underground assets must not take place without authority from the owner of the assets. The exact location and depth of all adjacent assets shall be physically proved by hand digging (pot-holing) or equivalent asset location techniques prior to commencement of work.

The effects of vibration on the asset must be considered when planning the work.

6.14 IDENTIFICATION OF ASSETS NOT ON PLANS

Where an asset that is not identified on any plans etc is located in the field, work should be suspended until the asset is positively identified and any remedial controls put in place. Depending on the nature of the risk, it may be necessary to notify the asset owner and obtain a revised plan.

6.15 ASSET SEPARATION DISTANCES

To avoid safety and operational conflicts resulting from space infringement issues, refer to the Street Allocation Diagrams in Section 13.

7. SAFE SYSTEMS OF WORK

A critical part of planning safe systems of work is making sure that the plans are accurate. With some assets installed over 60 years ago, it is likely that changes would have been made to the surface of the land at some stage. Road widening and regrading of surfaces are common causes for inaccuracies in records. For this reason, when working from old records, pot-holing and/or pipe and cable locating devices should be used. The relevant authority or asset owner should be told of any inaccuracies in records.

Asset owners typically require notification of a major project or where the project may require supply of a service or product outside normal residential demand.

A safe system of work should be sufficiently robust to include site controls that will ensure assets on construction sites are not damaged. All those who dig the ground should be aware of the assets in the area before they dig and have appropriate controls in place. Particular attention needs to be given to relocated assets and persons new to the site to ensure they are aware of the assets and their locations.

At the project planning stage it is important to consider minimising damage to surface infrastructure and disruption of services to residents, pedestrians and traffic. Any construction or maintenance technique should ensure adequate clearances are maintained between assets and that other assets crossings are identified.

Access to assets must be maintained at all times to ensure emergency and scheduled maintenance activities can be carried out by the asset owner. Contractors should also give consideration at the planning stage for site storage of material and traffic areas associated with construction activities so these do not impede access to or damage assets.

Consideration should also be given to the appropriate level of supervision and training, including specific industry awareness training, for an individual undertaking work near any gas or electrical assets.

7.1 EXCAVATION USING NON-POWERED HAND TOOLS

For more information on how to safely dig near an asset, specific information is provided on the Telstra website via the following link www.telstra.com.au/dialb4udig/digging.htm Excavation with hand tools shall be carried out carefully up to, but not closer than, the minimum distances specified in Table B.

There is a duty of care when excavating near cables, pipes and plant. Before using machines to excavate, **underground assets must first be exposed by pot-holing** with **non-conductive** tools to identify its location. Damage can also result in serious injury or death to workers and widespread disruption to services and traffic.

7.1.1 Work on top of or below an underground asset

No disturbance of the underground assets, including any mechanical cover (eg concrete or polymeric cover slab), should occur without prior notification to the asset owner.

Excavation must not be carried out below an underground asset unless steps are taken to ensure that:

- the asset/s or the integrity of the asset and support material is not damaged

- under-crossing shall be at right angles whenever possible
- such excavation below the asset/s should not come within the distance specified in Table B.

  Note: all transmission cables, pipelines and petrochemical networks may have separate requirements and the asset owners should be contacted before commencing work
- steps must be taken in consultation with the asset owners to ensure the asset is adequately supported.

  Note: Also see Section 6.10 Directional Boring.

7.1.2 Work beside an underground asset

If any excavation beside underground assets comes within the clearances specified in Table B, then the asset owner must be notified prior to work commencing. Measures should be agreed upon to ensure the stability of the surrounding soil or material.

7.2 ACCIDENTAL CONTACT WITH UNDERGROUND ASSETS

In the event of an inadvertent contact with an underground asset, it is essential to notify the asset owner and comply with the reporting requirements under the OHS Regulation (Chapter 12).

7.2.1 Electrical assets

Should contact be made with a live overhead power line or a flash-over occur between a live overhead power line and a crane or an item of mobile plant, the following actions shall be taken:

- an attempt should be made to break the machinery's contact with the live overhead power line by moving the jib or driving the machine clear
- if it is not possible to break the contact with the live overhead power line, the operator of the crane or mobile plant should remain inside the cabin of the crane or on the plant item. The network operator should be called immediately to isolate power to the live overhead power line. The operator must remain in place until the power has been isolated and the 'all clear' given by the network operator

  > When a crane or item of plant inadvertently contacts overhead power lines, circuit protective devices may operate to automatically turn the power off. However, some protection devices are designed to automatically reclose thereby re-energising the power lines after a short period of time, typically 1–4 seconds.

- if it is essential to leave the cabin or the operator's position due to fire or other life threatening reason, then jump clear of the equipment. Do not touch the equipment and the ground at the same time. When moving away from the equipment, the operator should hop or shuffle away from the plant item (with both feet together) until at least 8 metres from the nearest part of the crane or plant. **Under no circumstances run or walk from the crane or item of plant as voltage gradients passing through the ground may cause electricity to pass through the body resulting in an electric shock**

- warn all other personnel and members of the public to keep 8 metres clear from the crane or item of plant. Do not touch or allow persons to touch any part of the crane or plant item and do not allow persons to approach or re-enter the vehicle until the network operator has determined the site safe. Remember electricity flows through the ground, so an electric shock could be received from walking close to the scene. If the crane or plant operator is immobilised, ensure the power supply has been isolated and the site made safe before giving assistance
- untrained, unequipped persons should not attempt to rescue a person receiving an electric shock. All too often secondary deaths occur because others get electrocuted trying to help earlier victims. If the crane or plant operator is immobilised, ensure the power supply has been isolated and the site has been made safe before giving assistance.

7.2.2 Gas assets

Should an incident involving gas assets occur, the following actions should be taken:

- all work should cease immediately
- operator is to shut down the plant or equipment UNLESS this process may provide an ignition source for any escaping gas
- it is essential to leave the cab or operator station, trench or enclosure and maintain an exclusion perimeter due to the risk of explosion or fire. Do not attempt to use any instrument which may provide an ignition source near the gas escape. This may include mobile phones, two way radios, etc
- warn all other personnel and/or public to keep clear from the worksite and equipment. DO NOT attempt to approach, re-enter or start the vehicle until the relevant authorities have determined the site is safe
- contact the fire brigade on 000 if life and/or property are threatened
- facilitate First Aid treatment and seek medical aid as required
- advise your organisation's emergency contact and request they immediately notify the relevant authorities, including the relevant asset owner
- initiate the emergency management plan and incident investigation process.

7.2.3 Sewerage assets

Should an incident involving sewerage assets occur, the following actions should be taken:

- cease work, make the site safe and contact the sewerage asset owner as soon as possible. Local circumstances and/or ownership should be considered
- if contaminated, shower or wash down with copious amounts of water. Remove any contaminated clothing as soon as practical
- there is a risk of infection from ingestion or eye contact. If eyes are contaminated, flush with copious amounts fresh potable water. If ingested, seek medical advice
- for skin contact, wash with soap and water. For broken skin and abrasions, also seek medical advice
- protect the public and watercourses from exposure to raw or untreated sewage
- if damage to a sewer pipe occurs during construction works, take appropriate steps to prevent surrounding material entering the pipe.

7.2.4 Water assets

- Cease work, make the site safe and contact the asset owner.

7.2.5 Telecommunications assets

- Report any damage to Telstra assets by phoning **13 22 03**.
- Contact specific asset owner if not owned by Telstra.

7.3 COOPERATION WITH AUTHORITIES

Constructing authorities and others operating in a public road reserve, rail reserve or private property have a duty of care to protect the existing assets of utility providers. It is essential to determine the location of existing assets by obtaining plans and proving the exact location before excavating.

Asset owners may have formal agreements in place describing how work shall be undertaken near each other's assets and these shall be complied with.

7.3.1 Obligations of asset owners and contractors

There is an obligation for all asset owners, contractors and service providers to observe the specifications and separation distances indicated in the Streets Opening Conference diagrams (see Section 13) or those agreed through consultation between asset owners.

All contractors should notify the relevant asset owners if they locate any asset that is not shown accurately on the plans. At no time may an asset be relocated or moved without the prior authority of the asset owner.

7.4 DOCUMENTED SYSTEMS OF WORK

A documented **risk assessment** developed in consultation with those supervising and undertaking the activity is necessary for all activities where excavation and inadvertent contact with underground assets may occur.

A **SWMS** is to be developed in accordance with the OHS Regulation which captures details of the risk assessment and the required training/qualification. All those workers undertaking the activities identified in the SWMS should be made aware prior to commencement of work (eg toolbox talk).

An **excavation permit** is an excellent method of managing the investigation and approval process leading up to the commencement of the excavation. A properly constructed permit will produce a rigorous process that must be followed and completed prior to excavation activities and includes the positive identification of underground assets.

Verification activities such as **audit and inspection** are an excellent means of ensuring that the process has been correctly implemented at a systems level and on the ground before and during the excavation activity.

7.5 TRAINING OF MANAGERS AND EMPLOYEES

Training is an integral component of reducing the risk of inadvertent contact with underground assets.

Managers and supervisors need to be made aware of the hazards and overarching requirements regarding inadvertent contact with underground assets such that they are able to implement safe systems of work and properly plan for and oversee the activities.

Both managers/supervisors and employees will benefit from information and training regarding the use of electronic detection devices, how to use the 'Dial Before You Dig' service and how to read plans supplied by the asset owners and/or 'Dial Before You Dig'.

Employees need to be made aware of the systems in place to minimise the risk of inadvertent contact with underground assets and also the hazards facing them if these systems are not employed.

Site-specific induction systems should include details such as the known location of assets, the site safety rules in relation to excavations (eg no excavations without a permit) and provide inductees access to, or a copy of, the utilities location plan for the work zone.

7.6 ASSET OWNER PLANS AND 'DIAL BEFORE YOU DIG'

A site meeting with the asset owners may be required to determine location/s and procedures for dealing with assets within the scope of work. This issue should be addressed during initial project development to provide time to establish a regime to manage any risks.

Before commencing any excavation work, reference shall be made to the details or plans of the utility or private assets in the proposed excavation area as well as a site inspection to identify any unmarked assets. Plans illustrating the location of known underground assets can be obtained from individual asset owners or the 'Dial Before You Dig' service.

As mentioned, the location of underground assets provided by a service or utility provider may not be accurate for many reasons. As complete accuracy cannot be guaranteed, the position of underground assets must be proven by hand excavation, pot-holing or other approved techniques.

For work in the vicinity of EHV electricity transmission cables it is mandatory to have a meeting with the asset owner prior to any work commencing.

7.7 CABLE/PIPE IDENTIFICATION DEVICES

An electronic pipe or cable locator should be used to more accurately identify the location of the underground asset – as asset owners' plans will not provide exact locations.

Once identified using such electronic device, care should be taken to mark the location of the underground asset on the ground's surface.

7.8 GROUND PENETRATING RADAR (GPR)

Ground penetrating radar (GPR) is emerging within the civil construction industry as an excellent tool for identifying underground assets and mapping assets on a wider scale.

GPR is a non destructive and non invasive technique for rapidly imaging the shallow surface (up to 10 m) and produces high resolution colour section in real time. Parallel images can be used to create a 3D image.

7.9 POT-HOLING

Pot-holing is the use of hand tools to excavate to a pre-determined depth to establish if assets exist in the immediate location. Pot-holing is a proven method of identifying assets.

Never assume that underground assets are positioned in the location as depicted on the plans or in the depth suggested. All underground assets should be positively identified prior to commencing excavation.

Pot-holing should be undertaken along the length of the proposed excavation to identify the path of underground assets and their depth. The information contained on the asset owner's plans and gathered during electronic identification methods helps in this process.

- careful digging (ie pot-holing) is the only sure way to identify the depth and alignment of underground pipes and cables
- pot-holing must be undertaken with reference to plans and other information provided by pipe and cable owners.

The amount of pot-holing should be determined with reference to the risk assessment for the site. Excavators should also pay attention to pot-holing requirements included in work practices provided with the network plans and onsite by a representative of the pipe and cable owner.

7.10 AIR AND WATER LANCING

Air/water lancing techniques may be used in some circumstances, but the advantage of these needs to be assessed against any inherent safety and environmental risks, eg dust generation, contaminated water runoff and possible damage to underground assets.

7.11 TRENCHLESS TECHNIQUES

Pot-holing must be used to locate existing underground assets to ensure adequate clearances are maintained between assets and to locate other asset crossings. Pot-holing at each asset crossing and at regular spacing along assets is recommended.

Where high risk assets are identified, consultation with the asset owner is required. Consultation is also required when using directional boring across existing utility lines. Where clearances required by other assets cannot be achieved at the proposed depth of asset installation, alternative solutions should be sought in consultation with the relevant parties.

It is crucial to provide the "as constructed" details on this type of installation for future reference because:

- the ground above the bore is typically undisturbed, not offering any indication of previous works
- of the inability of directionally-bored installations to provide warning tape or mechanical protection above the asset
- the bore may not follow a direct route.

7.12 SAFETY OBSERVERS

Excavation work around underground assets should only be undertaken with the assistance of a competent safety observer.

The safety observer/s should be given sufficient control of the activity to call for a cessation of work in the event of system failure or observation of unsafe practice which may give rise to an inadvertent contact with an underground or overhead asset.

When excavating near or adjacent to underground assets it is important to be aware of overhead hazards such as overhead powerlines. Risk assessment may dictate a requirement for more than one safety observer for such activity, eg one observer to mitigate inadvertent contact with underground hazards and the other to mitigate inadvertent contact with overhead hazards.

7.13 CONFINED SPACES

Excavations are generally not confined spaces. However, confined space provisions may apply to certain excavations where the excavation enters foul or contaminated ground or opens a live sewer. Also, where the atmosphere can be altered by exhaust gases or other contaminants, the excavation is to be treated as a confined space. Further information is given in WorkCover's *Code of Practice: Excavation,* Section 4.

7.14 GLOBAL POSITIONING SYSTEM (GPS)

GPS technology provides an excellent opportunity to plot the location of underground assets and maintain that information for the duration of the project. This is especially important in maintenance and long term projects.

GPS locations, when captured, should be noted on relevant plans. This information should also be provided to asset owners for any as built/modified infrastructure or previously unidentified underground assets.

7.15 ABOVE GROUND IDENTIFICATION DEVICES

Previously in this document, many above ground identification devices have been discussed that may assist identifying underground assets.

The Western Sydney Orbital Project (M7) successfully implemented a process where different coloured conduits (according to the nature of the asset) were temporarily inserted into the pot-hole directly onto the underground asset. These conduits, when back filled, extended approximately 1-1.5 metres above the ground and were plugged on top to prevent dirt and debris entering the conduit. These above ground locators enabled easy visual identification of the path of known underground assets and, when a measuring tape was inserted into the conduit, provided the exact depth of the asset.

8. TRAINING, INSTRUCTION AND INFORMATION

The OHS Act requires employers to provide such information, instruction, training and supervision as may be necessary to ensure the health, safety and welfare of their employees while at work.

In addition, some activities are restricted to persons holding the relevant certificate of competency, for example scaffolding and operation of cranes and some load shifting equipment. See the OHS Regulation or the *Industrial Certification Manual* for a full list of such activities.

8.1 TRAINING REQUIREMENTS

In addition to the requirements of construction training, all persons undertaking work involving underground assets must be instructed, trained and assessed as competent for the tasks they are undertaking.

Training includes but is not limited to:

- induction
- general health and safety induction training
- work activity health and safety induction training
- site specific health and safety induction training (Clause 216 OHS Regulation)
- risk assessment methodology
- training in the use of SWMS
- plan/map reading
- utility specific statutory training.

8.2 INDUCTION TRAINING

The OHS Regulation requires that employees receive OHS induction training, including general health and safety induction training, work activity based induction training and site specific induction training, and that this training covers the topics set out in the *Code of Practice: Occupational Health and Safety Induction Training for Construction Work 1998.* The training must cover the following points:

- arrangements for the management of OHS, including arrangements for reporting hazards to management
- health and safety procedures relevant to the work of the employee, including the use and maintenance of risk control measures
- how to access any health and safety information that the employer is required to make available to each employee
- any other induction training relevant to the place of work (eg confined spaces entry training), having regard to the competence, experience and age of the new employee.

8.3 TRAINING TOPICS

Training should draw on knowledge of the known hazards and risks in your operations, including matters described in this Guideline. The source of risks should be pointed out and the adverse outcomes that have been experienced by others should be used to stress the importance of safety.

The training provided and the instruction given should at least include all safe work methods to be used on the job and matters described in this Guideline, that is, all hazards, risks and control measures for control of hazards.

8.4 WHO SHOULD RECEIVE TRAINING?

The target groups for training at a workplace include but are not limited to:

- managers and supervisors of employees and/or other persons undertaking work considered at risk of injury and/or who have responsibility for implementing safe operating procedures
- OHS committees and OHS representative/s
- staff responsible for the purchasing and maintenance of plant, PPE and for designing, scheduling and organisation of work activities
- persons undertaking risk assessments or preparing SWMS
- employees and subcontractors undertaking the work, including employees of labour hire organisations.

As the needs of each target group are different, the content and methods of presenting training material should be tailored to meet the specific needs of each group.

8.5 PROVISION OF INFORMATION AND INSTRUCTION

Information may include:

- the results of any applicable risk assessment
- SWMS
- a review of such a risk assessment and/or SWMS or operating procedure
- any other relevant OHS information.

Employers should brief each employee as to the contents of risk assessments and SWMS when each employee and/or other person first begins to perform tunnelling work, at regular intervals thereafter, and whenever there are changes to risk assessments or new information about health and safety risks becomes available.

Employees and other workers should have, on request, ready access to risk assessments and SWMS.

9. CASE STUDIES AND CHECK LISTS

9.1 REPAIRING SEWERAGE PIPES

A reactive dig and repair job was commenced by a work crew of a sewage and drainage authority following the internal surcharge of a sewer line at a preschool adjacent to the worksite. CCTV was used to identify the repair location of the sewer. Damage to the sewer pipes apparently occurred during the laying of electrical conduits approximately 20 years ago and a contractor had carried out a repair of that damage. The repairs appear not to have been referred back to the responsible sewerage authority and eventually resulted in the internal surcharge at the preschool.

The work crew did not find indicator plates or markers identifying underground power in the immediate area, and, because locating equipment was not readily available, made a decision not to delay the work and to commence excavating with a mechanical excavator. The excavator uncovered bricks marking an electricity asset directly over a conduit. Marker tape was found but was not immediately obvious.

An incident was declared by the work crew and work stopped when the conduits were uncovered. The asset owner was called to the site and supervised the remainder of the repairs. An insulated spud bar was used to break up concrete that was placed around the pipe in the original repair. The pipe was replaced, work completed and the excavation backfilled. The incident was reported as a near miss.

The hazards shown here include a broken sewer pipe and high voltage cables.

The risks were electric shock, contaminated and hazardous atmosphere (from sewer gases) and possible infection.

Failure to identify the presence of these cables before work commenced exposed the workers to the risk to health and safety.

Once the risk was identified, the controls included the use of insulated tools to excavate under the supervision of an authorised person from the asset owner.

9.2 COUNTRY TELECOMMUNICATIONS CABLE DAMAGE CASE STUDY

At this location, a contractor working for a telecommunication carrier performing combined pre-ripping and plough operation to install new optic fibre cable, damaged the Telstra major interstate fibre cables.

The new route was being installed through rural paddocks and properties by D7 dozer and trenching machinery. The route was being installed parallel to the existing Telstra major fibre route.

At the manhole, approx 20 metres from the damage location, a 30 fibre cable, 16 fibre cable and a 30 pair copper cable left the manhole at right angles following the fence line. The contractor failed to identify the break off from the manhole shown on the plans. These cables were subsequently damaged during the pre-ripping procedure near the fence line.

The contractor believed the main cables where in another location, the one they had been following, and they had not noticed the manhole (located approximately 20-30 metres from the pre-ripping process) until after the damage had occurred. Two markers on either side of the manhole were clearly visible from a distance.

Site observations

- The Telstra fibre cable route was clearly marked with Telstra yellow concrete markers, which was easily visible.
- The manhole was marked with a yellow concrete marker post at either end of the manhole.
- The cable route was clearly shown on Telstra plans that the contractor obtained from the 'Dial Before You Dig' service.
- There was no visible sign of asset location (pot-holing) on the ground such as markers, paint, peg lines, markings on the ground etc.
- There were deficiencies with the safe system of work used on the project.

9.3 CITY TELECOMMUNICATIONS CABLE DAMAGE CASE STUDY

A contractor in the west of Sydney drilling pier holes for the construction of townhouses caused significant damage to telecommunication cables resulting in severe disruption to telecommunication services in country NSW.

An auger operated by an excavation contractor made a direct hit on a telecommunications cable route. Thousands of telephone lines, mobile phone towers, EFTPOS terminals and data lines went dead all over NSW instantly.

The auger, a giant drill, severed six fibre optic cables running between 12 and 60 fibres each and a 2400 copper pair cable, about seven kilometres from the Parramatta exchange.

Physical cable damage was not confined to the one hole in the ground – it wrenched and ripped cables clean out of manholes for hundreds of metres on either side.

One of the cables was the main feed to the Bathurst and Orange area, others carried mobile phone traffic. Almost all the copper lines were in use by local households and businesses and, not least of all, the main ATM (asynchronous transfer mode) internet backbone running to the south and west out of Sydney. At one ISP alone, more than 100,000 customers across four states were unable to log on to the internet for hours. Also 250,000 Foxtel service subscribers were disconnected, some for nearly 12 hours.

It was not just the phone services that went down. EFTPOS services died, and staff from a Bathurst supermarket were reduced to hunting around other businesses for manual transfer forms for more than a day so customers could buy groceries and debit their bank accounts. E-mail access in Bathurst was out too.

Had the 'Dial Before You Dig' service been contacted on 1100 and the appropriate plans used, the damage could have been avoided.

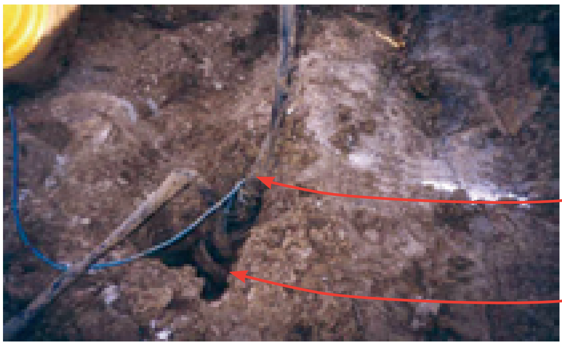
If there is any doubt at all about cable location, Telstra will send staff to show contractors and property owners how to check for stray lines. However, there was no call placed to the 1100 service for this damage.

When people in west Sydney picked up their phones and found no signal, they might have expected their mobiles or other carrier services to fill the gap. But Telstra, Optus, AAPT, Vodafone and Primus were all affected to some extent.

This incident was the cable cut of all cable cuts, but cut and flooded cables take down parts of the telephone and data network every day.

It took 50 technicians until 11.00 that night just to restore all the services, and two-and-a half days to finish all the work.

Sub-ducts and cables laying on the construction site, pulled out by an auger.



Twisted sub-ducts and optical fibre.

One of the bored holes where the cables and conduits had been pulled out.

Twisted sub-ducts and optical fibre.

Through these bored holes large amounts of cables and sub-ducts had been pulled out. Thus, causing major damage to cables and joints in the Telstra Network.

9.4 EXAMPLE OF AN INCIDENT REPORT USED BY AN ELECTRICITY ASSET OWNER

'Excavator operator injured when hitting 11,000 volt underground cable'

Date:	07/10/05
Incident occurred at a place of work (refer OHS Act 2000)	✗ (Construction site)
System voltage involved:	11,000 kV
Address:	Northumberland Road
Work being done for:	✗ Contestable work done for customer
Category:	✗ General public (workers – non networks worker)
Category type:	✗ Electric shock
Treatment:	✗ Medical treatment given (Hospital)
Description of injuries:	Excavating for ASP to relocate 11,000 volt UG cables, excavator hit cable causing explosion and feeder trip. Victim received shock from excavator and was taken to hospital for check up. No permanent injuries
Network element involved in incident:	✗ Underground mains
Object involved in incident:	✗ Excavator
Location of incident:	✗ Urban
Location type:	✗ Public Roadway (including footpaths to property boundary)
	✗ Accident area exposed to weather (ie outdoors)
Possible causes of incident:	✗ Failure to follow written procedures
Briefly describe possible causes of incident in more detail:	Workers had located cable via searches but proceeded to dig with excavator beyond marker tape and hit cable
Initial corrective action:	ASP and excavator operator advised of the dangers associated with excavation near cables. Advised that any work beyond covers or marker tapes can only be done using hand tools
Corrective action taken:	• excavator operator advised of his responsibilities when working near underground assets • ASP reminded of his responsibilities in regard to site supervision and the need to consult plans before commencing any excavation work
Follow up:	Cable isolated and repaired by IE. 50 customers interrupted for 5.2 hours

9.5 CASE STUDY: CONSTRUCTION OF THE M7 MOTORWAY

The Abi Leighton Joint Venture (ALJV) conducted an extensive risk assessment before commencing on the project and services both above and below the ground were identified as a major risk.

The ALJV consulted with the asset owners who identified an extensive number of assets in the M7 corridor and local road upgrades.

Plans were obtained from 'Dial Before You Dig' and from the asset owner. Electronic services detection was also conducted. These assets were then surveyed and non-destructive digging conducted to positively identify each asset. Colour coded conduits were then placed on top of the assets.

The ALJV still recorded hits to the assets as not all assets were identified on the plans or by 'Dial Before You Dig'.

Meetings were arranged by the ALJV with management and field staff, asset owners, subcontractors and 'Dial Before You Dig'. From these meetings the ALJV developed the following procedures through consultation to reduce the possibility of impacting on these assets:

- a request to de-energize high risk electrical assets where possible was made to the asset owner. A training course was developed and delivered by the ALJV and Integral Energy to approximately 500 ALJV and subcontractor employees on the project
- permits to excavate and work around assets were reviewed and developed with input from all stakeholders. The mandatory exclusion zones for underground assets were doubled
- colour coded conduits were used to identify the type of asset, location and depth
- when working in the asset zones, only toothless buckets were permitted to be used on plant
- banners, posters, stickers and signage were extensively used to remind all personnel of the procedures.

The ALJV, in consultation with a manufacturer, developed a GPS backpack to identify a known asset by comparing it to the ALJV survey database. This allows the ALJV to mark out existing assets and make this information more accessible and easier to understand.

By consulting and training all stakeholders, the ALJV was able to implement safe work methods and dramatically reduce the number of incidents impacting on assets.

Colour Coded Conduits used to identify assets

Manufacturer’s backpack being used by ALJV survey staff

The manufacturer’s pocket PC allows quick recognition of underground assets by touch screen technology. This identifies the type of asset and its approximate location.

10. FURTHER INFORMATION

10.1 AUSTRALIAN STANDARDS

• AS 2648.1	*Underground marking tape*
• AS 4026	*Electrical cables for underground residential systems*
• AS 1345	*Identification of the contents of pipes, conduits and ducts*
• AS 2566.2	*Buried flexible pipelines*
• AS 4271	*Interim – Geographic information data dictionary*
• AS 1742.3	*Traffic control devices for works on roads*
• AS/NZS 4360	*Risk management*
• AS 4799	*Installation of underground utility services and pipelines within railway boundaries*
• AS 4292.1	*Railway safety management*
• AS 2865:2001	*Safe working in a confined space*
• AS 1165	*Traffic hazard warning lamps*
• AS 1345:1995	*Identification of the contents of pipes, conduits and ducts*
• AS 1742.3	*Traffic control devices for works on roads*
• AS 1743	*Road signs – specifications*
• AS 1744	*Forms of letters and numerals for road signs*
• AS 1906	*Retroreflective materials and devices for road traffic control purposes*
• AS HB81	*Field guide for traffic control at works on roads:*
	(HB81.1 Short term urban works – daytime only
	HB81.2 Short term rural works – daytime only
	HB81.3 Mobile works
	HB81.4 Short term night works
	HB81.5 Works on unsealed roads
	HB81.6 Bituminous surfacing)

Australian Standards are available from SAI Global **www.saiglobal.com/shop**
email sales@sai-global.com or phone 13 12 42.

10.2 WORKCOVER NSW CODES OF PRACTICE

- *Code of Practice: Work Near Overhead Power Lines*
- *Code of Practice: Excavation*
- *Code of Practice: Moving Plant on Construction Sites.*

10.3 OTHER STANDARDS AND REFERENCES

- Streets Opening Conference (2007) *Guide To Codes and Practices for Streets Opening*
- Streets Opening Conference (1999) *Model Agreement for Local Councils and Utility Service Providers*
- *Service and Installation Rules of New South Wales* (2006)
- AUS-SPEC 306U AUS-SPEC *Road Openings and Restoration* (2004 and earlier additions)
- AUS – SPEC 7200 C0219 *Construction – Roadways – Road openings and restorations for utilities* (2007).

  For Streets Opening Conference enquiries, contact The Secretariat, Institute of Public Works, Engineering Australia (NSW Division)
  Phone 02 9267 6677 Fax 02 9283 5255 email ipwea@ipwea.org.au

  For AUS–SPEC enquiries contact: Manager Specifications, Standards Australia, 286 Sussex Street Sydney NSW 2000. GPO Box 476 Sydney NSW 2001
  Phone 02 8206 6713 Fax 02 8206 6021 email aus-spec@standards.org.au

10.4 LEGISLATION

- *Electricity Supply Act 1995*
- *Electricity (Consumer Safety) Act 2004*
- *Gas Supply Act 1996*
- *Occupational Health and Safety Act 2000*
- *Pipelines Act 1967*
- *Sydney Water Act 1994*
- *Hunter Water Act 1991*
- *Roads Act 1993* and *Road Regulations 1994 (as amended)*
- *Local Government Act 1993*
- *Contaminated Land Management Act 1997*
- *Telecommunications Act 1997.*

11. APPENDIX A – UNDERGROUND ASSET LOCATION CHECKLIST

Worksite location: ____

(street name, cross street, landmarks)

____

Plans provided by: Dial Before You Dig ☐ Yes ☐ No Contractor ☐ Yes ☐ No
Asset owner ☐ Yes ☐ No

Underground assets located:

Utility (Note Utility from which plans were obtained)	Plans received as per dial before you dig information	Plans current Check dates	Plans indicate assets in vicinity	Assets checked	Pot-holing req'd	Pot-holing done	Stand-by req'd	Site marking completed	(sketch on rear of sheet)
	✓	✓	✓	Y/N	Y/N	Y/N	✓	Y/N	Y/N
Communications ……………………									
Electrical ……………………									
Water ……………………									
Sewerage ……………………									
Gas ……………………									
Other ……………………									
Other ……………………									

Sketch worksite and Utility locations on reverse side of page

Additional Comments:

____

____

____

____

Plans verified and confirm all assets as located? ☐ Yes ☐ No

Person locating asset	**Person carrying out work**
Signed	Signed
Name (Print) ……………………………………… Business Name ……………………………………	Name (Print) ………………………………………
Date completed checks ……/……/……	Date received checked results ……/……/…… Completed Checklist and Utility Plans included in job-pack. ☐ **Yes** ☐ **No**

Underground Asset Location Checklist – SAMPLE ONLY

Diagram of UG Assets as located on site

Indicate the north point with an arrow

Drawn by

Name ___________________

Sign ____________________

Date _____ / _____ / _____

The above sketch should contain the following details:

- street alignments (where applicable)
- lot boundaries (where applicable)
- name of street and suburb
- north point
- nearest cross street
- distances from relevant assets/boundaries
- depth of cover (only if available)
- signature and name (drawn by).

12. APPENDIX B – WORKERS COMPENSATION INSURANCE

Anyone who employs workers, and in some cases engages contractors, must maintain a current workers compensation insurance policy. Penalties apply for failing to have a current policy in place.

All employers have a legal liability to pay workers compensation to workers who are injured in the course of their work, and employers are required by law to hold a workers compensation insurance policy from a licensed WorkCover insurer to cover that liability.

For workers compensation insurance purposes the *Workplace Injury Management and Workers Compensation Act 1998* (the Act) defines a worker, subject to certain specified exceptions, to mean:

A person who has entered into or works under a contract of service or a training contract with an employer (whether by way of manual labour, clerical work or otherwise, and whether the contract is expressed or implied, and whether the contract is oral or in writing).

In addition, the Act deems certain other persons to be workers for workers compensation purposes, eg some types of contractors.

For assistance in clarifying your obligation, contact your insurer or the WorkCover Assistance Service on **13 10 50**.

13. APPENDIX C – TYPICAL FOOTWAY ALLOCATIONS FOR UTILITY SERVICES AND DEPTH OF COVER IN ROAD RESERVES

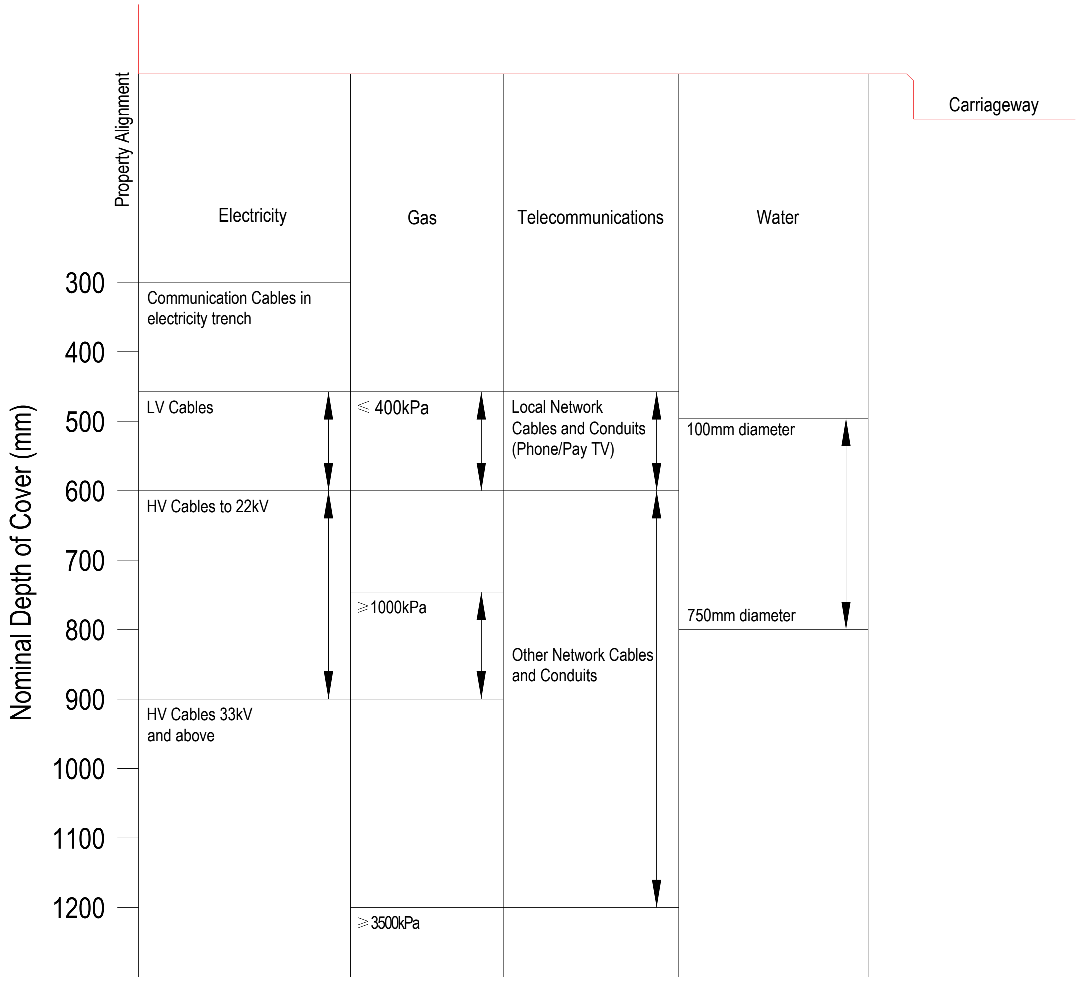
The diagrams in this section have been sourced from the publication entitled *Guide to Codes and Practices for Streets Opening 2007* published by the NSW Streets Opening Conference (SOC). These diagrams are typical examples only, and may not be up-to-date. The current edition of the SOC document should always be consulted prior to undertaking work that impacts on underground services to ensure that the information used is up-to-date.

Source: NSW Streets Opening Conference: Guide to Codes and Practices for Streets Opening 2007

For the purpose of this section, note that sewer lines have not been specifically identified.

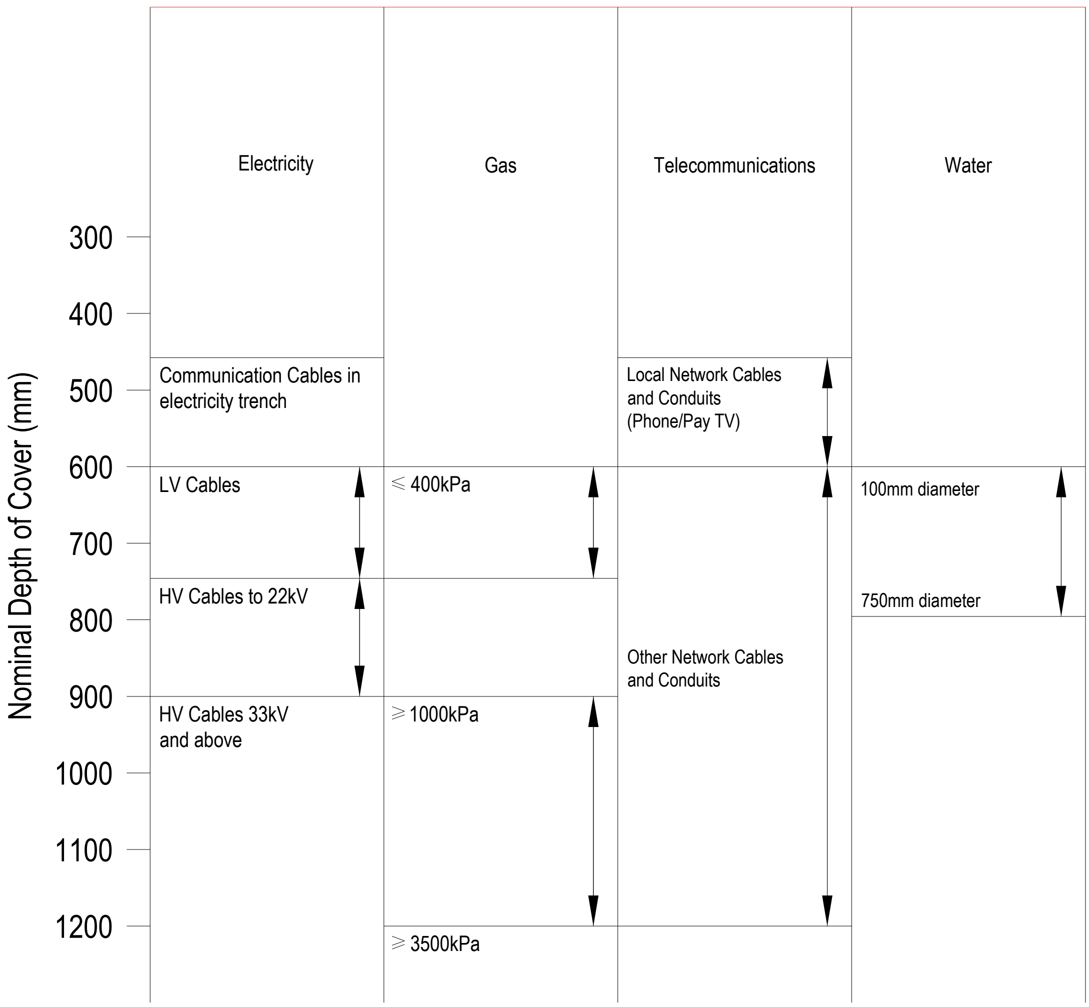
13.1 NOMINAL DEPTH OF COVER OF UTILITY SERVICES IN ROAD RESERVES

13.1.1 In footways



Source: NSW Streets Opening Conference: Guide to Codes and Practices for Streets Opening 2007

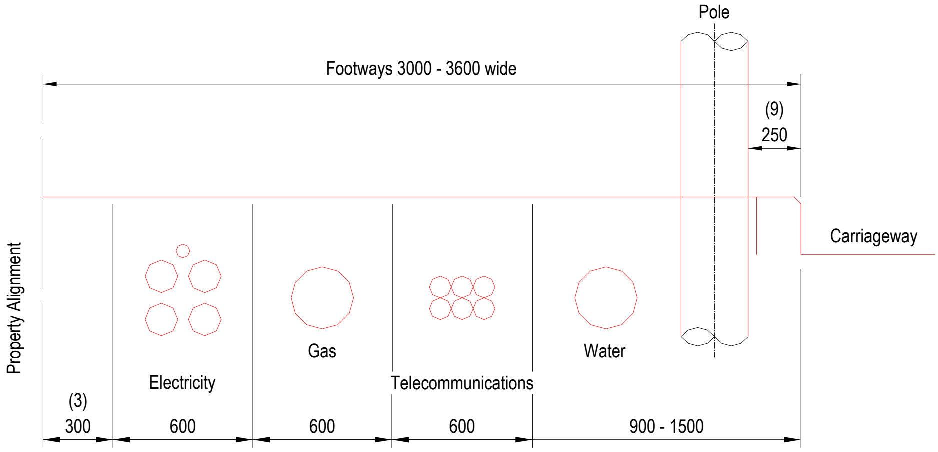
13.1.2 In carriageways

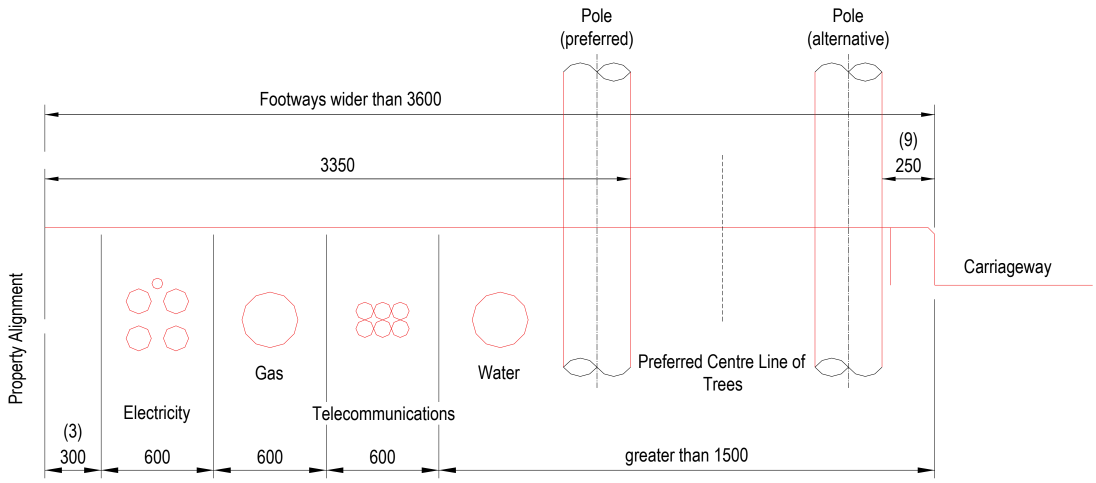


Source: NSW Streets Opening Conference: Guide to Codes and Practices for Streets Opening 2007

13.2 UTILITY/SERVICE PROVIDER ALLOCATION OF SPACE IN FOOTWAYS

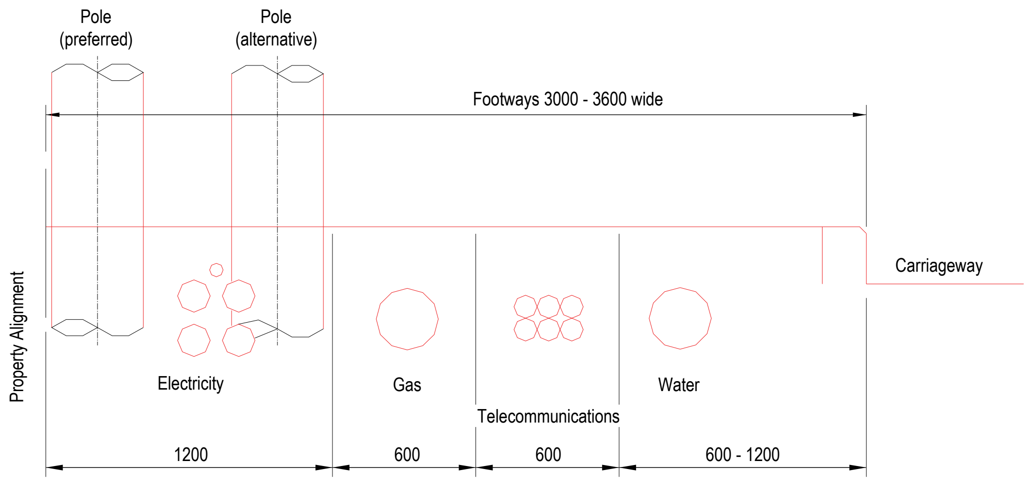
13.2.1 Streets dedicated prior to 1 January 1991

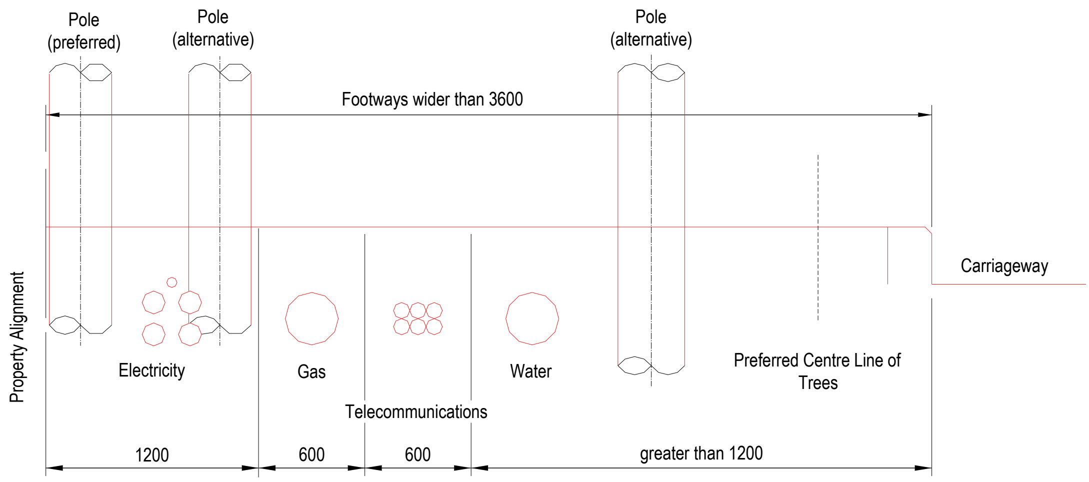




Source: NSW Streets Opening Conference: Guide to Codes and Practices for Streets Opening 2007

13.2.2 Streets dedicated after 1 January 1991





Source: NSW Streets Opening Conference: Guide to Codes and Practices for Streets Opening 2007

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Document No: MDI 0028

Amendment No: 2

Mains Design Instruction

Underground distribution network design

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MDI 0028 Underground distribution network design

CONTENTS

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 maybe 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 the 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.

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 bole 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

<table>
<tr><th rowspan="2">Road classification</th><th rowspan="2" colspan="2">Scenario</th><th colspan="2">Minimum depth of cover above conduits</th></tr>
<tr><th>Standard Trench Profile</th><th>Concrete encased conduits
(100mm spacing required around conduits)</th></tr>
<tr><td rowspan="3">RMS classified roads</td><td colspan="2">Existing road</td><td>1200mm</td><td>1000mm</td></tr>
<tr><td colspan="2">Proposed road – assets energised before road construction completion</td><td>1800mm</td><td>1500mm</td></tr>
<tr><td colspan="2">Proposed road – assets energised after road construction completion</td><td>1500mm</td><td>1200mm</td></tr>
<tr><td>URD roads</td><td colspan="2">Existing and proposed roads</td><td>750mm</td><td>Not applicable</td></tr>
<tr><td rowspan="4">Underbore road crossings
(as per ETS 0081)</td><td rowspan="2">Existing</td><td>RMS Roads</td><td>1500mm</td><td rowspan="4">-</td></tr>
<tr><td>Non RMS Roads</td><td>750mm</td></tr>
<tr><td rowspan="2">Proposed</td><td>RMS Roads</td><td>2100mm</td></tr>
<tr><td>Non RMS Roads</td><td>750mm</td></tr>
</table>

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.

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 m^2, 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 m^2, 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:

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

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.

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 mm^2 Al, XLPE
- 11kV 3 core 240 mm^2 Cu, XLPE
- 11kV 3 core 300 mm^2 Cu, XLPE
- 22kV 3 core 240 mm^2 Al, XLPE
- 22kV 3 core 240 mm^2 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.

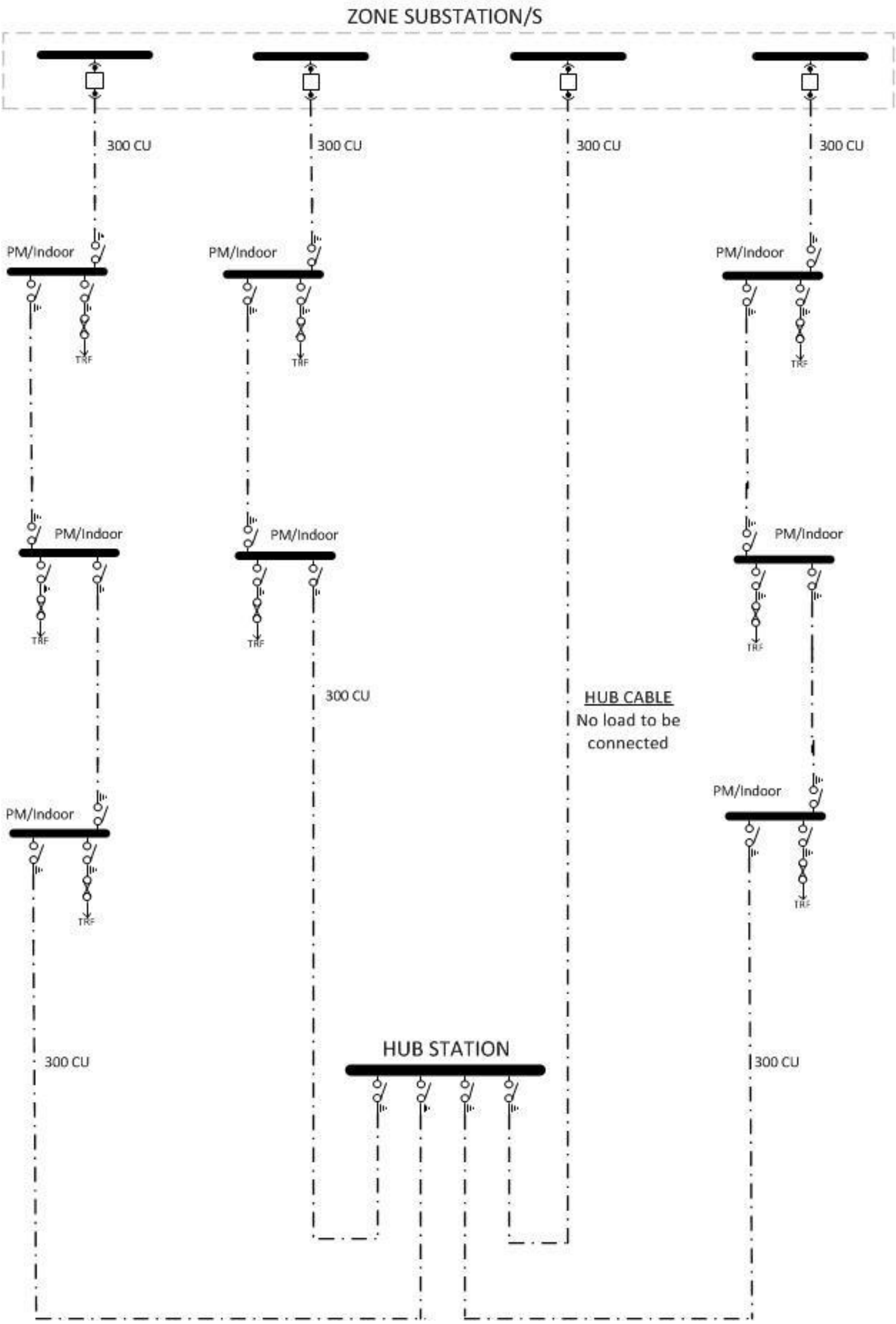

Figure 1: Basic example of a Hub Station circuit diagram

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^{o}C to 40^{o}C. The air temperature inside the padmount cubicle can reach and cause internal equipment ambient to be 55^{o}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.

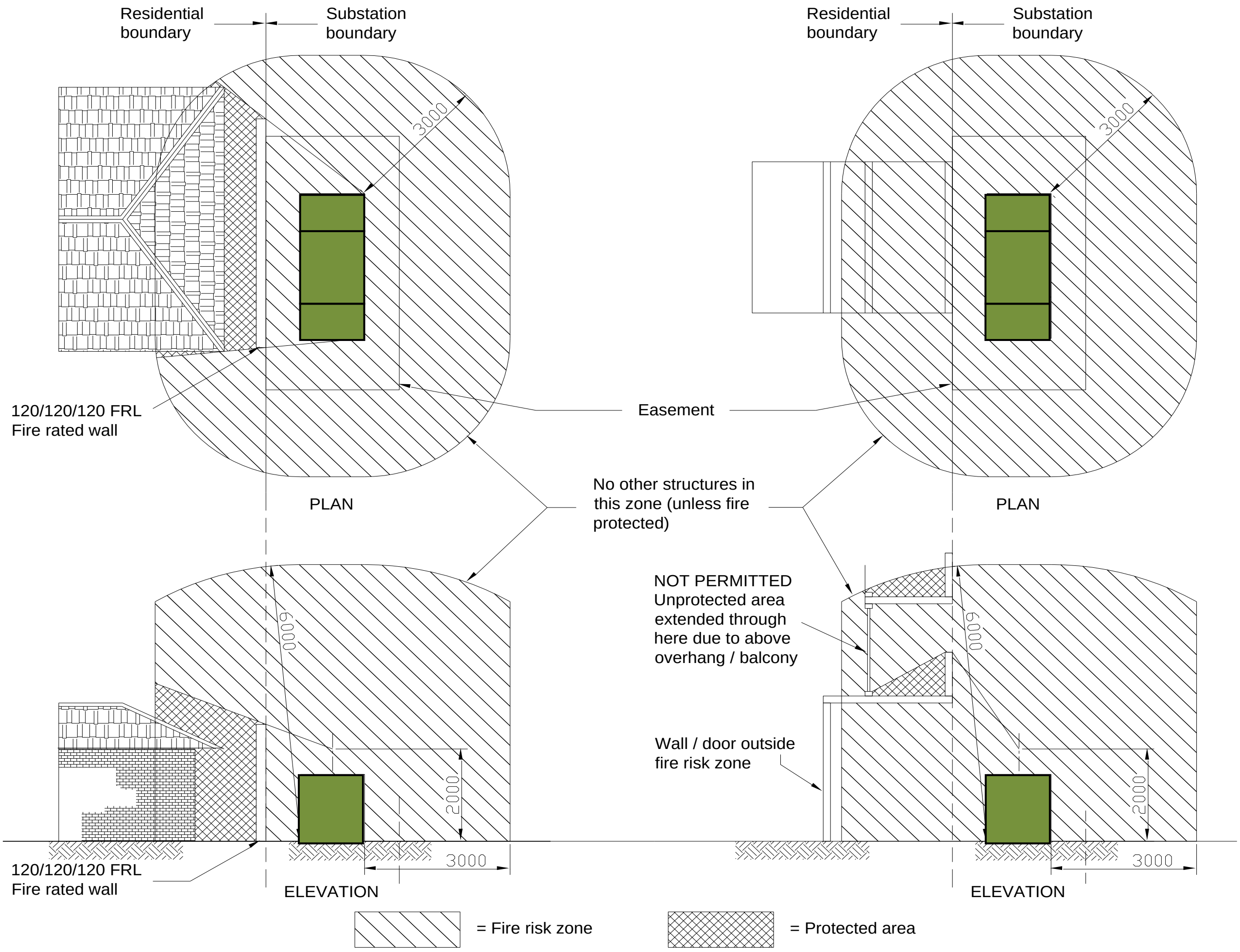

Figure 2 - Example use of screen walls in fire zones

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.

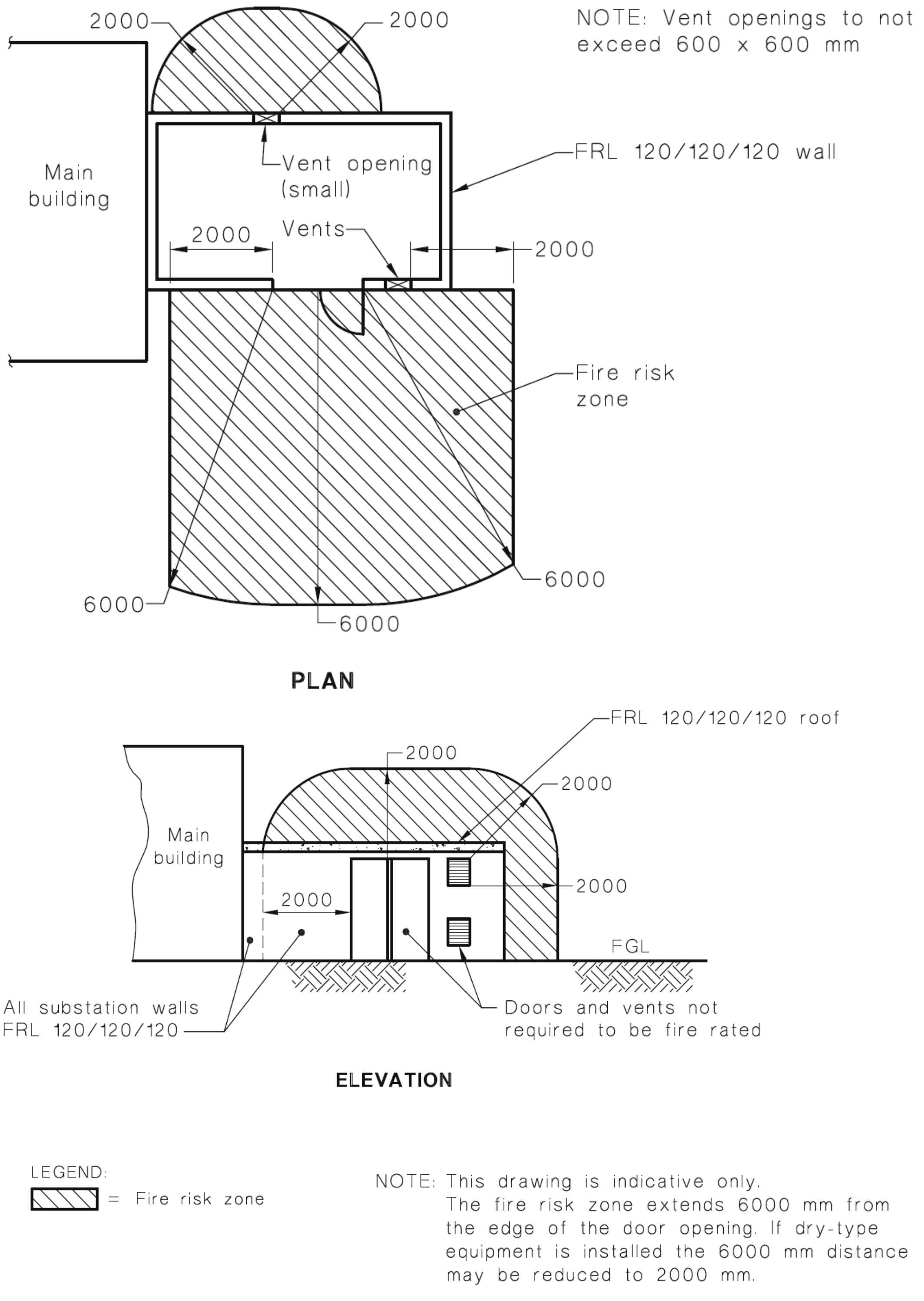

Figure 3 - From AS 2067 - Figure C5 Attached or adjacent substation with fire-rated walls and roof non-fire-rated doors and vents

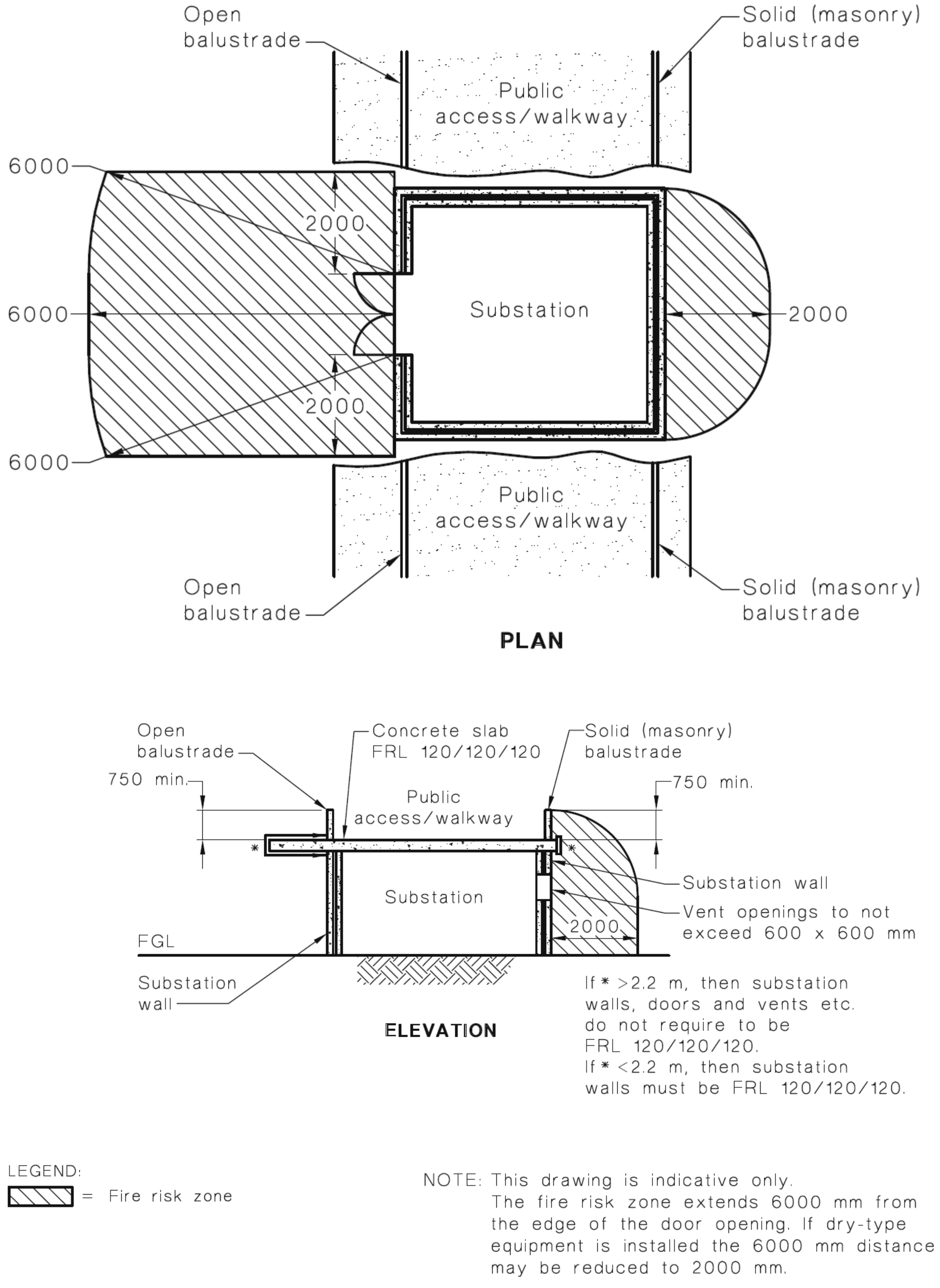

Figure 4 - From AS 2067 - Figure C6 Indoor substation with public access above

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).

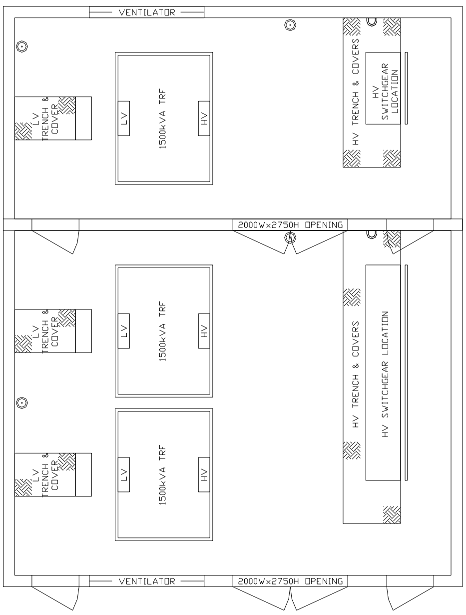

Figure 5 - Three (3) transformer substation

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.

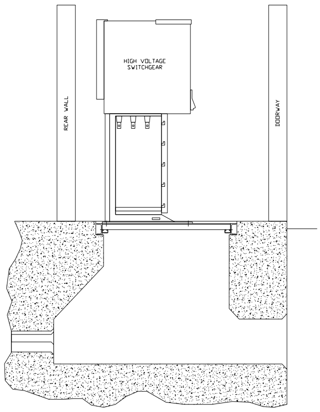

Figure 7 - Alcove style switching room

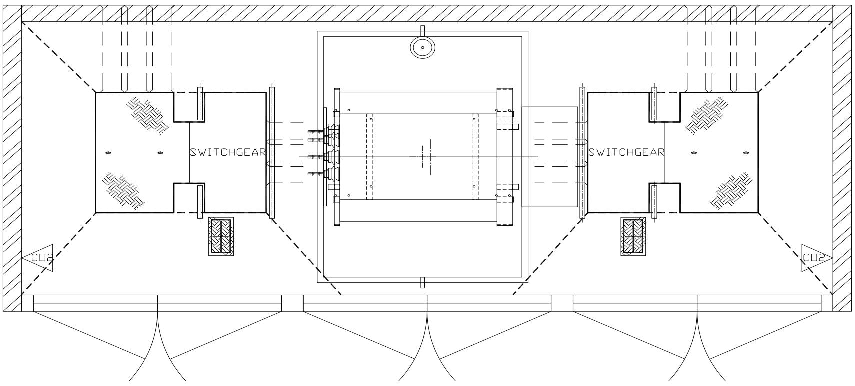

Figure 8 - Padmount style indoor substation

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^{o} C inside the substation building, above the air intake temperature, the fans will start when the temperature inside the room reaches 35 ^{o}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 300mm^2. 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 mm^2-aluminium or 25 mm^2 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 mm^2 single core copper, XLPE insulated cable with copper screen having a minimum10 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 insulting 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.

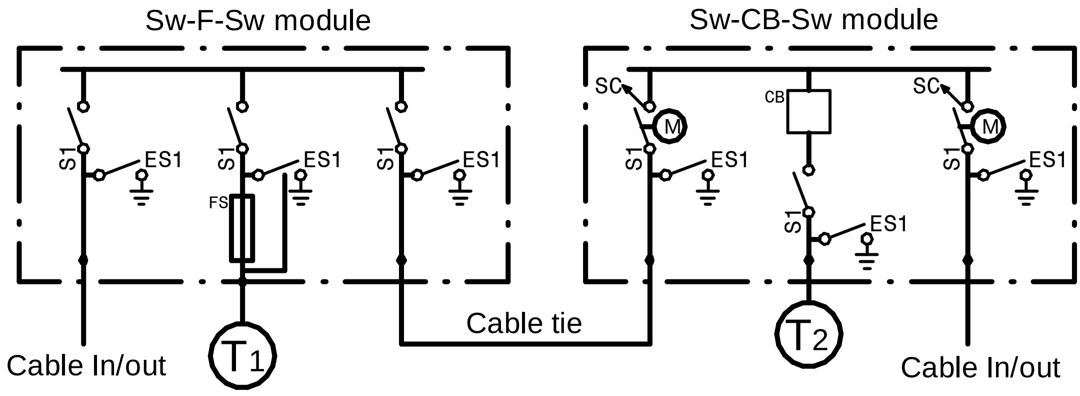

Figure 9 – Example two (2) transformer arrangement

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 240mm^2 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 300mm^2.

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 $70mm^2$ 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
• 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	• 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 $70mm^2$ 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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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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ELECTRICAL SAFETY

FOR PLUMBERS

WORKPLACE FACT SHEET

KNOW THE DANGERS

Plumbers run the risk of receiving an electric shock when cutting metallic water pipes or replacing water meters. This fact sheet has been developed to help you understand why you may be at risk and what you can do to work safely.

THINGS YOU SHOULD DO BEFORE STARTING WORK

- Complete a risk assessment. This will identify hazards (including work practices and procedures) and help you implement appropriate control measures.
- If appropriate, inform the customer and isolate the electrical supply. Locate the main switch/es and turn them off attaching a "Do not operate" tag. Remember, this may not isolate all stray voltage.
- Know the location of underground or overhead power lines and their proximity to your work site before commencing digging or climbing. Dial **1100** or visit **www.1100.com.au** before you begin any digging work.
- Test water pipes with a self-testing voltage indicator for stray voltage.
- If the earth wire needs to be moved or disconnected, or shows signs of being damaged, or where any existing metallic pipe is to be replaced in part or in it's entirety by plastic pipe or other non-metallic fittings or couplings, the work must not commence until the earthing requirements have been checked by an electrical contractor and modified, if necessary.

Call 131 081 and put safety first.
www.endeavourenergy.com.au

Endeavour Energy

THINGS YOU SHOULD DO BEFORE STARTING WORK

BRIDGE THE GAP, AVOID THE ZAP!

When cutting a water pipe, disconnecting a water heater or water meter it is important to provide an alternate circuit for electrical current to travel. Otherwise, it may travel through you!

5 STEPS TO SAVING YOUR LIFE

01 Test water pipes with an approved testing device to determine if there is any voltage in the pipes. If a voltage reading of 5 volts or above is detected, warn the customer and contact Endeavour Energy immediately as there is a problem with the electrical system.

02 Clean water pipe back to the bare metal on either side of the work area that you intend to cut/work on. This assists the bridging conductor to achieve a good connection.

03 Attach the bridging conductor to the cleaned pipe and secure it firmly ensuring both ends of it will not come loose during work. Do not work outside of the bridging conductor.

04 Complete the job whilst working inside the bridged area.

05 Remove the bridging conductor once all work inside the bridge has been completed including all joining work.

WHEN BRIDGING

- Every time, before using one, visually inspect the bridging conductor for any damage.
- Ensure bridging conductors have a current rating of no less than 70 amps.
- Ensure suitable bridging conductors with insulated screw type clamps are fitted for each end of the electrical bridging conductor.
- Ensure PPE is used, especially insulated electrical gloves (minimum 500 volts). Every time, prior to use, ensure gloves are checked for damage such as holes.
- Do not break or remove the bridge until all work on the bridged area is completed and continuity of the metallic service pipe is restored.
- Remember, the removal of a bridging conductor during work may result in electrocution.

OTHER WAYS TO MAKE YOUR WORKSITE "POWER SAFE"

- Find out about any work areas which may be hazardous for other reasons such as gas, water etc.
- Look for obvious signs of underground services such as conduits, pipes, warning tape, bricks or equipment.
- If required, arrange for the isolation of electricity supply or the application of insulating matting onto service and point of attachment by Endeavour Energy.
- If there are power lines near the worksite, install appropriate signage.

SAFETY EXCELLENCE

IN EMERGENCIES CALL 131 003

24 hours a day, 7 days a week

If you have any questions about what you should do to stay safe please call 131 081 or visit us at www.endeavourenergy.com.au

0611-ENE2352_PL

LIVING SAFELY WITH ELECTRICITY

When working outside, whether it's a small job or large job or even something you do every day, you need to be aware of the electrical dangers of working near overhead power lines or underground cables.

Endeavour Energy wants to help protect you from potential electrical dangers on your work site. In turn, this will ensure families, households and businesses can continue to enjoy a safe and reliable electricity supply.

This brochure highlights some of the things you can do to avoid electrical dangers on the job.

Did you know?
Australian households receive communication, gas, water and electrical services via a labyrinth of cables stretching millions of kilometres underground. If just one of these cables is damaged, you could potentially be seriously injured and/or isolate thousands of households from essential services. Such incidents can result in hefty fines.

01 Call Emergency Services on **000**.

02 Request an ambulance if anyone is injured.

03 Report the incident to Endeavour Energy on **131 003** as soon as possible.

SAFETY EXCELLENCE

IN EMERGENCIES CALL 131 003

24 hours a day, 7 days a week

If you have any questions about what you should do to stay safe around damaged power lines and other electrical infrastructure please call 131 081 or visit us at www.endeavourenergy.com.au

0611-ENE2351-CONT

51 Huntingwood Drive
Huntingwood NSW 2148
PO Box 6366 Blacktown NSW 2148
T: 131 081 • F: 61 2 9853 6000

Endeavour Energy

SAFETY ON THE JOB

Call 131 003 and put safety first.
www.endeavourenergy.com.au

Endeavour Energy

BE ALERT AT WORK

Do you know where the underground cables are?

Unfortunately, serious incidents occur when excavators hit underground cables because cables aren't identified before work has commenced. Obtaining information about underground cable locations once involved making numerous calls to many utility providers.

Now there's really no excuse. Information and site maps showing the general location of underground services can be obtained by calling **1100** or visit **www.1100.com.au**. Remember it's the law.

Check, double check, triple check and reassess

Always check, double check, triple check and reassess for electrical dangers on the job. Remember, earthmoving operations often require material to be relocated to mounds or piles. When this happens under and around power lines it reduces the clearance distances between plant and the electrical infrastructure.

Completed your job?

Stay alert when packing up or removing scaffolding or equipment or when returning plant to its transit position.

Transporting trees?

Remember tall trees and shrubs such as palms can come into contact with power lines. Water is a good conductor of electricity and can therefore conduct through vegetation due to its water content.

Excavating?

Always check the voltage of cables listed on plans so that you can then apply this to *Work Near Underground Assets Guide 2007*, WorkCover NSW, to determine what the clearance and other requirements are to commence excavation. Select the safest plant for the job, e.g. toothless buckets and blunt hand tools. Before using mechanical plant to dig, use a cable location service to check the accuracy of plans. Always pothole by hand with non-conductive, blunt hand tools.

Look up and live

If a tip-truck, scaffolding, pump, ladder, crane or metal platform approaches or comes in contact with overhead power lines, the operator and even people nearby, could be electrocuted. Before starting work always look up and identify the location of any overhead power lines. Plan the job to minimise work near and around power lines.

Compare the height of power lines to the maximum height of your equipment, and ensure the full reach of your equipment will not breach the approach distances outlined in the *Work Near Overhead Power Lines Code of Practice 2006*, WorkCover NSW. For "ordinary persons" WorkCover requires an approach distance of at least three metres from overhead power lines (up to 132,000 volts).

Additional clearances are required when working near power lines carrying higher voltages. It's also a good idea to nominate a co-worker to observe and check that you and your equipment do not go into the approach distance zone.

HOW CAN YOU HELP?

Electricity can jump

You don't have to be touching power lines to get an electric shock because electricity can 'jump' – also known as arcing. A safe 'clearance' distance needs to be maintained to prevent electricity from arcing across to you and your equipment.

Five things to remember

01 Check, double check, triple check and reassess – always assess your work site for electrical dangers before you start and stay alert until you've left the site.

02 Look up and live – identify the location of overhead power lines and plan your job away from them.

03 Dial **1100** or visit **www.1100.com.au** before you dig – confirm the location of all underground cables before you begin any excavation work.

04 Before using mechanical plant to dig, check the accuracy of your plans using a cable location service. Pothole by hand using blunt plant items.

05 Always maintain a minimum approach distance from power lines and assign a co-worker as an observer while you operate and move machinery around power lines.

DIAL BEFORE YOU DIG®
www.1100.com.au

ELECTRIC & MAGNETIC FIELDS – WHAT WE KNOW

ABOUT EMFS

ELECTRIC AND MAGNETIC FIELDS – OR EMFS – ARE FOUND EVERYWHERE THERE IS ELECTRICITY. THEY ARE INVISIBLE.

For many years, questions have been raised about whether EMFs affect people's health. It remains a controversial issue although research over more than 40 years has greatly increased our understanding. There have been thousands of studies – some suggesting a link, others not, and some raising further questions. As electricity is so widespread in our society, questions about electricity and health are important to people. The purpose of this brochure is to inform the public about the issue – what we know, and what we are doing about it.

WHAT ARE ELECTRIC FIELDS?

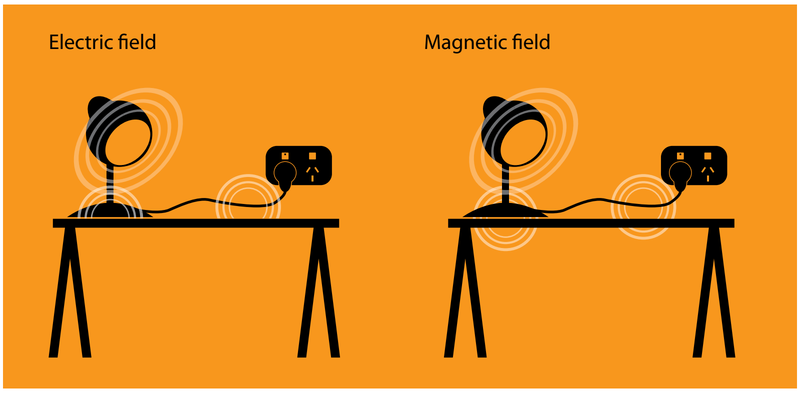
An electric field is a region where electric charges experience an invisible force. The strength of this force is related to the voltage, or the pressure which forces electricity along wires. Electric fields can be present in any appliance plugged into a power point which is switched on. Even if the appliance itself is turned off, if the power point is on, an electric field will be present.

Electric fields are strongest close to their source, and their strength diminishes rapidly as we move away from the source, in much the same way as the warmth of a fire decreases as we move away from it. Many common materials such as brickwork or metal will block electric fields. As such, walls, tables and bench tops can act as a shield.

WHAT ARE MAGNETIC FIELDS?

A magnetic field is a region where magnetic materials experience an invisible force produced by the flow of electricity, commonly known as current. Unlike electric fields, magnetic fields are only present when electric current is flowing. In other words, if an appliance is operating, a magnetic field is produced. For most appliances, once the appliance is switched off, the current stops flowing and there is no magnetic field. However, for an increasing number of appliances, particularly electronic equipment, some current flows even when they are switched off, but on standby. For these appliances, a magnetic field is present unless the appliance is switched off at the wall.

The strength of a magnetic field depends on the size of the current (measured in amps), and decreases rapidly once we move away from the source. While electric fields are blocked by many common materials (see illustration), this is not the case with magnetic fields. This is one reason why power lines may contribute to magnetic fields in the home and why burying power lines will not eliminate them.



DO EMFS CAUSE ADVERSE HEALTH EFFECTS?

Research on EMFs and possible health effects has been conducted for over 40 years. This includes over 2,900 studies at a cost of more than $490 million internationally. Many questions have been answered but not all questions.

The research has generally focused on the magnetic field component as this has raised more issues than electric fields. There have been two main areas of research, *epidemiology* and *laboratory* studies. Both areas would need to provide links between EMFs and adverse health effects for causality to be accepted by health authorities.

Epidemiology is about people's health. This research looks at statistics to see if there are patterns of disease in large groups of people. The difficulty with large statistical studies is that they take several years to produce meaningful results, and even then, there are different opinions about how the results should be interpreted. There may be other factors in the study (such as how EMFs are measured or patient histories) which could complicate the interpretation of the results. Some studies have reported statistical links between EMFs and cancer while others have not. Scientists generally agree that the epidemiological studies aren't strong enough by themselves to establish that adverse health effects exist.

In the laboratory researchers have studied living cells as well as animals and human volunteers to see if EMFs have any effects.

There have been many hundreds of these studies reported, and scientists examine them for results which can be successfully repeated in different laboratories. In over 40 years of research there have been no such reproducible results. Hence the evidence from the laboratory is that low level EMFs of the type experienced by the public do not cause the health effects that some have claimed. Lack of consistency in the results of the laboratory studies is one reason why scientists treat the weak positive results from some epidemiological studies with scepticism.

SCIENTIFIC REVIEWS

It is well accepted by scientists that no one study considered in isolation will provide a meaningful answer to the question of whether or not EMF can contribute to adverse health effects. In order to make an informed conclusion from all of the research, it is necessary to consider the science in its totality. All of the research is reviewed periodically by expert panels which are established by national or international bodies with the purpose of trying to determine whether or not human exposure to EMF is related to adverse health effects.

The most recent extensive review was carried out by the World Health Organisation (WHO) in 2007 which found:

"Scientific evidence suggesting that everyday, chronic low-intensity (above 0.3–0.4 μT) power-frequency magnetic field exposure poses a health risk is based on epidemiological studies demonstrating a consistent pattern of increased risk for childhood leukaemia. Uncertainties in the hazard assessment include the role that control selection bias and exposure misclassification might have on the observed relationship between magnetic fields and childhood leukaemia. In addition, virtually all of the laboratory evidence and the mechanistic evidence fail to support a relationship between low-level ELF magnetic fields and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal, but sufficiently strong to remain a concern."

WHAT DO HEALTH AUTHORITIES ADVISE?

In Australia, the relevant health authority is the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), an arm of the Commonwealth Department of Health and Aging. ARPANSA (in their Fact Sheet 19 Electricity and Health) advise that:

"The scientific evidence does not firmly establish that exposure to 50 Hz electric and magnetic fields found around the home, the office or near power lines is a hazard to human health."

"At the present time there is no proven evidence that exposure to low level electric fields is a health hazard (excluding of course electric shock)."

The WHO advises that:

"Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields."

ARE THERE EMF GUIDELINES FOR ESTABLISHED HEATH EFFECTS?

The Australian electricity industry follows the "Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields" as developed by the National Health and Medical Research Council (NHMRC) in 1989. The NHMRC Guidelines suggest a magnetic field public exposure limit of 1,000mG. These Guidelines are currently recommended by ARPANSA pending finalisation of their new Guideline.

The two internationally recognised exposure limit guidelines originate from the

» Institute of Electrical and Electronics Engineers (IEEE) of the USA, and

» International Commission on Non-Ionizing Radiation Protection (ICNIRP), an expert advisory body to the WHO.

Under the IEEE Standard of 2002 the recommended magnetic field public exposure limit is 9,040 milligauss.

Under the ICNIRP guidelines of 2010 the recommended magnetic field public exposure limit is 2,000 milligauss.

GUIDE TO COMMON EMFS

These days it is relatively easy to measure magnetic fields using a gaussmeter.

The fields are measured in a unit of milligauss (mG) or microtesla (μT). 1 microtesla (μT) equals 10 milligauss (mG).

To give you an idea of the relative strengths of EMFs, the following guide shows the typical magnetic fields close to appliances and under power lines.

Note that owing to variations in the design of electrical appliances and the loadings on power lines, the levels of magnetic fields can vary. The following table is based on a consistent set of measurements undertaken by power authorities in Australia using similar techniques and protocols to overseas measurements. Due to the difference in appliance design and voltages overseas, the field levels shown in overseas publications can often be different from those in the table.

Typical magnetic field measurements and ranges associated with various appliances and power lines are outlined below:

Localised EMFs may also be encountered in specific situations such as near substations, underground cables, specialised electrical equipment, or at elevated locations near lines. Note that the strengths of EMFs decrease rapidly with distance from the source.

FIGURE 1: TYPICAL MAGNETIC FIELD MEASUREMENTS AND RANGES

	Typical Measurement (mG)	Range of Measurement (mG)
Stove	6	2-30
PC	5	2-20
TV	1	0.2-2
Electric blanket	20	5-30
Hair dryer	25	1-70
Refrigerator	2	2-5
Toaster	3	2-10
Kettle	3	2-10
Fan	1	0.2-2
Overhead distribution line (under the line)	10	2-20
Overhead transmission line		
» under line	20	10-200
» edge of easement	10	2-50

Appliance Measurements taken at normal user distance

WHAT IS THE BEST RESPONSE?

Electricity utilities continually review scientific developments related to EMFs and are guided by relevant health authorities. In Australia, ENA recommends that electricity utilities provide balanced and accurate information to the community and design and operate electrical power systems prudently within relevant health guidelines. This includes such actions as:

» providing training to staff;

» informing the community;

» measuring field levels for the public and employees;

» ensuring that fields are within established guidelines set by health authorities; and

» practising "prudent avoidance" when building new electrical facilities.

Prudent avoidance involves reducing magnetic field exposure where this is practicable and can be done at modest cost. If utilities can easily keep people out of fields or in lower fields, then that, the industry believes, is a common sense thing to do.

So what can you as an individual do to reduce exposure to EMFs? There are some things you can do very easily. Since EMFs drop off rapidly as you move away from their source, you can modify your use of electrical appliances such as clock radios. You can locate beds away from a wall that has a switchboard outside and you can switch off your electric blanket before you get into bed. These actions will reduce exposure to EMFs but remember that no-one knows if doing any of these things will improve health outcomes at all.

Organisations which can provide further information about EMFs include:

» your local electricity utility or the Energy Networks Association (ENA);

» the Radiation Safety Unit of your state Health Department;

» the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) - www.arpansa.gov.au

» the World Health Organisation (WHO) – www.who.int

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