

Substation Design Instruction

Installation of conduits in transmission/zone substations and switching stations

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Substation Design Instruction

ASSET STANDARDS AND DESIGN

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SDI 531 INSTALLATION OF CONDUITS IN TRANSMISSION/ZONE SUBSTATIONS AND SWITCHING STATIONS

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1.0 PURPOSE

To define the installation requirements for conduits in transmission/zone substations and switching stations.

2.0 SCOPE

This document defines the installation requirements of conduits and fittings for power cables, control cables, earth cables and telecommunication cables in transmission/zone substations and switching stations.

Telecommunication cables include fibre optic, pilot and telephone cables.

3.0 REFERENCES

Internal

- Company Policy 9.9.1 - Network Asset Maintenance
- Company Policy 9.2.5 - Network Asset Design
- Company Policy 4.0 - Environment
- Company Procedure GSY 1066 - Worksite Hazard and Risk Assessment
- Mains Design Instruction MDI 0047 - Overhead transmission mains design
- Mains Construction Instruction MCI 0006 - Underground Distribution - Construction standards manual
- Substation Design Instruction SDI 503 - Transmission and zone substation fire detection, control and suppression systems
- Substation Design Instruction SDI 505 - General details and minimum requirements
- Substation Design Instruction SDI 510 - Buildings
- Substation Design Instruction SDI 540 - Transformer oil containment
- Endeavour Energy Electrical Safety Rules
- Network Management Plan December 2013 Review

External

- *Work Health and Safety Act 2011 (NSW)*
- ENA National Electricity Network Safety Code (Doc 01-2008)
- NSW - Network NSW Specifications - Electrical Conduit, Conduit Fittings, Cable Protection Covers and Marker Tape
- Filoform Safety Data Sheet (01-02-2012 Review) - Expanding polyurethane filler
- AS 2700:2011 - Colour standards for general purposes
- AS/NZS 2032:2006 - Installation of PVC pipe systems
- AS/NZS 2053.1:2001 - Conduits and Fittings for Electrical Installations part 1 General requirements
- AS/NZS 2648.1:1995 - Underground marking tape - Non-detectable tape

4.0 DEFINITIONS AND ABBREVIATIONS

Backfill¹	Material used for filling trenches and excavations after a conduit has been laid, is usually placed on top of bedding material.
Conduits²	Parts of a closed wiring system enclosing cables in electrical installations, which allows the cables to be drawn in or replaced. Conduits may have a circular or non-circular cross section.

¹ AS/NZS 2032:2006 - Installation of PVC pipe system

² AS/NZS 2053.1:2001 - Conduits and fittings for electrical installations part-1 General requirements

Conduit fittings	Devices designed to join or terminate one or more lengths of conduit, and include couplers, elbows, bends junction boxes and tees.
Heat of hydration	Heat liberated when cement is mixed with water. This heat is called the heat of hydration, the result of the exothermic chemical reaction between cement and water. The heat generated by the cement's hydration raises the temperature of concrete.
Marking tape³	Tape that is buried directly above underground services to provide visual warning during subsequent excavation.
UPVC	unplasticised polyvinylchloride

5.0 ACTIONS

5.1 General

All conduits shall be of UPVC construction.

Reference shall be made to Network NSW Specifications: Electrical Conduit, Conduit Fittings, Cable Protection Covers and Marker Tape.

All conduits exposed to direct sunlight shall be suitable for outdoor use and they shall be manufactured with protection against solar radiation.

All conduits, including spare conduits, shall be fitted with draw wires. Each draw wire shall be of a non-electrical conducting material and it shall be capable of being left in contact with ground water for a number of years without deterioration. The draw wire shall be continuous throughout the conduit lengths and be secured at each end of each conduit run to prevent accidental removal. All draw wires shall have a breaking strain suitable for the cables to be installed.

Conduits which extend from the basement to the property boundary or beyond do not need to be fitted with draw wires provided that arrangements are in place to blow-in a draw wire along the entire route length at a later time.

All conduits shall be sealed by end caps or plugs after installation to prevent ingress of contaminants - refer also to clause 5.3.3.

To accommodate future cables, additional spare conduits shall be incorporated in the design to cover the ultimate arrangement of the substation. In addition, as a guide an additional two power cable conduits, one earth cable conduit and one telecommunication conduit shall be provided in each bank. Consideration can also be given to including one telecommunication conduit with all control cable banks if the future need for fibre optic cable in the switchyard is expected.

Conduit installation shall comply with the requirements of this Standard. If a different type of installation method is to be used, prior approval shall be obtained from the Network Substations Manager, Asset Standards and Design.

5.2 Conduit requirements

Conduits shall be in accordance with Network NSW Specifications: Electrical Conduit, Conduit Fittings, Cable Protection Covers and Marker Tape.

³ AS/NZS 2648.1:1995 - Underground Marking Tape part-1 - Non detectable tape

The standard conduit colours, classes and inside diameter requirements for substation use are indicated in table 1.

Conduit use	Colour	Class	Nominal inside diameter (ID)
Conduits for telecommunication cables	White	Heavy duty rigid	25mm up to 110mm
Pilot cables or earthing cable	Orange	Heavy duty rigid - min PN 12 rating	50mm
Conduits for power cables	Orange	Heavy duty rigid - min PN 12 rating	125mm, 150mm & 200mm
Conduits for control cables	Orange	Heavy duty rigid - min PN 12 rating	Up to 125mm as appropriate to achieve max. 50% cable volume

Table 1: Standard conduit requirements

5.3 Installation requirements

5.3.1 General

Conduit laying requirements, including separation, ground cover requirements and the installation of marking tape to provide visual warning during subsequent excavation shall be in accordance with the drawings indicated in clause 5.5. Conduits shall be encased in accordance with clause 5.3.2 when conduits are installed under hardstand areas or where additional protection is required for the cables.

All conduits shall be laid straight and uniform.

Conduits for impending underground power cables, communications, earthing and the like are to extend to within 500mm of the inside of the site boundary.

All underground conduits entering a transmission or zone substation or switching station building shall slope away from the building entry point - refer also to clause 5.3.3.

All joins in conduits shall be glued to prevent moisture ingress and all conduits, with or without cables, shall be sealed at both ends in accordance with clause 5.3.3. All glues and seals shall not cause any deterioration to the conduit, cable covering or to the draw wire installed in the conduit runs.

Fire stopping shall be in accordance with SDI 503.

5.3.2 Encased conduits

Where additional protection is required, conduits shall be encased in 14:1 sand cement mix or concrete with a minimum compressive strength of 15 MPa in 28 days depending on the degree of protection required for the cables. A minimum of 100mm of uniform concrete cover shall be provided over the top conduit of the encasement. Refer to the drawings indicated in clause 5.5.

To hold the position of the conduits while they are encased, conduits shall be adequately secured to avoid flotation and approved preform polystyrene foam (or similar material) spacers shall be placed between the conduits.

Construction joints in the encasing material shall use suitable steel dowels that extend into the concrete encasement on each side of the joint.

The encasement shall not cause overheating and deformation of the conduits through the heat of hydration.

5.3.3 Conduit sealing

To prevent water and contaminants entering the building and its basement through conduits, suitable measures shall be taken as indicated below.

All conduits shall be thoroughly cleaned before sealing and sealing products shall be applied in accordance with the manufacturers' instructions.

To assist with future cable work, the products used to seal the conduits shall be able to be removed easily using hand tools with minimum effort.

As indicated in clause 5.3.1, all joins in conduits shall be glued to prevent moisture ingress.

The sealing approach specified below applies to the conduits at the building and also to the first open point in the remote end of the conduit - located either within the substation boundary (first joint bay), or in the street or footpath allocation beyond the substation boundary. Any previously continuous conduits that are cut for any reason shall also be sealed in the same manner.

Reference shall also be made to SDI 510 for details of the substation drainage requirements.

Conduits sloping away from the building entry point:

As indicated in clause 5.3.1, all conduits entering a transmission or zone substation or switching station building shall slope away from the building entry point wherever possible.

In this application both ends of the conduits shall be sealed with expanding foam, Auslec type HILCF126-BU (stock code SP10000) or an approved equivalent; unless the conduit is empty in which case the expanding foam shall be used to seal the conduit entering the building and a plastic conduit plug shall be fitted onto the remote end of the conduit.

Where conduit plugs are used to prevent the ingress of contaminants into empty conduits, they shall be taped in place, to prevent them being dislodged during work such as backfilling.

Conduits sloping towards the building entry point:

At existing sites where conduits do not slope away from the building entry point or where there is known or likely to be water ingress through the conduits, both ends of the conduits shall be fitted with the following sealing methods or approved equivalent.

Application	Sealing method	Nominal conduit size	Type No.	Details	Stock Code
Conduits with cable/cables installed:	Expanding polyurethane resin sealing kit Filoform type MD III*	50mm	MD III-50 mm	For openings up to a max of 50 mm	001566959
		100mm	MD III-110 mm	For openings up to a max of 110 mm	001566967
		125mm	MD III-160 mm	For openings up to a max of 160 mm	001566975
		150mm			
	Engineered seal Hauff-Technik press seals or approved equivalent	200mm	MD III-200 mm	For openings up to a max of 200 mm	001566983
		various	Engineered seals shall only be used to seal conduits in exceptional circumstances subject to the approval of the Network Substations Manager.		
Empty conduits:	Expanding polyurethane resin plug sealing kit Filoform type MD IV*	50mm	MD III-50 mm sealing kit (referred to above) is suitable for empty 50mm conduit.		
		100mm	MD IV-3	For openings min 95 mm to max 125 mm	001566991
		125mm	MD IV-4	For openings min 125 mm to max 160 mm	001567007
		150mm			
	Engineered plug seal Hauff-Technik press seal plug or approved equivalent	200mm	MD III-200 mm sealing kit (referred to above) is suitable for empty 200mm conduit.		
		various	Engineered plug seals shall only be used to seal conduits in exceptional circumstances subject to the approval of the Network Substations Manager.		

Table 2: Sealing methods

**Refer to the MSDS for the safe installation and management of the product.*

5.3.4 Conduits for portable buildings

For portable type buildings where there is no basement, the sections of conduit buried beneath the portable building shall be encased in concrete and a suitable protective covering shall be installed around any exposed conduits that extend from the ground into the portable building floor.

5.3.5 Telecommunication conduits

Telecommunication conduits shall be continuously joined lengths from the point of entry to the substation basement of the associated feeder cable to the respective termination cabinet; with a minimum number of bends for ease of installation. All bends for the fibre optic cables shall have a minimum bending radius of 200mm so that the fibre optic cable is not damaged upon installation.

All telecommunication cables that are routed within cavity walls shall be installed in non-metallic conduits.

5.3.6 Control cable conduits

All control cable conduits shall be installed in accordance with this instruction and drawing number 366066. They shall be of sufficient size to cater for twice the maximum quantity of cables required for the ultimate design.

5.3.7 Conduits installed in sloping ground

Where difficulty is encountered in obtaining sufficient cover at the building wall due to site conditions and basement levels, (for example, a building constructed on sloping land), concrete encased ramps or conduits extending deeper than the basement floor levels may be constructed.

The design of concrete encased ramps or conduits shall be large enough to accommodate the bending radius of the cables. The bending radius of UPVC conduits shall be larger than the cable manufacturers' recommended minimum installed radius.

The minimum bending radius of conduits shall be four (4)⁴ metres for 11/22kV and six (6)⁴ metres for 33kV, 66kV and 132kV cables - see Figure 2 below for more details on conduits installed in sloping ground.

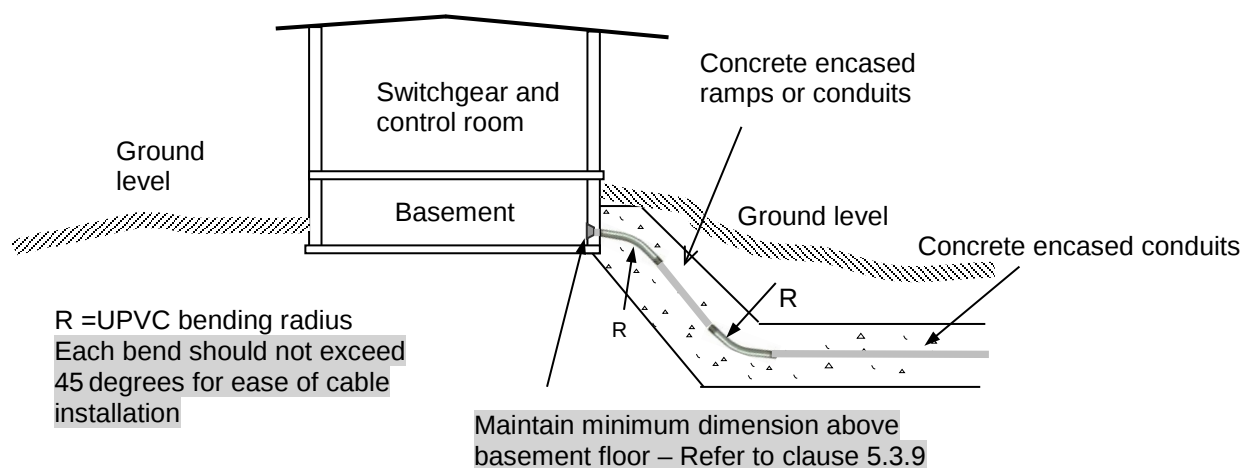


Figure 2: Conduit installation on sloping ground

5.3.8 Transformer bund cable entries

Conduits for power and control cable entries used in transformer bunds shall be installed in accordance with SDI 540 and drawing numbers 295183 and 369643.

5.3.9 Entry level at building

Power cable conduits entering the building and its basement shall be installed at least 50mm above the finished floor level. Conduits not associated with power cables shall be installed above or at the same level as the power cables.

5.3.10 Bellmouths

Where conduits for power cables pass through walls or other sharp edge surfaces, conduit bellmouths shall be fitted on the inside of the wall or surface.

⁴ The bending radii for conduits, which requires two bends as shown in Figure 2, may be increased to include extra safety margins for facilitating pulling of cables (for convenience as well protecting cables from damage).

5.4 Testing after installation

After the conduits are installed and prior to the installation of draw wire or cables, conduits shall be thoroughly cleaned of any obstruction, sand or dirt with an Endeavour Energy approved cleaning mandrel. The mandrel string shall be pulled manually through the conduit in both directions in the presence of Endeavour Energy's Authorised Person.

A manufacturer approved sizing mandrel approved by Endeavour Energy shall also be used to check the integrity of the conduits in the presence of Endeavour Energy's Authorised Person.

5.5 Drawings

Drawings appropriate to this Standard are listed below.

Drawing No.	Title
295183	Transmission and zone substations standard bund arrangement and detail
366060	Standard trench profiles within a substation mains feeders and auxiliary transformer conduits
366061	Standard details for basement cable ramps, pits and trenches and conduit penetrations in basement and cable walls
366066	Standard details for control cable conduits within substation security fenced area
369643	Standard trench profiles within a substation transformers conduits

6.0 AUTHORITIES AND RESPONSIBILITIES

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

Manager Asset Standards and Design has the authority and responsibility for making recommendations to the General Manager, Asset Management in respect to this instruction.

Network Substations Manager, Asset Standards and Design, is responsible for keeping the content of this instruction up to date.

All **Endeavour Energy staff and/or contractors** are responsible for:

- Meeting the requirements of this instruction and SDI 505.
- Working in accordance with local and statutory requirements.
- Maintaining public safety.
- Working in accordance with Endeavour Energy's Electrical Safety Rules.
- Updating the Endeavour Energy Ellipse database.

All **Project Managers** are responsible for:

- Meeting the requirements of this instruction within their area of responsibility.
- Overseeing that Endeavour Energy employees and/or contractors engaged to perform the work have appropriate qualifications.
- Overseeing that appropriate equipment details are entered into the Ellipse database as part of the work.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Network Substations Manager, Asset Standards and Design

Documentation Distribution Coordinator : Branch Process Coordinator