

Substation Design Instruction

Transmission and zone substation fire detection, control and suppression systems

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Substation Design Instruction

ASSET STANDARDS & DESIGN

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SDI 503 TRANSMISSION AND ZONE SUBSTATION FIRE DETECTION, CONTROL AND SUPPRESSION SYSTEMS

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1.0 PURPOSE

To outline the minimum requirements for fire mitigation in zone and transmission substations and switching stations.

2.0 SCOPE

This instruction **must** be read in conjunction with SDI 505 – Minimum design and construction requirements for transmission and zone substations. It outlines the minimum requirements to mitigate the risk of damage to substation assets and the environment in the event of a fire in all new transmission and zone substations, and switching stations. The adoption of the requirements for existing sites will be evaluated on a case by case basis.

The impact of a fire on assets and the environment depends on the type of asset and its relative location in the substation. Therefore, fire mitigation systems for buildings and transformers have been considered separately.

3.0 REFERENCES

Internal

Board Policy (Environment) 4.0 – Environment
Company Policy (Network) 9.2.5 – Network Asset Design
Company Policy (Network) 9.9.1 – Network Asset Maintenance
Company Procedure (Health & Safety) GSY 1066 – Worksite Hazard and Risk Assessment
Substation Design Instruction SDI 505 – Minimum design and construction requirements for transmission and zone substations and switching stations
Substation Design Instruction SDI 510 – Buildings
Substation Design Instruction SDI 509 – Fire hydrants
Substation Design Instruction SDI 528 – Substation signs and equipment labels
Substation Design Instruction SDI 540 – Transformer oil containment
Substation Maintenance Instruction SMI 124 – Maintenance data entry and defect prioritisation
Endeavour Energy Electricity Network Safety Management System (ENSMS)

External

Work Health and Safety Act 2011
Building Code of Australia (BCA) 2012
ENA National Electricity Network Safety Code (Doc 01-2008)
Australian Standard AS 1670.1:2004 - Fire detection, warning, control and intercom systems - System design, installation and commissioning Part 1: Fire
Australian Standard AS 1851:2005 – Maintenance of Fire Protection Systems and Equipment
Australian Standard AS 1851:2012 – Routine Service of Fire Protection Systems and Equipment
Australian Standard AS 2067:2016 – Substations and high voltage installations exceeding 1kV a.c.
AS 4072.1:2005 Components for the protection of openings in fire-resistant separating elements Part 1: Service penetrations and control joints
AS 4428.1:1998 – Fire Detection, Warning, Control and Intercom Systems – Control and Indicating Equipment – Fire
AS ISO 14520.1:2009 – Gaseous fire-extinguishing systems – Physical properties and system design
AS 4072.1:2005 – Components for the protection of openings in fire-resistant separating elements Part 1: Service penetrations and control joints
ENA DOC 18:2015 – Guideline for the Fire Protection of Electricity Substations

4.0 DEFINITIONS AND ABBREVIATIONS

CBD

Central business district

Ellipse

Endeavour Energy asset database

FM

Factory Mutual Global (United States based commercial property insurer and risk manager)

FRL

Fire resistance levels

NFPA

National Fire Protection Association (United States based authority on fire, electrical and building safety)

SDI

Substation Design Instruction

SMI

Substation Maintenance Instruction

STU

Substation terminal unit

VESDA

very early smoke detection aspirator

5.0 ACTIONS

5.1 Fire detection system

5.1.1 General

Fire detection systems **must** be designed, installed and commissioned in accordance with AS 1670, and fire control and indicating equipment **must** comply with AS 4428.

Fire detection **must** be provided in building rooms, concealed roof spaces and basements to adequately cover the **risk** area.

The installation of fire detection equipment **must** be carried out by a service provider that is accredited to install the particular type and brand of chosen fire detection equipment.

Where a particular fire detection system has not been previously endorsed, the Designer/Project Manager **must** obtain approval for use from the **Substation Assets Manager**.

5.1.2 **Integration with** existing systems

When a new system is being installed, the existing fire detection system **must** be assessed for serviceability and either replaced or integrated with the new system, as appropriate.

5.1.3 Detection system

Advanced detection

A very early smoke detection aspirator (VESDA) fire detection system or equivalent scheme **must** be used for the locations listed below:

- Transmission substations/switching stations;

- Zone substations/switching stations supplying CBD areas and/or commercial/industrial loads; and
- Indoor transformer enclosures.

This type of system samples and analyses the air using a network of PVC pipe containing small holes. When a certain amount of smoke is present, a signal is sent to the fire protection panel.

Together with the nominated areas within the station, such as building rooms, concealed roof spaces and basements, it **must** also be provided internally in all AC and DC panels, and internally over the full length of tunnel board panels.

The sampling unit associated with the detection system **must** be typically located as close as practical to the fire alarm panel. Where multiple sampling units are required, a diagram showing the location of all of the sampling units **must** be fitted in the vicinity of the fire alarm panel.

All sampling holes need to be accessible for routine testing/maintenance. Where the equipment is within a HV room/cage (such as an AFIC cell enclosure), then means shall be provided to enable testing without entering the room, by for example providing facility for the sniffer pipes to be accessible from outside the room.

Basic detection

The fire detection requirements for zone substations/switching stations remote from CBD areas, which supply rural and/or residential loads, are set out below:

- A standard and basic type of fire detection system using point smoke or heat detectors **must** be used to send a signal to the fire protection panel.

5.1.4 Alarms

The following alarms **must** appear on the substation STU and on the Huntingwood or Coniston control room master station as priority alarms:

- | | |
|---------------------------------|--------------------|
| • Fire alarm | Operated/restored |
| • Fire system status | Activated/disarmed |
| • Fire equipment failure | Operated/restored |
| • Fire system AC supply failure | Operated/restored |

Fail safe contacts with a minimum rating of 120V DC **must** be used for inputs to the SCADA system.

At the substation fire protection panel, LED indication **must** show the system status (activated/disarmed), zones in alarm, and zones disabled. The Project Manager, in consultation with the fire system service provider, **must** decide the most suitable alarm zoning arrangements for the site.

The fire alarm **must** initiate audible warnings by the use of internal sirens and a single fire bell located outside of the control building that houses the fire panel. Visual warnings **must** be provided by a single strobe light located outside of the control building housing the fire panel. This strobe light **must** be located in a prominent position that can be easily seen from the front property boundary.

The fire system **must** accommodate fully expandable inputs and outputs.

5.1.5 Fire panel location

The fire alarm panel **must** be mounted on the wall inside the substation control building in close proximity to the main entrance door that provides access to the operator's desk and telephone.

5.1.6 Mains power supply

The fire control panel power supply **must** be provided from a dedicated substation AC supply.

5.1.7 Backup battery supply

Backup batteries **must** be installed to provide a power supply in the event that the mains supply is temporarily unavailable.

The capacity of the battery **must** be capable of maintaining the system in normal working (quiescent) condition for at least 72 hours, after which sufficient capacity **must** remain to operate two (2) worst case alarm zones and associated ancillary control functions for a minimum of 30 minutes.

Installed batteries **must** be permanently marked with the installation date.

5.1.8 Signage and instructions

Instructions **must** be fixed on or adjacent to the fire system panel to provide information to persons operating the system.

Signs **in accordance with SDI 528 - Substation signs and equipment labels, must** be erected advising that doors are not to be left open when the site is unattended.

Signage and instructions **must** be obvious and legible.

Additional information that **must** be mounted adjacent to the fire panel includes:

- a fire detection block plan;
- a plan of the motorised roof smoke vents and/or positive pressure fans if installed;
- an interface matrix diagram in accordance with AS1851, if fire detection, hydrant, extinguishing systems and the like interface with other systems; and
- an operation manual that includes commissioning results and other relevant information such as baseline data. This can be mounted in an A4 portrait acrylic brochure holder or similar.

5.2 Fire stopping

All service penetrations, such as control and power cable openings, trenches and ducts, **must** be filled with a two-hour (2-hour) fire rated (minimum) fire-stop¹ product such as mortar or fire-board. However, ducts in external basement walls do not need to be fire-stopped if they are continuously buried below ground from the basement into the street or footpath allocation beyond the substation boundary.

To prevent damage to cables, fire-stop products **must** be easily removable using hand tools with minimum effort.

¹ AS 4072.1:2005 – Components for the protection of openings in fire-resistant separating elements Part 1- Service penetration and control joints

To limit the spread of fire from control panel bases into cable trenches, barriers with a minimum two-hour (2-hour) fire rating **must** be installed. To enable the barriers to be easily removed and restored, loose fitting chequer plate (or similar) **must** be installed in the control panel floor. The gaps between the chequer plate, the panel and the cables going into the trench **must** be neatly filled with expanding fire pillows such as KBS seal bags or equivalent. The fire pillows **must** be correctly sized to enable them to be overlapped and laid flat.

To limit flame propagation, all exposed cables within the transformer bunded area **must** be coated with an approved fire cable coating that does not de-rate the cable on which it is applied, such as KBS cable coating (minimum dry film thickness of 1.6mm) or equivalent.

The concrete in the bund walls and bund floor **must** be designed to provide four-hour (4-hour) fire rating to the bund walls and floors including the joints.

All joints in the fire walls above the top of the bund walls **must** be sealed with a suitable four-hour (4-hour) fire rated sealant.

Fire stopping methods in accordance with AS 4072 **must** be suitable for the environment in which they are installed.

Reference **must** also be made to SDI 510 – Buildings, for additional fire stopping requirements related to buildings.

All fire stopping that is removed for any purpose shall be immediately reinstated to meet the required compliance level indicated in this standard.

Evidence of fire resistance of service penetrations and control joints shall be provided in accordance with AS 4072.1.

5.3 Positive pressure fans

Where positive pressure fans are used, their control circuits **must** be linked to the fire panel.

The fans **must** be automatically disabled in the event of a fire. Any necessary instructions **must** be mounted adjacent to the fire panel and at the fans if necessary.

5.4 Concealed roof spaces

To enable the installation of fire detection equipment, access holes or other appropriate means **must** be provided to allow entry into concealed roof spaces.

5.5 Fire mitigation

5.5.1 Existing systems

Decommissioned water deluge systems **must** either be removed or suitably labelled to indicate that they are no longer in use.

When a new system is being installed, existing CO₂ gaseous systems **must** be assessed for serviceability and either replaced or integrated with the new system, as appropriate.

5.5.2 Outdoor transformers

Transformers that are involved in substantial fires are usually damaged beyond economical repair, so they do not require fire suppression when installed in outdoor enclosures. In the event of a transformer fire, fire brigade staff will enter the substation and apply a foam/water mixture to smother the fire, only after an Endeavour Energy operator advises that it is electrically safe to do so.

Steps **must** be taken to confine the fire to the transformer and limit the consequential damage to other assets in the vicinity. This **must** be achieved on outdoor transformers by fire rated walls or by maintaining minimum separation distances in accordance with the table below.

Where fire walls are used, the transformers may need to be de-rated if ventilation is restricted.

Adjacent transformer separation

In accordance with AS2067 and considering the requirements of NFPA 850 guidelines, FM data sheet 5-4 and ENA DOC 18 the following minimum separation distances are required between outdoor transformers (from bund to bund).

Transformer oil volume - litres	Minimum separation distance - metres
1000 to <1900	3
1900 to 19,000	7.6
Over 19,000	15.2

Where the above distances cannot be achieved, a four (4) hour FRL fire wall, designed to withstand the effects of projectiles from exploding transformer bushings or lightning arresters, **must** be installed between the transformers.

The type of construction **must** be formed reinforced concrete, reinforced concrete pre-cast panels or block-work.

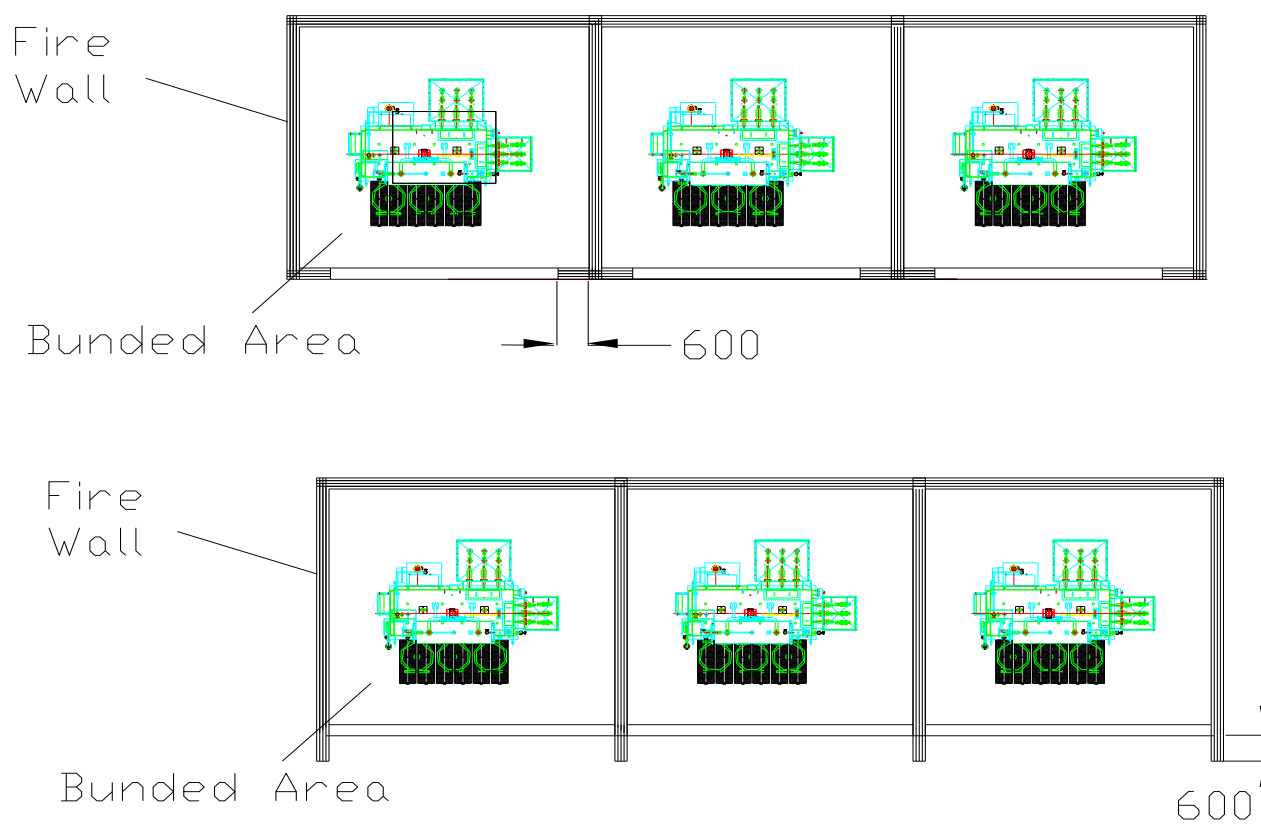
All fire walls **must** be designed by a structural engineer.

Supporting columns **must** be constructed from reinforced concrete.

The fire wall **must** extend at least 300mm above the highest point of the transformer including the conservator tank; however, when a transformer enclosure is close to a building then the firewall **must** extend 500mm above the height of the adjacent building roof, whichever is the greater.

Where the transformers are in close proximity, measures **must** be taken to reduce the possibility of the fire progressing from the open side of one (1) transformer bay into the open side of the adjacent transformer bay.

This **must** be achieved by either of the following methods:



- Extend the side fire wall 600mm across the front of the bund.**
- Extend the side fire wall 600mm beyond the front edge of the bund.**

Transformer to building separation

The following minimum separation distances are required between outdoor transformers and buildings (from edge of bund).

Transformer oil volume - litres	Minimum separation distance - metres		
	2-hour FRL wall or roof	Non-combustible wall or roof	Combustible wall or roof
1000 to <1900	3	3	7.6
1900 to 19,000	4.6	7.6	30
Over 19,000	7.6	15.2	30

Where the above distances cannot be achieved, a four (4) hour FRL fire wall, designed to withstand the effects of projectiles from exploding transformer bushings or lightning arresters, **must** be installed between the transformer and building.

The type of construction **must** be formed reinforced concrete, reinforced concrete pre-cast panels or block-work.

All fire walls **must** be designed by a structural engineer.

Supporting columns **must** be constructed from reinforced concrete.

The fire wall **must** extend a minimum of 300mm beyond the highest point of the transformer including the conservator tank, and it **must** be of a suitable height and width to shield the building and its roof from the potential radiated heat from the transformer fire.

In accordance with AS 1940, the side walls and returns on the fire wall must be designed such that the minimum *transformer to building separation* distance is maintained between any open sides of the transformer enclosure and the building.

Where the transformer enclosure is in close proximity to a multi-storey building, then consideration must be given to returning the top of the fire wall over the top of the transformer, so that the separation distance is maintained; or alternatively the parts of the building exposed must be four (4) hour fire-rated.

Where the transformers are parallel to a boundary fence and they are within the distances specified above, then a fire wall **must** be placed between the boundary fence and the transformer when the area surrounding the substation includes items such as buildings that require protection from fire initiated or propagated by the substation. When considering the future development of the adjacent lots, the guaranteed setbacks as determined by council can be utilised in the distance calculation.

5.5.3 Indoor transformers

Indoor transformer enclosures **must** be fitted with a gaseous fire suppression system that is harmless to people who may be present in the area when the gas is discharged (refer to section 5.7).

5.5.4 Control and switch room fire suppression

Fire suppression systems are not required in transmission or zone substation/switching station control or switch rooms.

5.6 Fire scheme summary

The following table contains a summary of the fire schemes required for new and existing transmission and zone substations and switching stations.

Station type	Control and switch rooms	Transformer enclosures	
		Indoor	Outdoor
Transmission	Fire detection	Fire detection/ gaseous suppression system	Separation or fire wall
Zone	Fire detection		

5.7 Gaseous fire suppression system

5.7.1 General

The use of fire suppression systems will only be considered under exceptional circumstances, subject to the approval of the **General Manager Asset Management** at the design stage of the project.

Gaseous fire suppression systems **must** be installed in accordance with AS ISO 14520.

The gaseous fire suppression system **must** be suitable for flooding areas that are usually occupied.

The system **must** smother the fire by reducing the atmospheric oxygen in the room to a level where combustion will not be supported, while still allowing people to comfortably breathe the reduced oxygen atmosphere and safely leave the protected room.

The extinguishing agent **must** comply with the following requirements:

- be colourless, odourless, electrically non-conductive, and have a density approximately the same as air;
- be comprised of naturally occurring gases that are found in the air that is breathed;
- be inert and engineered to suppress a fire at its earliest stages, while not causing a hazard to people who may be present;
- the system **must** operate by reducing the atmospheric oxygen in the substation rooms to a level that will not support combustion;
- when the gas is discharged, it **must** allow people to comfortably breathe the reduced oxygen atmosphere, while safely and easily leaving the protected room; and
- the gas **must** leave no toxic or corrosive deposits on the equipment.

Where the gaseous system selected deviates from the abovementioned requirements, the Designer/Project Manager **must** obtain approval for its use from the Substation Assets Manager.

5.7.2 Storage

The gas storage cylinders and associated equipment for the system **must** be located in a suitable place within the substation to enable the tanks to be easily inspected and replaced while not obstructing the installation/removal of equipment or personnel movement within the substation.

5.7.3 Operation

The system **must** operate through a very early smoke detection aspirator (VESDA) fire detection system or equivalent scheme (refer to section 5.1.3).

Controls for the normal operation of the system **must** be fitted with a label to identify their use and provide clear instructions on their operation.

The following minimum safety provisions **must** be incorporated:

- time delay of 30 seconds (typical) **must** be provided to allow evacuation prior to the gas discharge into the room;
- an inhibit switch or lock-off valve, where required, to prevent the automatic discharge of the extinguishing agent;
- Aural and visual pre-discharge alarms that operate continuously on commencement of the 30 second (typical) discharge time delay;
- warning notices in accordance with AS 4214;
- outward-swinging self-closing doors that can be opened from the inside, including when locked from the outside; and
- means for the prompt ventilation of protected areas after discharge of the extinguishing agent. This may range from opening of doors to provision of forced draft ventilation.

6.0 AUTHORITIES AND RESPONSIBILITIES

Manager Asset Standards & Design has the authority and responsibility for approving the amendments to this Standard in accordance with GAM0001.

Substation Assets Manager, Asset Standards & Design has the authority and responsibility for keeping the content of this instruction up to date.

All **Endeavour Energy employees and/or contractors** have the authority and responsibility for:

- meeting the requirements of this instruction and SDI 505;
- working in accordance with local and statutory requirements;
- maintaining public safety; and
- working in accordance with Endeavour Energy's Electrical Safety Rules.

All **Project Managers** have the authority and responsibility for:

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

All **Regional Transmission Managers** have the authority and responsibility for:

- keeping the fire detection and suppression system in an operational state; and
- verifying that fire walls and separation are in accordance with this standard.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Substation Assets Manager, Asset Standards and Design

Documentation Distribution Coordinator : Standards & Process Administrator