

Western Power's Asset Management System

Distribution Substation Plant Manual 2019 Chapter 5 – Fire Clearances



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Document control

Endorsement approvals

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Record of revisions

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Key documents providing direction and influencing this document

Doc #	Title of document
DM# 40304923	Asset Management System
DM# 41965928	Safety in Design Guidelines
DM# 50473207	DSPM Governance and Technical Documents Register

This document gives direction to and influences the following documents

Doc #	Title of document
Various DQM documents	Distribution Substation Design Projects

Stakeholders (people that were consulted when document was updated)

Position / Function / Section

Asset Management - Asset Performance

Asset Management – Safety Environment Quality and Training

Asset Management - Grid Transformation

Asset Operations – Network Operations

Asset Operations – Operational Services

Asset Operations – Network Connection Services and Emergency Management

Business and Customer Service – Customer Service

Notification list (people to be notified when document is updated)

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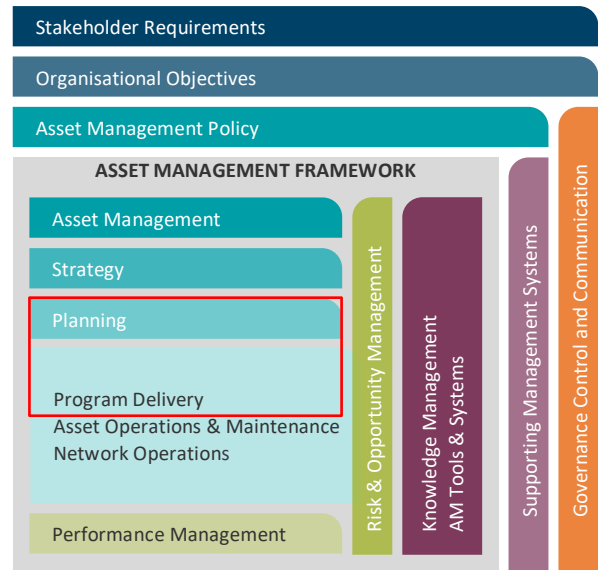
Business and Customer Service – Customer Service

This document must not be made available to personnel outside Western Power without the prior written approval of Western Power.

Document classification and hierarchy

A key requirement of the Western Power Asset Management Policy (AMP) is to develop and maintain an Asset Management System (AMS). This Distribution Substation Plant Manual is defined as a technical document within the AMS document classification and structure and sits within the planning and Program Delivery components of the AMS.

The AMS and the interrelationships between the collection of documents, tools and systems that are used for asset management are described in the AMS document EDM# [40304923](#).



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1. Introduction

This Chapter of the Distribution Substation Plant Manual (DSPM) contains ground mounted substation plant related information and information regarding the fire risk associated with this plant.

Generally, the fire risk associated with Distribution Transformers installed on Western Power's network is relatively low with few transformer fires occurring in the past. These incidents were mainly associated with lightning strikes on pole top transformers in non-built up areas. However, there may be sites with ground mounted transformers where measures should be taken to further reduce the fire risk. An example of this is where it is not practical to maintain the required fire clearances between Western Power's substation equipment and other structures or buildings due to land size restrictions. This Chapter of the DSPM provides guidance on the fire clearances that are required and are based on the volume of oil contained within the distribution transformers. Please refer to Chapter 4 of the DSPM – Plant General Arrangements for the oil volumes associated with specific transformers.

2. Disclaimer

The information contained within this Chapter shall not be used for anything other than their intended purpose (as stated within this chapter). Other documents that refer to the information within this chapter shall not change the intended purpose whether it is written or inferred.

This Chapter alone does not claim to demonstrate compliance with any Government Regulations or Industry Standards. These drawings are to be read in conjunction with the following Western Power documents:

- i. Western Australian Distribution Connections Manual (WADCM)
- ii. Underground Distribution Schemes Manual (UDSM)
- iii. Overhead Line Design Manual (OHLDM) for DSM 3-24 drawing.
- iv. Distribution Design Catalogue (DDC)

The information within this Chapter is generic in nature and may not be suitable for all electricity network substation sites. It is the designer's responsibility to make sure that these drawings are suitable for the proposed substation site prior to use.

3. Compliance with this Chapter of the manual

For each electricity network substation installation, a fire risk assessment (FRA) should be undertaken and documented. The FRA is to demonstrate compliance to the requirements of this manual.

The following hierarchy of risk controls provide guidance on meeting these obligations:

1. Where possible elimination of the hazard. The hazards associated with Distribution Transformers are documented within Western Powers Distribution Transformer and Metering Units Hazard Management Register¹ and the DSPM Hazard Management Register². Where the hazard cannot be eliminated the residual risk should be documented within the project hazard management register.
2. Minimization of the risk by the following means:
 - a. Substitution (to get a lower hazard). A customer HV supply may be more appropriate to meet the customers risk appetite. The customer can use their own transformers (such as dry type or FM Global approved transformers) if a lower risk level is required compared to what Western Power can offer.

¹ EDM 42958805

² EDM 47791256

- b. Isolation (from persons). Consider a fire rated substation room, fire rating of adjacent buildings or substation screening.
 - c. Engineering controls such as appropriate site selection, correct electrical protection settings and fuse sizes, screening or a fire rated building shall be considered by the designer.
3. Administrative controls. Such as access and egress routes should be documented and shown along with fire risk zones on the project design drawings. Easements or restricted covenants can be placed on the property title.
 4. Personal protective equipment (PPE) for use during inspections and equipment operation. Refer to Western Power's Personal Protective Equipment (PPE) Procedure for guidance³ on the selection of PPE.

The FRA should consider the following:

- a. Preventing the spread of fire, protect personnel and to limit the consequential damage (provision of appropriate redundancy/security where appropriate). Methods may include the provision of one or two fire rated substation rooms, fire rated screen walls or oil bunds.
- b. The control or elimination of ignition sources. For example: Perhaps one transformer can meet the load requirements of the installation instead of two transformers (if the second transformer is installed for reliability reasons only). The customer can install mission critical infrastructure (such as on site generation) or a replacement transformer may be readily available from Western Power should the need arise.
- c. The detection and suppression of fires for all indoor substations and buildings shall meet the requirements of the National Construction Code. Extinguishing media for transformer oil fires shall be dry chemical, CO₂, water spray (fog) or foam. Direct water jets cannot be used⁴.
- d. Protection of adjacent property. Fire clearances specified in Table 5.1 of this document should be maintained, or fire rated substation buildings or fire resisting screen walls should be used.
- e. Protection of public safety in the vicinity of HV installations against fire and explosion. The Designer should consider the likely hazards and associated risks when transformers are installed in areas that are frequented by members of the public, especially areas where there are large public gatherings.

Where the substation is installed within a road reserve it is the Designer's responsibility to complete the FRA and document it within the project hazard management register.

When the substation is installed within a customer's premises a fire risk control strategy should also be developed by the building owner or entity responsible for the building in consultation with Western Power's Designer / Design Manager. Each substation site and its surroundings are subtly different in physical construction and operational requirements. The fire risk control strategy shall consider the conservation of property, continuity of operations, and life safety by adequate fire protection and fire prevention measures. Where a substation is contained within a host building it is the building owners' responsibility to ensure the substation is considered in the buildings fire safety verification. This fire safety verification shall be in accordance with the requirements of the National Construction Code. An electricity network substation is classified as a Class 8 building within the National Construction Code.

NOTE: In addition to life safety and equipment protection, the insurer of the installation / building or entity may have additional requirements that need to be considered in locating and the design of the electricity network substation.

³ EDM 27090942

⁴ Nytro Libra safety data sheet

4. Transformer fire risk mitigation

To mitigate the fire risk associated with an electricity network substation located near to a habitable building, fire rated barriers can be used around the substation to reduce the size of the fire risk zone. These barriers may take the form of a fire resisting screen wall that extends a minimum of 300mm higher than the highest transformer. Alternatively, the building itself can be of fire resisting construction. The fire resisting section of the building needs to extend in a vertical direction up to the dimension G_4 as shown in Table 5.1, or to the building height plus a 750 mm parapet, whichever is less. The building fire resisting wall should be a distance of at least G_3 from the outside edge of the fire source transformer. The fire resisting construction must have a fire risk level (FRL) of not less than 120/120/120.

An electricity network substation located within a host building must be separated from any other part of the building by construction having an FRL of not less than 120/120/120; and have all doorways in that construction protected with an outward opening, self-closing fire door having an FRL of not less than /120/30. Doors and all associated hardware shall be fire rated to AS/NZS 1905. The fire resisting structure shall be designed according to the requirements of the Australian Standard applicable to the type of construction used (refer to AS 4100 for steel, AS 3600 for concrete and AS3700 for a masonry structure).

Adequate vent openings shall be provided for pressure relief of the substation building to prevent structural damage in the event of an explosion. In substations where a transformer is installed, the ventilation provided to cool the substation equipment will meet this requirement. For ventilation of the substation building, fire dampened vents shall be installed as prescribed within Chapter 3 of the DSPM. They shall be fitted with rotating type blades held in the open position by two thermal links in parallel and shall conform to AS 1682 and AS/NZS 1668.

Where ducts or other penetrations enter the cable trench within the substation building, the customer shall fit removable watertight seals to both ends of the installed ducts or penetrations prior to hand over. The seals shall be water and oil tight before and after cable installation. Network Operator personnel will reseal all ducts or penetrations after installation of network cables. Where ducts are installed between fire segregated switch-rooms, the customer shall seal the ducts after the installation of all cables to maintain the required fire rating.

Fire resisting construction of all building elements, within the electricity network substation fire risk zone, shall meet the requirements of the National Construction Code (NCC) Volume 1, Specification C. As the transformers used by Western Power contain a quantity of Nytro Libra oil, with a minimum flash point of 135°C, the hydrocarbon heating regime shown in Appendix B of AS/NZS 1530.4 shall be used instead of the standard curve to determine the fire resistance of the construction.

The general arrangement (critical dimensions) of Western Power's distribution transformers as well as the quantity of oil contained in the transformers is provided within Chapter 4 of the DSPM. The general layout and features of the substation building, or substation screen walls are shown in Chapter 3 of the DSPM for each substation site.

5. Fire Clearances for Distribution Transformers

Table 5.1 provides guidance for the minimum distances required for the separation of transformers without an enclosure and for the separation of transformers and buildings.

The dimension WPG_1 is measured from the outside edge of the fire source transformer to the nearest protrusion of the adjacent transformer. Western Power has interpreted the requirement of clearance (G_1) within AS/NZS 2067:2016 Table 6.1 to be between transformers or transformers and other items of plant within the substation site and accepts that there will possibly be a higher level of substation equipment damage in the event of a transformer fire where this clearance has not been met. AS/NZS 2067:2016 Appendix C allows the combined oil volume of all transformers within the substation site to be used to determine the clearances to structures outside of the substation site where transformers are not segregated

by clearance G_1 . This will negate the requirement to provide the additional land required for fire clearance (G_1) between transformers and will not increase the safety risk of the substation site by still maintaining G_2 , G_3 , and G_4 that is standard industry practice.

Table 5.1: Fire Clearances for Transformers

Combined Oil Volume of all transformers (L)	Horizontal clearance to other transformers WPG_1 (m)	Horizontal clearance to combustible surface G_2 (m)	Horizontal clearance to 2-hour fire resistant surface G_3 (m)	Vertical extent of 2-hour fire resistant surface G_4 (m)
$100 \leq 1000$	1	6	1	4.5
$>1000 \leq 2000$	1	7.5	1.5	7.5
>2000	1	10	4.5	15

6. Use of land within the Fire Clearances Zone

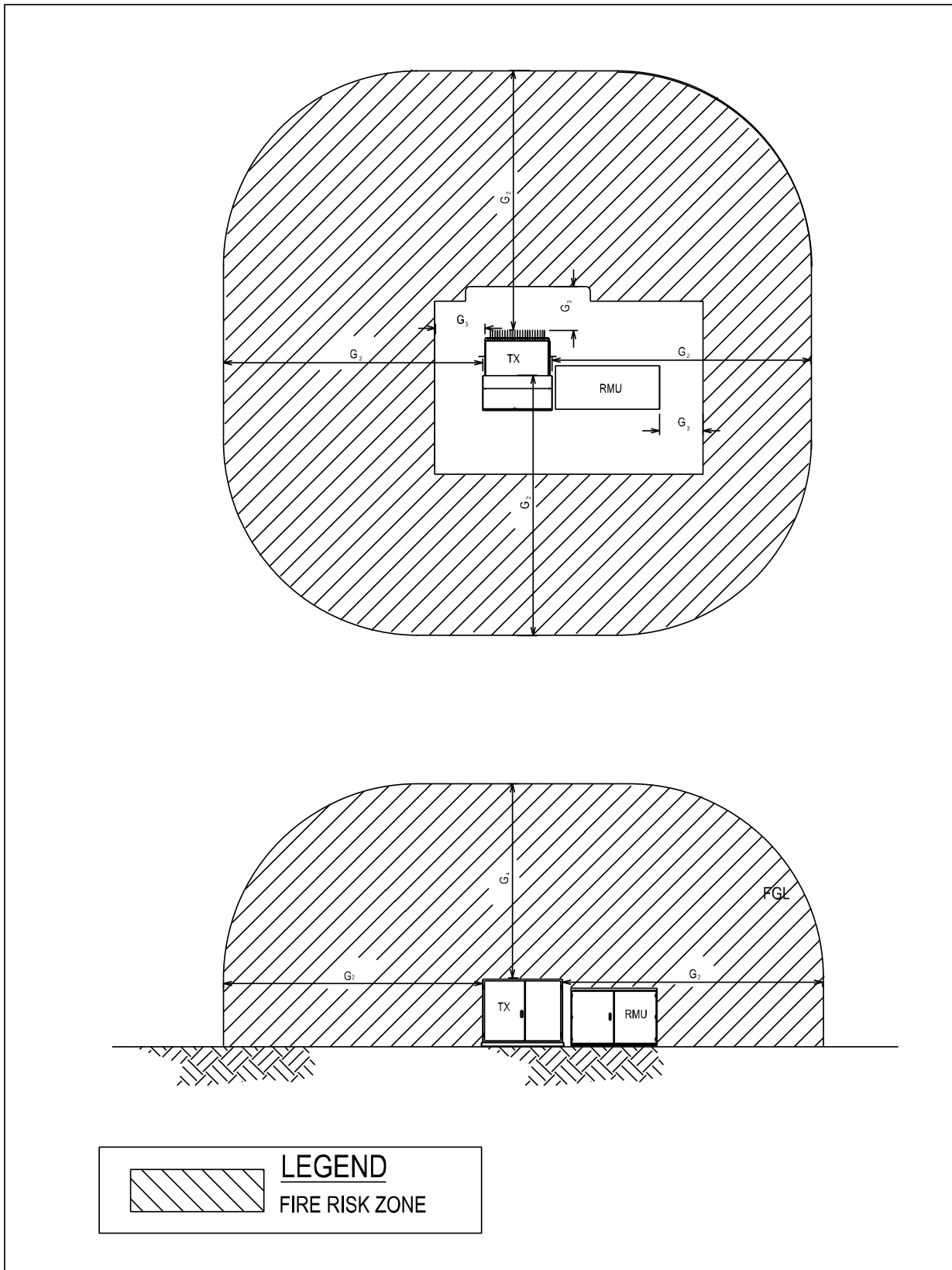
The following shall be considered by the designer when negotiating the location of the substation site / building with the land owner. The land owner shall ensure the use of the land around the substation does not contribute to an increase of the fuel load or fire risk associated with the substation site:

- No essential public access/exit/escape shall pass through or open into the fire risk zone. Generally, no other structure or building is permitted within the substation fire risk zone unless it has a two-hour fire rating.
- The substation shall be kept clear of combustible items including vegetation or refuse for a distance of at least 3 m from the transformers.
- Any potential flow of transformer oil spillage shall be prevented from escaping the substation building or substation site and reaching a watercourse or property boundary by such means as the use of natural ground slope, or the provision of a diversion channel, kerb or oil containment bund.

This Chapter of the DSPM also provides examples of fire clearance drawings that provide a diagrammatic representation of the fire clearances required around Western Power's distribution substation plant.

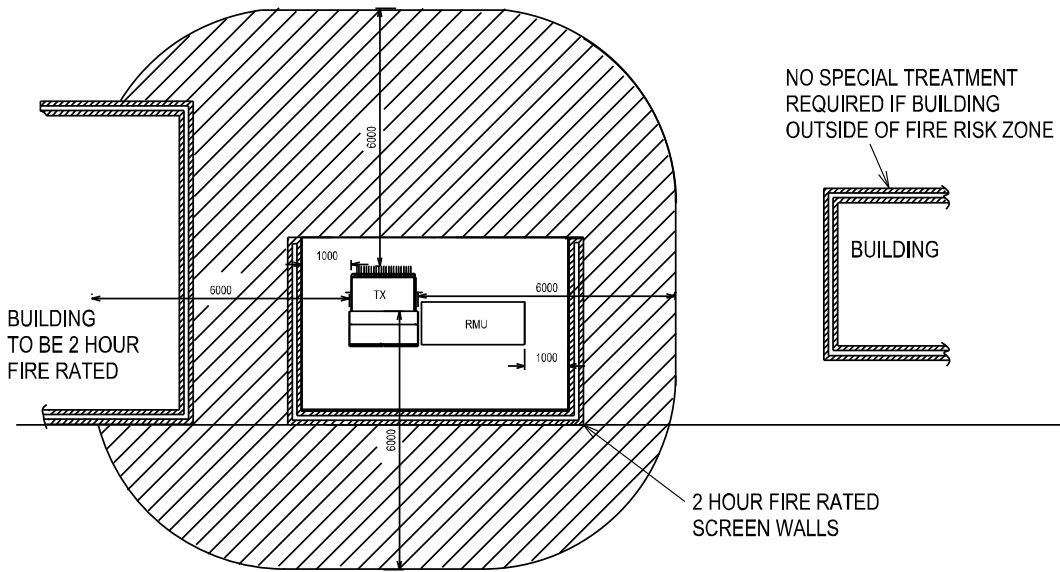
7. Fire Clearances for Distribution Substations (Drawings)

7.1 Modular Package Substations (MPS)

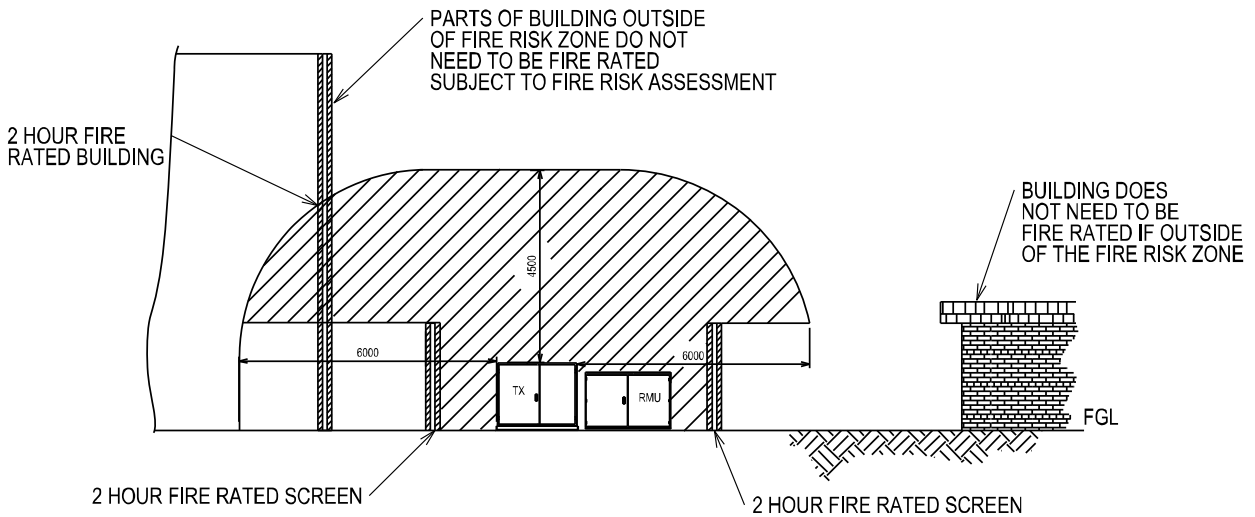


REV. No.	DATE	DESCRIPTION	CHEK.	APROD.	TITLE	DISTRIBUTION SUBSTATION PLANT MANUAL	westernpower
A	08-2019	ORIGINAL ISSUE		KG	FIRE RISK ZONE FOR DISTRIBUTION MODULAR PACKAGE SUBSTATIONS (MPS)	DRAWN: GC	DRG. No.
						CHECKED: AP	DATE: 08-2019
						SCALE: NTS	
						APPROVED: AS	REV. A
						APPROVED: MS	SHT. 1

7.2 Screened Modular Package Substations (MPS)




PLAN VIEW




ELEVATION

LEGEND

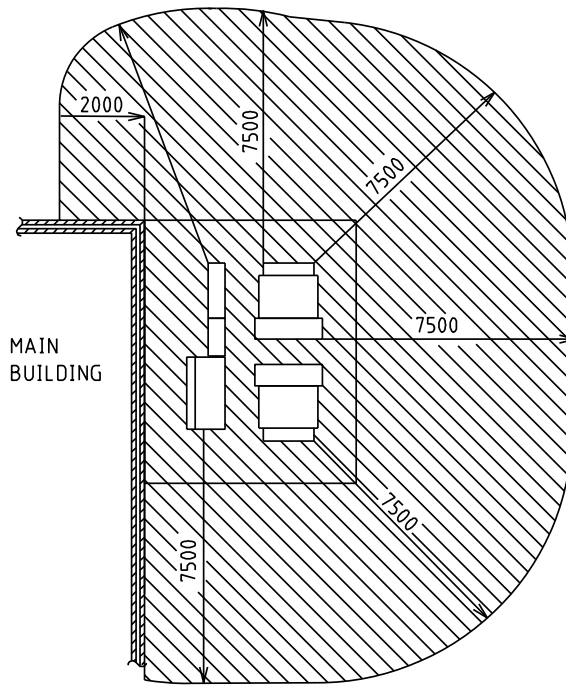
 FIRE RISK ZONE

REV. No.	DATE	DESCRIPTION	CHKD.	APRD.
A	09/2019	ORIGINAL ISSUE	KG	AM

TITLE
EXAMPLE: FIRE RISK ZONE FOR MODULAR PACKAGE SUBSTATIONS (MPS) WITH 2 HOUR FIRE RATED SCREEN WALLS

DISTRIBUTION SUBSTATION PLANT MANUAL		
DRAWN: GC	DATE: 09/2019	DRG. No.
CHECKED: AP	SCALE: NTS	DSPM-5-01
APPROVED: AS		REV. A SHT. 2
APPROVED: MS		

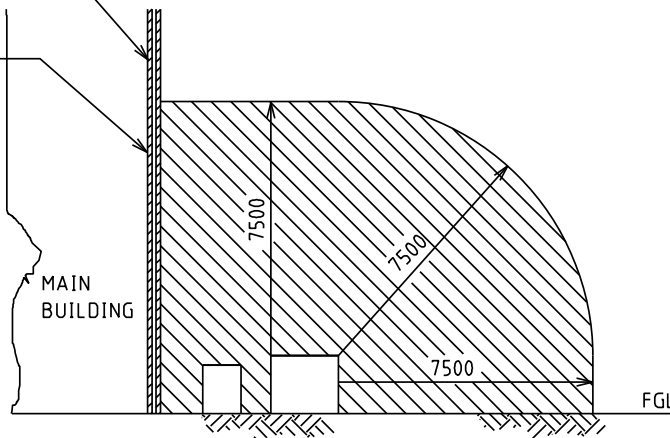
7.3 Cluster Substation (non-fire rated example)



PLAN

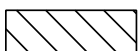
WINDOWS ETC ONLY PERMITTED OUTSIDE OF FIRE RISK ZONE

2HR FIRE RATED WALLS



ELEVATION

LEGEND



FIRE RISK ZONE



CUSTOMER SERVICES DIVISION
DISTRIBUTION SUBSTATION
MANUAL

2MVA SUBSTATION
TOTALLY NON FIRE RATED

DRAWING No.

DSM-5-03

SHEET 1 OF 1

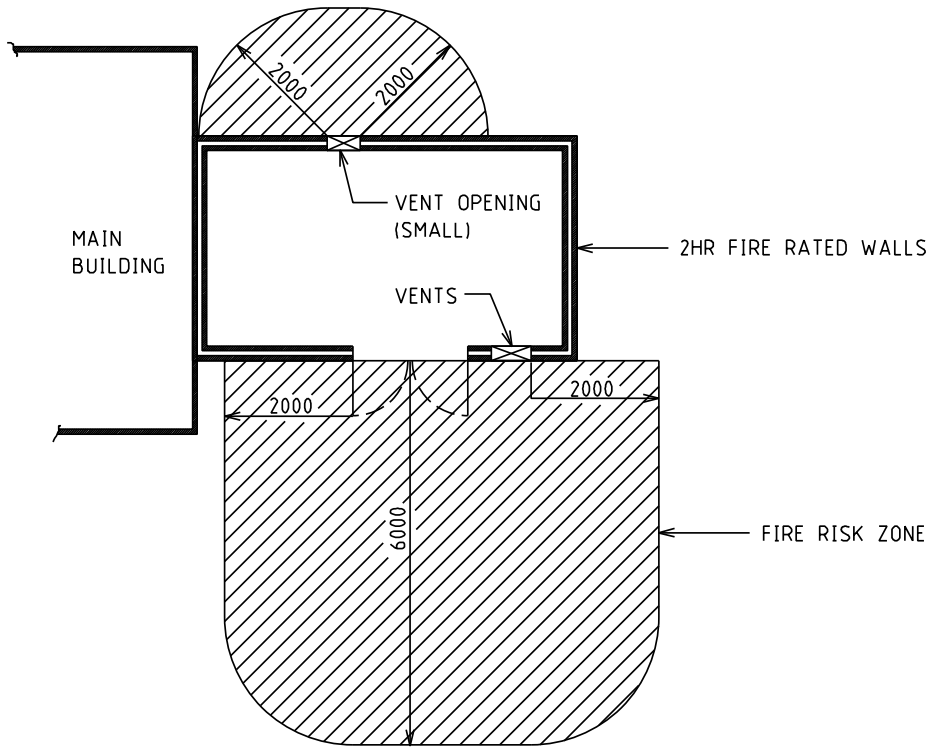
DATE:

01/06/97

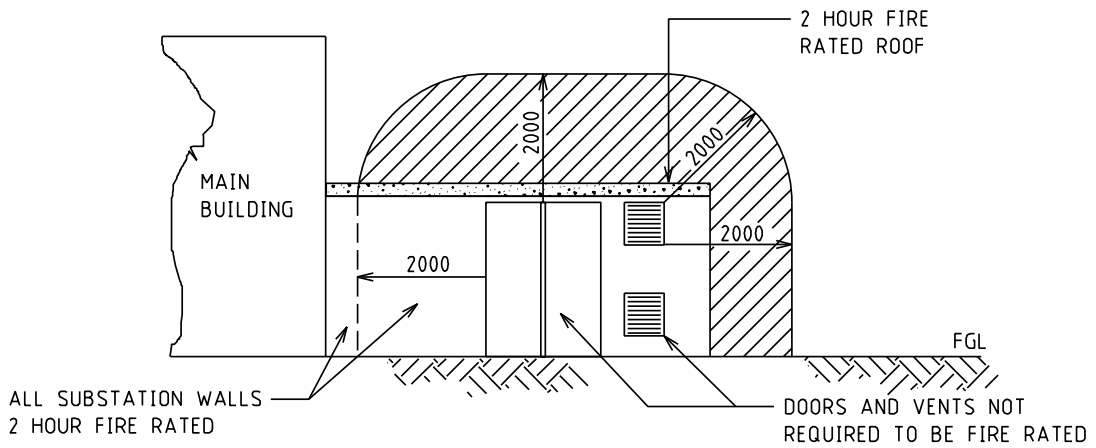
REVISION:

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7.4 Substation Building (non-fire rated example)




PLAN



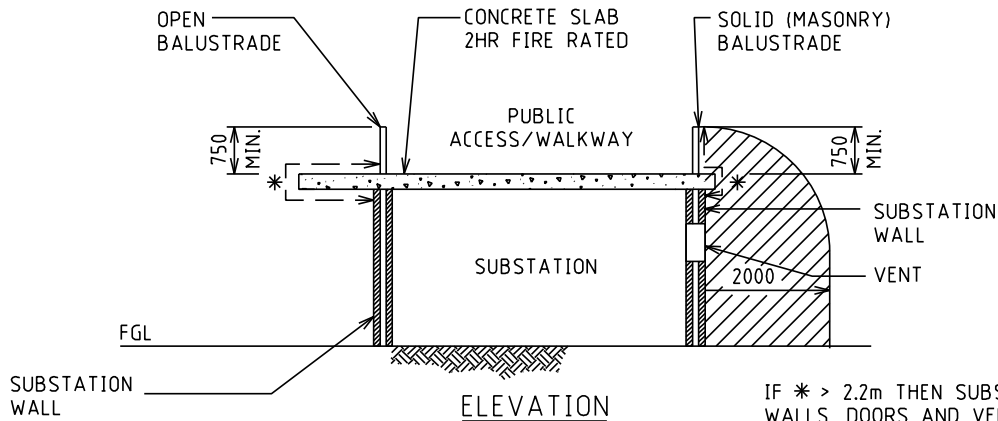
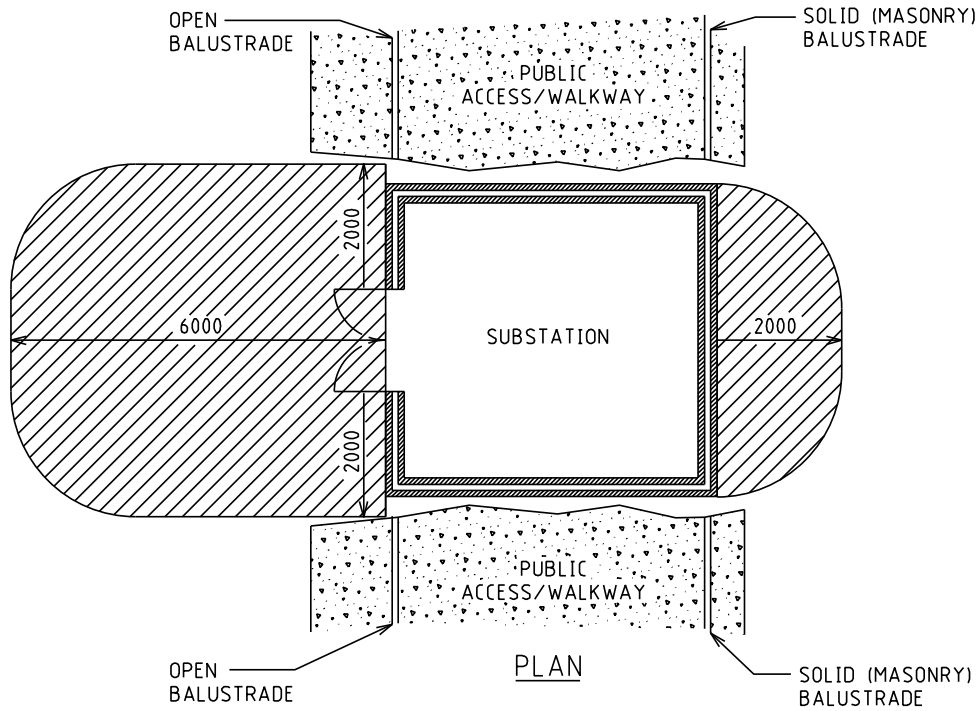
ELEVATION

LEGEND

 FIRE RISK ZONE

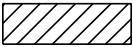


7.5 Substation Building (non-fire rated with walk way over, example)



IF * > 2.2m THEN SUBSTATION WALLS, DOORS AND VENTS etc DO NOT REQUIRE 2HR FIRE RATING
 IF * < 2.2m THEN SUBSTATION WALLS MUST BE 2HR FIRE RATED

LEGEND

 FIRE RISK ZONE

