AMS 10-61 Fire Detection and Suppression

2023-27 Transmission Revenue Reset

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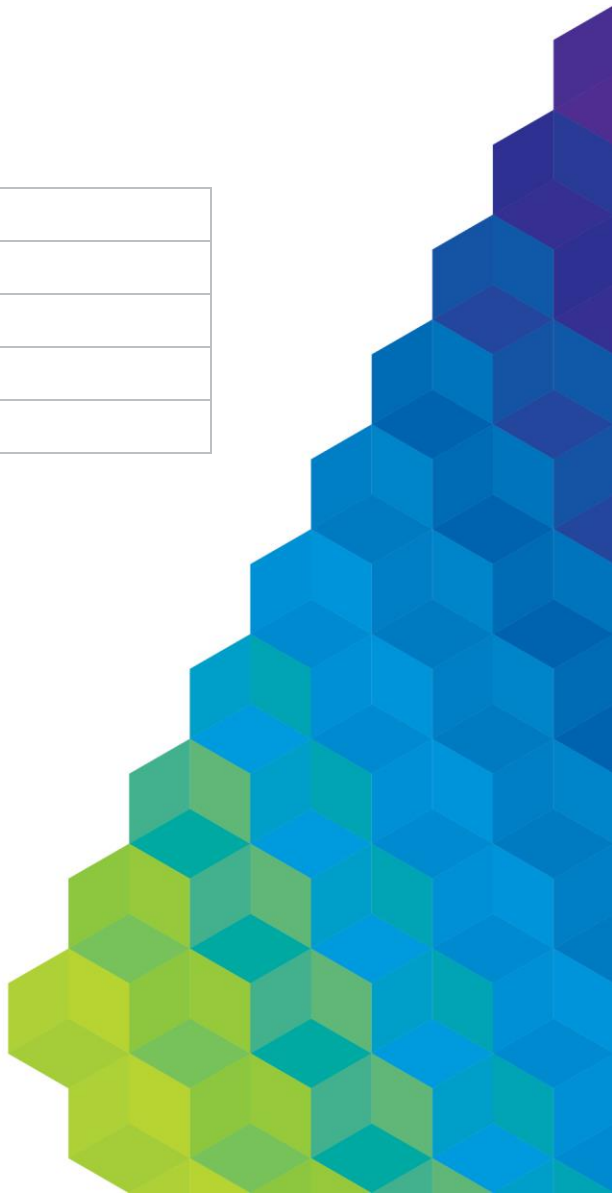

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Table of Contents

1 Executive Summary

This document describes the asset management strategies for Fire Protection System (FPS) and Fire Suppression System (FSS) assets located at terminal stations in the Victorian electricity transmission network.

Terminal station buildings and switchyards are equipped with a combination of FPSs and FSSs, such as:

- Very Early Smoke Detection and Alarm (VESDA) Fire Detection Systems (FDTS);
- Multi zoned Smoke detectors and Fire Indicator Board (FIB);
- Portable Fire Extinguisher (PFE);
- Fire rated doors and walls between zones;
- Fire pillows;
- Fire walls;
- Water Deluge System (WDS); and
- Fire Hydrant System (FHS).

The FPS and FSS assets are in place to mitigate the effects of potentially destructive fires. A fire in a terminal station can cause extensive damage to critical assets in the electricity supply chain which can take time to replace thereby causing long supply disruptions resulting in huge disruption to the community. Fire at terminal stations also has potential to spread, which poses a high risk for properties etc. in surrounding areas. Hence detection of fire and initiation of fire suppression as early as possible is the key to minimising fire related risks in terminal stations.

Condition assessments at terminal stations indicate that 25% of FHS assets and 25% of WDS assets are in poor or very poor condition and are likely to require replacement/ refurbishment within the next ten years. Upgrade programs and replacement projects have been initiated for the affected terminal stations and are expected to be complete by 2022.

The following summarises the fire detection and suppression asset management strategies:

1.1 Strategies

1.1.1 Fire Protection System

- Continue regular inspection and tests for all Fire Protection System in accordance with the relevant Australian Standard, AS1851: Maintenance of Fire Protection Systems and Equipment.

1.1.2 Fire Hydrant System

- Progressively replace all the remaining Fire Hydrant System in C4 and C5 conditions with systems complying with relevant Australian Standards.

1.1.3 Water Deluge System

- Assure the refurbishment / replacement of Water Deluge System that is in Poor (C4) condition. (MLTS is scheduled to be completed in 2022)

1.1.4 Other Fire Safety Infrastructure

- Replace failing smoke detectors and Fire Indicator Panels in Control Buildings.

2 Introduction

2.1 Scope

The purpose of this document is to define the asset management strategies for the Fire Protection Systems (FPS) and Fire Suppression Systems (FSS) associated with the AusNet Services' electricity transmission network in Victoria

This asset management strategy applies to all FPSs and FSSs in buildings and plant located in switchyards associated with AusNet Services' electricity transmission network in Victoria. This asset management strategy forms part of a suite of documentation that supports the management of AusNet Services' assets.

2.2 Objectives

The objectives of this asset management strategy are to:

- present an overview of the FPS and FSS assets and their respective age/ condition profiles;
- manage business and network risks presented by fire, efficiently and to within acceptable limits;
- ensure the effective and consistent management of FPSs and FSSs throughout their life-cycle; and
- demonstrate that FPSs and FSSs are being managed prudently and economically throughout their life-cycle.

2.3 Asset Management Objectives

As stated in *AMS 01-01 Asset Management System Overview*, the high-level asset management objectives are:

- Comply with legal and contractual obligations;
- Maintain safety;
- Be future ready;
- Maintain network performance at the lowest sustainable cost; and
- Meet customer needs.

As stated in *AMS 10-01 Asset Management Strategy -Transmission Network*, the electricity transmission network objectives are:

- Maintain top quartile benchmarking;
- Maintain reliability;
- Minimise market impact;
- Maximise network capability;
- Leverage advances in technology and data analytics;
- Minimise explosive failure risk.

3 Asset Definition

3.1 Asset Function

Fire detection and suppression systems are required to minimise service disruption and asset damage in case of fire. Terminal stations in the Victorian electricity transmission network are provided with different kinds of FPSs and FSSs which are listed below:

In Buildings:

- Very Early Smoke Detection and Alarm (VESDA) Fire Detection Systems (FDTS);
- Multi zoned Smoke detectors and Fire Indicator Board (FIB);
- Portable Fire Extinguisher (PFE);
- INERGEN (trade name) Gas FSS in three critical terminal stations;
- Fire rated doors and walls between zones;
- Fire pillows / fire walls used to seal-up all secondary cable entry points to critical buildings within terminal stations.

In the Switchyard and Transformers:

- Water Deluge System (WDS);
- Fire Hydrant System (FHS) for buildings and transformers;
- Fire Walls.

All terminal stations have VESDA systems which are very sensitive systems used to detect smoke as early as possible. Usually large number of detectors are used in different fire zones which are connected to a multi zone Fire Indicator Panel / Board (FIP/B) providing alarm to the Transmission Operations Centre and respective fire agencies.

FHSs are installed at strategic positions to provide water supply for fire-fighting agencies attending in response to a fire. The water supply for these hydrants comes via underground pipe work from external mains supply or on-site storage facilities such as dams and tanks. An example of an FHS is shown in Figure 1. Several stations have booster pumps installed to support weaker supply pressures.

PFEs are kept in all buildings for small fire suppressions.

INERGEN, which are gaseous FSSs, have been installed at three critical stations (SMTS, ROTS and HWTS). These systems use a combination of inert gases (Nitrogen, Argon and Carbon dioxide) to extinguish the fire without damage to sensitive equipment. Release of these gases on fire reduces the oxygen level in room to 12.5% which quickly extinguishes the fire giving sufficient time for people to breathe and leave the room. An example of a gaseous FSS is shown below in Figure 2.

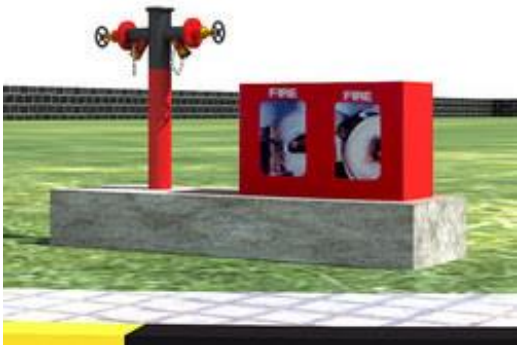

Figure 1: Fire hydrant system

Figure 2: Gaseous fire suppression system

In switchyards, fire walls and FHSs are installed to provide fire protection to power transformers and buildings (from outside). WDSs provide fire suppression for power transformers, when there is no other fire containment measure. Figure 3 illustrates an example of a WDS operating on a station transformer.

Other fire protection measures for power transformers include bund walls to contain oil spills, fire hydrants, and physical separation of transformers from other assets.

Figure 3 – Water deluge system operating on a power transformer

All systems are alarmed to the network control centre and in most cases the local MFB (Metropolitan Fire and Emergency Services Board) or CFA (Country Fire Authority).

3.2 Asset Population

3.2.1 Buildings

VESDA (Very Early Smoke Detection Alarm) FDTSs are installed in all terminal station buildings that house critical protection, control and communications equipment. The control buildings are divided into fire zones and protected by smoke detectors linked to an FIB at the building entrance.

All buildings also have PFEs suitable for small electrical fires.

3.2.2 Switchyards

All terminal stations have Fire hydrant systems (FHSs) installed to suppress fire hazards[1] in switchyards and buildings (from outside). They are installed at strategic positions to provide water supply for firefighting agencies attending in response to a fire on buildings, transformers or any other major oil filled equipment.

Figure 4 shows the three types of pipe material that are used; UPVC, Asbestos Cement (AC) and Iron.

Figure 5 shows the type of pipe work and type of water supply to FHSs respectively in all the terminal stations.

[1] Station Design Manual – Volume 5, Section 15.

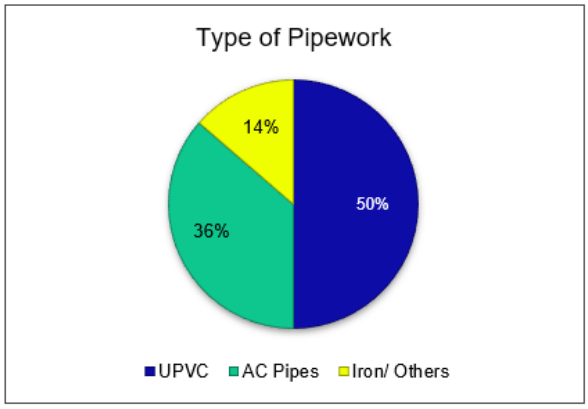

Figure 4 – Type of pipe work at terminal stations

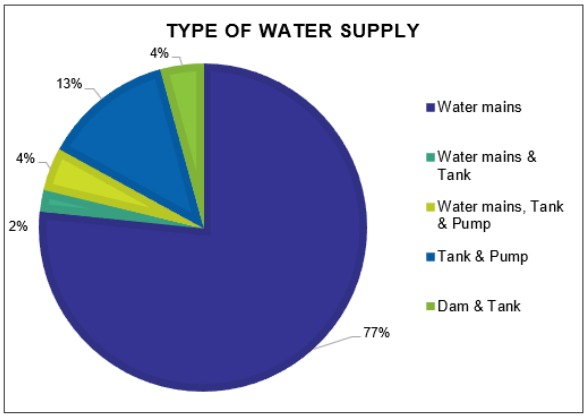

Figure 5 – Type of water supply at terminal stations

All power transformers installed in terminal stations have oil containment bund walls. A total of 42% have fire walls and 31% possess the required physical separation. Fire walls have mainly been installed in terminal stations located in the Melbourne metropolitan area. Eight terminal stations have WDSs installed (10% of the power transformer population).

Table 1 below shows the number of WDSs installed in terminal stations.

Table 1: Population of WDS assets

Terminal Station	No. of Fire Deluge System (2020)
HWTS	4
KTS	3
MLTS	3
ROTS	2
SMTS	1
Total	13

3.3 Asset Age Profile

VESDA FDTSs were installed in all terminal stations between 2001 and 2005. Thermal and smoke detectors were also installed in parallel to VESDA FDTSs as independent systems in several locations. The useful life of detectors and FIB panels is expected to be 12 – 15 years.

The gaseous FSSs are approximately 15 years old.

FHSs and associated pipe work were installed when the stations were first established, with limited subsequent augmentation.

Figure 6 shows the age distribution of FHSs installed in all the terminal stations.

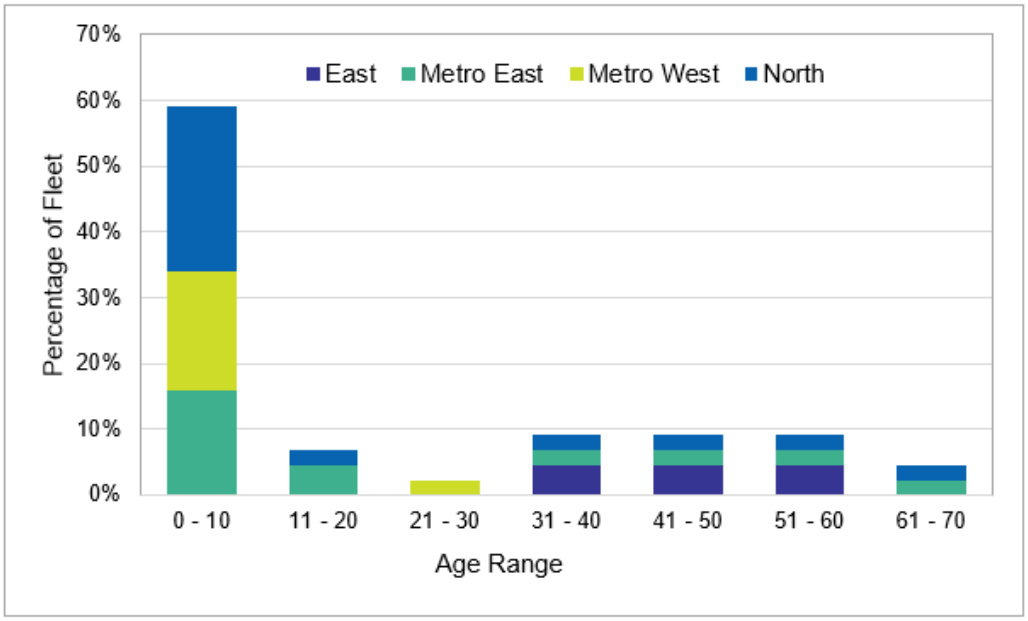

Figure 6 – Age distribution of FHS assets

Over the past decade, the WDS at terminal stations have been refurbished/ replaced, so these have effective lives which are much younger than the transformers they are protecting. Figure 7 shows the service age distribution of WDSs installed in terminal stations.

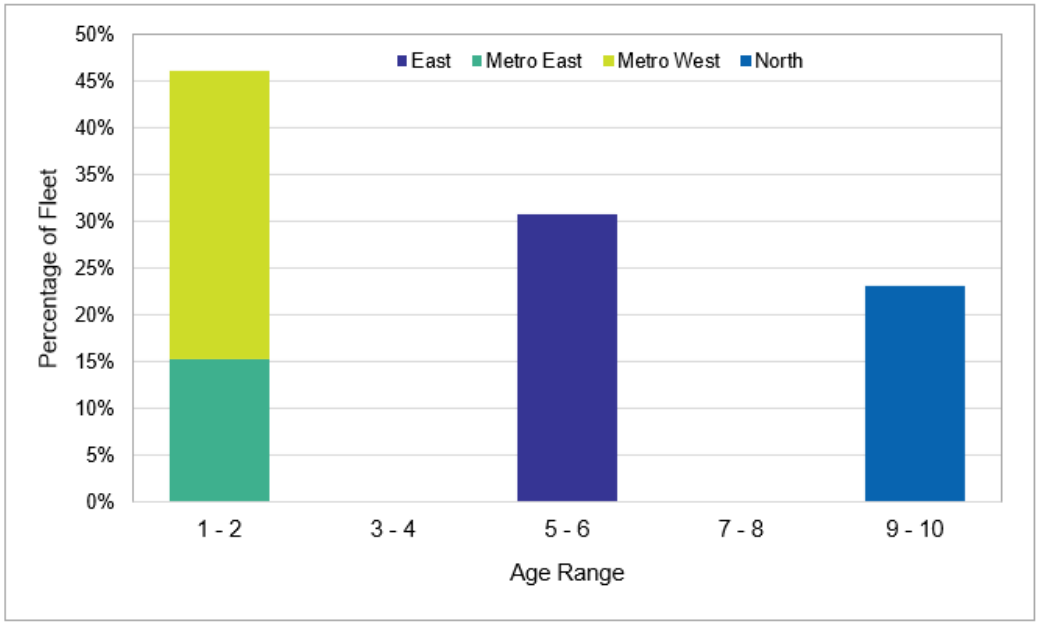

Figure 7 – Age/ Service age distribution of WDS assets

3.4 Asset Condition

The condition of FPS and FSS assets were assessed adhering to the criteria described in the Table 2below. The following table provides definition of the various condition scores and recommendations.

Table 2: Condition score definition and recommended action

Condition Score	Condition Description	Recommended Action
C1	Very good or original condition	No additional specific actions required, continue routine maintenance and condition monitoring.
C2	Better than average for age, Good condition	
C3	Average condition	
C4	Poor condition	Remedial action/replacement within 2 – 10 years.
C5	Very poor and approaching end of life	Remedial action/replacement within 1 – 5 years.

A condition score of C1 to C3 corresponds to an acceptable condition where no additional action (apart from continued routine maintenance and condition monitoring) is proposed. A condition score of C4 or C5 corresponds to assets with high to very high risk requiring remedial action in a relatively short defined timeframe.

Considering the importance of FPS assets in the control of fire related damage in terminal stations periodic inspections and operational checks are required. The maintenance activities are defined in AS 1851.1 and inspections and compliance checks are completed in accordance with this standard.

3.4.1 FDTS, PFE, FSS, FIB and INERGEN

All FDTSs, PFEs and FSSs are generally in good condition. Periodic maintenance and testing (every month) are carried out as per the relevant requirements of the Australian Standards for continued reliable operation. These systems are replaced when operational failure is detected in routine operational tests. The INERGEN FSS are also maintained in accordance to standard maintenance requirement in AS1851.1. These systems are due for the 10 yearly hydrostatic testing and recharge which requires the gas cylinders to be transported to the supplier's designated workshop.

Concerns have been raised about the effectiveness of these systems due to sealing requirements of the rooms. Buildings containing these systems are not tested for sealing capabilities and hence effectiveness of systems may be limited. Currently a fire risk study is proposed to be conducted to assess the fire risk and the effectiveness of these systems in present circumstances. Based on the outcome of this fire risk study a decision will be made regarding the continuation of these systems including their extension to other stations.

3.4.2 WDS

The WDSs in five terminal stations are between Very Good C1, Good C2 and Poor C4 condition.

Keilor Terminal Station (KTS), Rowville Terminal Station (ROTS) and South Morang Terminal Station (SMTS) have its WDS upgraded recently and so are in Very Good condition (C1).

The WDS in Hazelwood Terminal Station (HWTS) was upgraded in 2016 and is in Good condition (C2), while the WDS at MLTS which is the only C4 site, is scheduled for replacement by 2022.

Table 3 and Figure 8 below show the overall condition profile of WDS assets.

Table 3: Overall condition rating of WDS assets at various terminal stations

Station	No. of WDS	Condition Rating	Remark
HWTS	4	C2	Upgrade completed in 2015 through asset work
MLTS	3	C4	To be upgraded in 2022
KTS	3	C1	Upgrade completed in 2019
ROTS	2	C1	Upgrade completed in 2019
SMTS	1	C1	Upgrade completed in 2019

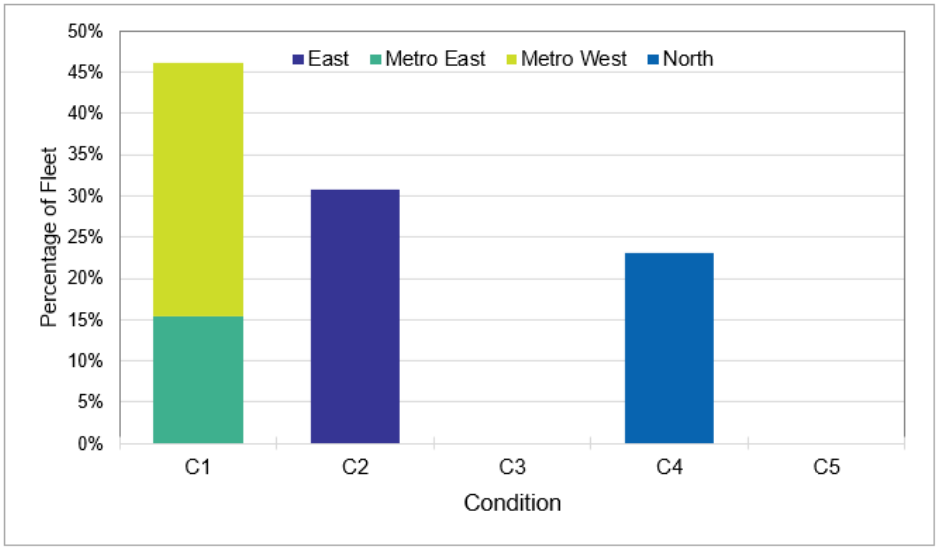

Figure 8 – Condition rating of WDS assets

3.4.3 FHS

Around 75% of the FHSs in Terminal Stations are in Very Good C1 condition to Average C3 condition, while approximately 25% are in condition Poor C4 and Very Poor C5 condition. This is due to some sites having asbestos pipe works which are not compliant with AS 2419.1.

Refer to section 3.3.5 for information on FHS asset replacement/upgrade projects. Figure 9 below shows the condition of FHS assets.

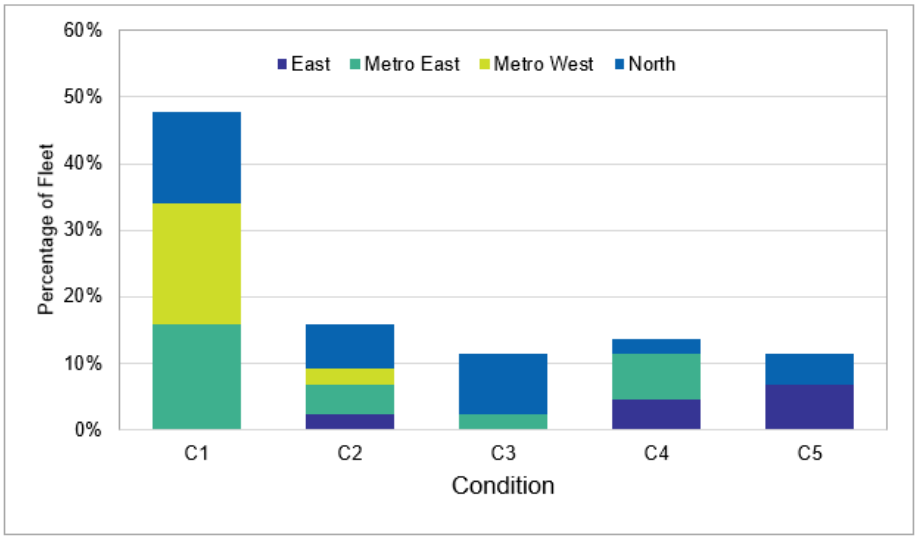

Figure 9 – Condition rating for FHS assets

3.4.4 Fire walls

Adequate fire walls are in place for in-service transformers in terminal stations located in the Melbourne metropolitan area and all are in good condition. Due to the recent inclusion of spare transformers at HWTS and SMTS, the new firewalls have been installed as required at these sites which was covered in the planned work program from 2014-2019. HYTS had a firewall installed between the M1 and M2 transformers which was completed in 2020.

3.4.5 Project details

All the projects for the replacement / installation of FPS & FSS assets are listed below in Table 4.

Table 4: FPS and FSS asset replacement project details

Project Name and Site Covered	Project Number	Completion Year
FHS		
Facilities – hydrants fire suppression (DDTS, MLTS, SHTS)	X842	2012
Fire Hydrant Replacement in North (KGTS, SMTS and TTS)	XA35	2014
Fire Hydrants Replacements in Central (HOTS, TGTS, KTS)	XB35	2014
Fire protection – Fire hydrants replacement & upgrade – stage 3	XC34	March 2017
Upgrade of FHS assets under station rebuild works (RTS, BTS, HTS, WMTS); Completed excepting WMTS Expect completion prior to 2022		2005-2022
Fire walls		
Installation of new firewalls at HWTS	TD-3527	2019
Firewall at HYTS	TD-6242	2019
WDS		
Sync Con refurb – Fire Deluge System (FBTS, BLTS and TSTS) NOTE: Synchronous Condensers have been retired, WDS on these 3 sites have been retired.	XB46	2012
HWTS Upgrading of transformer fire deluge systems	VD30	2016
Upgrade / replacement of WDS at the due to corrosion and age-related issues: KTS & SMTS	TD-6242	2019
FIB		
20 Terminal stations with FIB in poor condition Annual budget allocated for “Urgent Facilities Works,” including FIBs	Approved	2014-2022

3.5 Asset Performance

3.5.1 Fire Hydrant System (FHS)

AS 2419.1 (1994) specifies hydrostatic testing of FHS at 1700 kPa or 1.5 times the working pressure, whichever is greater. Some of the older pipe work and fittings (which were not designed to meet such pressure levels) have failed during testing and required replacement.

System bursts were observed during the tests at Horsham Terminal Station (HOTS), Moorabool Terminal Station (MLTS), Shepparton Terminal Station (SHTS) and Terang Terminal Station (TGTS).

Several FHS utilise asbestos pipes to supply the water for fire control and the condition of these pipes is uncertain. These pipes are not pressure tested due to fear of failure (high probability) during the high pressure test making reasonably accurate condition assessment very difficult. In the case of an AC pipe failure, the repair work could be delayed significantly due to work restrictions on any modification/repair works on assets containing asbestos cement material. Replacing these pipes is a major driver to renew the FHS at various terminal stations.

There have also been some issues regarding excessive pipeline pressure drop, insufficient flow rates, insufficient residual pressure and in some cases lack of booster connections for the CFA in shared pipe work with domestic pipes. These factors badly affect the performance of FSSs in the event of a fire hence; FHSs require good water

pumps and other sources of water such as water storage tanks with sufficient storage capacity for water supply during fire incidents. Recent FHS renewal projects have found that 50% of terminal stations lack water supply pressure.

In some cases where transformer augmentation occurs and fire hydrant systems are extended, the local CFA/MFB do not grant fire compliance certificates and require the complete system to be upgraded, such as at Bendigo Terminal Station (BETS) in 2012.

3.5.2 Other Fire Suppression Systems (FSSs)

All the WDSs were installed when the transformers were installed. The insides of some of the pipes may be corroded. In case of a fire associated with a transformer, water sprayed through corroded pipes could contain corroded particles that may cause further damage to the equipment.

Testing of the transformer WDSs are difficult as they are critical assets and need to be taken out of service for tests. Normally they are tested after planned maintenance works on the transformers they are associated with.

The [C-I-C] FSSs are expensive to maintain as they are subject to ten yearly maintenance programs which involve hydrostatic testing of cylinders and refilling of gas at designated workshops.

3.5.3 Short useful service life for Fire Indicator Panels (FIPs)

The suppliers / manufacturers of FIPs have recommended 15 years of useful service life for FIPs due to the involvement of software and electronic components which have a short life span. In addition, no condition assessment methodology is available to detect the imminent failure of an FIP which would enable proactive replacement before failure. However, the replacement is fairly simple and inexpensive and is based on functional failures (tested every month). Based on their age and useful life, provision has been made in work programs to replace these assets on failures supported by historical data. Several FIP and FDTS replacements are included in major rebuild projects.

3.5.4 Suspended Failures

Defects in the Fire Detection and Suppression which are identified prior to actual failure or fault are defined as suspended failures. Figure 10 shows the suspended failures of fire protection systems during the period 2015- 2019. Suspended failures are also referred to as “preventative actions” which are identified during routine station inspections.

Fire protection system has the fire hydrants as the most common item flagged to be an issue at 24% of all notification raised. This is followed by the fire indicator panel at 14%, then issues associated with the VESDA system at 9%, then the balance is made-up of the fire indicator panel, fire equipment and valves.

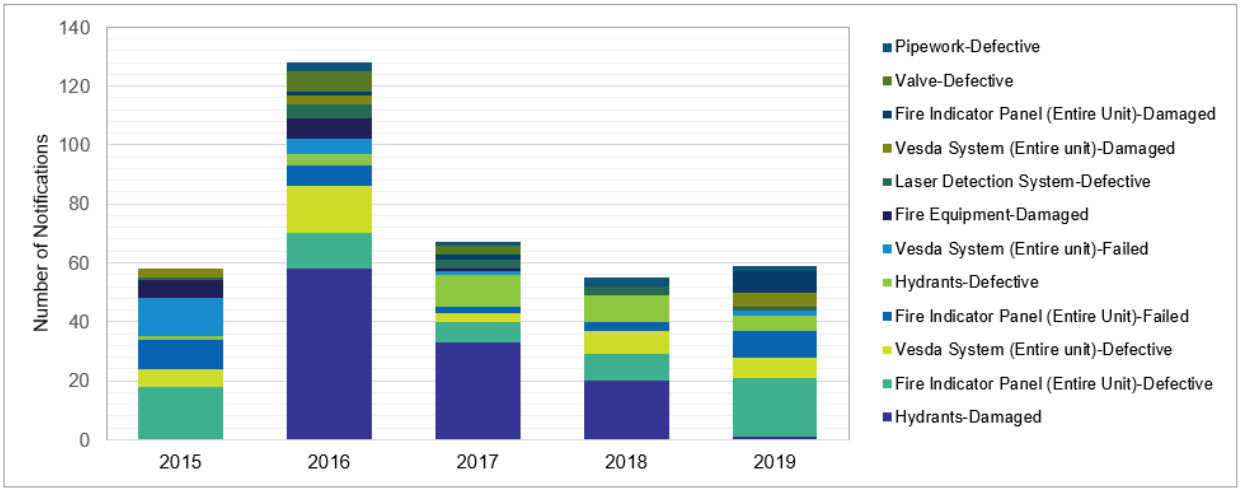

Figure 10 – Fire protection system, suspended failures

3.5.5 Functional Failures

Functional failures, also known as Faults, result in the system not being able to perform its intended purpose and therefore, appropriate action is necessary to maintain the performance and security of the system.

Fire protection failures is dominated by issues with the VESDA system at 24%, followed by faults at the laser detection issues at 21%, then fire indicator panel issues at 19%, then water supply issues. Figure 11 shows the distribution of the issues.

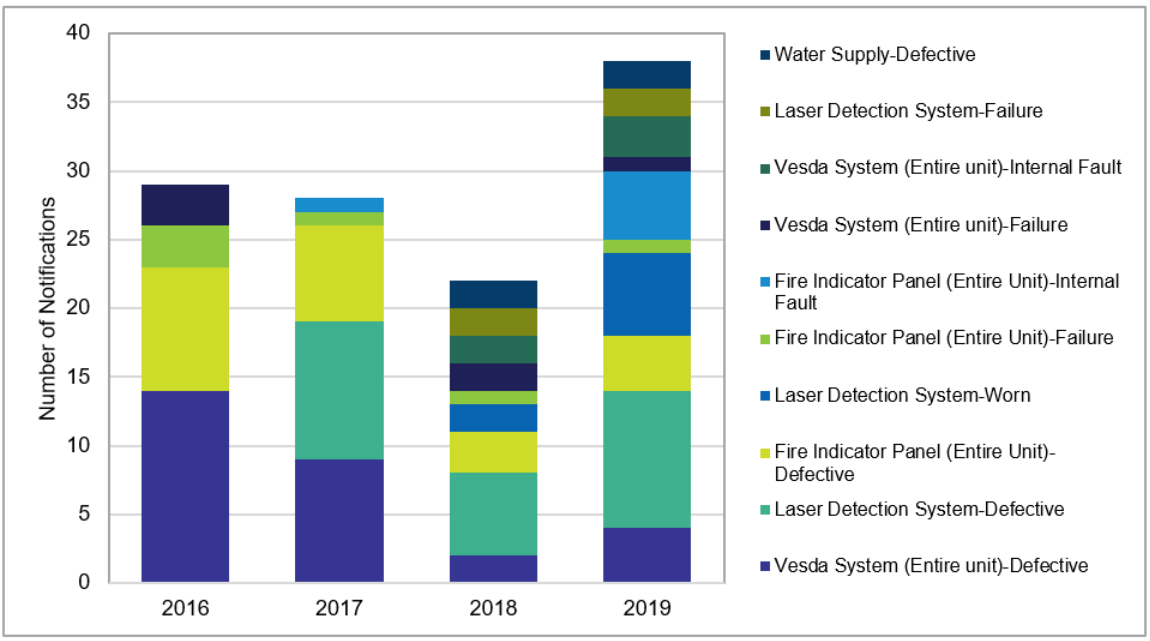

Figure 11 – Fire protection system, functional failure

3.6 Asset Criticality

The consequence of failure of the FPS and FSS can vary significantly and are discussed in detail in Section 5. To get a quantitative value of the system's criticality, the economic impact of a fire becoming out of control or progressing to a stage that the fire brigade is not able to prevent damage to the equipment inside the control room/ control building which results to a loss of supply from the station and for a long duration, also known as a "station black" event.

For this analysis, the fire hydrant system (FHS) is assessed as it is the system that the fire-fighting agencies use to control the fire in the terminal station, when it eventuates. The economic impact is calculated by adding these components:

- Value of Unserved Energy
- Market Impact
- Collateral Damage

3.6.1 Value of Unserved Energy

The value of unserved energy is obtained from the Transmission Connection Planning Report (TCPR) produced by the various Distribution Businesses in Victoria every 5-years. The value of unserved energy is provided in $s per kilowatt hour.

3.6.2 Market Impact

The market impact represents the value of losing a terminal station due to the fire and AEMO has to obtain the station's load capacity elsewhere to preserve the security of the National Electricity Market (NEM). The market impact value is provided in $s per kilowatt hour.

3.6.3 Collateral Damage

The collateral damage of a fire in a control house includes the cost of the equipment including the relays and the structure itself, which needs to be repaired or replaced.

3.6.4 Overall Criticality

The consequences of a fragile fire hydrant system can be allocated into five criticality bands based on their economic impact as the result of the failure. These asset criticality or consequence impacts are irrespective of the likelihood of the actual failure of the FHS.

The five criticality bands are tabulated and shown in Table 5.

Table 5 – Criticality Band

Criticality Band	Economic Impact due to a failure
1	<= 1 replacement cost
2	1 to 3 x replacement cost
3	3 to 10 x replacement cost
4	10 to 30 x replacement cost
5	>30x replacement cost

The criticality assessment compares calculated consequence cost over the replacement cost. For the FPS, the criticality value is the ratio of the consequences of a fire in a Control Building and the cost to replace the system.

Table 6 in Section 5.1 presents the criticality-condition risk matrix for the FHS fleet. The numbers indicate the quantity of terminal stations which have FHS under a specific Condition Score and have a consequence of failure within a Criticality Band.

4 Other Issues

These are other issues related to Fire Detection and Suppression systems inside Terminal stations:

- Asbestos hazards identified in the supply pipelines, including the possibility of these bursting during testing of the FPS and FSS, as well as handling issues when these are replaced.
- Records for fire detection and suppression assets are incomplete and lacks essential information such as installation date, and asset-specific condition.
- Obsolescence of some of the fire detection and suppression system render the older systems for replacement.

5 Risk Assessment

There are varying risks associated with a failure of a terminal station's FHS, ranging from collateral damage of a station asset, environmental impact/damage, personnel & public safety, and community impact.

Depending on the nature and scale of the deficiencies of the FHS, solutions vary from targeted asset replacement, station refurbishment or whole station rebuild. The integration of FHS and FSS upgrades should be considered during the scope development phases of such projects as it has been proven to be the most economical solution.

A semi-quantitative risk analysis was undertaken for each station by considering the components that were given a condition rating of Poor to Very Poor (C4 to C5), using the criticality values from penalties caused by non-compliance to relevant regulations, as well as unit rates for repair/replacement.

5.1 Risk Matrix

The criticality assessment following the discussion in Section 3.6 identifies 6- stations to be in Level A risk (stations located in the red region); and 15-terminal stations in Level B risk (one terminal station in Criticality 4 and Condition 2; 5-terminal stations in Criticality 3 and Condition 3; 6-stations in Criticality 3 and Condition 4; and one station in Criticality 2 and Condition 5).

Table 6 below shows the fire hydrant systems risk matrix.

Table 6 – Fire hydrant systems risk matrix

		CONDITION					
		C1	C2	C3	C4	C5	Consequence / Replacement Cost
CRITICALITY	5	0	0	0	0	0	> 30.0
	4	4	1	0	2	1	10.0 - 30.0
	3	15	6	5	6	3	3.0 - 10.0
	2	4	0	0	2	1	1.0 - 3.0
	1	0	0	0	0	0	< 1.0

The stations that have Very Poor condition (C5) Fire Hydrant Systems are Redcliff Terminal Station (RCTS), Hazelwood PS (HWPS), Loy Yang (LY), Yallourn PS (YPS) and Loy Yang Power Station (LYPS), while the 2-stations that have Poor condition (C4) and Criticality 4 (Cr4) FHS are GNTS and TBTS. FTS, HWTS, JLTS, SVTS, WETS complete the list of stations with C4 condition FHS.

Among these terminal stations, FTS, GNTS, HWTS, SVTS, and RCTS will have their FHS upgraded via Stage 4 of the *Fire Hydrant Upgrade program* which is scheduled for completion by 2022.

5.2 Program of Works

The proposed program of works for Regulatory Period 2023 to 2027 is provided in Table 7 below. During the next couple of years prior to the start of the new Regulatory Period, some of the sites will be addressed as part of the station re-build or refurbishment projects.

Table 7: Civil Infrastructure, Program of Works 2023-2027

Name of Program	Stations	Scope of works
Fire Hydrant Upgrade Program	HWPS, JLTS, LY, LYPS, TBTS, WETS, and YPS. Other critical sites: FTS*, HWTS*, SVTS*, GNTS*, RCTS*	Replace fire hydrant system, replace old pipe works, introduce water tank, etc.
Water Deluge System	MLTS+	Replace gauges, water pumps, etc. by 2022
Fire Indicator Board replacement program	Stations which are identified with poor condition FIBs during station inspections	Annual budget of a small amount is allocated for urgent facilities works, which includes FIBs

NOTES:

1. Stations which have an asterisk (*) are scheduled to have the Fire Hydrant System upgraded via *TD-3464: Fire Hydrant Upgrade, Stage 4*, together with MBTS, BLTS, RWTS, MWTS, and EPS. This program is expected to be completed before the next Regulatory Period.
2. MLTS' Water Deluge System (WDS) is scheduled to be replaced by 2022.

6 Asset Strategies

Key asset management strategies for fire detection and suppression include:

6.1 Fire Protection System

- Continue regular inspection and tests for all FPSs in accordance with the relevant Australian Standard, AS1851: Maintenance of Fire Protection Systems and Equipment.

6.2 Fire Hydrant System

- Progressively replace all the remaining FHSs in C4 and C5 conditions with systems complying with relevant Australian Standards.

6.3 Water Deluge System

- Assure the refurbishment of WDSs that is in C4 condition. (MLTS to be completed by 2022)

6.4 Other Fire Safety Infrastructure

- Replace failing smoke detectors and FIPs in Control Buildings.