Penrose Substation Outage

Implementation Plan

22 December 2015

Issue 1

Contents

1.0 Electricity Authority Inquiry into Penrose Substation Outage

On 7 October 2014, the Minister of Energy and Resources (the Minister) wrote to the Electricity Authority (the Authority), requesting (under section 18 of the Electricity Industry Act 2010) that the Authority undertake an inquiry into the Penrose substation outage that occurred on 5 October 2014.

The Authority has undertaken an inquiry, which included outputs of the investigation conducted by Transpower and Vector, including the independent expert (CCI) report.

The Minister released the Electricity Authority Inquiry report on 26 November 2015, together with the Transpower/Vector joint investigation report, the independent cable expert report, and a range of other reference documents.

1.1 Recommendations from the investigation and inquiry

The Transpower/Vector joint investigation report includes recommendations for improvement actions that will reduce future risk from outages caused by cables and cable joints installed in air. The Authority's report endorses those recommendations and includes additional recommendations.

1.2 Requirement for an Implementation Plan

The Authority report includes a recommendation that:

> Vector and Transpower submit to the Authority for approval an implementation plan by 31 December 2015. After the plan is approved, Vector and Transpower should submit progress reports to the Authority every six months until all actions have been completed (the monitoring period). Vector and Transpower should engage with the Authority during the monitoring period as may be required by the Authority from time to time.
>
> The Authority will monitor progress made towards completion of the recommended improvement actions and will report to the Minister if there are any deviations from the implementation programme.

1.3 Transpower and Vector Joint Response to the EA Report

The purpose of this document:

Transpower and Vector have prepared an Implementation Plan in response to the recommendations arising from the joint investigation, and the Authority inquiry reports.

In general, the recommendations contained in the Transpower/Vector joint investigation report, and the Authority inquiry reports are written in relatively high level terms. The purpose of the Implementation Plan is to translate these high level recommendations into specific and measurable actions. There is some overlap between the recommendations made

in the Transpower/ Vector joint investigation and the Authority inquiry reports. As a result – and for the sake of completeness – several actions appear twice as they refer to recommendations separately noted in each report. To assist the reader, this Implementation Plan includes cross-references identifying these overlaps.

2 Recommendations from the joint Transpower/Vector report

The recommendations in the Transpower/Vector joint investigation report include:

No	Recommendation
Learning 1: Cable joints installed in air with other cables in close proximity can cause sustained fires when they fail.	
1	Transpower and Vector implement changes at Transpower's Penrose substation as part of the recovery works, including installing replacement cables in two trenches containing segregated ducts for each cable to effectively eliminate the risk of fire causing multiple cable failures.
2	Transpower and Vector review locations where power cables are installed in open air environments to identify any asset risks at the following locations: • Transpower/Vector points of connection (GXPs); • Vector's network; • Transpower sites; and take appropriate actions to mitigate these risks
3	Vector review and update its relevant policies, procedures and practices with respect to cables, and cable joints installed in air.
4	Transpower incorporate learnings from the Penrose cable fire into asset management practice, including design standards. Include mitigation of risks from failures of cable joints in open air.
Learning 2: Risk management processes did not identify very low probability events that had not previously occurred on the network.	
5	Vector review and update its risk management framework, and risk identification processes.
6	Transpower incorporate learnings from the Penrose cable fire into risk review processes.
Learning 3: The nature of the incident identified opportunities for improvement of standard operating procedures.	
7	Vector update its standard operating procedures to apply key learnings from the incident.
8	Transpower update its standard operating procedures to apply key learnings from the incident.
Learning 4: The current asset and risk management processes at the physical interface between Transpower and Vector's networks need to be improved.	
9	Transpower and Vector review contractual terms and management processes at points of connection to ensure key learnings from the incident are incorporated.
10	Transpower improve the business process for assessing and agreeing to customer requests for access and occupation of Transpower land.
11	Transpower establish an on-going process to provide assurance about the status and condition of customer assets on Transpower land and the potential risks to the grid.

2.1 Joint Transpower/Vector Report Recommendation 1

Cable joints installed in air with other cables in close proximity can cause sustained fires when they fail.

1 Transpower and Vector implement changes at Transpower's Penrose substation as part of the recovery works, including installing replacement cables in two trenches containing segregated ducts for each cable to effectively eliminate the risk of fire causing multiple cable failures.

2.1.1 Introduction

Transpower and Vector are already well advanced in their work to implement changes at the Penrose substation to complete a permanent reinstatement of the components damaged during the fire. The new solution has been designed to eliminate the risk of fire causing multiple cable failures. The new solution will be designed to eliminate the original cause of the incident so that it cannot occur again at the site.

2.1.2 Implementation Plan

Transpower and Vector have already agreed new cable routes through the Transpower switch yard. These will allow segregated paths for the cables to be installed, creating diversity in the layout and avoiding locations where all circuits are laid in close proximity. In addition, the new circuits will be buried so that any cable joints required will not be installed in air. The new solution is designed to remove the contributing factors that caused the outage in October 2014 so that it will not occur again.

The Implementation Plan has been linked to the improvements already occurring at the site to improve onsite co-ordination of activities.

Transpower/Vector will:

- Agree new, separate cable routes through Transpower's switchyard (completed);
- Design a new permanent solution at the Penrose substation (completed);
- Construct the new cable trenches by 30 June 2016; and
- Complete all additional upgrade works by 30 November 2016.

2.2 Joint Transpower/Vector Report Recommendation 2

Cable joints installed in air with other cables in close proximity can cause sustained fires when they fail.

2 Transpower and Vector review locations where power cables are installed in open air environments to identify any asset risks at the following locations:

- Transpower/Vector points of connection (GXPs);
- Vector's network;
- Transpower sites;

And take appropriate actions to mitigate these risks.

2.2.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendation 4.

2.2.2 Introduction

Following the Penrose fire, Transpower and Vector have reviewed their networks to identify other locations where in-air cable joints exist in critical locations and assessed the associated risks and possible mitigation strategies.

Vector has performed a risk analysis of all in-air cable joints on its entire network. The risk analysis identified 133 locations with the potential to have significant consequences to customer supply should an in-air joint fail catastrophically because of the potential of either secondary damage to neighbouring circuits, and/or the potential for a fire to propagate to neighbouring circuits.

Transpower undertook a desktop assessment of 37 sites classified as Category 1 and essential Category 2 sites (as defined by TP.DS 61.06 – Issue 4, Substation fire Mitigation Standard) with an additional three included (Whirinaki, Rangipo & Tekapo A) added at the suggestion of Transpower's Operational Engineering Group.

- 29 sites have cables within the switchyard boundary fence;
- Five sites (Central Park, Haywards, Otahuhu, Penrose and Whirinaki) were identified as having cable joints installed within building basements; and
- 19 sites have cables through the switchyard installed in air, i.e. not buried/encased in the ground.

2.2.3 **Implementation Plan**

Vector will:

- Inspect all 133 sites on the Vector network where there are multiple cables in open air, including Transpower and third party substations, assess the consequences of failure, and identify actions to mitigate risks identified from the inspections (completed);
- Proactively apply a flame retardant coating to all in-air joints located at these 133 sites 15 February 2016;
- Complete all other actions identified to mitigate the risks for lower priority sites by 30 June 2016; and
- Amend its maintenance schedules to amend inspection cycles for all significant open air cable installations by 30 April 2016.

Transpower will:

- Inspect all critical Transpower substations to identify cable joints in air, assess the consequences of failure, and identify actions to mitigate risks identified from the inspections (completed); and
- Complete all actions identified to mitigate the risks at critical sites by 31 May 2016;

At several Grid Exit Points, Transpower and the connected customer will implement interim risk mitigations, such as the application of intumescent paint or sandbags to cable joints in air. Three sites have already been completed, and progress is underway at Penrose and Whirinaki, a plan is in place to ensure all identified work is completed by December 2016.

Transpower has updated its Standard Maintenance Procedure (SMP02.07.001: Thermographic Survey – Transmission Equipment) to include an explicit requirement to ensure that any exposed cable joints are included and assessed in the survey process.

2.3 Joint Transpower/Vector Report Recommendation 3

Cable joints installed in air with other cables in close proximity can cause sustained fires when they fail.

3 Vector review and update its relevant policies, procedures and practices with respect to cables, and cable joints installed in air.

2.3.1 Introduction

While Vector has an extensive and comprehensive set of policies, procedures and practices, a number of areas were identified during the investigation that could be improved as a result of the new information that became available as part of the investigation process.

2.3.2 Implementation Plan

Vector will:

- Review and amend policies, procedures and practices that deal with cable system design, installation and maintenance.

Vector has identified the following areas where improvements to policies, procedures and practices are to be implemented:

- Revised design standards that stipulate all new cable joints be buried direct, or where this cannot be achieved:
    - Minimum vertical and horizontal separation spacing limits shall be applied (completed); and
    - Joints shall be covered, enclosed or encased in such a way as to minimise the risk of damage to all other cables (completed).

- Revised design standards stipulating more stringent requirements implemented on
    - cable support structures (completed); and
    - Cable joint support structures by 15 April 2016.

- Revised maintenance standards implemented for high voltage cables:
    - Standard ESM301 Maintenance of HV Cables reviewed by 31 March 2016.

2.4 Joint Transpower/Vector Report Recommendation 4

Cable joints installed in air with other cables in close proximity can cause sustained fires when they fail.

4 Transpower incorporate learnings from the Penrose cable fire into asset management practice, including design standards. Include mitigation of risks from failures of cable joints in open air.

2.4.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendation 3.

2.4.2 Introduction

The findings from the investigation provide an opportunity for improvement of asset management standards to incorporate learnings.

2.4.3 Implementation Plan

Review and amend Transpower asset management standards that deal with cable system design, installation and maintenance.

Transpower's approach will be as follows:

- Review and amend (if required) Transpower's cable specification to minimise collateral effects of fire by 31 March 2016; and
- Transpower will review its fire risk standard TP DS 61.06 to include a risk based approach to identifying and valuing substation asset fire risk. This will ensure a consistent, repeatable approach is used to evaluating risks and potential mitigations in site reviews. This standard will be updated by 31 March 2016. Transpower will assure that the standard is applied by monitoring the outputs of the site reviews.

Transpower has updated its Standard Maintenance Procedure (SMP02.07.001: Thermographic Survey – Transmission Equipment) to include an explicit requirement to ensure that any exposed cable joints are included and assessed in the survey process.

2.5 Joint Transpower/Vector Report Recommendation 5

Risk management processes did not identify very low probability events that had not previously occurred on the network.

5 Vector review and update its risk management framework, and risk identification processes.

2.5.1 Introduction

Vector has reviewed the findings and new information available from the joint investigation and will incorporate this into its asset risk framework.

2.5.2 Implementation Plan

Vector will:

- Review and amend its asset risk management framework for each asset category (completed);
- Amend its procurement processes and contracts to request suppliers to make Vector aware of any significant issues with product failures by 30 June 2016;
- Create a dedicated role within its networks business focused on managing asset risk identification and management processes (completed);
- Complete its assessment of asset risk profiles at GXP's to ensure the criticality of assets is considered (completed);
- Complete its assessment of asset risk profiles at significant Zone Substations by 31 March 2016; and
- Review its risk identification processes to ensure any learnings from the incident are applied by 31 March 2016.

2.6 Joint Transpower/Vector Report Recommendation 6

Risk management processes did not identify very low probability events that had not previously occurred on the network.

6 Transpower incorporate learnings from the Penrose cable fire into risk review processes.

2.6.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendation 3.

2.6.2 Introduction

Transpower has a variety of processes that are intended to identify risks at its substation sites. These multiple processes can grouped into two broad classifications:

- Operational management processes (1st line of defence); and
- Oversight processes (2nd line of defence).

The operational management processes include routine inspections, condition assessments, and the feedback from planned and reactive maintenance. The oversight processes include reviews of specific design compliance issues, and the identification and analysis of high impact low probability (HILP) risks.

2.6.3 Implementation Plan

The Authority inquiry report found that although a specific HILP study had been carried out at Penrose substation in 2012, this did not identify the power cables in the concrete trench as a risk that could threaten the grid assets.

Transpower will review the scope of risk studies, including HILP event studies, to ensure coverage of assets owned by connected parties on Transpower land by 30 June 2016.

Work is currently underway to review and rationalise the Operational Management and Oversight Processes described above. This will result in an improved approach to site risk review, including a collaborative approach to risks associated with assets owned by others on Transpower land. The revised approach will be defined, documented and approved for implementation by 30 June 2016.

2.7 Joint Transpower/Vector Report Recommendation 7

The nature of the incident identified opportunities for improvement of standard operating procedures.

7 Vector update its standard operating procedures to apply key learnings from the incident.

2.7.1 Introduction

As part of the investigation report commissioned by Transpower/Vector, specialists from Cable Consulting International (CCI) recommended changes to Vector's operating procedures to prevent reclosing onto tripped circuits where in-air joints exist. CCI identified there is a potential to accelerate a fire if a circuit is reclosed onto a failed joint and recommended amending Vector's operational procedures to avoid this potential situation.

2.7.2 Implementation Plan

Vector will update its standard operating procedures for locating faults on feeders with cable sections installed in air by:

- Amending its operating standard (EOS003) to include additional restrictions on reclosing on tripped circuits that contain sections of in-air cables (completed);
- Updating SCADA tiles to provide information to operating staff on the location of in-air joints (completed);
- Completing refresher training for all operating staff on the risks associated with in-air joints (completed); and
- Vector will review its communications and existing access arrangements with the NZFS to identify opportunities for improvement by 31 January 2016.

2.8 Joint Transpower/Vector Report Recommendation 8

The nature of the incident identified opportunities for improvement of standard operating procedures.

8 Transpower update its standard operating procedures to apply key learnings from the incident.

2.8.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendation 9.

2.8.2 Introduction

The incident has highlighted some opportunities to improve current Transpower operating procedures. These include procedures for enabling safe access for the NZFS personnel in the event of a fire in a substation; the operating procedures for manual reclose of circuits following a fault, and standard procedures for major event management.

2.8.3 Implementation Plan

Transpower's implementation plan will be as follows:

- Transpower will review its communications and existing arrangements with the NZFS, to identify opportunities for improvement. A workshop with the NZFS has been completed;
- Review the improvement opportunities generated from the NZFS workshop and instigate, rollout and communicate changes by 31 May 2016;
- Ensure that operating procedures are in place to minimise the risk that an operator could close onto a faulted transmission circuit cable section by 31 March 2016; and
- Define and document major event management training based on CIMS model for the Grid Operators, Regional Service Managers or other first responders by 31 May 2016.

2.9 Joint Transpower/Vector Report Recommendation 9

The current asset and risk management processes at the physical interface between Transpower and Vector's networks need to be improved.

9 Transpower and Vector review contractual terms and management processes at points of connection to ensure key learnings from the incident are incorporated.

2.9.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendation 5.

2.9.2 Introduction

The incident has highlighted the opportunity for Transpower and Vector to improve the asset management interface with respect to Vector assets on Transpower property.

2.9.3 Implementation Plan

Transpower/Vector's approach will be as follows:

- Transpower has reviewed the standard contractual terms from the Benchmark Transmission Agreement (Schedule 6 – Access and Occupation), and considers that they are fit-for-purpose;
- Vector has reviewed the contractual terms in the current agreements with Transpower;
- Transpower and Vector will jointly undertake a review of asset management processes at the interface to be completed by 30 June 2016; and
- Transpower and Vector will jointly review the Access and Occupancy schedules (and the associated review mechanisms) by 30 June 2016.

2.10 Joint Transpower/Vector Report Recommendation 10

The current asset and risk management processes at the physical interface between Transpower and Vector's networks need to be improved.

10 Transpower improve the business process for assessing and agreeing to customer requests for access and occupation of Transpower land.

2.10.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendations 5 and 6.

2.10.2 Introduction

The incident has highlighted the opportunity for Transpower to improve the asset management interface with respect to customer assets on Transpower property.

2.10.3 Implementation Plan

Transpower's approach will be to:

- Review the business process for assessing and approval to customer requests for access and occupation of Transpower land by 31 May 2016; and
- Ensure that a risk assessment is part of the process by 31 May 2016.

2.11 Joint Transpower/Vector Report Recommendation 11

The current asset and risk management processes at the physical interface between Transpower and Vector's networks need to be improved.

11 Transpower establish an on-going process to provide assurance about the status and condition of customer assets on Transpower land and the potential risks to the grid.

2.11.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Authority recommendations 5 and 6 and Transpower/Vector joint report recommendations 6 and 9.

2.11.2 Introduction

The incident has highlighted the opportunity for Transpower and its connected customers to improve the asset management interface with respect to customer assets on Transpower property.

2.11.3 Implementation Plan

Transpower's approach will be to:

- Establish an ongoing process to provide assurance about the status and condition of customer assets on Transpower land and the potential risks to the national grid. This process is to focus on critical sites, and to include agreement of risk mitigation plans with customers. This will be completed by 30 June 2016.

A process is underway for a comprehensive review of Access and Occupation schedules to update the records of customer assets on Transpower land, and evaluate the risks associated with those assets. The risk reviews for the most critical sites are scheduled to be completed by 30 June 2017.

3 Recommendations from the Electricity Authority draft report

The Authority report contains recommendations that have been noted in the table below. The report contains further points that expand on these recommendations, and in some cases, there is a target date set for improvements to be completed.

No	Recommendation	Assigned to
1	Lessons from the Penrose incident must be shared with industry stakeholders	Vector and Transpower
2	Supply-critical components should be given higher risk management priority than non-critical components, even if the probability of occurrence is low	Vector
3	The particular characteristics of each asset must be considered in determining the risk profile of the asset	Vector and Transpower
4	In-air cable joints must be identified and the associated fire risk mitigated	Vector and Transpower
5	Asset boundaries require improved management between asset owners to ensure clear division of responsibility	Vector and Transpower
6	Access and occupation arrangements must be reviewed and complied with	Transpower
7	Planning standards should be reviewed by Vector to ensure the standards are appropriate	Vector
8	Future State of the Network reviews should be re-scoped to ensure the reviews are effective	Vector
9	An independently peer reviewed, post-event safety review must be undertaken to identify improvement opportunities	Vector, Transpower and the NZFS

3.1 Electricity Authority Recommendation 1

Lessons from the Penrose incident must be shared with industry stakeholders

11.4 The detailed background, failure mechanisms and key lessons of the Penrose fire have potential values for other electricity lines businesses. The Authority recommends that Vector and Transpower share the findings of this inquiry and the investigation with other electricity lines businesses.
11.5 Where barriers exist to the sharing of information, Vector and Transpower must tell the Authority about the nature of the barriers and the limitations placed on information sharing.

3.1.1 Introduction

The Transpower/Vector joint investigation found that there was limited sharing of information and learnings about cable fires across the industry, both in New Zealand and internationally.

3.1.2 Implementation Plan

Transpower and Vector will arrange an industry workshop to share the learnings from the Penrose Outage by 31 March 2016.

3.2 Electricity Authority Recommendation 2

Supply-critical components should be given higher risk management priority than non-critical components, even if the probability of occurrence is low

11.6 The Authority recommends that Vector reconsider how it prioritises risks for its asset management programme so that it gives priority to supply-critical network components. Vector should undertake this review immediately and implement recommendations on improvements before 31 March 2016.
11.7 As discussed in section 5 of this report, Vector has previously given priority to overhead components of its network. However, failure of supply-critical network components can have the most significant impact on customers and Vector should give a high priority to identifying and managing those failures, even if the probability of such failures may be low.

3.2.1 Introduction

Vector has a comprehensive Asset Management programme in place and is subject to periodic external review to support continuous improvement. The findings from the joint investigation will be used to facilitate further improvement in Vector's asset management practices.

3.2.2 Implementation Plan

Vector's approach is to systematically review the risk profile of all asset classes in its network to verify if the current risk profile is still appropriate or requires amendment. The proposed methodology will be as follows:

Vector will:

- Review its generic risk profile models for each of the nine key asset classes by 30 November 2015 (completed);
- Review site specific risks at all Transpower supply (GXP) points by 20 December 2015 taking into account interdependency risk between specific Vector assets and inclusive of Transpower assets (completed); and
- Collate and evaluate the risks at these GXPs and issue any required improvement works by 31 March 2016 for its contractors to complete by 30 November 2016.

3.3 Electricity Authority Recommendation 3

The particular characteristics of each asset must be considered in determining the risk profile of the asset

11.8 The Authority recommends that Vector and Transpower review their fire risk mitigation standards and asset management policies to better align with the key characteristics of specific installations. Vector and Transpower should undertake this review immediately and implement recommendations on improvements before 31 March 2016.
11.9 For example, a Transpower standard exists that considers fire risk in cable basements but it does not anticipate other in-air installations (ie in-air cable trenches) that have essentially the same characteristics and pose similar risk profiles.

3.3.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Transpower/Vector joint report recommendation 4.

3.3.2 Introduction

During the joint Transpower/Vector investigation, no industry-wide agreed, common or optimal approach to specification and selection of fire mitigation systems for electrical reticulation systems was identified. It is noted that the Electricity Networks Association (ENA) drafted a fire protection standard in 2008, but has yet to gain agreement and finalise this guideline.

3.3.3 Implementation Plan

Transpower/Vector will review their current practices against the learnings from the investigation and will continue to monitor wider industry practice for further guidance.

Transpower's approach will be as follows:

- Transpower will review its fire risk standard TP DS 61.06 to include a risk-based approach to identifying and valuing substation asset fire risk. This will ensure a consistent, repeatable approach is used to evaluating risks and potential mitigations in site reviews. This standard will be updated by 31 March 2016 and Transpower will assure that the standard is applied by monitoring the outputs of the site reviews.

Transpower has updated its Standard Maintenance Procedure (SMP02.07.001: Thermographic Survey – Transmission Equipment) to include an explicit requirement to ensure that any exposed cable joints are included and assessed in the survey process.

Vector's approach will be to:

- Review its standard ENG-028 (Electricity Network Guidelines: Fire protection for Zone Substations) by 30 April 2016; and
- Review its standard ENS-195 (Maintenance of Zone Substation Fire Suppression Systems) by 31 March 2016.

3.4 Electricity Authority Recommendation 4

In-air cable joints must be identified and the associated fire risk mitigated

11.10 To address explicitly the risk of fire ignition from cable joints, the Authority recommends that Vector and Transpower review their standards for existing power cable joints in in-air situations. For new installations, joints in in-air situations should be avoided where practicable. Vector and Transpower should undertake this review immediately and implement recommendations on improvements before 31 December 2015.
11.11 A number of relatively low cost fire mitigation solutions have been identified by the investigation in its survey of electricity lines businesses. These options should be fully considered and, where appropriate, implemented.

3.4.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Transpower/Vector joint report recommendations 2 and 4.

3.4.2 Introduction

Following the Penrose outage, Transpower and Vector have reviewed their networks to identify other locations where in-air cable joints exist in critical locations and assessed the associated risks and possible mitigation strategies.

3.4.3 Implementation Plan

Transpower undertook an assessment of 37 sites classified as Category 1 and essential Category 2 sites (as defined by TP.DS 61.06 – Issue 4, Substation fire Mitigation Standard) with an additional three included (Whirinaki, Rangipo & Tekapo A) added at the suggestion of Transpower's Operational Engineering Group.

- 29 sites have cables within the switchyard boundary fence;
- Five sites (Central Park, Haywards, Otahuhu, Penrose and Whirinaki were identified as having cable joints installed within building basements; and
- 19 sites have cables through the switchyard installed in-air, i.e. not buried/encased in the ground.

At several Grid Exit Points, Transpower and the connected customer will implement interim risk mitigations, such as the application of intumescent paint or sandbags to cable joints in air. Three sites have already been completed, and progress is underway at Penrose and Whirinaki, a plan is in place to ensure all identified work is completed by December 2016.

Transpower's approach will be to:

- Review and amend any Transpower cable specifications to minimise collateral effects of fire by 31 March 2016; and
- Review fire risk standard TP DS 61.06 and add guidance checklists so that these can be used in site reviews by 31 March 2016.

Vector's approach will be to identify all locations where records indicate the presence of multiple in-air circuits of significance and to physical inspect all sites. Vector identified 133 sites and has completed a physical audit of all these sites. Since June 2015, Vector has progressively applied a flame retardant coating to all in-air joints located at these sites to reduce the probability of a future failure propagating away from the fault site. As at 22 December 2015, mitigation actions have been completed on all but one of the high risk sites, with all remaining sites expected be completed by 15 February 2016.

For all future installations, Vector has drafted an amended design standard (ENS-0225) which stipulates that in-air joint installations should be avoided where possible, but if they must be required, they must be installed with fire resistant coatings and be subject to physical separation from other circuits.

On completion of the works at Swanson tunnel, Vector considers that implementation of this recommendation has been completed.

3.5 Electricity Authority Recommendation 5

Asset boundaries require improved management between asset owners to ensure clear division of responsibility

11.12 The Authority recommends that Vector and Transpower pay greater attention to formalised asset management practices at all boundaries where assets connect to the grid. Vector and Transpower should undertake an immediate review of their asset management policies and implement recommendations on improvements before 31 March 2016.
11.13 If the findings from the review indicate a systematic issue beyond Penrose substation, the Authority recommends that Vector and Transpower undertake a comprehensive review of asset management practices at all points of interconnection between their networks. In addition, Transpower should review asset management practices at all network asset boundaries.

3.5.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Transpower/Vector joint report recommendations 9, 10 and 11.

3.5.2 Introduction

Following internal reviews, Transpower currently considers that the contract is fit-for - purpose and no changes to contractual terms are required. The rationale is that the contract terms themselves were not a contributory factor in the failure to identify the fire risk to grid assets that occurred at Penrose substation. The investigation found that Transpower and Vector's management processes associated with the Access and Occupation terms in the Connection Agreement had not been fully effective, and that this contributed to a lack of awareness of the risk.

Therefore, it is proposed that the Implementation Plan should focus on review and improvement of management processes, rather than updating the contractual terms and conditions.

3.5.3 Implementation Plan

Transpower/Vector will jointly undertake a review of asset management processes at the interface and this will be completed by 31 March 2016.

3.6 Electricity Authority Recommendation 6

Access and occupation arrangements must be reviewed and complied with

11.14 All of Transpower's access and occupancy arrangements and procedures through which third parties are allowed to locate assets and equipment at important substations must be fully reviewed and include a periodic compliance review. Transpower should undertake this review immediately and implement recommendations on improvements before 31 March 2016.
11.15 The Authority recommends that Transpower review its arrangements regarding access and occupancy, and compliance with those arrangements. Transpower should undertake this review immediately and implement recommendations on improvements to its standard contract before 31 December 2015. The Authority recognises that completion of individual contracts between Transpower and its customers may take some time to complete and some form of prioritisation may be required.
11.16 The inquiry found that the arrangements, through which Transpower had provided Vector with access to locate its cables in the Penrose trench were not well understood by either Vector or Transpower. For example, important schedules recording the cables in the trench were inaccurate and had not been updated, and approvals for locating additional cables in the trench had not been documented. These issues must be addressed and corrected in the review.

3.6.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Transpower/Vector joint report recommendations 10 and 11.

3.6.2 Introduction

Following the joint investigation both Vector and Transpower have found anomalies in asset data associated with boundary assets between the two businesses, and an unclear understanding of the Access and Occupancy arrangements between the two parties, which need to be clarified.

3.6.3 Implementation Plan

Transpower will complete a review of the Access and Occupancy application and approval process. Any improvements will be identified, and any required changes implemented by 31 March 2016.

Transpower has reviewed the Access and Occupancy standard contract and believes that the contract terms and conditions are fit-for-purpose.

Further information and implementations can be found in recommendations 10 and 11 of the joint investigation report.

3.7 Electricity Authority Recommendation 7

Planning standards should be reviewed by Vector to ensure the standards are appropriate

11.17 The Authority recommends that Vector review its network planning standards with respect to the definition of a single credible contingency event relevant to the multiple power cables co-located within close proximity. Vector should undertake this review immediately and implement recommendations on improvements before 31 March 2016.
11.18 Thirty-eight power cables supporting 19 supply-critical circuits co-located within an in-air trench was a primary risk factor in the Penrose fire incident. The cable trench was effectively a single contingency risk for the 19 supply-critical circuits. Such supply-critical circuits should have had at least one level of redundancy inherent in the network design.
11.19 Included in the lengths of power cables were 11 kV power cables that Vector managed using a 'run to failure' maintenance approach. Locating 'run to failure' cables in an in-air situation in close proximity to other assets that have a higher standard applied to them was a critical factor in extent of supply disruption that resulted from the Penrose fire. Vector must reconsider the application of its network planning standards for these situations.

3.7.1 Introduction

Vector has been reviewing its current practices to identify opportunities to improve its planning, risk and asset management standards. In particular, Vector is focusing on improving the methods in which supply critical installations are identified and how planning and asset management practices are tailored to better mitigate risks where elevated consequences of failure have been identified.

3.7.2 Implementation Plan

Vector's approach will be to:

- Review its current definition of a single credible contingency event in its planning standards by 29 February 2016;
- Review its current security standards with respect to single credible contingency events by 29 February 2016; and
- Review its asset management standards to minimise the likelihood of a cable joint failure creating a subsequent failure on a co-located cable circuit by 31 March 2016.

3.8 Electricity Authority Recommendation 8

Future State of the Network reviews should be re-scoped to ensure the reviews are effective

11.20 Vector and the AECT should review the scope of the biennial State of the Network Reviews to ensure that the reviews achieve what was intended, and that any limitations are fully understood.
11.21 The Authority recommends that the scope of future State of the Network Reviews include supply-critical network components, and an assessment of how the associated risks are being managed.
11.22 Vector and the AECT should undertake the review immediately and include recommendations on improvements in the 2016 State of the Network review and report.

3.8.1 Introduction

Vector has an agreement (New Deed Recording Essential Operating Requirements) with its majority shareholder (the Auckland Energy Consumer Trust) whereby Vector has an obligation to prepare, on an annual basis, or such other longer frequency as reasonably directed by the Trust, a report from an independent expert addressing each of the following areas:

a) the state of the Company's electricity lines in the District with regard to maintenance programmes and expenditure;
b) any need for upgrading the Company's electricity lines in the District;
c) the capacity of the Company's electricity lines in the District in relation to forecast demand; and
d) Any security risks to the Company's electricity lines in the District.

3.8.2 Implementation Plan

Vector's approach will be to:

- Review the current terms of reference as agreed with the Trust (completed);
- Propose any amendments (if required) to the Trust by 28 February 2016; and
- Incorporate the revised terms of reference in the next review and report.

3.9 Electricity Authority Recommendation 9

An independently peer reviewed, post-event safety review must be undertaken to identify improvement opportunities

11.23 An early post-event review involving Vector, Transpower and NZFS should have taken place. The lack of such a review has raised, at a late stage in the inquiry, important questions about communications and safety management during and after the fire. Resolution of inconsistencies between the perspectives of Vector, Transpower and NZFS could reveal important lessons and opportunities for improvement in emergency management procedures.
11.24 The Authority notes that in the final stages of this inquiry, Transpower has said that it is considering a safety review that will bring together Vector, Transpower and NZFS in a review of the safety and inter-agency aspects resulting from the Penrose fire.
11.25 The Authority considers that the review must include engagement with relevant field and office personnel from Vector, Transpower and NZFS, especially the onsite personnel involved on 5 October 2014. The results must be widely disseminated with relevant stakeholders. This review will provide opportunities to consider and improve safety and fire control management for emergency responses involving high-voltage electrical facilities.
11.26 The Authority recommends that the safety review be externally peer reviewed by an appropriate independent safety authority and the outcomes publicised by 31 March 2016.

3.9.1 Cross-reference

The actions in this section of the Implementation Plan are also linked with the Transpower/Vector joint report recommendations 7 and 8.

3.9.2 Introduction

The nature of the Penrose incident has highlighted opportunities for improvement of current procedures. The event highlighted the importance of enabling safe site access for the New Zealand Fire Service (NZFS) personnel in the event of fire in a substation.

3.9.3 Implementation Plan

Transpower will facilitate a workshop between the relevant parties to review the event by:

- Drafting a workshop scope to encompass the recommendations (complete);
- Commissioning an independent expert (as recommended by the NZFS) to act as the workshop facilitator (complete);
- Attending the workshop (along with representatives from Transpower's/Vectors field contractors involved in the Penrose event) planned for 15 December 2015;

- Arrange for an external peer review by an appropriate independent safety authority and publish the outcomes by 31 March 2016; and

Refer to recommendations 7 and 8 of the joint investigation report for additional details of the Implementation Plan.

4 Proposed Reporting Template

The Authority has requested that Transpower and Vector submit six-monthly progress reports until all actions are complete. Transpower and Vector propose to provide a regular update in a simple table format to provide clear progress reporting:

Recommendations from Transpower/Vector joint report				
Recommendation/Action	**Progress Update**	**Company**	**Due Date**	**Status**
1				
2				
…				

Recommendations from the Electricity Authority report				
Recommendation/Action	**Progress Update**	**Company**	**Due Date**	**Status**
1				
2				
…				

5 Contacts

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