Fire Investigation Report

19 Gavin Street, Ellerslie, Auckland

Incident Information:
F1700571
Significant Economic Impact
2:17 a.m. 5 October 2014

Report completed by:
New Zealand Fire Service, Region 1
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Author's Brief

My full name is [Redacted] I am a Specialist Fire Investigator in the Auckland Fire Region for the New Zealand Fire Service.

I have served with the NZ Fire Service since 1967. I have been responsible for determining cause and origin of fires for the last 30 years, while serving as an operational Station Officer and have been specialist fire investigator since 2001.

I have completed various Fire Service training courses in origin and cause fire investigation tactics as well as an expert witness course.

I have attained the Graduate Certificate in Fire Investigation from the Charles Sturt University Sydney, Australia in 2007.

I have completed the NZ Fire Service training courses have qualified as an NZQA assessor for fire investigation.

As a Specialist Fire Investigator in the NZ Fire Service I am required to respond to significant fires in accordance with Operational Instructions with the principal objectives being to co-ordinate, supervise or undertake investigations into major and serious fires, including fatal fires, by determining the point of origin of a fire and from this establishing the cause of a fire.

I have previously given expert evidence on fire investigation and origin and cause of fires in the District and High Courts of New Zealand.
New Zealand Fire Service

Executive Summary

A fire involving high voltage power cables in a concrete lined trench located at Transpower's Penrose substation had occurred. This caused a major power outage to some areas of Auckland which were supplied with power from the substation. Fire spread also damaged some high voltage cables outside the trench and a small area outside of the switchgear building.

NZFS received a 111 call from a neighbour of the substation at 2:18 a.m. on 5 October 2014.

Fire crews arrived to discover a fire in a section of a cable trench within the switch yard area, however due to the power not being isolated at that stage, fire fighting was unable to commence.

The first fire appliance arrived at 2:26 a.m. but it was not until 3:23 a.m. when an initial fire attack occurred in the area of the switchgear building, preventing serious fire damage to the switchgear building.

Following the initial fire attack which extinguished the fire threatening the switchgear building, which was within the switchyard area, fire crews were forced to withdraw. This was due to a concern that power had not been isolated from all areas around the fire. Re-entry to the switchyard area did not occur until 4:37 a.m. when confirmation was received of the power being isolated.

The delay in being able to recommence firefighting did allow fire spread from where the fire originated along the length of the trench.

While some fire damage occurred to areas outside the cable trench, most fire damage was contained to the cable trench.

An investigation team, including a NZ Fire Service Specialist Fire Investigator, a UK cable expert, Vector and Transpower Engineers as well as private Fire Investigators appointed by insurers was set up. A team approach is internationally recognised as best practice when investigating major fires.

As part of the investigation, fire damaged cables from the area and point of origin, were removed for the cable expert to carry out a closer inspection. Samples of cables not affected by the fire, were also removed for inspection.

A number of the cables removed were also taken to the UK for a more in depth investigation by the cable expert.

The Teams origin and cause investigation confirmed the fire originated in the cable trench near the T11 transformer. A transition joint in the Remuera 11kV feeder cable in this area failed causing an initial release of a large amount of heat, which caused the outer covering of the feeder cable to gradually heat up and ignite. Due to the large number of power cables surrounding this transition joint, once the outer covering had ignited, the fire then gradually spread to the other cables. The concrete lids covering the trench allowed the heat from fire to build up heat within the trench and assisted the fire spread along the trench.
New Zealand Fire Service

The cause has been classified as accidental due to a failure within a transition joint of the Remuera 11kV feeder cable

A report from the UK cable expert will be produced covering the cause of the failure.
New Zealand Fire Service

Terms of Reference

Sponsor:

Area Manager, Auckland City.

Incident Background:
The Officer in Charge (OIC) of this incident considered the circumstances of the fire met the criteria requiring the attendance of a Specialist Fire Investigator as per National Commander’s Instruction P3. The OIC made this request through the New Zealand Fire Service Communications Centre who summoned the author of this report to attend the incident as a Specialist Fire Investigator (SFI).

The reason for the attendance of a Specialist Fire Investigator was: Significant Economic Impact.

Objectives:
Determine the origin and cause of the fire through best practice analysis and investigative processes.

Scope:

- Focus on this incident specifically, but consider historical data and information from this site and other similar incidents, and other incident information that may have a bearing or contributed to the outcome.
- Analysis of the circumstances and factors, including the occupant(s) actions, building fire loading and design, fire protection/suppression systems performance, circumstances of the fire, and result of the fire.
- Where evidence or suspicion of a deliberate fire start is discovered, the matter is to be referred to the Police who will then have the responsibility for further investigation. The Police may request that the NZFS Specialist Fire Investigation Officer assist with the origin and cause determination.
- Produce a completed report for the report sponsor outlining all relevant findings.
Description and Use of Building

This Penrose Substation is a large and important part of the National Grid. The substation was established in the 1920's to meet the growing demand for electricity and has been expanded at different times.

The site is used as a Transpower substation to reduce the high voltage power from 220 kV to 33kV and 22kV power cables which is then transferred to other areas. Vector has its own power cables passing through the site in a number of areas including the concrete lined cable trench in which the fire started, with some cables also attached to the switchgear building on site.

Due to the site consisting of a large amount of volcanic rock, this has forced a large number of high voltage cables to be above ground as well as in the concrete lined trenches.

The cable trench where the fire occurred commenced near the switchgear building which goes through to Gavin St where cables then go under the road. The length of the trench is about 100m with fire damage of various degrees occurring to about 60m of the cables.

The cable trench did not have any fire detection installed or protection/suppression installed.

A security perimeter fence surrounded the entire site with the switchyard where the fire occurred also surrounded by a security fence.

A CCTV camera was installed for a recent project involving a new cable trench being constructed and was located near the switchgear building, however this only gave a restricted view of the fire and not the area of origin.

Photo 1: An aerial view of the substation with attached descriptions of the various areas on site. The Vector 33kV cable trench which contained the area of origin is located is outlined in yellow.
Pre-Incident Events

At 11:21 p.m. on 4 October 2014 a Remuera 11kV feeder cable from Vector's Remuera's substation, which ran through the cable trench at Gavin St, tripped the switchgear at the Remuera substation, cutting power to various parts of East Auckland.

Investigations were carried out by Vector, to find the fault. As nothing was found the Remuera 11kV feeder cable switchgear was closed to allow power to flow at 1:21 a.m. however it immediately tripped again. At that stage no reports of any issue at Gavin St Substation were apparent.

At 2:04 a.m. on 5 October 2014 the control room for Vector noticed that a fault at the Penrose Substation was showing an issue with transformer T11. This was located in the area of origin of the cable trench fire. The on call Transfield technician was responded to investigate. At 2:10 a.m. the transformer T11 tripped, which occurred before the Transfield technician arrived.
Discovery of Fire

At 2:17 a.m. Witness 1, whose property backs onto the Penrose substation, had heard a series of explosions and went outside to investigate. He observed a glow in the area of the transformer T11 and the cable trench in the switch yard. He then called the Fire Service while observing the fire gradually increasing in intensity.

Photo 2 was taken by Witness 1 before the Fire Service arrived.

The Transfield technician, Witness 2, called into investigate the tripping of transformer T11, arrived at Gavin St and opened the gate to the Penrose substation site at 2:41 a.m. This allowed the Fire Service into the general area of the substation at that stage.

Fire crews and the technician confirmed they observed a fire in Vector's cable trench between T10 and T11 from outside the fenced off switchyard area.

Photo 2: The circle indicates the view of the fire neighbours who placed the original 111 call observed from Gavin St.
Fire Service Response

Information sourced from New Zealand Fire Service Computer Aided Despatch Incident Report.

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<tr>
<th>Incident Number</th>
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<tr>
<td>Call Type</td>
<td>Electrical Sub Station Fire</td>
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<tr>
<td>Method call received</td>
<td>111 Telephone</td>
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<td>Incident date</td>
<td>5 Oct 2014</td>
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<td>Incident time</td>
<td>2:17:35 a.m.</td>
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<td>1st Arrival</td>
<td>MTWE237</td>
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<td>2nd Arrival</td>
<td>REMU211</td>
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<tr>
<td></td>
<td>2:26:25 a.m.</td>
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</tbody>
</table>

On the arrival at Gavin St a fire in the switch yard area was observed. Fire Crews were unable to enter the substation site until the Transfield technician arrived.

When closer to the switch yard fire crews observed a fire in the area of the cable trench beside the T11 transformer (Photo 3) however this was outside the fenced switchyard.

Photo 3: The view of the fire that the first arriving fire crews observed from outside the security fence at 2:41 a.m. near the substation switchyard. At this stage they were unable to enter the yard.
Photo 4: The state of the fire just prior to fire crews being able to enter the switch yard at 3:23 a.m.

Process of Investigation

Interviews

An investigation team was made up of employees of Vector and Transpower, investigators employed by the insurers and a NZ Fire Service Specialist Fire Investigator.

The investigation team interviewed Transfield, Transpower and Vector staff who had been onsite at the time of the incident for their observations on their arrival and during the incident.

The Officers and crew of the 1st and 2nd arriving fire appliances were interviewed by the team about their observations and actions, both on arrival and for the duration of the incident.

The Fire Service Operational Commander was also interviewed about the choice of Fire Service tactics, as well as his observations for the duration of the incident.
Witness 1 who was first to observe the fire and who placed the first 111 call was interviewed by the Fire Service specialist Fire Investigator.

**Scene Examination**

The fire was mainly confined to a high voltage cable trench which carried about 20 high voltage power cables, including various 33kV, 22kV and 11kV cables. Some of the cables were attached to the switchgear building, close to where the concrete lined cable trench commenced. However, some cables just ran through the trench but were not connected to the switchgear building, such as the Remuera 11kV feeder cable which was the cable involved in the original fault.

Fire had damaged power cables located in racks adjacent to the trench above the ground, and other cables connected to the switchgear building, including the cables on the exterior of this building. Fire only damaged a small section of the exterior of the switchgear building due to the initial fire fighting attack carried out.

The cable trench which is concrete lined including the concrete lids, is about 100m in length running from the switchgear building to Gavin St. The high voltage cables in the cable trench are placed on steel brackets, off the ground with some cables placed directly on the concrete base of the trench.

Communication Cables that were in a cable tray which ran at right angles across the cable trench close to transformer T11 were also affected by the fire.

Fire had damaged a large amount of the cables in the trench with about 60 m of cable being affected by fire to varying degrees. The closer to Gavin St the less damage had occurred. The section of cables most severely damaged by the fire was in the area of transformer T11 and the switchgear building where the fire in the trench had spread to.

The concrete lids which enclosed the cable trench had initially contained the fire within the trench but had also slowed access for firefighters into the trench. The fire had vented where timber had been beside the concrete covers.

Once timber at the end of the trench close to the switchgear building had been consumed in the fire, the fire spread towards the building and damaged the cables on racks next to the building.

The switchgear building also sustained minor damage to exterior cladding.

Fire crews confirmed the fire originally was confined to the area of the cable trench near transformer T11. The inability of fire crews to enter the yard allowed the fire to spread up to the switchgear building and gradually along the cable trench until fire suppression occurred.
Photo 5: The circle indicates the area where the fire was first observed by the on call Transfield Technician and first arriving fire crews. The transformer T11 is where Vector was first made aware of a possible problem onsite. The arrow indicates where the communication cables to transformer T11 which sent the initial fault signal to Vector, at 2:04 a.m. due to the cables being affected by the fire in the trench.
Photo 6: A view of the cable trench with the concrete covers removed. The arrow indicates the location of where the most severe damage to power cables has occurred.
Photo 7: A view of the exterior of the switchgear building where fire fighting prevented fire entering the switchgear building.

Photo 8: Heat affected cables about 40m from the point of origin.
Area and Point of Origin

Area of Origin

Fire had severely damaged power cables in a concrete lined cable trench which commenced near the switchgear building. Cables in the trench had sustained severe fire damage in the section from the switchgear building to about 10m past transformer T11. The cable fire damage became less as the distance extended away from the area of origin towards Gavin St.

Copper splatter was located on the concrete wall in the area of the opposite where the transition joint was located.

Cables in the trench were located on steel brackets attached to the wall of the trench, a few cables were also placed directly onto the base of the trench.

A tray containing communication cables which ran across of the top of the trench to transformer T11, had a timber cover.

In a number of areas timber had been inserted beside the concrete lids.

The section of the trench next to the switchgear building did have more timber around the end of trench. This would have ignited during the fire adding to the fire load in that area.

Once all of the concrete lids were removed during the fire investigation of the cable trench, the investigation team inspected the fire damage to the cables and fire spread patterns. It was determined by the investigation team that the area of origin requiring a more in depth investigation, was from the switchgear building to transformer.

It was observed that in the area of a cable transition joint the fire damage to surrounding cables including the transition joint was severe.

This area was also where the fire was first observed by fire crews and the first arriving Transfield technician.
Photo 9: The timber cover over the communication cable is in the area where flames were first observed by the Transfield technician and the first arriving fire fighters to have vented out of the trench.
Photo 10: The circle indicates the area where fire patterns and physical evidence of the failed transition joint were discovered.

Photo 11: Copper splatter on the wall adjacent to where the transition joint was located.
**Point of Origin**

The fire investigation team, which included a cable expert from the UK, investigated the entire length of the cable trench. Fire damage to the cables and fire spread patterns in the trench indicated the area of the severely damaged transition joint in the Remuera 11KV feeder cable as the point of origin. This was located on the 2nd layer of cables on a steel bracket.

An inspection of the transition joint in situ by the UK cable expert revealed indications of a major fault occurring within the joint. Part of the joint was found on a different layer below the point of origin. The UK cable expert indicated the failure would have resulted in a severe heat release in the cable causing the outer covering of the cable, to heat up and eventually ignite. Cables close to the Remuera 11KV feeder cable would have been subject to heat transfer from the initial ignition. Eventually the fire from all cables in the trench collectively contributed to a serious fire in the trench and spread until extinguishment occurred.

Information received from Transpower and Vector of data from the cable trench indicated the Remuera 11kv cable was the first cable to fault.

![Photo 12: The arrow indicates the Remuera 11kV feeder cable transition joint that failed within the cable trench and is considered to be the point of origin.](image-url)
Photo 13: A view of the transition joint with an arrow indicating where the failure occurred.

Photo 14: A close up view of the transition joint which failed creating the massive heat release which caused the heating and eventual ignition of the outer covering of the cables.
Conclusions

Supposed Cause

Based on the evidence available at the time of this investigation, the classification of this incident has been recorded as Accidental.

The investigation concluded that a fault in a single transition joint of the Remuera 11kV feeder cable, located in a concrete lined cable trench occurred.

This generated sufficient heat to commence heating up the outer covering of the cable. Once the cable covering ignited the fire gradually spread through the cables surrounding the initial transition joint.

Diagram 1: The 1 pointer indicates the location of the transition joint that first failed tripping the Remuera 11kV power cable located in the cable trench near T11.

Elimination of Other Possible Causes

The Fire Investigation Team investigated the entire length of the cable. The UK cable expert removed the fire damaged cables for a closer inspection in a workshop established close to the scene. Some of the cables were also taken to the UK where the cable expert continued the investigation. Vector also sent their engineers to the UK to join the cable investigation.

A report from the cable expert confirmed the fault had occurred in the transition joint on the 11kv cable at the point of origin where the initial ignition occurred. A more detailed report of the failure of the transition report will be produced by the UK Cable expert.
Report Approvals

Investigation and report completed by:

Investigator

Name: [Redacted]
Job Title: Fire Risk Management Officer
26 May 2015 03:08p.m.

Everything in this statement is true to the best of my knowledge and belief, and I made the statement knowing that it might be admitted as evidence for the purposes of the standard committal or at a committal hearing and that I could be prosecuted for perjury if the statement is known by me to be false and is intended by me to mislead.

A technical review of this report has been completed by:

[Redacted]
Job Title: Manager Fire Investigation & Arson Reduction
11 August 2015 03:59PM

This report has been approved by:

Name: [Redacted]
Job Title: Area Manager, Auckland City
Date: 11 August 2015 04:11PM

and complies with the New Zealand Fire Service Official Information Policy (POLCM2.).