Study Committee B1

Insulated Cables

Paper 11165_2022

# Developments towards a Risk Based Maintenance program to reduce fires at LV cable terminations and plastic enclosures


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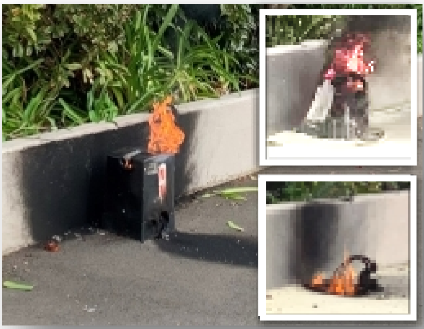
## Motivation

Every year, a small percentage (estimated at < 0.1%) of LV cables and pillars catch fire following an internal component failure. Most LV cable and fuse failures in pillars are a nuisance to the customer. However, a pillar fire may be a significant hazard to people, property, and reputation.

Even though the risk per pillar is low, the risk of the fleet can become high due to the high number of assets in this fleet and their proximity to residential and busy urban areas.



## Managing the risks

Failures of the pillar as a whole, or of one or more components inside, encompass a wide range of possibilities. Various triggers, causes and contributing factors include vehicle impact, moisture, undersized components and many more.

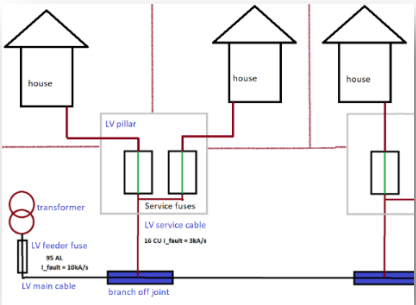
Understanding how failures might occur in the first place, and how these failures in turn can lead to a fire, are foundational to control this risk.

Consequences of a failures in the LV pillar fleet include electric shock due to unauthorized access to internal live components, damages to customer property, power outages, due to a fire of the pillar housing or an uncontrolled arc flash.

## LV underground Network configuration in NZ

Electricity customers connected to underground LV reticulation in New Zealand are typically fed from a network via a fuse inside an LV enclosure on the boundary of the road and the property.

The picture below shows a typical NZ residential LV network configuration including plastic LV pillars, which encloses the main service fuses for two or three dwellings.

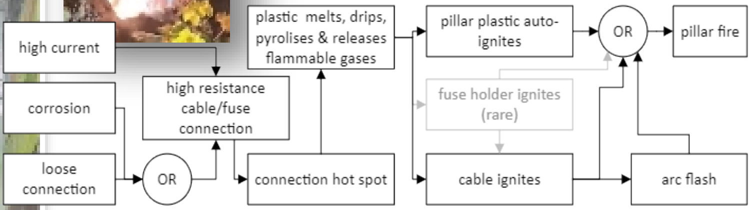



## Developing a RBM Strategy

The objective of the investigation was to collect information required to develop a risk-based maintenance strategy.

Developing and performing detailed inspections, failure investigations, lab testing, monitoring internal T & RH, and literature research has allowed us to better understand the main failure modes and the process of ignition of the plastic enclosures.

Future work includes consequence and risk analysis, selecting efficacious maintenance and renewal actions, and developing or applying fault detection techniques.

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## Case Study: fire at a plastic pillar

A fire occurred at an LV pillar which resulted in the complete destruction of the pillar, and property of the customer damaged. The figure below show a pillar before, during and after a fire.

Additional photos and videos had become available through members of the public that provided a wealth of information to conduct the failure investigation.

The result of this fire was fire damage to customer’s mailbox. Figure 2 below shows the remains of two similar style pillars, of different brands, after a fire.

## ‘Fault detecting’ smart meters

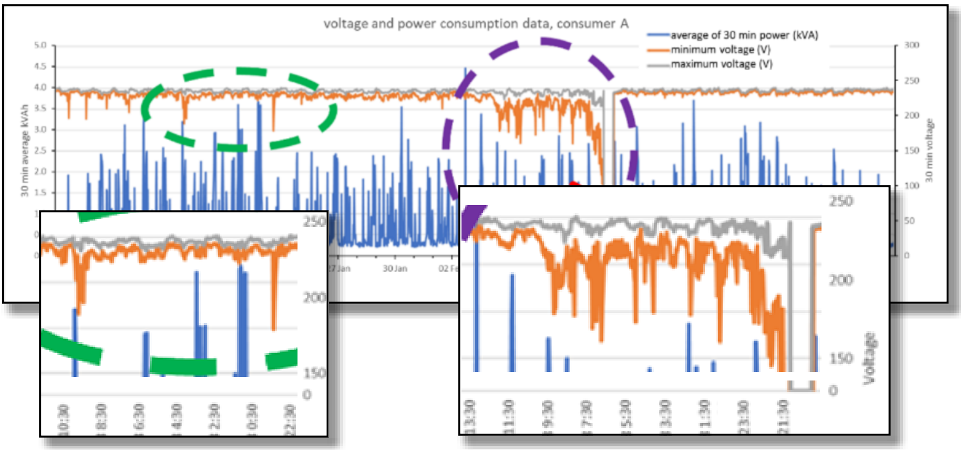
Smart meter data from the customers showed that poor power quality had preceded the event for weeks. voltage and current disturbance waveforms preceded the fault many weeks and days before the failure. These disturbances can even be detected in the data collected by the 30-minute intervals measured by the 'smart meters' installed in the NZ power network.

Disturbances in voltage may be useful as a diagnostic indicator. Fault monitoring equipment that detects 'temporary short-circuit transients in a real grid' as explored by [5] or Power Quality Meters as employed by [6] could provide diagnostics to detect these defects on LV cable circuits.

## Fault investigation result

The clip showed that a short circuit occurred while the fire was in progress, and the power stayed on for more than 2 seconds. This indicates that the short-circuit was the effect of the fire, not the cause.

Analysis of the video and photos taken of the fault event indicates that a sustained arc event can be triggered by a fire occurring at a pillar. The fire in turn could be the result of a fault of a component inside a pillar.



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## Examples of fuse 'burn ups'

Hot connections on the fuse holder can damage both the fuse holder, the connected cables and the pillar housing.

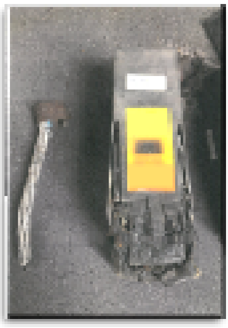
Electrical arcing or an open flame may also be a cause, contributing factor or effect of such overheating.

Signs of overheating due to a 'hot connection' include among others A) melted and deformed plastic, B) signs of pyrolysis (incomplete combustion) such as blackening, soot and brittle of the cable insulation & fuse holder, and C) signs of high temperature corrosion.

## Corroded fuse holder connections

The figures above shows an example of a fairly new fuse holder melted and charred electrical cable inside a pillar.

The figures below example of aluminium cable conductor of which the insulation has charred off (left), the heat damaged fuse holder base and insert (right) note the grub screw and part of the connection plate still connected to the conductor



## Finding fuse 'burn ups'

Fuse burn ups are typically found by customers calling with power quality complaints, such as flickering lights. The fault rate is estimated to be in the order of 1% per year.

LV pillars are externally inspected on a 5-yearly cycle. Newly developed inspections of the pillar internals were performed on 50 pillars near 5 different locations were a 'pillar fire' had occurred. These yielded only 2 pillars with slight indications of possible defects.


## Thermal scan of a hot connection

The newly developed internal inspections includes a thermal scan of the pillar components. The pictures below shows an example where a hotspot is evident on one of the fuse holders: 48.5°C is evident at one end of the fuse holder, while the pillar body is at 25.3 °C.

## Conclusion

Scheduled external and internal inspections do not seem efficacious to detect hot fuses that could start a fire.

Internal inspections after a call-out to fix power quality does provide quality information to inform an failure analysis.