Life On-Line:

Lichen Growth and its Impact on Insulators

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Background and Objectives

Background

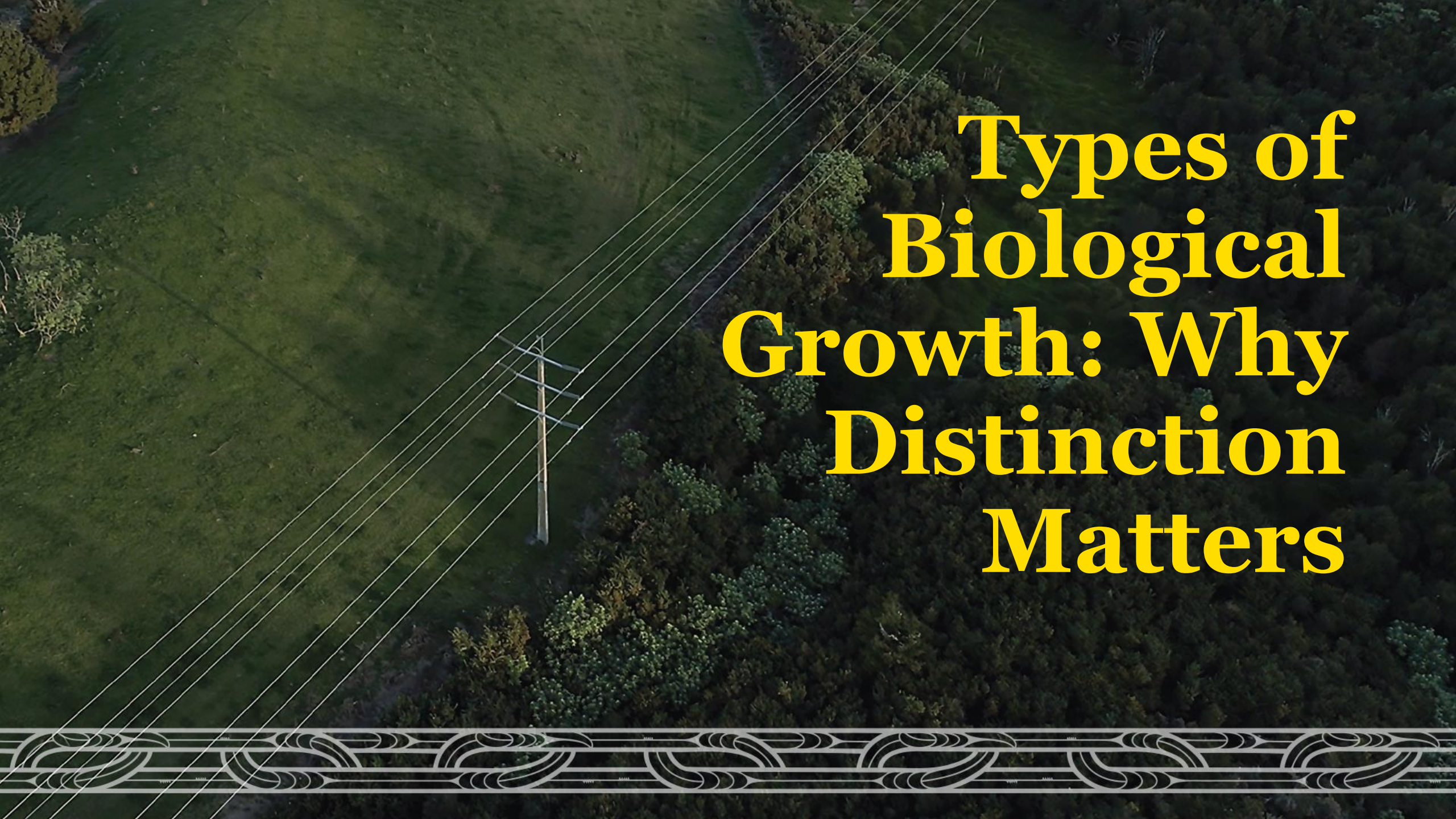
- Biological growth on insulators is common and reported worldwide
- Impacts differ depending on type of growth, insulator, and environment

Our case:

- Significant lichen growth observed on some of our polymer insulators
- Lichen growth to this degree is not well documented
- Available documentation generally infers minimal risk
- Concerns raised over potential impact to insulator performance

Objectives

- Differentiate between lichen and other types of biological growth
- Highlight environmental factors promoting lichen growth
- Analyse our lichen-covered insulator samples and sites
- Confirm whether lichen growth affects insulator structural integrity
- Determine whether lichen growth affects electrical performance
- Assess implications for operation at different voltages
- Present findings and make some very bold claims!



Types of Biological Growth: Why Distinction Matters

Fungi

- Multicellular organisms composed of long, thread-like filaments
- Feed on organic additives and fillers
- Can secrete enzymes and acids
- Limited penetration observed in Silicone
- Unlikely to cause severe degradation of Silicone material
- Impact on insulator performance is low

Algae

- Photosynthetic organisms requiring light and constant moisture
- Feed on organic carbon
- Strong evidence of:
  - Degradation of Silicone material
  - Reduced flashover voltage
  - Increased leakage current
- Impact on insulator performance is high

Lichen (Focus of this study)

- Symbiotic organism (fungi + algae)
- Fungi take nutrients from algae, algae take water from fungi
- Slow growing with shallow roots in Silicone surface material
- Limited evidence of Silicone material degradation
- Limited evidence of impact to electrical performance

Environmental Drivers for Lichen Growth

- High humidity
- Frequent wet-dry cycles
- Clean air
- Partially shaded
- Moderate temperature
- Northland area is perfect for lichen growth!

Site and Insulator Description

Site Description

- Lichen observed on insulators on WPA-WRR 33kV circuits
- Line is built to 110kV standards but only operated at 33kV
- Site is located in Waipapa, Northland
- Waipapa is a mostly industrial area near Kerikeri
- Most environmental drivers for lichen growth met
- Doubts over air quality, but generally good

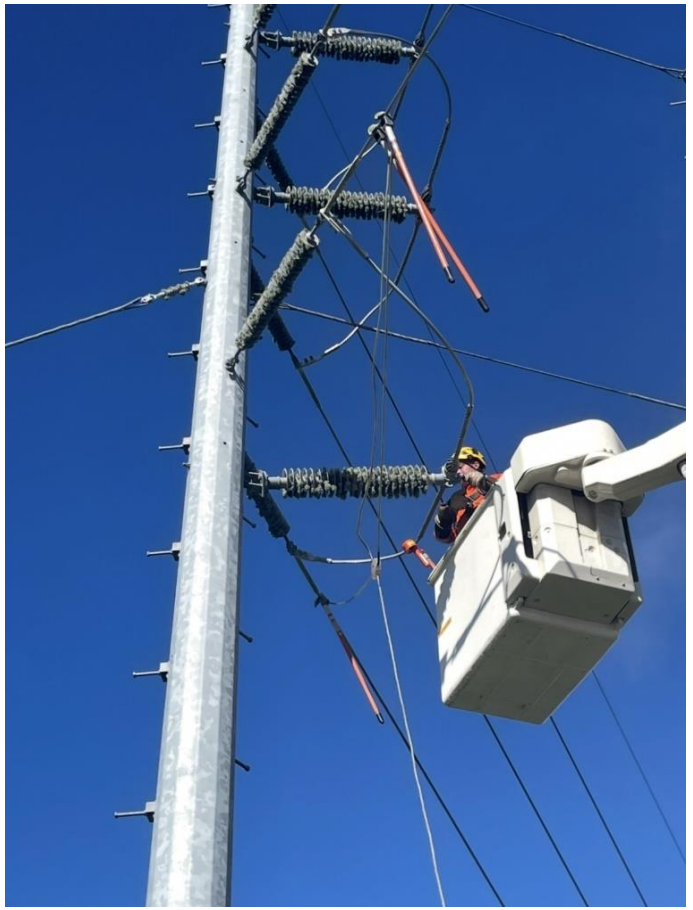
Insulator Description

- 110kV composite line post (HTV Silicone rubber housing)
- Operated at 33kV
- Installed in 2005, ~21 years in service
- Approaching end of life
- Significant lichen growth observed

Testing and Results

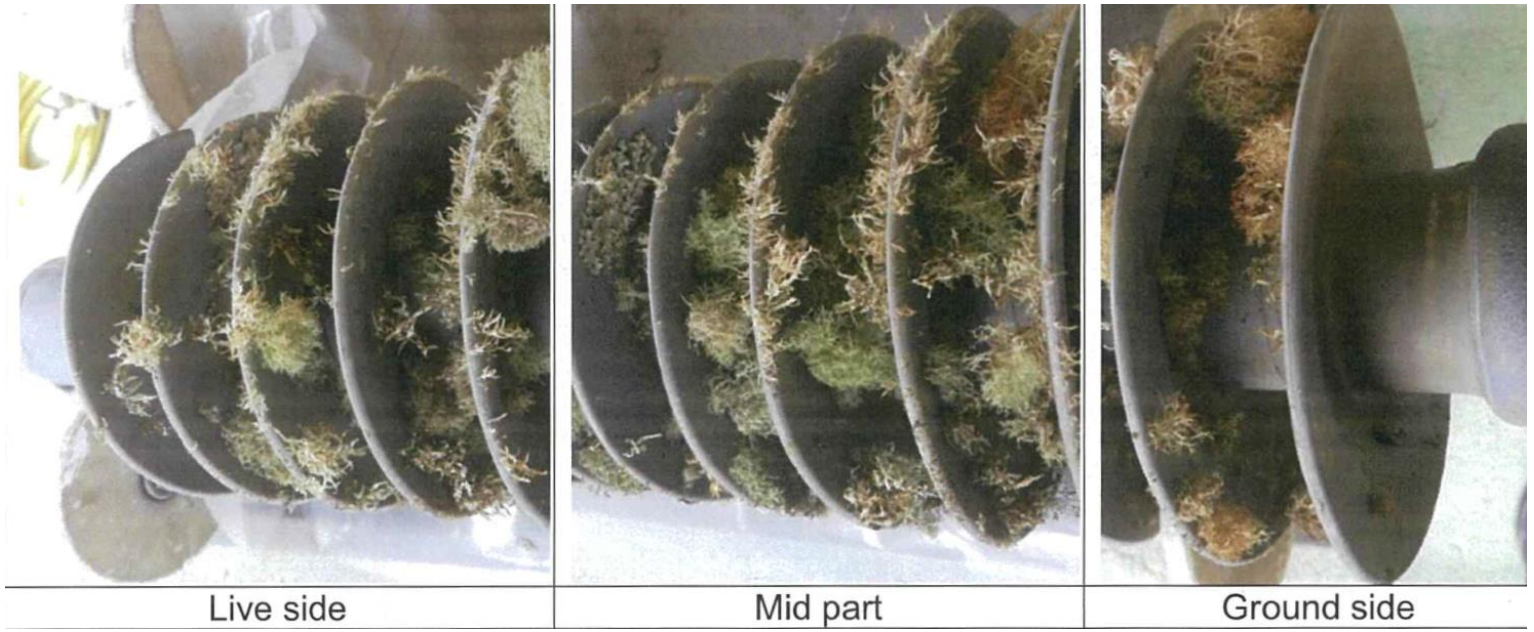
Test Overview

- Two identical insulators removed from the same site
- One sent to manufacturer for physical and chemical analysis at their laboratory
- Another sent for dedicated electrical performance testing at our store



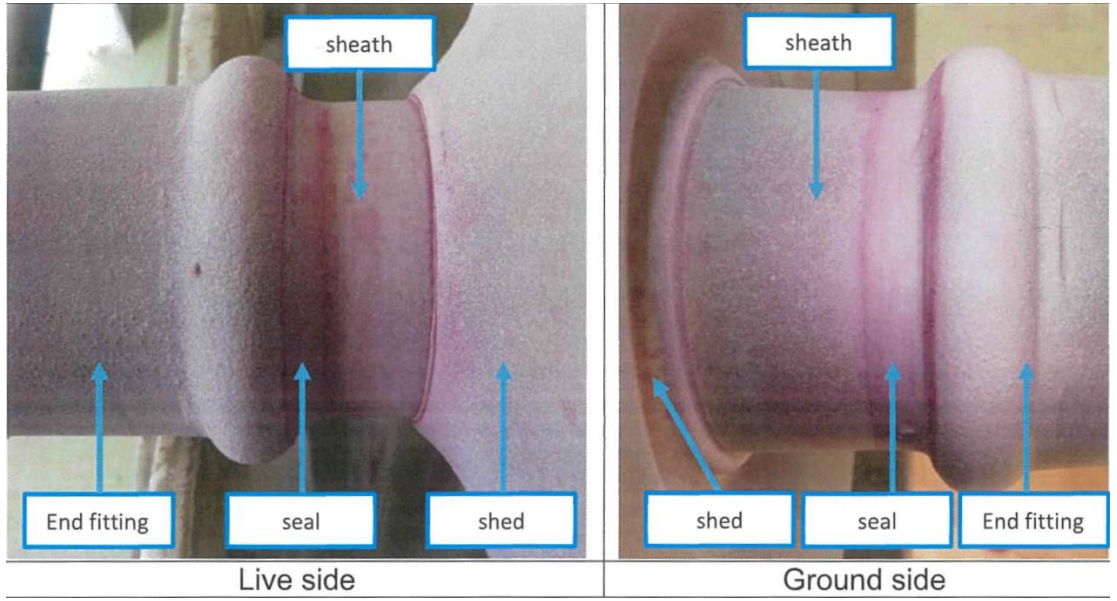
Visual Observations

- Continuous biological growth observed along entire Silicone body
- No trace of degradation, erosion, electrical activity, or debonding of the Silicone



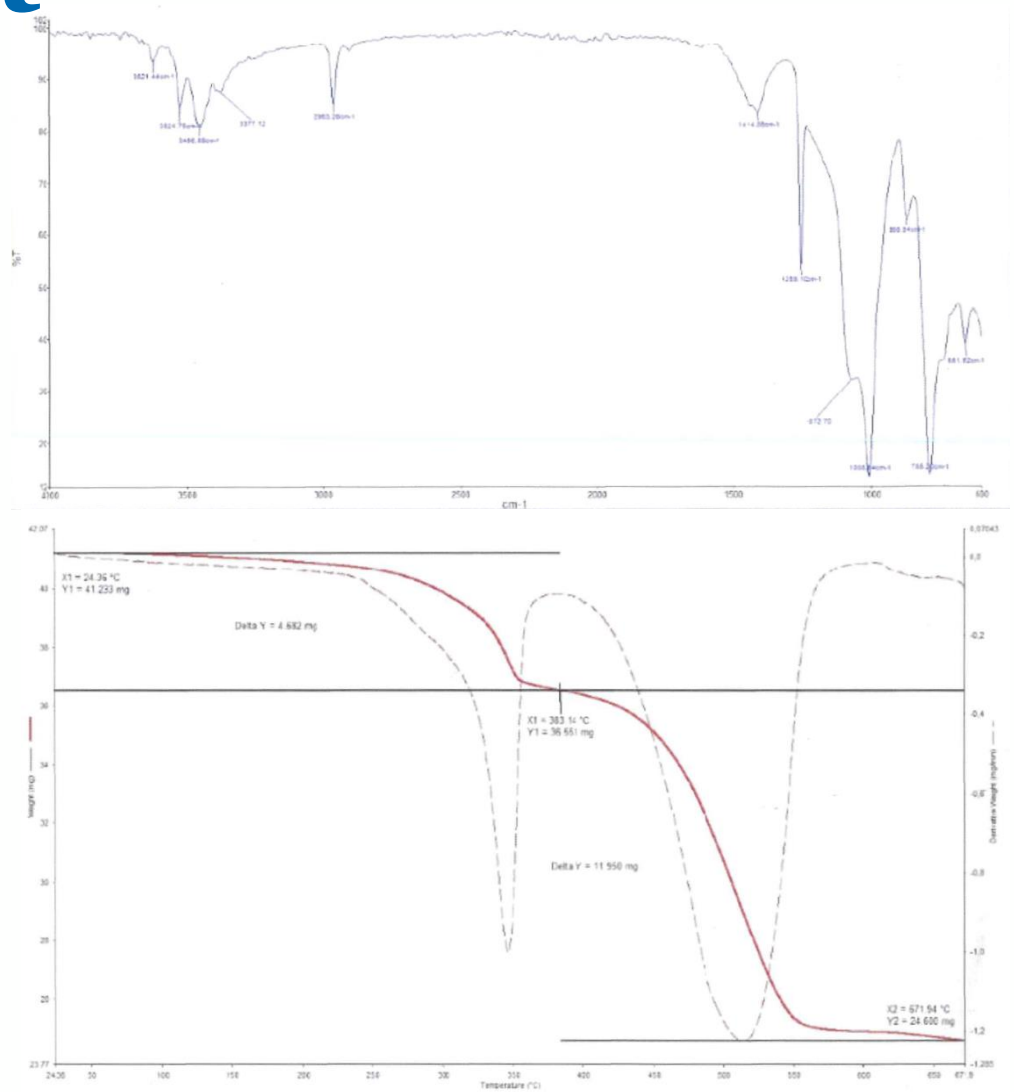
Fitting Tightness

- Dye penetration used on both ends of insulator
- Very light de-bonding of the edges of the seals and sheds
- Deteriorations are superficial
- Consistent with normal ageing



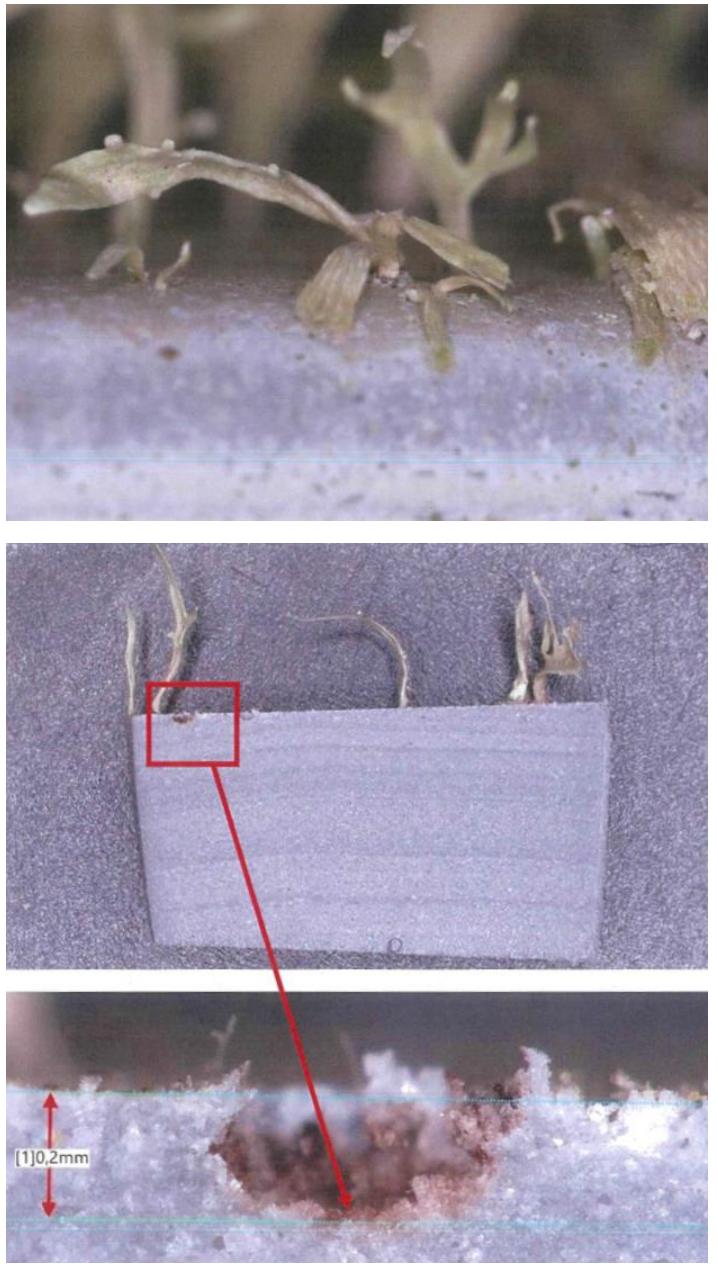
Silicone Fingerprint

- Fourier Transform Infrared spectrum and Automated Thermogravimetry analysis confirms material is HTV silicone rubber with ~68% ATH filler
- Shore A hardness is ~50±5 (within expected range)
- Density is ~1.625g/cm^3 (consistent with new material)



Silicone Ageing

- Lichen embedded via roots in Silicone surface
- Root penetration depth limited to ~0.2 mm
- No propagation into bulk silicone
- Hydrophobicity loss is minimal and localised to root pores

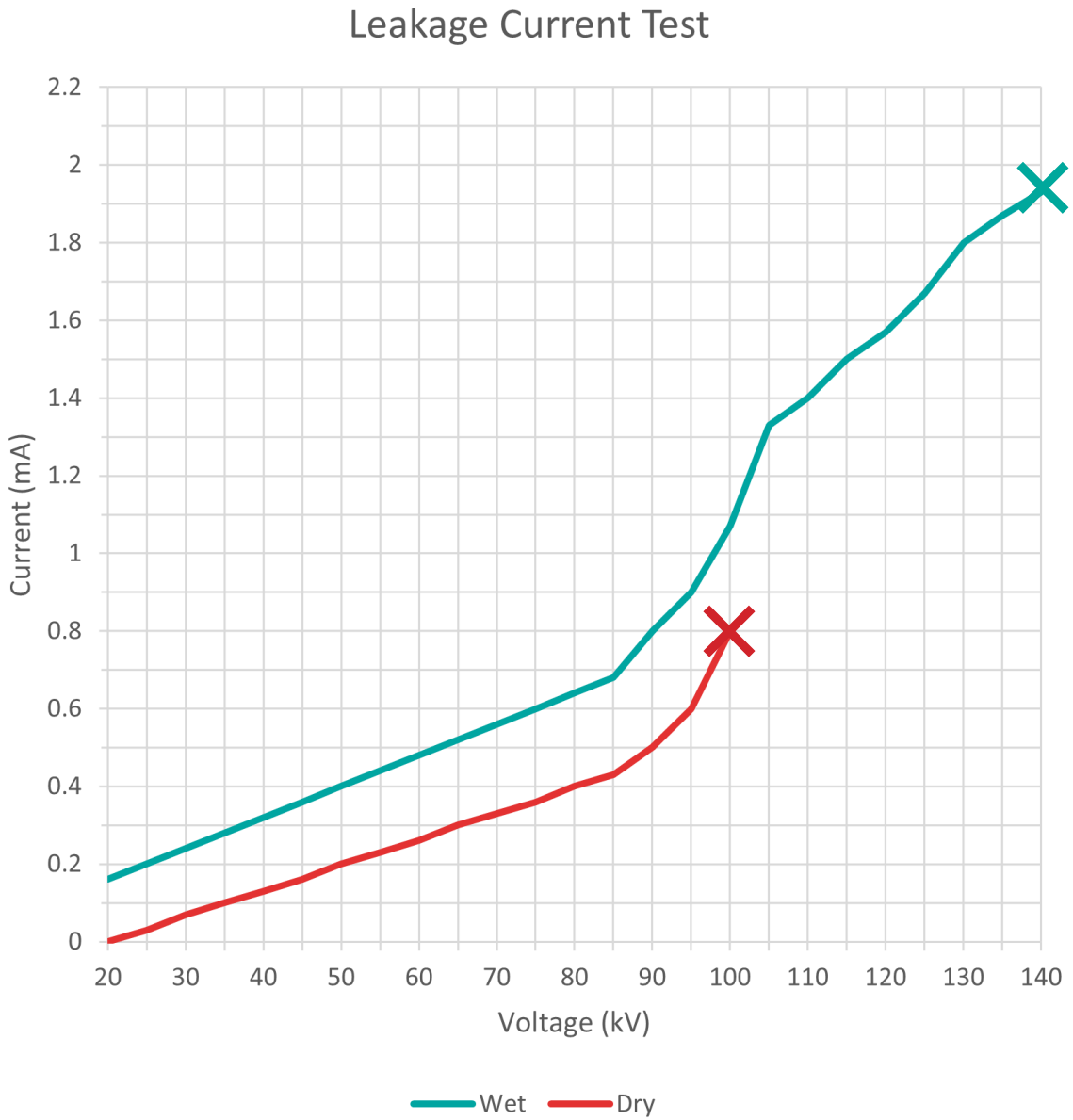


Flashover Voltage

- Flashover voltage test performed under dry and wet conditions
- Voltage increased from 20kV to 140kV (equipment limit)
- No electrical flashover occurred in any test

Leakage Current

- Leakage current measured under dry and wet conditions
- Voltage increased from 20kV to 140kV (equipment limit)
- Dry test aborted at 100kV due to noticeable lichen destruction
- Dry: ~0.8mA at 100kV
- Wet: ~1.9mA at 140kV
- Results consistent with clean insulators



Performance Assessment

- No trace of degradation, erosion, electrical activity, or debonding of the Silicone
- Lichen-induced degradation is superficial and does not compromise bulk dielectric material
- Potential minor hydrophobicity loss observed at lichen root sites only
- No detected electrical performance loss in dry or wet conditions
- At 33kV operation, the 110kV-rated insulators retain substantial performance margins
- There are no obvious significant risks attributed to the lichen growth in this particular application

The Implications: Where to from here?

Hypothesis

- Insulators are rated for 110kV, but operate at 33kV
- The observed voltage drop (~19kV) is lower than normal, and distributed over a larger surface area than normal
- It is hypothesised that the unusually significant lichen growth may be due to the reduced voltage stress across the insulator surface
- If this is correct, higher operating voltages may limit or potentially reverse lichen growth
- This might also explain the observed destruction of lichen growth during the dry testing at ~100kV
- To test this theory, a second site was selected for comparison

Site 2 Description

- Site is located in a rural area North of Kaikohe, Northland
- Lichen observed on insulators on multiple structures in the area
- Structures contain one circuit operating at 110kV, and the other at 33kV
- Identical 110kV-rated Silicone insulators and equipment used on 110kV and 33kV sides
- All equipment installed in 2011, ~15 years in service

- **What did we find??**

Site 2 Findings

- Significantly more lichen growth observed on 33kV side
- It is hypothesised that lichen growth on Silicone insulators is limited when operated at higher voltages
- It may also be true that lichen growth is destroyed above an specific voltage threshold
- More testing and monitoring over time will be required to confirm this

Key Conclusions

- Lichen growth appears to thrive in lower voltage environments, while being limited in higher voltage applications, although more testing is required to confirm this
- Besides minor hydrophobicity loss, lichen growth is unlikely to cause severe degradation of Silicone insulators
- Even significant lichen growth does not appear to affect the electrical performance of Silicone insulators
- There are no obvious significant risks attributed to the lichen growth in these particular applications

References

- D. Lepley, “Investigation on a 110kV composite insulator returned from New Zealand / Line LT WPA-WRR1,” Sediver Research Centre, Saint-Yorre, France, Nov. 2023.
- INMR. “Biological Growths on Composite Insulators.” INMR. https://www.inmr.com/biological-growths-on-composite-insulators/ (accessed May. 5, 2026)
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Questions?

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