Chemeca 2016
Design and Operation of High Voltage R&D Test Facility for Bushfire Mitigation Technologies

Blake Stewart, Process Engineer at HRLTG
The Project:
PBSP REFCL Technologies

HRL Technology Group (HRLTG) was contracted by the Victorian Government to assist with several activities required to complete their Network Assets Project. This project required power distribution businesses to install new network technologies that will better control the faults in Victorian networks, which may cause fires. HRLTG was involved with several critical studies throughout the project including:

• Ground Fault Trials at Frankston South Zone Sub Station in 2014
• Vegetation Fault Trials at Springvale West Zone Sub Station in 2015
• REFCL Field Trials at Kilmore South Zone Sub Station in 2015
PBSP REFCL Technologies

About the program

• Genesis of program and projects
  – 2009 Victorian Bushfire Royal Commission and subsequent recommendations
  – 2011 Powerline Bushfire Safety Program (PBSP) was established\[1\]
  – PBSP initiated several projects, one being REFCL Technologies Trials

• HRLTG worked in a multi-disciplinary team to perform the following research activities as part of the REFCL trials:
  – Experimental program to assess the probability of bushfire ignition from electric arc faults
  – Field trials to assess the effectiveness of protection equipment to reduce bushfire ignition risks from:
    • Wire on ground faults on an actual network
    • Vegetation faults on an actual network
  – Field trials to demonstrate the findings
PBSP REFCL Technologies

• Rapid Earth Fault Current Limiter
  – REFCLs can detect phase-to-earth faults. They then cancel the voltage on the fault within milliseconds of detecting it[2.]
  – With modifications could they limit the voltage of the fault to below the point where it can start a fire
  – Multi-wire powerlines make up about two thirds of all rural powerlines so an improvement to bushfire safety for these powerlines would be significant[3.]
REFCL’s in action

• What REFCL’s do\textsuperscript{[2.]}

Detect the fault, ascertain which phase is carrying the fault, compensate residual current (drop voltage close to zero), test if the fault still exists, identify which feeder the fault is on
Frankston Field Trials

- Initiating Ground Fault Ignitions
  - Specifically designed and built HV test facility
  - Located adjacent to UE ZSS in Frankston South
Frankston Field Trials

‘Wire on Ground’ Bushfire Ignition Probability Testing

- Impact velocity
- Soil and Grass Conditioning
- Bounce height
Springvale Vegetation Testing

Vegetation Conduction ‘Branch Touching Wire’ Bushfire Ignition Probability Testing

– Specifically designed and built HV test facility
– Located within UE ZSS in Springvale West
Springvale Vegetation Testing

Test rig designed to replicate a tree branch contacting a live conductor

Ignition probability impacted by:

- Species
- Moisture content
- Branch diameter
- Wind
Trials performed on a live network in Kilmore South to demonstrate REFCL performance

- Both ground fault and vegetation conduction
Safety Challenges - HV Facility

Performing R&D testing using HV equipment on a live network introduced a number of safety and operational challenges.

- Safety was the highest priority throughout all stages of the project.
- Multiple layers of protection were built into each process.
Safety Challenges - HV Facility

- Both test spaces relied heavily on pneumatically driven pistons and an interlocking system
- An interlock on the entry door meant that the door could not be opened until entry was safe
- The final layer of protection was the use of earthing sticks, contact and non-contact voltage testers, PPE and Electrical Access Permit’s
- Other safety measures included the design and installation of a suitable earth grid
- All equipment and structures were earthed and connected to the local earth grid at multiple locations
- Radio transmitted surveillance cameras provided a live feed of the test facility
- Software and hardware protection systems were utilised
- All supported by stringent procedures
Other Safety Challenges

Apart from high voltage hazards there were risks associated with:

- Fires and hot surfaces, smoke, manual handing, hot atmosphere, cold atmosphere, insects, wildlife, automated equipment, trip hazards, low voltage electricity, high pressure, lighting, noise
- These hazards were managed through the production and review of JSEA’s and SOP’s as well as mandatory daily safety meetings

Unblemished safety record was maintained throughout all trials!
Safety – Lessons Learned

• Where possible install interlocks
  – Make them visible (especially software/programed interlocks)
  – Belt and braces

• Be thorough before design/commissioning
  – Complete SOP’s, JSEA’s, etc. and review them as the design evolves
  – Use experts

• Procedures and PPE are a last line of defence
What was Achieved

• Effective completion of all objectives
  – Thousands of tests
  – Over several years
  – At multiple locations

• Outcomes allowed the Victorian Government to develop performance standards for REFCL’s with the aim of significantly reducing the risk of bushfire ignitions from powerlines

• The performance standards were included in the Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016[^4] which were enacted on 1 May 2016
References


Acknowledgements

HRLTG would like to acknowledge the Victorian Government who financed the Network Asset Project through various departments and agencies including the Department of Economic Development, Jobs, Transport and Resources (DEDJTR), Powerline Bushfire Safety Taskforce (PBST) and Powerline Bushfire Safety Program (PBSP). We would also like to acknowledge Energy Safe Victoria (ESV) for funding the initial risk assessment projects prior to the REFCL field trials. We would like to thank Tony Marxsen from Marxsen Consulting for his leadership and expertise. Finally we would like to thank the various Distribution Businesses who assisted with the design, commissioning and operation of the HV R&D test facility.