An Introduction To Rapid Earth Fault Current Limiters (REFCL) & Ground Fault Neutralisers (GFN)

APEX Summit 2018
August 17, 2018
Akshay Dogra

Beca

State of Emergency in Victoria

"24 hours of terrifying through the eyes of those who were there, the witnesses caught inside the firestorm that would re-write history and change all the rules" - ABC

"The situation is very, very serious. This state has never been in a more dangerous situation in the last 30,000 years. We are sitting, truly, on a little pile of gun powder and smoking cigarettes" - CNN

Beca

Presentation Overview

- What is a Rapid Earth Fault Current Limiters (REFCL)?
- Why is REFCL technology being used
- Explanation of GFN
- Earthing History
- Conclusions

What is a REFCL?

- A Rapid Earth Fault Current Limiter (REFCL) is a electricity network protection device that responds to earth faults.
- A REFCL detects and cuts the energy flow within milliseconds on the phase (line), thus reducing the possibility of a fire being started.
- It uses the remaining two phases on the powerline to maintain a continuous power flow, thus ensuring that no customer's power supply is interrupted.

What is a REFCL?

Why is REFCL Technology Being Used?

- REFCL technology was originally developed in Europe for reliability benefits.
- However, in Victoria it is utilised as a potential technology to further prevent bushfires.
- Existing electricity network protection devices in Victoria can take up to half a second to cut power supply in the event of earth faults, which can be long enough for a fire ignition in very dry conditions.

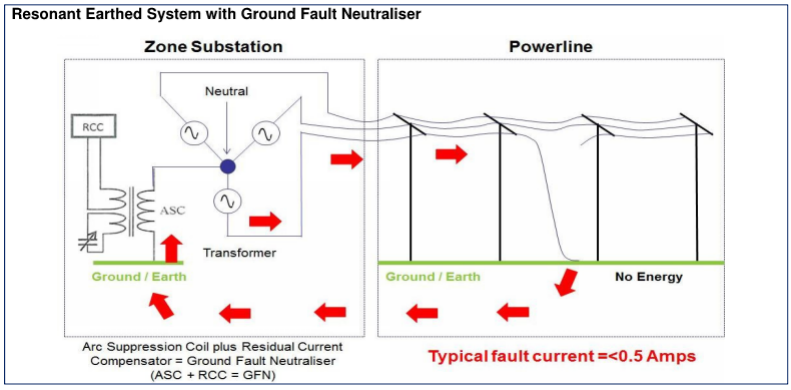
Why is REFCL Technology Being Used?

- The type of REFCL considered optimal for this task is Ground Fault Neutraliser.
- First Testing for GFN installation were done at United Energy's Frankston South Zone Substation in 2014 and again in 2015 at AusNet Services Kilmore South Zone Substation.

Beca

How A Ground Fault Neutraliser works

- A GFN is a type of a REFCL technology that detects and limits powerline-to-earth faults via devices installed at zone substations.



Source: REFCL Bushfire Prevention, AusNet Services

Beca

How A Ground Fault Neutraliser works

These two images were taken from ultra-slow motion video of the Kilmore South trial. The image above shows that on GFN-protected powerlines, there was a clear absence of high energy arcs, with current falling from 15 amps to near zero within 70 milliseconds.

By comparison, as the image above illustrates, tests with powerlines protected by existing equipment ('neutral earth resistor') showed that, within 0.9 of a second, sufficient current would be flowing into the ground to cause intense ignition of very dry vegetation. This protection equipment would not have detected the fault until 1.5 seconds had lapsed.

Source: REFCL Bushfire Prevention, AusNet Services

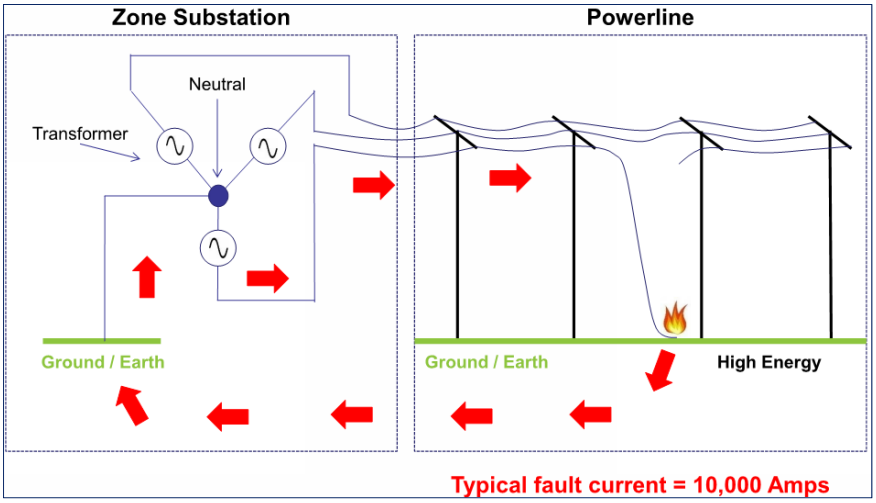
Beca

Earthing History

- So today we will be looking at 4 different types Earthing schemes and their effectiveness in the network.
  - Solid Systems
  - Resistive Systems
  - Resonant Systems – ASC
  - Resonant Systems – GFN

Beca

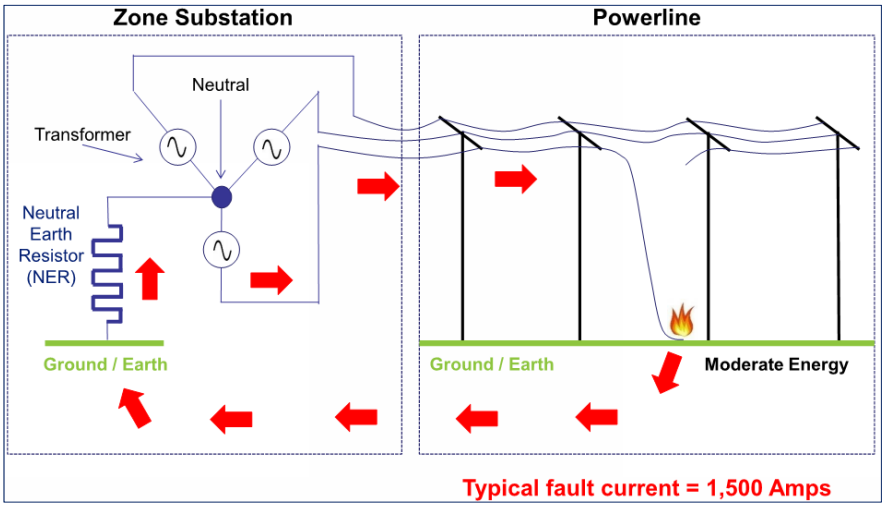
Solid Systems



Source: REFCL Bushfire Prevention, AusNet Services

beca

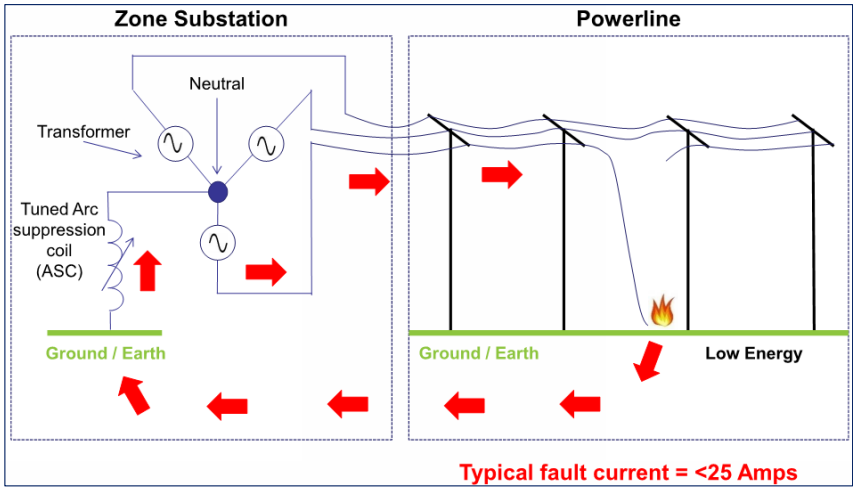
Resistive System



Source: REFCL Bushfire Prevention, AusNet Services

beca

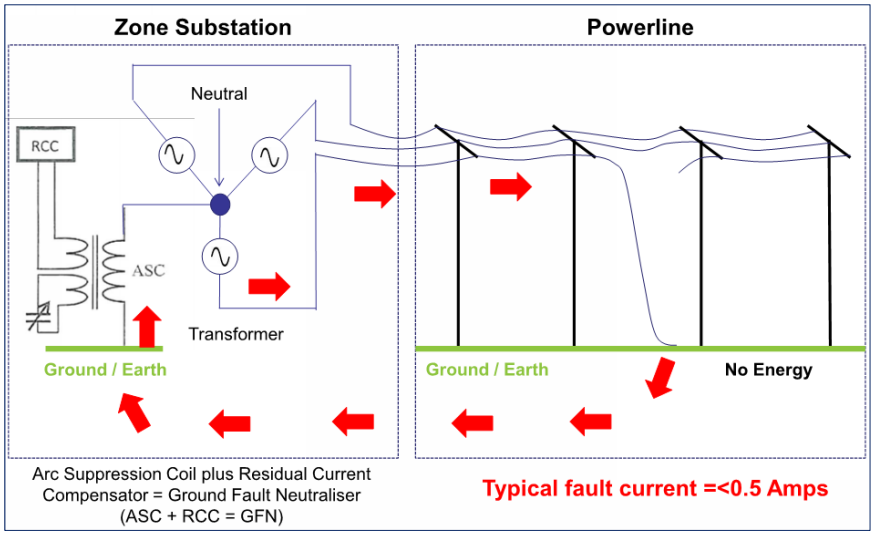
Resonant Systems - ASC



Source: REFCL Bushfire Prevention, AusNet Services

Beca

Resonant Systems - GFN



Source: REFCL Bushfire Prevention, AusNet Services

Beca

Earthing History

Earthing Scheme	Fault Current	Fault Relieve	Pros	Cons
Solid Systems	10kA	0.1 – 1 sec	• Functionality irrespective of network size • Low over voltages in fault free phases	• Very large faults • Disconnection of customers • EPR rises • High fire & personal hazard
Resistive System	1.5kA	0.1 – 1 sec	• Functionality irrespective of network size • Reduced over voltages in fault free phases • Directional measurement facilitated.	• Large fault currents • Disconnection of customers • EPR rises • High fire & personal hazard
Resonant System -ASC	25A	1.0 sec	• Reduced fault currents • Less EPR rises • Less fire hazard • System can temporarily be operated with earth fault	• Optimisation & tuning required depending on the network size. • Unbalance may cause high dissymmetry voltages. • Transient over-voltages and re-striking in cable networks • Fault site difficult to find due to lower fault currents.
Resonant System - GFN	<50mA	< 60 – 70msec	• Fast fault current elimination. • System can be operated in faulty conditions. • Customers must not be disconnected. • Less fire & personal hazard.	• Optimisation & tuning required depending on the network size. • Unbalance may cause high dissymmetry voltages. • Fault site difficult to find due to less power release.

Beca

Conclusion

- Implementation of REFCL & GFN throughout Victoria's distribution substations.
- How does a GFN work.
- Four different types of earthing schemes- solid, resistive, ASC & GFN.
- Pros & cons for each schemes

Beca

Questions

Beca