Implications of Arc Flash Estimator Tool

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EEA - Health and Safety Workshop – 19th October 2016

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In the beginning ….

there was an EEA Guide

and it had both "targets!" and a "deadline!"

(CC) Sebastian Ritter

Initial Response – Arc Flash 1.0

Operational restrictions introduced : de-energisation > 400 kVA
Blanket PPE requirements at and below 400kVA

Problematic operationally:
- Conservative for larger transformers
- PPE centred for smaller transformers.
- Hard to justify, inconsistent and perceived as unreasonable.
- Seen as an imposition and not owned by field staff.

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Arc Flash 2.0

A new approach was required based on site specific details, so that that the AFH could be managed appropriately: assessed, avoided and minimised.

Development, in early 2015, of the Arc Flash Estimator project.

The key objective was to make arc flash hazard assessments routine, widespread and a necessary part of safety policy and procedures.

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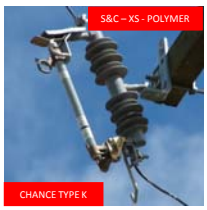
LV Arc Flash Hazards

Critical factors that effect the LV Arc Flash Hazard:

- HV and LV fuse sizes
- HV and LV fuse types
- Transformer Rating
- Transformer Impedance
- Feeder and system impedance
- Transformer and LV board design

These factors must be known so that the hazard can be quantified and manage appropriately.

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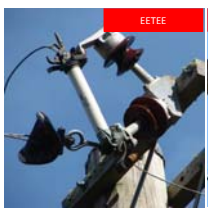
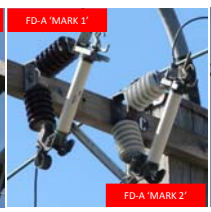
Arc Flash Estimator Project

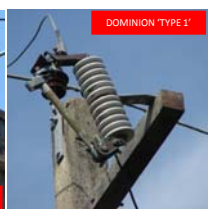
GIS data:

- Geographical (transformer & feeder circuit XY)
- Transformer data and impedance (where known)

Feeder impedances profiled and estimated
Historic practice and assets documented
Legacy fuse mounts and types named, documented and TCC curves gathered (≈200)







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The Arc Flash Estimator

An offline hazard assessment tool that uses Network asset and system data to estimate the arc incident energy (AIE) at or downstream from any new or existing distribution transformer

Available to Delta staff and contractors and can be used in the field with very little training.

Conservative assumptions made where fuse sizes or transformer impedances are unknown




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Examples

The following three examples of different 300kVA substations seek to demonstrate the functionality and utility of the AFE and the variability of the potential AFH:

Example	Substation Name	Voltage [kV]	HV Fault Level [kA]	Feeder Distance [km]
1	Sturdee St 24	6.6	18	0.1
2	Lovelock Gardens	6.6	6.2	2.2
4	GO108 (Glenorchy)	11	0.2	38

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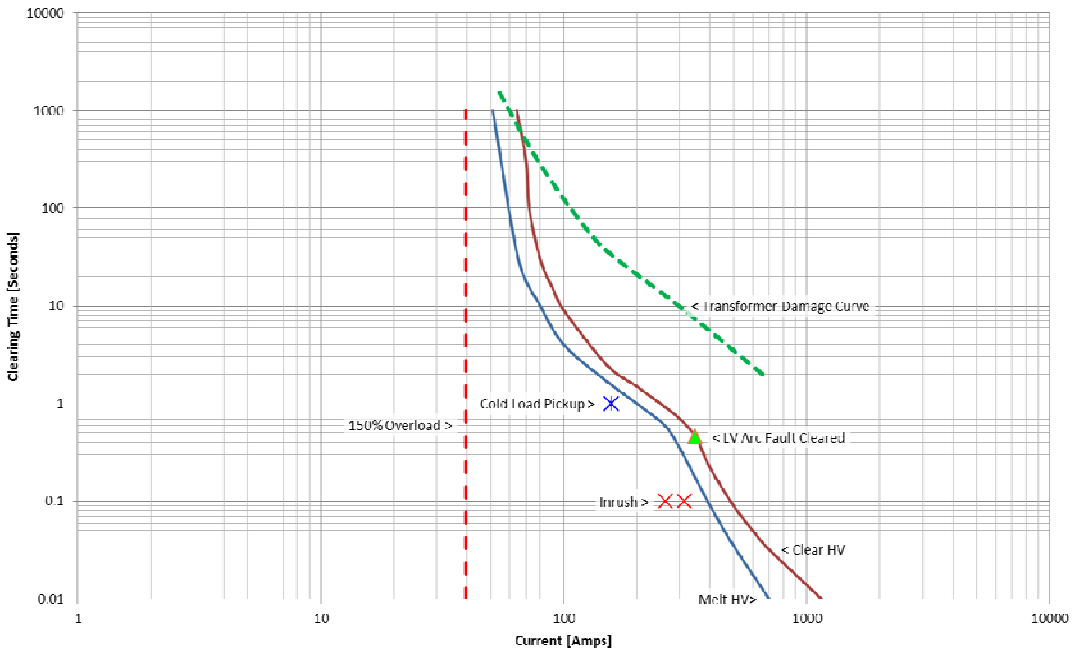
Stu

Dua

Rel

Pro

AFI



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Reducing Hazard – SFAIRP*

Using the AFE it can also quickly be seen that the potential incident energy could be reduced to below 3 J/cm^2 (0.8 cal/cm^2) with the installation of Safelink switchgear.

Given the additional cost to install switchgear it could be argued that the *minimum practicable operating time* has been achieved using the existing overhead fuses.

***S**o **F**ar **A**s **I**s **R**easonably **P**racticable

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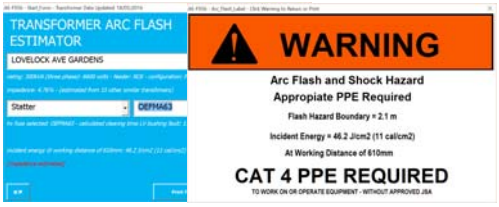
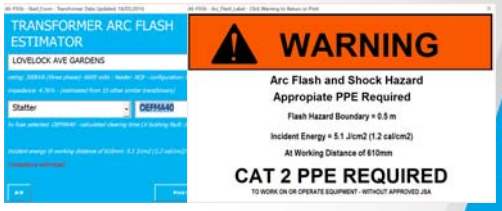
Lovelock Ave Gardens Substation (Old Assets / Oil Switchgear)

Installed in 1971
Operating Voltage 6.6kV
“Exposed Live Parts” – SM-EI MADS
Protected by existing 63A Oil Fuses
LV fuse sizes unknown

The AFE indicates that the HV fuses could be reduced to 40A and so reducing the AFH and incident energy level to around 5 J/cm^2 (1.2 cal/cm^2).





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Cromwell (New World) Substation (Group Fusing)

20 year old substation

Group fused @ 50A (300kVA + 200kVA) through SDAF3

Impedance not in GIS (statistical methods used)

Desk study indicated that De-energisation was required

Using actual impedance AIE reduced

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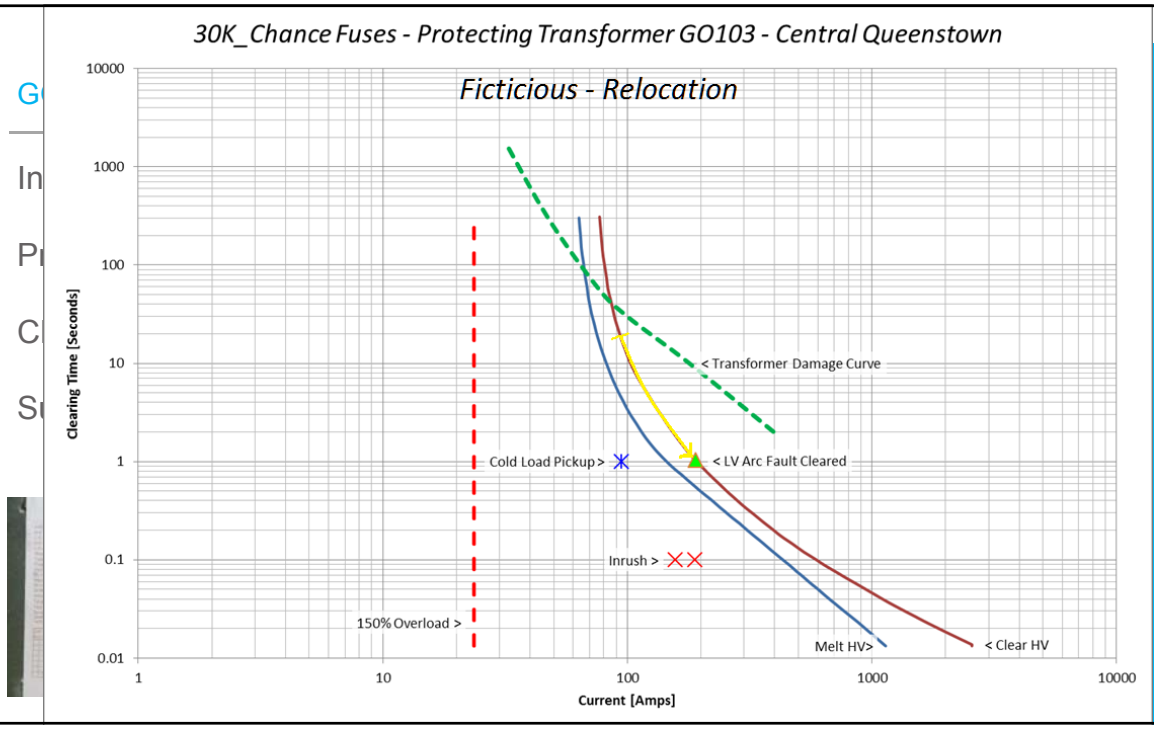

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Example Summary

	Existing Protection	AFH J/cm² (cal/cm²)	Alternative Protection	AFH J/cm² (cal/cm²)
Sturdee St 24	30A ELF	**21 (5)**	Safelink 40A	**3 (0.8)**
Lovelock Gardens	63A Oil	**40 (9.5)**	40 A Oil	**5 (1.2)**
GO103 (Glenorchy)	30 A Type K	**368 (88) X**	20 A Type K	**32 (7.7)**

Table 2: Assessment Example Summary – Existing/Alternative Protection

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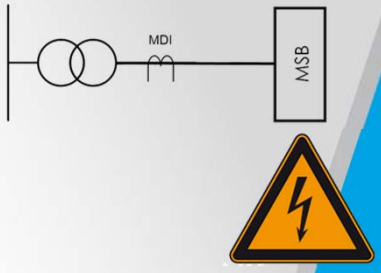
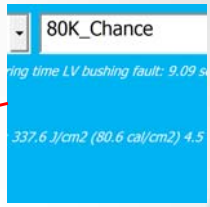
Example - Transferred AIE and AFH to Consumer

ORC Flood Pumps – Lake Waipori
6.6kV - 500kVA Transformer
Protected by 80A Chance Type K fuse links
Direct Bolted Connection to Consumer Main Switch
Very high AIE transferred to Consumer
Work with Consumer to manage the risks





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Variables and Variability

The examples demonstrate:

- Variability of AIE and the AFH
- Mitigation by changing or reducing fuses
- Sensitivity to:
  - transformer impedance
  - feeder length

Some distribution substations are inherently safer than others due to their design, fuses or location.

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Paper, Scissors, Rock!

discrimination

inrush

cost

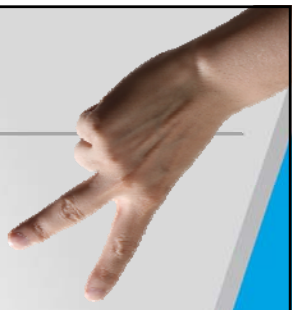
maloperation

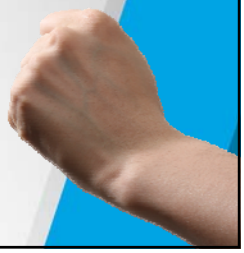
stock

cold load pick-up

overload

damage curves





"Minimum Practicable Operating Times"
SFAIRP

Brave New World

The AFE project has landed with the Health and Safety at Work Act.

ESR were open to interpretation and often ignored.

The HSWA appears to have teeth and has the attention of a high level audience in most companies.

The HSWA has reinforced key principles such as SFAIRP, ALARA and requires better practice and Safety in Design (SiD).

AFH assessments are more than mere incident energy level calculations, they are about real risks and what is possible or achievable within a given company.

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Implications of Arc Flash Estimator Tool

The AFE project has:

Created the framework for accessing Arc Flash Hazards

Has raised awareness and discussion

Empowered designers, field staff and system control to collaboratively manage risks

Has put a value on good record keeping and information

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Conclusion

The AFE answers the following questions:

- What is the AFH at or downstream of a transformer?
- What is the minimum practicable AFH achievable?

The AFE project is ongoing and iterative and has raised awareness and discussion.

We have now moved away from prescriptive practices and standards.

The AFE initiative has driven change and led to the first full distribution protection review since 1986.

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The End

"… knowing what you don't know"

Acknowledgments

Thanks should go to all those who have consistently asked difficult questions, demanded easy answers and so driven this process.

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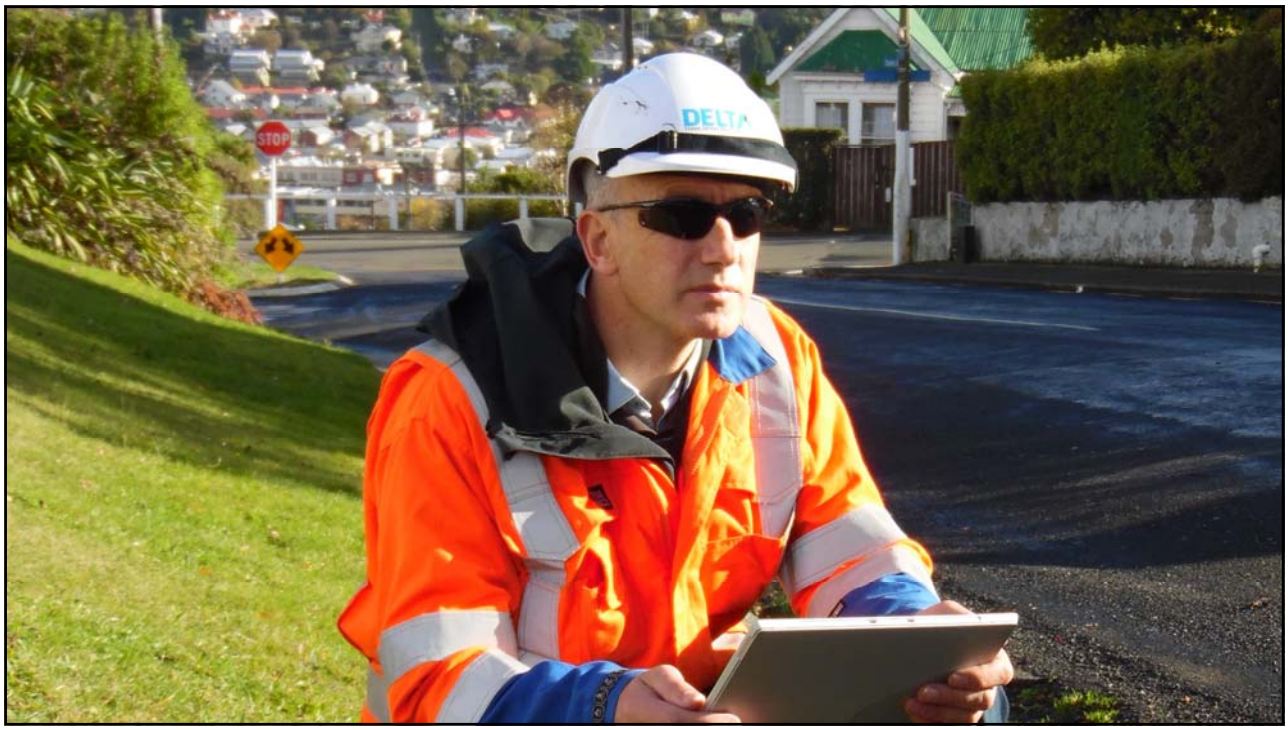
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