





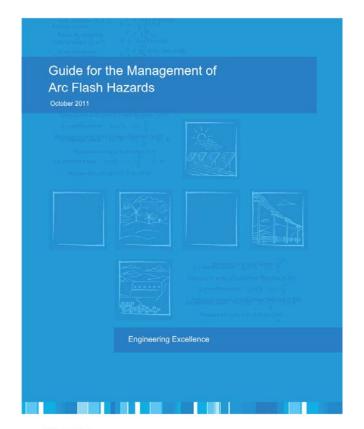






### **Guide Review**

- The original guide was published in 2011.
- It contained the first steps to continuing development.
- Being reviewed as part of a five-yearly cycle. Prioritised.











# Working Group

Representative	Organisation
Steve Macdonald (chair)	Orion
Stuart Banks	Mitton ElectroNet
Cosmin Cosma	Westpower
Yanosh Irani	Meridian Energy
Glen Busby	RPS
Brian Ultee	Contact Energy
Graeme Johnson	Aurora
Dave Hammond	PowerCo
Andrew McMahon	Transpower
Ian Stedall	Genesis Energy
Gilbert Zieleman	ABB







## Aim

Improve the understanding of, and the ability to manage arc flash hazards for everyone within the wider Electrical Supply Industry.







## Legislation, Standards and Guidelines

- New Zealand:
  - H&S Act and Regulations
  - Electricity Act
  - EEA Safety in Design Guide
- North America:
  - IEEE 1584 AF Calculations
  - National Fire Protection (NFPA 70E) PPE and tables method
  - The National Electrical Safety Code (NESC) Tables method





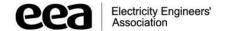


### **Technical Content**

The guide has been prepared under four main parts:

- 1. Arc Flash Knowledge
- 2. Engineering Analysis
- 3. Risk Assessments
- 4. Mitigation of Hazard

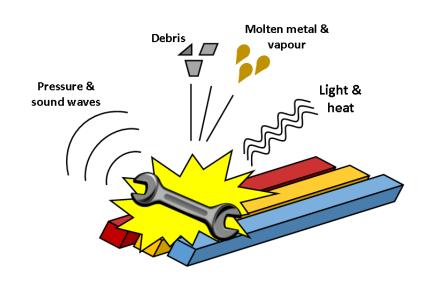






## 1. Arc Flash Knowledge

- Background appreciation.
- Goal to get people to stop, think and consider alternative ways of completing tasks.
- Contributing factors.
- Consequence of exposure.
- Pass on the knowledge.









# 2. Analysis

- Gathering data.
- Calculation methods.
- Incident energy levels (cal/cm<sup>2</sup>) & arc flash boundaries.









#### Varying Methods

- IEEE 1584 (empirical)
- Doughty Neal (empirical)
- Ralph Lee (theoretical)
- Dan Doan (theoretical)
- Table methods
  - NFPA 70E
  - NESC

- Collect the system and installation data
  - Determine the system modes of operation
- Determine the bolted fault currents
- Determine the arc fault currents
- •Find the **protective device** characteristics and the duration of the arcs
- Document the system voltages and classes of equipment
- Select the working distances
- •Determine the **incident energy** for all equipment
  - Determine the **arc flash-protection boundary** for all equipment

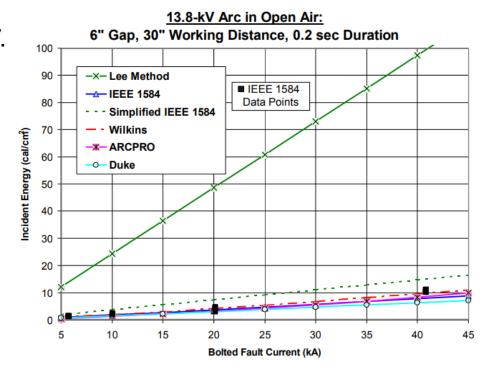






#### Comparison

- IEEE1584 completed tests to 13.8 kV.
- Typical to use Lee method:
  - Higher voltages
  - Lines scenarios
- Lee method limited to  $I_{bf}$  only.
- EPRI research
  - New empirical model











## 3. Risk Assessments

Once hazards are established, We can determine the risk.

- SiD Guide process.
- Anyone can complete a risk assessment, at any stage.

			Consequence					
			Trivial	Minor	Moderate	Major	Catastrophic	
			Trivial or no treatment required	Injury with short-term recovery	Injury with medium term recovery	Severe or permanent injury or fatality	Multiple fatalities	
	Frequent	Routinely seen in this industry	High 11	High 13	Extreme 20	Extreme 22	Extreme 25	
Likelihood	Likely	Occasionally seen, 2 or 3 times per year	Moderate 5	High 12	High 15	Extreme 21	Extreme 24	
	Possible	Seen less than once per year	Moderate 4	Moderate 7	High 14	High 17	Extreme 23	
	Unlikely	Occurs once every few years	Low 2	Moderate 6	Moderate 9	High 16	High 19	
	Rare	Hypothetical occurrence	Low 1	Low 3	Moderate 8	Moderate 10	High 18	

Source: EEA Safety in Design Guide







## 4. Mitigation

- Health and Safety at Work Act 2015.
- Health and Safety at Work (General Risk and Workplace Management) Regulations 2016.
- Electricity Act 1992.
- Electricity (Safety) Regulations 2010.



Source: The National Institute for Occupational Safety and Health (NISOH)







STEP 1 A) Substitute the hazard to reduce the risk

B) Isolate the hazard to reduce exposure

C) Implement engineering controls

One or more in the most appropriate and effective way.

STEP 2

Implement administrative controls

STEP 3

Provide and use adequate PPE

Source: EEA Safety in Design Guide



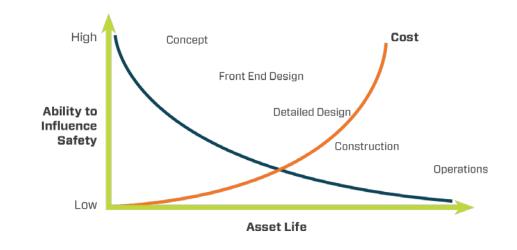




### **Engineering Controls**

#### Some examples:

- Protection settings
- Arc flash detection
- Delayed opening / closing
- IAC Switchgear





The ability to influence safety, for lower cost.







#### **Administrative Controls**

- Establishing boundaries
- Warning Labels
- Training
- Process for operations (e.g. Remote switching)
- Manufacturers operating procedures (IAC). Doors closed.



#### Arc Flash and Shock Hazard Present Appropriate PPE Required

#### RFN CB5

Arc Flash Boundary 7.80 m
Incident Energy @ 0.91 m 9.62 cal/cm²
Working Distance 0.91 m
Shock Hazard Exposure 11000 Vac
Always Maintain MADs

Always carry out a Risk Assessment prior to encroaching the 8 cal/cm<sup>2</sup> boundary. 8 cal/cm<sup>2</sup> Boundary 1.1 m

26/09/2017

#### **PPE Requirements**

Arc-rated (AR) clothing and equipment with an arc rating equal to or greater than the determined incident energy.

AR overall, AR face shield and AR balaclava, AR rainwear (AN), hard hat, safety glasses, hearing protection, leather gloves, leather footwear

CALCULATIONS BASED ON NORMAL SYSTEM CONFIGURATION







## Personal Protective Equipment Arc Rated (AR)

- Layering
- Natural fibers
- Suits
- Hoods
- Face, eye and hearing protection
- NFPA 70E









- Common PPE mistakes.
- Usually a combination of control measures is required, which includes PPE.
- Consider if PPE is appropriate even if exposure is to an arc flash is <1.2 cal/cm<sup>2</sup>



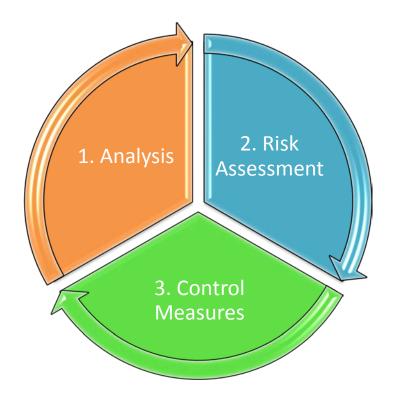






# Continuing Cycle

- 1. Assess hazards first (previous section).
- 2. Likelihood/consequence of the identified hazard affecting a person.
- 3. Application of mitigation techniques.









#### What is Next?

- Industry consultation ✓
- Incorporating feedback.
- Final changes being made.
- Research of work by the Electric Power Research Institute.

Aiming to be available on the EEA website by the end of July 2018.







## Questions

