INDEPENDENT PRICING AND REGULATORY TRIBUNAL

ELECTRICITY NETWORK SAFETY MANAGEMENT SYSTEM FORMAL SAFETY ASSESSMENT AUDIT GUIDANCE

SEPTEMBER 2016

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Risk is peculiar to time, place and circumstance. So unless specifically indicated to the contrary, this report only applies to the particular situation or scenario that is the subject of this commission.

PROJECT DETAILS

Client:	Independent Pricing and Regulatory Tribunal (IPART)
Project Name:	Electricity Network Safety Management System Formal Safety Assessment Audit Guidance
Client Reference:	Project Report
R2A Reference:	501-01

REVISION SCHEDULE

VERSION	DATE	DESCRIPTION	PREPARED BY:	REVIEWED BY:	ISSUE AUTH BY:
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0.9	16/8/16	Revised draft	TAP	RMR	
0.95	18/8/16	Revised draft	RMR	TAP	
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DISTRIBUTION

	DISTRIBUTION	NUMBER	COMMENTS
i	Client	1	Steve McHardy
Ii	R2A	1	Client File
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TABLE OF CONTENTS

SUMMARY

The purpose of the project is to establish an audit guideline for application to the formal safety assessment (FSA) component of New South Wales electricity network operators' electricity network safety management systems (ENSMSs).

This was seen as necessary to overcome the arguable differences between safety objectives identified in the *Electricity Supply Act 1995* and the associated 2014 Regulation, the requirements of *AS 5577:2013 – Electrical network safety management systems* and interaction with the *Work Health and Safety Act 2011*.

R2A's proposed approach is to adopt the SFAIRP (so far as is reasonably practicable) principle as this is the only one that is consistent with all three documents. The ALARP (as low as reasonably practicable) encouraged by AS 5577 is seen as acceptable so long as the acceptable or tolerable risk result is tested to see if further precautions are reasonable following the hierarchy of control. The hierarchy requires consideration of (in order of effectiveness) hazard elimination, hazard isolation, engineered controls, administrative controls and lastly, PPE (personal protective equipment).

Through this process it was determined that the most appropriate form of guidance would be a revision of IPART's Electricity Network Audit Guideline, incorporating specific ENSMS FSA guidance.

To be updated after the presentation workshop on 22 September 2016.

1. OBJECTIVE

The objectives of this project are to:

- Facilitate a common understanding amongst stakeholders of the key requirements of the formal safety assessment (FSA) component of New South Wales electricity network operators' electricity network safety management systems (ENSMSs), and
- Develop an audit framework for application to the (FSA) component of NSW electricity network operators' ENSMSs. This will support the electricity network safety regulator functions of the Independent Pricing and Regulatory Tribunal (IPART).

Ultimately these audits are to be done on behalf of the people and parliament of NSW to ensure continuing public confidence in the safety of the electrical supply system.

In R2A's view, the objective is to assist IPART to have confidence, via its audit regime, that all credible, critical safety hazards have been identified and all reasonable practicable precautions are in place at NSW electricity networks, meaning that the networks are 'safe'.

This involves identifying regulatory obligations for both IPART and the network operators, and revising IPART's existing ENSMS audit guidance to address these in a clear and consistent manner.

2. METHOD

As part of the project a number of tasks were completed. These are summarised below.

2.1 DOCUMENTATION REVIEW

R2A completed a review of relevant legislation, standards, guidelines and reports to establish an understanding of the legislative and regulatory context and framework within which IPART and NSW's electricity networks operate. Documents reviewed include:

- *Independent Pricing and Regulatory Tribunal Act 1992.*
- *Electricity Supply Act 1995*.
- *Electricity Supply (Safety and Network Management) Regulation 2014.*
- *AS 5577:2013 – Electrical network safety management systems.*
- *AS 31000:2009 – Risk management: Principles and guidelines.*
- *Work Health and Safety Act 2011*.
- IPART, 2016. *Electricity Networks Audit Guideline.*

2.2 GENERATIVE INTERVIEWS

R2A held generative interviews with representative personnel from IPART and NSW electricity network operators to discuss current approaches to ENSMS formal safety assessments, and the specific requirements of the documents reviewed. This information was then collated to develop the preliminary argument to test with the larger stakeholder workshop. Steve McHardy, IPART, Principal Engineer, Energy Networks Regulation, and Tim Procter and Richard Robinson, Directors of R2A attended all meetings.

The following personnel participated in the generative interviews:

27July 2016, IPART office:

- Ausgrid – Steve Poropat and Matt Webb
- Transgrid – Andrew McAlpine
- Lord Howe Island – by phone – Andrew Logan
- Endeavour Energy – Rick Wallace and Anthony Baerwinkel
- APA – by phone - Stuart Dodds

28 July 2016, Essential Energy Sydney office:

- Essential Energy – by conference call – David Matteson, Lawrence Clark, Gerard Lang, Michael Flannery, Chris Dalitz and Brian Glawson

28 July 2016, IPART office:

- Sydney Trains – Nicholas Loveday, Sean Budge and Christopher Lees
- ActewAGL – by conference call – Rob Walker, Wayne Cleland, Leyland Hinch, Paul Wheatley and Ralph Swatch
- Jacobs - Ian Boake, Mark Jameison and Anuraag Malla
- Metro Trains Sydney – Joyce Lin, John Minchin and Brett Brimfield.

29 July 2016, IPART office:

- Cutler Merz – Ryan Dudley.

2.3 DRAFT AUDIT GUIDANCE

Following the generative interviews R2A prepared a draft audit framework and project report for IPART review. After IPART review the draft framework's content was integrated in the IPART's existing Electricity Network Audit Guideline, and an accompanying briefing paper prepared for circulation to operators as preliminary information for the stakeholder workshop.

2.4 STAKEHOLDER WORKSHOP

A workshop session will be held at the IPART's Sydney office on Thursday 22 September 2016. The following stakeholders attended and participated in the session:

- Steve McHardy IPART, Principal Engineer, Energy Networks Regulation.
- Other attendees to be listed

The session will be facilitated and documented by Richard Robinson and Tim Procter, R2A Due Diligence Engineers. As an introduction to the session, Richard provided the group with a safety due diligence presentation briefing and attached as Appendix A. R2A then presented the draft audit framework for comment by the stakeholder group

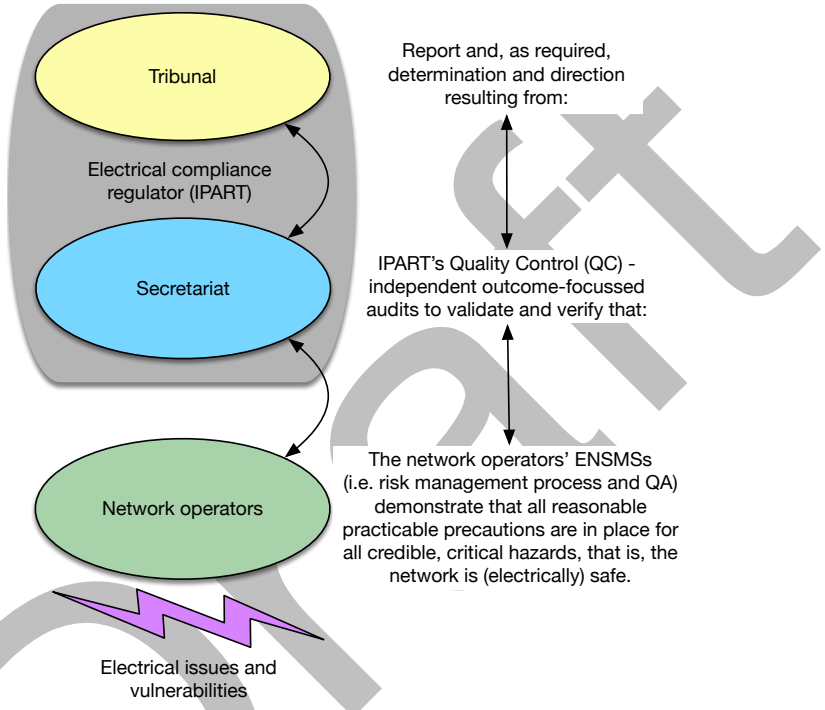
2.5 FINAL AUDIT GUIDANCE

Following the workshop R2A recommended updates to IPART's Electricity Network Audit Guideline to reflect stakeholder workshop feedback. Following final IPART review this was issued as a first release as Appendix B to this report.

3. IPART'S ROLE AS SAFETY REGULATOR

3.1 LEGISLATION

The NSW Independent Pricing and Regulatory Tribunal (IPART) is, inter alia, the safety regulator for all NSW electricity networks. IPART was created by the *Independent Pricing and Regulatory Tribunal Act 1992* (the IPART Act). It consists of a Tribunal, with the power to make determinations and issue directions to regulated parties, and a Secretariat who advises the Tribunal and liaises with regulated parties. This is shown in the regulatory concept diagram below.



IPART regulatory concept

As safety regulator of NSW electricity networks, IPART's key role is to gain assurance that electricity network operators are operating in a safe manner. IPART does this via an audit regime of operators' electricity network safety management systems (ENSMSs).

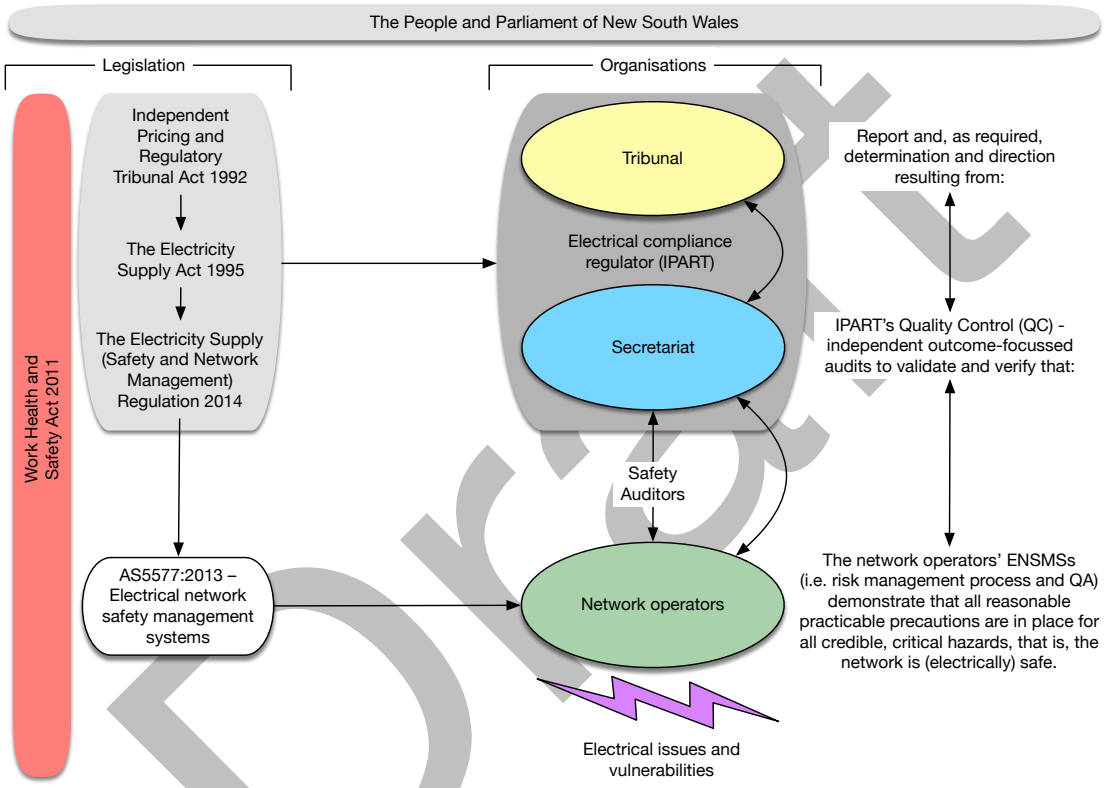
IPART's power to require audits arises from the IPART Act and, in relation to electricity networks, the *Electricity Supply Act 1995* to which the IPART Act refers. The *Electricity Supply Act* overarches a number of regulations, including the *Electricity Supply (Safety and Network Management) Regulation 2014* (the Regulation).

The Regulation sets out legal requirements for safe network management by operators. Clause 5 requires that network operators must take all reasonable steps to ensure that the design, construction, commissioning, operation, and decommissioning of its network is safe. The Regulation also calls up *AS 5577:2013*

– *Electrical network safety management systems*. IPART's ENSMS audit regime tests operators against the requirements of the Regulation and AS 5577.

3.2 AUDIT GUIDELINE CONTEXT

In the wider context of NSW safety legislation, the Regulation and AS 5577 sit alongside the *Work Health and Safety Act 2011* (WHS Act). Operators have duties under the WHS Act to, so far as is reasonably practicable, eliminate and (failing that) reduce safety risks.



Current interfaces between legislation and organisations

The current interfaces of the various legislation and organisations in and around IPART and the operators are shown in the diagram above.

This concept is expanded in the following sections.

3.3 ENSMS REQUIREMENTS

Within this legislative context, to meet IPART's regulatory requirements audits must determine whether:

1. Each network operator has taken "all reasonable steps to ensure that the design, construction, commissioning, operations and decommissioning of its network (or any part of its network) is safe", as per clause 5 of the Regulation.

2. The safety management system of each operator meets the primary objective of assisting network operators to comply with Clause 5 and in particular supports, as per clause 6 of the Regulation:
   - the safety of members of the public,
   - the safety of persons working on networks,
   - the protection of property (whether or not belonging to a network operator),
   - the management of safety risks arising from the protection of the environment, and
   - the management of safety risks arising from loss of electricity supply.

3. The safety management system is in accordance with AS 5577 (which refers to both WHS legislation [at clause 1.2(b)] and AS 31000, the risk management standard [at clause 4.3.2]), as per clause 7(1) (a) of the Regulation. AS 5577 Appendix A (normative) includes a specific requirement and guidance to conduct a formal safety assessment. Appendix B (informative) emphasises the need for the consideration of risk control alternatives, particularly in the evaluation of alternative designs when the consequences can include fatalities (B3).

4. Addresses other requirements of the Regulation, including:
   - Safety matters related to network reliability, advice to the public, and bushfire risk as listed in clause 7(1) (b).
   - The consideration and/or implementation of any code, standard or guideline specified to the network by the Minister as per clause 7(2) and 7(3).
   - The implementation of the ENSMS, as per clause 8.

3.4 ENSMS AUDITS

ENSMS audits are conducted by independent external auditors. IPART maintains the power to accept or reject any particular auditor, and provides a number of arrangements through which an auditor may be engaged to audit an operator's ENSMS and report to IPART.

Operators and ENSMS auditors receive guidance on how audits are to be conducted in IPART's 2016 *Electricity Networks Audit Guideline* (the Guideline). This sets out:

- Audit fundamentals, including the independence, expertise and quality processes required of auditors,
- The audit process, including audit initiation, auditor nomination, audit proposal, undertaking the audit, submitting audit reports, and post-audit activities,
- Audit compliance findings requirements, and
- Specific ENSMS audit aspects, including audit objectives, scope, timing, and criteria (with reference to specific relevant AS 5577 clauses regarding, for example, formal safety assessments),
- Specific guidance for other types of electricity network audits such as critical infrastructure licensing and network reliability, neither of which are addressed in this review.

3.5 FORMAL SAFETY ASSESSMENT AUDITS

In this overarching context IPART plans to conduct a second round of ENSMS audits, examining ENSMS formal safety assessments. To facilitate this IPART has commissioned R2A to propose revisions to the Guideline to specifically address the formal safety assessment requirements arising from the Regulation and AS 5577.

The proposed revised Guideline is to specifically address the complexities of auditing of a formal safety assessment, including how auditors may reconcile the differing approaches adopted by operators (especially ALARP approaches) and how the inherent judgements in risk assessments may be addressed through a compliance-based audit process.

AS 5577 notes that it exists in the context of WHS legislation and that nothing in it relieves any all persons working on or near electricity networks of any obligation under jurisdictional or national work health and safety obligations [Clause 1.2 (b)]. The 2011 WHS legislation requires that hazards should be eliminated so far as is reasonably practicable (SFAIRP) and if not eliminated, reduced SFAIRP.

AS 5577 notes that that hazards should be eliminated so far as is reasonably practicable (SFAIRP), and that if is not reasonably practicable to so, by reducing risks to a low as is reasonably practicable (ALARP) [Clause 1.2 (e)]. In the normative Appendix A, AS 5577 then goes on to say that the Formal Safety Assessment (FSA) should identify opportunities for further safety improvement, even if the risk have been assessed as ALARP (Appendix A, Section A4, last paragraph). This is actually the SFAIRP position.

In R2A's view, the only practical way to resolve this position is for the FSA audits to assume that SFAIRP is the primary audit criteria for the management of all network hazards.

4. ENSMS FSA AUDIT GUIDANCE

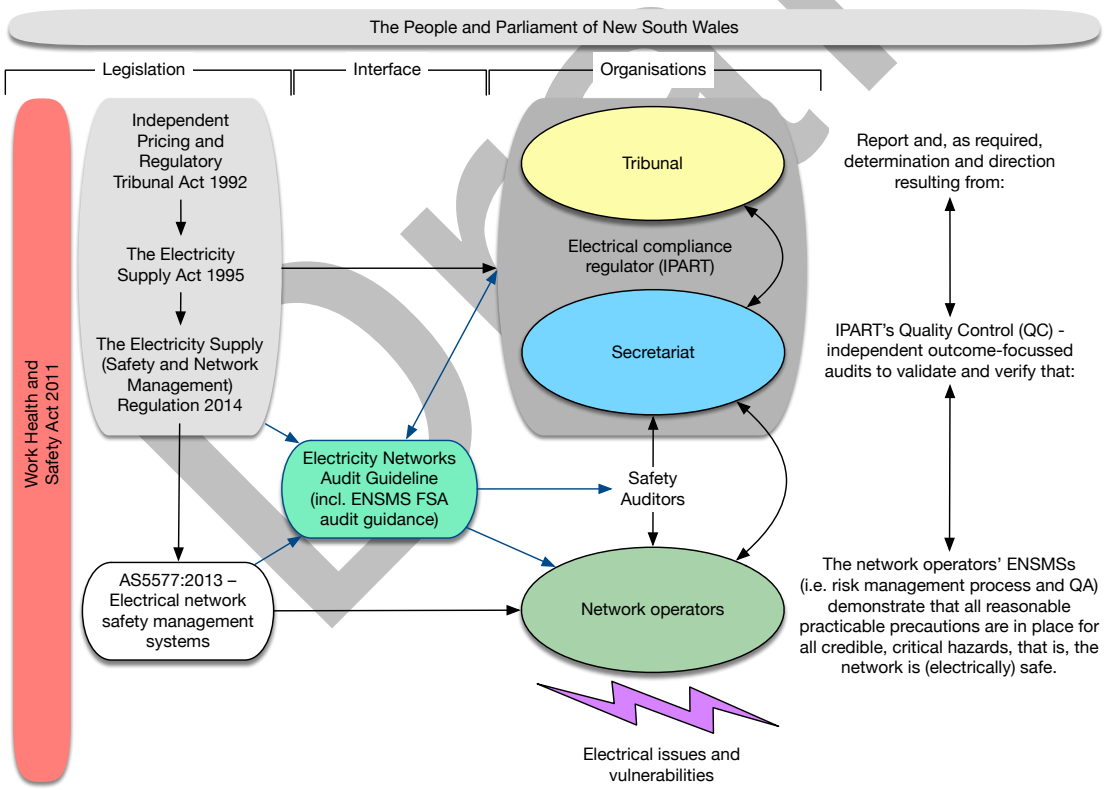
The proposed revised Guideline incorporating ENSMS formal safety assessment audits is attached as Appendix B. The following sections detail the interface requirements, philosophy and complexities underlying the proposed changes top the Guideline's content.

4.1 INTERFACES

The requirements of an ENSMS in general, and its incorporated formal safety assessment in particular, arise from a range of legislative and regulatory sources. In an audit both the auditor and auditee attempt to reconcile these legislative drivers with organisational actions.

As such the proposed revised Guideline links these two domains, with the aim of helping auditors (and hence IPART) have confidence that the audit findings provide true reflections of operators' attempts to address their legislative requirements.

This relationship is shown in the modified interfaces diagram below.



Interfaces between legislation, proposed revised Guideline and organisations

4.2 'ALARP', 'SFAIRP' AND 'ALL REASONABLE STEPS'

There are three key safety requirements present in the suite of legislation under which the NSW electricity network operators act. These are:

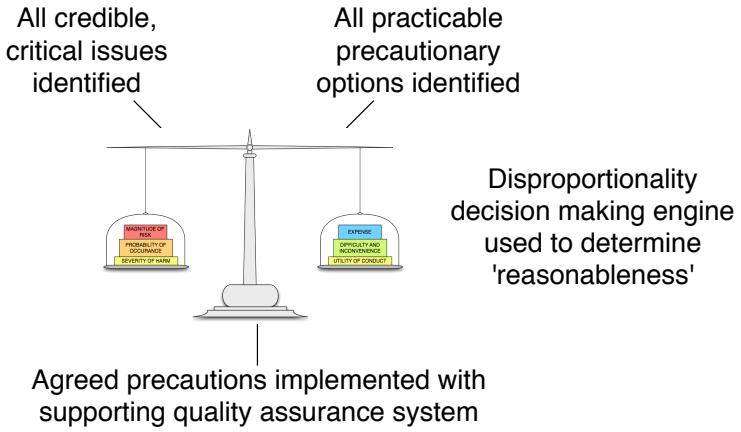
- **The Regulation**: An operator must take "all reasonable steps to ensure that the design, construction, commissioning, operations and decommissioning of its network (or any part of its network) is safe".[1]
- **AS 5577**: An operator must manage safety hazards "by eliminating risks so far as is reasonably practicable [SFAIRP], and if it is not reasonably practicable to do so, by reducing those risks to as low as reasonably practicable [ALARP]".[2] That is, reduction of risk levels until they are below target risk criteria. The standard also notes that operators should "identify opportunities for further safety improvement, even if risks have been assesed as being ALARP".[3]
- **WHS Act**: An operator must "ensure, so far as is reasonably practicable [SFAIRP], the health and safety of … workers [and] other persons is not put at risk from work carried out as part of the conduct of the business or undertaking."[4] Officers of an operator "must exercise due diligence to ensure that [the operator] complies with that duty".[5]

In terms of an ENSMS formal safety assessment, each of these three requirements require three main steps:

- Identify safety hazards relating to the network,
- Determine and implement appropriate precautions to address these hazards, and
- Ensure these precautions are maintained over time.

R2A's safety due diligence approach implements the R2A 'Y' model shown below. This has four steps. Firstly, identification of all (relevant) credible scenarios or hazards; secondly, identification of all possible practicable precautions for each critical hazard: thirdly, a determination of which precautions are reasonable in the circumstances and; fourthly, a quality assurance process to ensure that reasonable precautions are properly implemented and sustained.

[1] *Electricity Supply (Safety and Network Management) Regulation* 2014, Clause 5.
[2] *AS 5577:2013 – Electrical network safety management systems*, clause 1.2(e).
[3] *AS 5577:2013 – Electrical network safety management systems*, clause A4.
[4] *Work Health and Safety Act 2011*, clauses 19(1) and 19(2).
[5] *Work Health and Safety Act 2011*, clause 27(1).

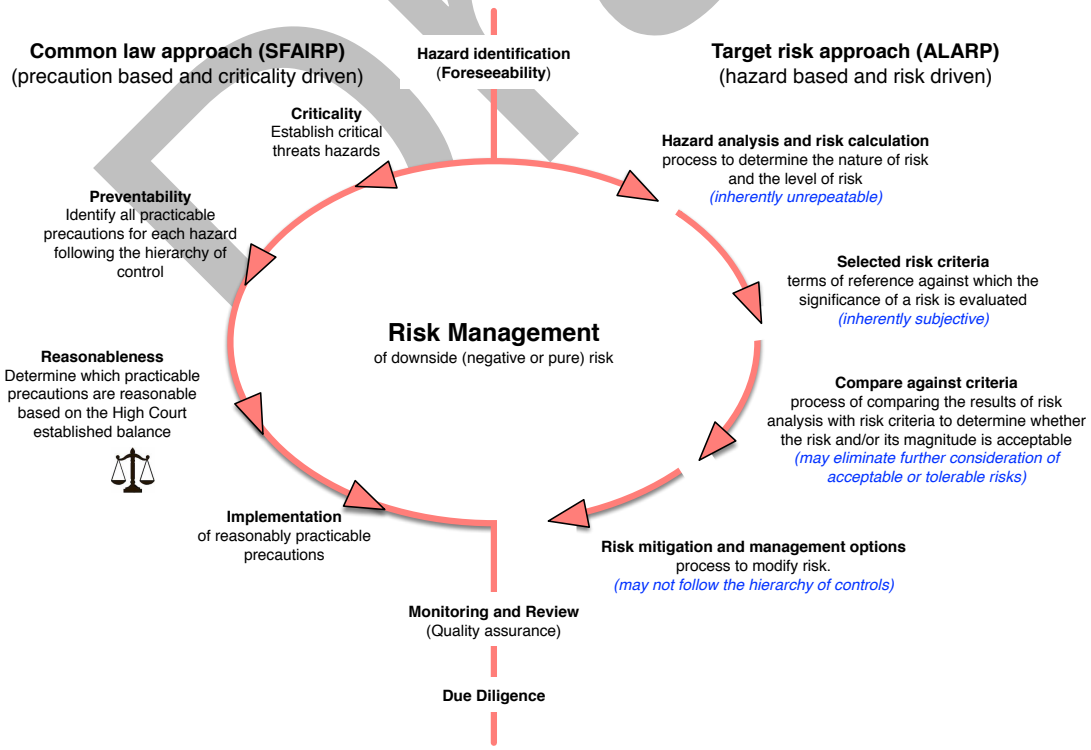


R2A 'Y' Model

This approach provides an efficient method to develop a clear argument as to why, so far as is reasonably practicable, all risks have been eliminated or, failing that, that all reasonable practicable precautions are in place. This approach addresses the requirements of both the Regulation and the WHS Act.

In contrast to the identification of practicable precautions and identification of reasonable options in the SFAIRP approach, the traditional approach to ALARP requires target risk criteria be set, and that once risk levels are judged to be below these no further precautions are required. That is, at this point the risk has been reduced as low as reasonably practicable.

The key steps in these two approaches are shown below.



Differences between SFAIRP and ALARP approaches

R2A's experience is that that the SFAIRP approach described in the diagram above provides a better outcome, particularly when considering low likelihood-high consequence events such as those related to loss of control of electrical energy.

This SFAIRP approach is arguably supported in Appendix B of AS 5577. Whilst describing what is required to demonstrate ALARP, AS 5577 notes that alternatives (or at least a search for them) must be undertaken. Two illustrative questions are posed:

(a) *What else could we do to reduce risk.*
(b) *Why have we not done it.*

The answer to the second question, for each physically possible alternative should be: *because the cost is grossly disproportionate to the benefit gained*. This is very definitely the SFAIRP position.

The most appropriate approach seems to be to ensure operators' formal safety assessments (at a minimum) meet the "all reasonable steps" / SFAIRP requirements.

Noting that the ALARP approach is still used by at least two of the operators interviewed during this project, the formal safety assessment audit framework must provide a mechanism for capturing required information from both the SFAIRP and ALARP approaches. In both cases the operators using the ALARP approach, after reaching the 'tolerable' level of risk, test for whether additional precautions could be justified, which is the central tenet of the SFAIRP approach. In this way SFAIRP is demonstrated.

4.3 AUDITING TO 'SFAIRP'

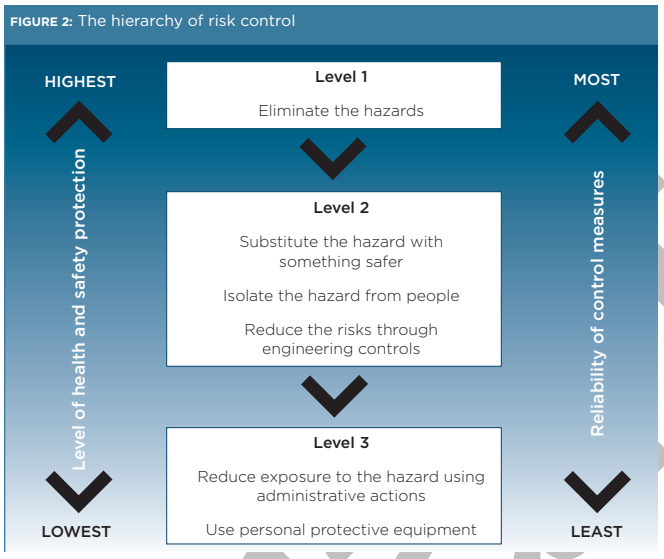
In general, audits require finding a balance between auditor (and IPART) confidence in findings gained from investigative detail, and audit efficiency in maximising results from time and resources required. That is, an efficient audit aims for the minimum audit sample size and examination approach needed to represent the population.

To address this the proposed revised Guideline comprises the following four overarching areas for audit investigation.

- That there is a formal argument as to why all credible, critical hazards have been identified.
- That for each significant hazard all recognised good practice precautions are in place, and if not, have been tested for reasonableness, and in the particular circumstances demonstrated as being unreasonable.
- That further possible practicable controls are considered (even if the risk is considered to be reduced to a 'tolerable' level), and that when considering further precautions, the hierarchy of control is applied as shown in the diagram below.
- That a quality assurance system is in place to ensure all reasonable practicable precautions are implemented and remain effective.

The first and fourth of these are standard requirements for any risk management, regardless of the SFAIRP/ALARP approach adopted. The second is a clearly articulated requirement in AS 5577 and the current IPART Audit Guideline, and by its nature is expected practice. The third ensures an appropriate focus is maintained on implementing all reasonably practicable precautions as required by the Regulation and the WHS Act.

The hierarchy of control is perhaps best explained by Workcover NSW[6] in the diagram below.



Hierarchy of Control

4.4 PROPOSED FSA AUDIT REQUIREMENTS

To demonstrate compliance in the four overarching areas investigation items listed in Section 4.3 operators must present supporting evidence. For formal safety assessment audits this evidence must specifically address the items in IPART's *Electricity networks audit guideline* Table B1 rows 2-4, which refer to specific AS 5577 clauses. Relevant references are noted in the following sections.

A discussion of ways in which this may be achieved is below.

4.4.1 ALL CREDIBLE, CRITICAL HAZARDS

Electricity networks audit guideline reference:

- Table B1 rows 2 and 3 (AS 5577 clauses 4.3.2, 4.3.3 and A3.1)

Operators would be expected to have the following in place to provide confidence that all credible, critical hazards (meaning those that can kill or maim) have been identified:

[6] WorkCover NSW (2011). *How to Manage Work Health and Safety Risks*. Code of Practice.

- **An ongoing historical review** of electricity network safety hazards and incidents.
- **An ongoing dialogue with the Australian electricity network industry** to understand emerging safety issues and themes. This should include generative interviews with staff and workers, discussion with regulators and perhaps even public forums.
- **A functional completeness check**, comparing identified hazards (including the loss of electricity supply) with critical exposed groups (i.e. members of the public and persons working on networks) and other critical exposed elements (i.e. property and the environment). This should include all relevant phases (e.g. design, construction, commissioning, operations and decommissioning), as well as abnormal and emergency situations.
- **A zonal completeness check**, based on hazards that may arise at or from specific assets in particular locations. This would be expected to be of particularly import, for instance, for the risk of network ignition of bushfire in high fuel load areas.

4.4.2 RECOGNISED GOOD PRACTICE

Electricity networks audit guideline reference:

- Table B1 row 4 (AS 5577 clause 4.3.4)

Recognised good practice is accepted as the baseline suite of precautions for generic industries. This is codified in international and Australian standards, industry codes and guidelines, and informal but accepted means of addressing common issues.

Operators must provide evidence demonstrating that for each significant hazard all recognised good practice precautions are in place. Where recognised good practice is not considered appropriate reasoning must be provided as to why, showing how the hazard is being managed to a similar standard by different means.

If recognised good practice is not implemented without justification for critical hazards that provide for, and no other precaution is put forward in its place it is likely the operation in question would be considered prohibitively dangerous.

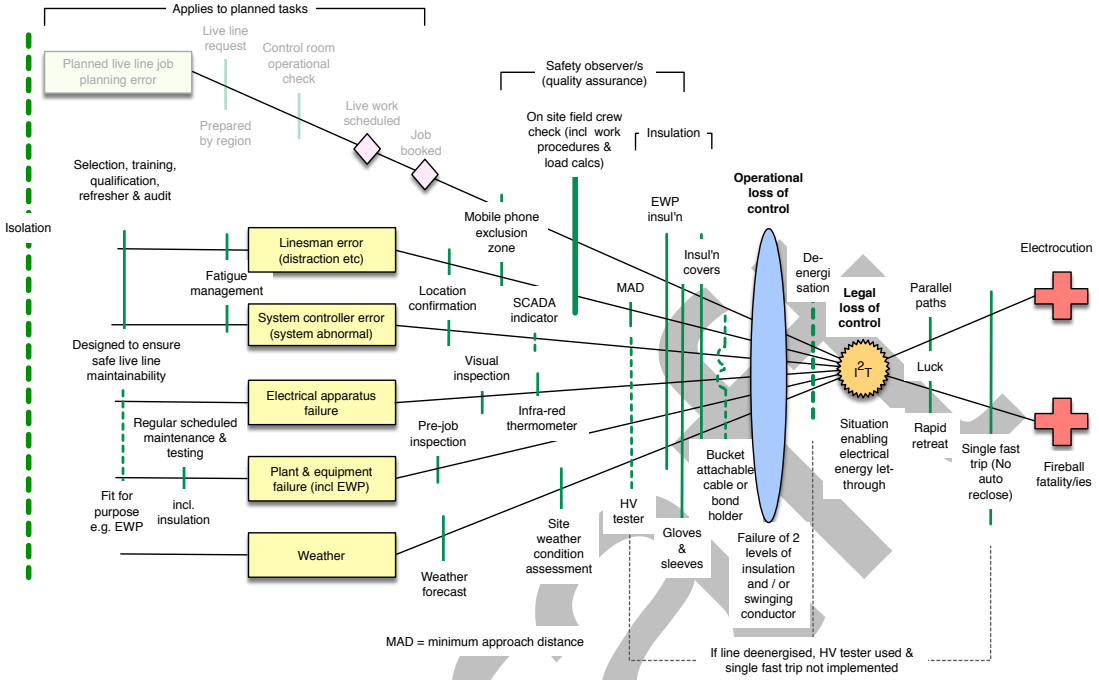
Appendix C provides a summary of the approach used by the Powerline Bushfire Safety Taskforce arising from the Victorian Royal Commission into the Black Saturday fires into how this issue was addressed. It is described further in the example for live high voltage work in the next section.

4.4.3 HIERARCHY OF CONTROL AND FURTHER PRECAUTIONS

Electricity networks audit guideline reference:

- Table B1 rows 2 and 3 (AS 5577 clauses 4.3.2 and 4.3.3)

The WHS Act requires that the hierarchy of control be applied when considering further precautions for a hazard. This must be done regardless of the level of risk as estimated in the ALARP approach. That is, a precaution that moves the estimated risk to the 'tolerable' zone must not be adopted at the expense of another precaution higher up the hierarchy of control if the latter is justified on the balance of the significance of the risk versus the effort required to reduce it.



Live 11 kV to 33 kV maintenance tasks using glove and barrier methods

Similarly, a potential precaution justified on this balance must not be rejected based on a 'tolerable' risk level.

A common and clear way to demonstrate how these principles are considered in risk assessments is through threat-barrier (bow-tie) diagrams, a sample of which is provided above for live 11kV to 33kV maintenance tasks using glove and barrier methods.

The power of these threat-barrier (bow-tie) diagrams is being able to show the time sequence of hazardous events and where existing (solid lines) and possible further or alternative controls (dotted lines) might act. Precautions act before the loss of control point and prevent the accident event from occurring at all. Mitigations act after the loss of control point to prevent the incident from escalating. This means that the hierarchy of control flows from left to right across the diagram and that the effectiveness and cost disproportionality of each possible new barrier can be tested in the context of all the existing barriers.

Discussions with operators during the generative interviews indicated that these were in use at all NSW electricity networks. An informative guide to *reasonably practicable* that incoprates threat-barrier diagrams is provided as Appendix C to this report.

4.4.4 QUALITY ASSURANCE

Electricity networks audit guideline reference:

- Table B1 row 2 (AS 5577 clauses 4.3.2)

Operators must provide evidence demonstrating that implemented precautions are inspected and maintained to ensure they remain effective. This should be done through formal quality assurance (QA) processes for physical and procedural precautions.

QA for physical precautions would be expected to include evidence of inspections, scheduled maintenance, repairs and so on.

QA for procedural precautions would be expected to include evidence of initial and refresher training for staff, scheduled reviews of procedures, formal change management processes and so on.

4.5 OTHER PROPOSED REVISIONS TO GUIDELINE

4.5.1 GENERAL

Electricity networks audit guideline reference:

- Chapter 1 (Purpose of this document)
- Chapter 2 (Audit fundamentals)
- Chapter 3 (Audit process)
- Chapter 4 (Audit findings)
- Chapter 6 (Critical infrastructure licence conditions audit)
- Chapter 7 (Reliability audit for electricity distributors)
- Chapter 8 (Compliance with the NSW Code of Practice for Authorised Network Operators)
- Appendices A, C-I

No changes are proposed for these sections.

4.5.2 BASIS OF ENSMS FSA AUDITS

Electricity networks audit guideline reference:

- Chapter 5 preamble

Minor wording clarifications.

4.5.3 ENSMS FSA AUDIT OBJECTIVE

Electricity networks audit guideline reference:

- Chapter 5.1

Minor wording clarifications.

4.5.4 DETERMINING ENSMS FSA AUDIT SCOPE

Electricity networks audit guideline reference:

- Chapter 5.2

The following text is inserted as Chapter 5.2.2, with a reference from the related dot point. The previous Chapter 5.2.2 (Specific auditor expertise) is relabelled Chapter 5.2.3.

> Initial audits may focus on the formal safety assessment process at a high level, looking at the overarching threats presented by the network. Subsequent audits may have a more targeted approach, investigating the formal safety assessment processes used in, for example, asset management, or to address bushfire ignition potential.
>
> Audits will often lead to specific document trails being followed during the course of the audit. Auditors should undertake a number of these in each audit sufficient to provide a representative sample of the operator's overall activities.

4.5.5 ENSMS FSA AUDIT TIMING

Electricity networks audit guideline reference:

- Chapter 5.3

No changes are proposed for this section.

4.5.6 ENSMS FSA AUDIT CRITERIA (OVERVIEW)

Electricity networks audit guideline reference:

- Chapter 5.4

No changes are proposed for this section, however Guideline Appendix B Table B1 to which it refers is updated as noted in Section 4.5.8 below.

4.5.7 ADDITIONAL PROPOSED ENSMS FSA AUDIT REQUIREMENTS

Electricity networks audit guideline reference:

- Chapter 5.5

No changes are proposed for this section.

4.5.8 ENSMS FSA AUDIT CRITERIA (DETAILS)

Electricity networks audit guideline reference:

- Appendix B Table B1

Amendments to ENSMS audit criteria relating specifically to formal safety assessment audits are discussed in Section 4.4 above, and are reflected in the revised Appendix B Table B1.

A requirement has been added to Row 2 (Planning – Planning for safe operation) for FSAs to ensure the involvement of relevant identified stakeholders in relevant stages of the FSA as per AS 5577 Appendix A clause A1(d).

5. NEXT STEPS

To be completed after the workshop on 22 September 2016.

APPENDIX A – WORKSHOP PRESENTATION

To be inserted after the workshop on 22 September 2016.

APPENDIX B – PROPOSED REVISED IPART ELECTRICITY NETWORK AUDIT GUIDELINE

See separate document for draft – final to be inserted

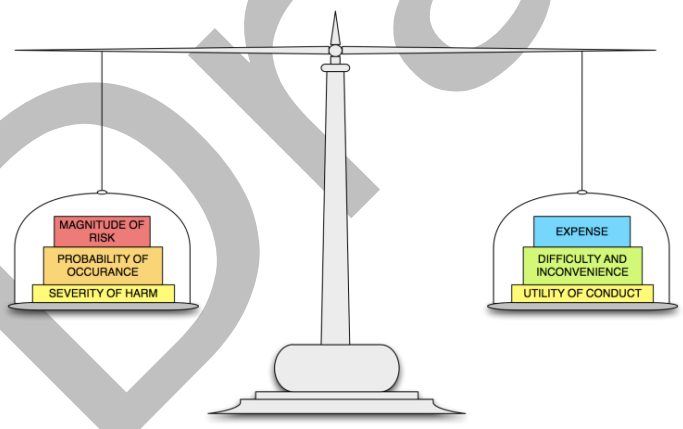
APPENDIX C – *REASONABLY PRACTICABLE*

This Appendix has been provided to enable insight as to how to demonstrate *reasonable practicability*. The example from the Victorian Powerline Bushfire Safety Taskforce has been selected for two reasons. Firstly, it shows how *reasonable practicability* has been demonstrated to deal with powerline bushfire firestarts on Catastrophic (Code Red) days in one Australian jurisdiction. Secondly, since by default, this has become *recognised good practice* in that state for network bushfire ignition control, to not implement such a precaution in NSW would need an appropriate argument.

As Michael Tooma notes[7], *reasonable practicability* is not new to the laws of man. It has been around for over a century. The particular formulation of *reasonableness* in this report is that based on a decision of the High Court of Australia[8] in 1982. Here Justice Sir Anthony Mason noted:

> *The perception of a reasonable man's response calls for a consideration of the magnitude of the risk and the degree of probability of its occurrence, along with the expense, difficulty and inconvenience of taking alleviating action and any other conflicting responsibilities which the defendant may have.*

This was interpreted per the diagram adapted from Sappideen and Stillman[9] (1995) shown below:



How would a reasonable defendant respond to the foreseeable risk?

This means that all reasonable practicable precautions are adopted based on the balance of the significance of the risk – probability of occurrence and severity of harm verses the effort required to reduce it – expense, difficulty and inconvenience, and utility of conduct.

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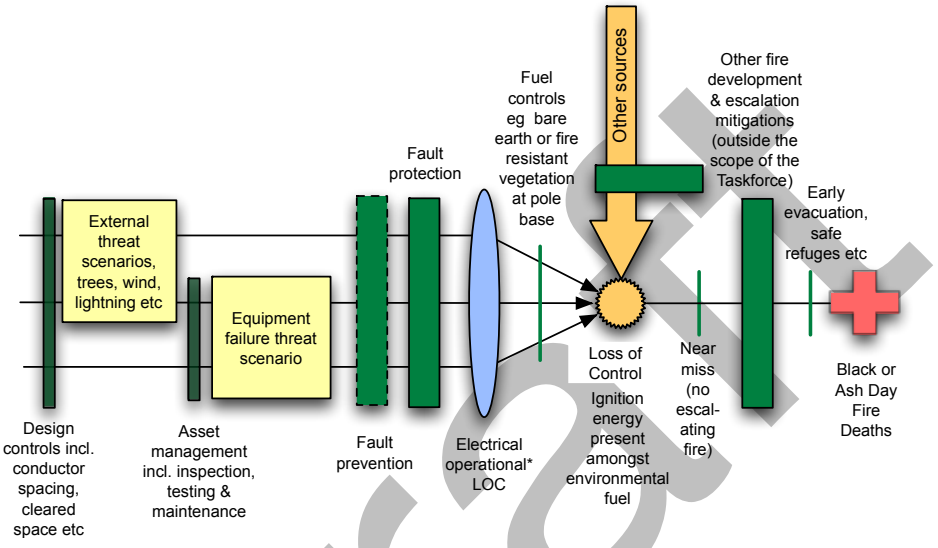
7 Michael Tooma (2012). *Due Diligence: Duty of Officers*. CCH Australia Limited. Page 8

8 *Wyong Shire Council vs Shirt* (1980) 146 CLR 40.

9 Carolyn Sappideen & R H Stillman (1995). *Liability for electrical accidents: risk, negligence and tort*. Engineers Australia Pty Limited, Crows Nest, Sydney. Page 22.

The Powerline Bushfire Safety Taskforce was formally constituted in August 2010 to consider how the Victorian Government should implement the recommendations of the Victorian Bushfires Royal Commission in relation to the replacement of powerlines (recommendation 27) and changing the operation of the network (recommendation 32).

The Taskforce developed a threat-barrier model to illustrate the threats that may result in the ignition of bushfires by powerlines and the barriers that prevent the ignition of bushfires by powerlines. A threat-barrier diagram from Appendix E of the report[10] is shown below.



Fire season electrical fire start threat-barrier diagram

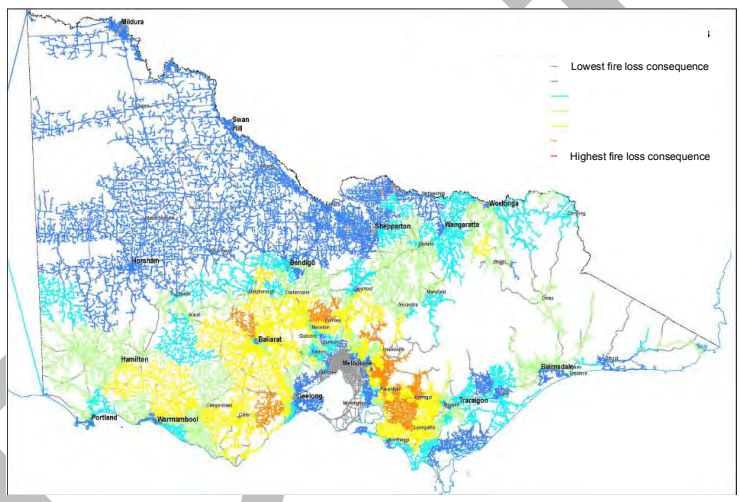
The loss of control point was defined by the Taskforce as the point at which sufficient ignition energy is present amongst environmental fuel to start a fire, that is, a potential bushfire start. Ignition energy is a combination of fault energy and duration. Defining the loss of control point in this way had the added advantage of representing the scope of the Taskforce's endeavours, that is, to the left hand side of the diagram. Fire starts due to sources other than power lines are shown by the vertical arrow. Mitigation barriers are after the loss of control point and were outside the Taskforce's Terms of Reference.

Arc ignition research indicated that electric arcs can ignite fires almost instantaneously (which could be as fast as two hundredths of a second) under worst-case conditions. The probability of bushfires being ignited can be reduced if power lines are turned off, or the fault current substantially reduced, faster than this ignition timeframe when a fault occurs. The Taskforce identified two types of equipment which satisfy these requirements, remotely controlled Automatic Circuit Reclosers (ACRs) and Rapid Earth Fault Current Limiters (REFCLs aka ground fault neutralisers).

[10] Powerline Bushfire Safety Taskforce. *Final Report.* 30 September 2011. Appendix E.

A precautionary risk analysis model was created to test the value of potential, practical precautions based on the threat-barrier diagram described above. That is, all practicable options are described and the model tests for precautions or combinations of precautions that provide the best investment. Based on the Black Saturday (2009), Ash Wednesday (1983) and Black Friday (1939) fires the model characterises the risk associated with these days as 100 Victorian deaths every 25 years.

Fire loss consequence data was produced by Phoenix – a fire characteristic mapping model developed by Dr Kevin Tolhurst and colleagues at the Bushfire Cooperative Research Centre (CRC). The inputs to the model include fuels, weather, topography, fire suppression levels, assets and their values, and scenario conditions. An analysis of the fire loss consequence data has revealed that, based on forced Ash Wednesday conditions with fires starting at 1pm that the highest 80 per cent of the state's fire loss consequence is associated with fire risk from approximately 16,450 kilometres of powerlines (about 21 per cent of total rural powerline length) that supply electricity to approximately 40,000 electricity customers (about 4 per cent of total rural customers).



Fire loss consequence by powerline section based on forced Ash Wednesday conditions with fires starting at 1pm

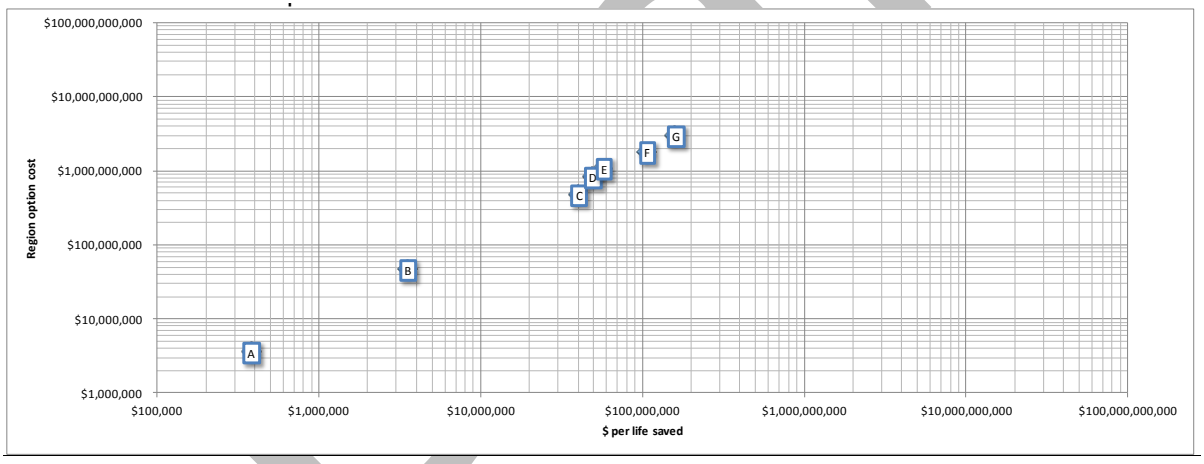
The risk analysis model has three levels of criticality for rural areas: extreme, very high and high presently characterised in the ratio of 1:0.3: 0.1, with extreme consequence areas as the base (worst) case. Relative risk per unit length (km) is presently done for life safety only, for an Ash or Black day. SWER (single-wire earth return) and multi-wire powerline options are identified. The precautions that are considered are shown in the table below with the values used for the extreme consequence region assessment.

Results are initially presented as a plot of quantum of risk vs. quantum of effort on a relative risk basis for a unit length of a powerline in the representative bushfire consequence areas. The model presently applies to the three fire loss consequence regions and is then summarised statewide.

Precaution	Δ fatality risk	Δ Effort ($ per km)
A) New generation SWER ACRs	50%	$1,114
B) REFCLs	70%	$7,976
C) Convert SWER to multi-wire (REFCL)	63%	$148,592
D) SWER – insulated wire	90%	$257,709
E) SWER – underground	99%	$332,727
F) Multi-wire – insulated wire	90%	$309,961
G) Multi-wire – underground	99%	$514,477

Relative effort is estimated on an average unit length (km) basis per option as capital expenditure (dollars)

The Taskforce concluded that the most cost-effective solution to reduce the likelihood of bushfires starting by powerlines is the widespread deployment of new protection network technologies (REFCLs and new generation SWER ACRs) assuming a change in the network reclose function, with the targeted replacement of powerlines with underground or insulated cable in the highest fire loss consequence areas.



Comparison of effectiveness of precautions, for the extreme fire loss consequence areas, with each precaution considered independently

The Victorian government[11] in 2011 accepted all of the recommendations of the Powerline Bushfire Safety Taskforce (Taskforce) with regard to powerline infrastructure and management in Victoria based on the above understanding.

The effectiveness of the REFCL option was tested and confirmed as effective in preventing single phase firestarts[12] during 2014.

[11] *Victorian Government Response to The Victorian Bushfires Royal Commission Recommendations 27 and 32*. December 2011

[12] See http://www.energyandresources.vic.gov.au/__data/assets/pdf_file/0003/1145172/REFCL-Trial-FINAL-report-Exec-Summary-plus-Ch-1-3-140804.pdf viewed 12 August 2016.

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