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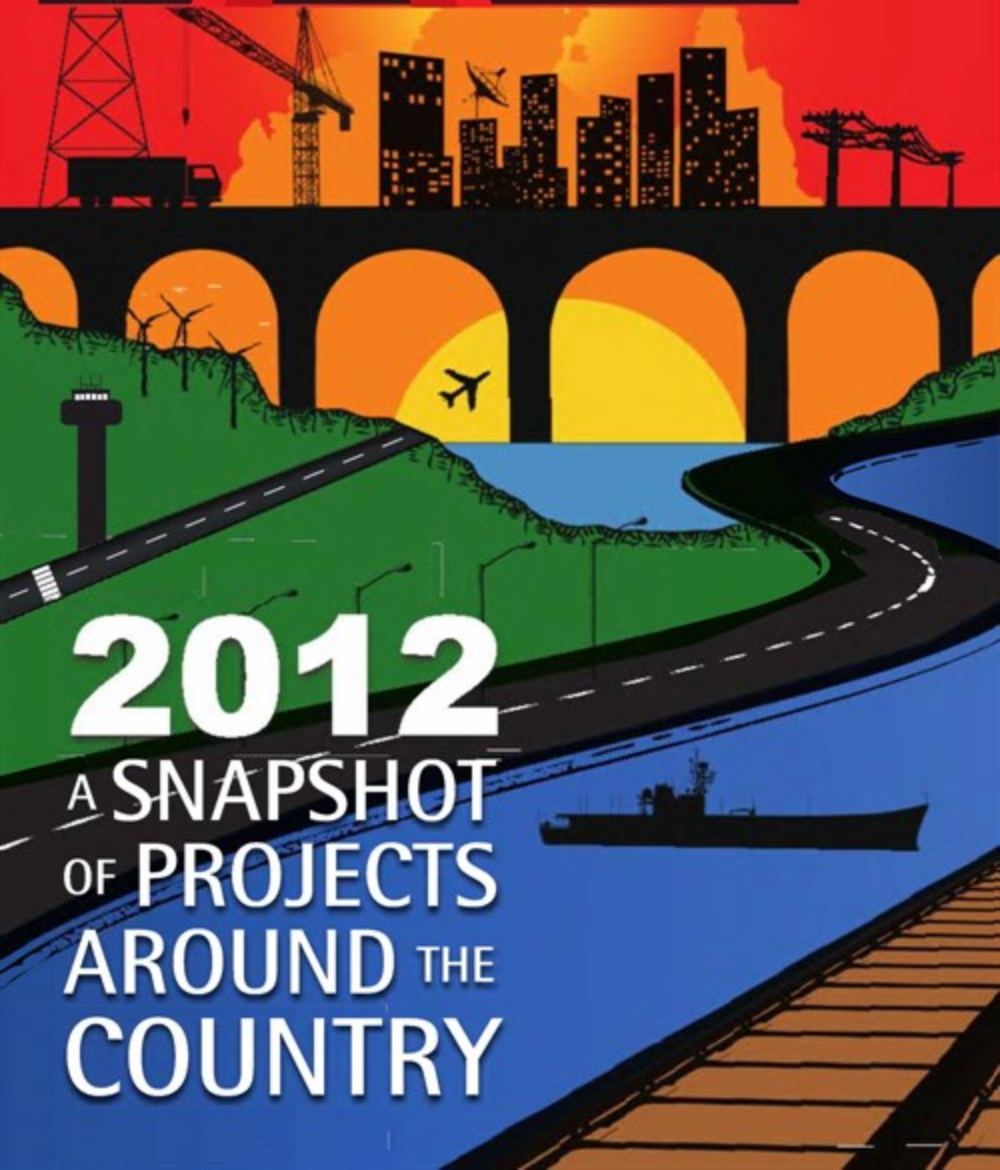


2012

A SNAPSHOT OF PROJECTS AROUND THE COUNTRY

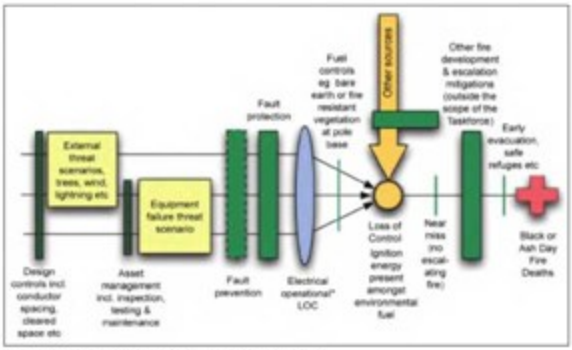
Managing bushfire risks of powerlines

by Richard Robinson

The Victorian government recently accepted all of the recommendations of the Powerline Bushfire Safety Taskforce with regard to powerline infrastructure and management in Victoria. Since the Taskforce took the provisions of the new model Work Health and Safety (WHS) legislation into account in its approach to the precautionary risk management, this perhaps represents the first formal occasion on which the outcomes of this approach in infrastructure terms can be assessed.

The 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).

Consistent with the precautionary-based risk management framework, the Taskforce developed a threat-barrier model (see diagram) 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. Such diagrams describe the nature of all practicable precautions and facilitate the determination of those which are reasonable based on the balance of the significance of the risk (probability of occurrence and severity of harm versus the effort required to reduce it), expense, difficulty and utility of conduct.



Threat-barrier diagram for a bushfire started by a powerline.

The Taskforce defined the loss-of-control point as the point at which sufficient ignition energy is present among environmental fuel to start a bushfire. Ignition energy is a combination of fault energy and duration. Fire starts due to sources other than powerlines are shown by the vertical arrow. Mitigation barriers are after the loss-of-control point and were outside the Taskforce's terms of reference.

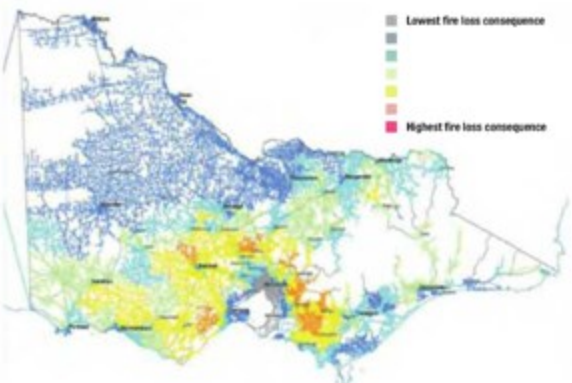
The precise mechanisms by which powerlines may start bushfires can be quite complex. While the fundamentals of fuel ignition processes in general have been well researched and are understood, most work to date has focused on scenarios that lead to ignition in the order of seconds, rather than considering ignition in hundredths of a second, as may happen with electric arcs. To address the knowledge gap regarding electric arcs, the Taskforce undertook a program of tests at Testing and Certification Australia's high-power laboratory in Sydney.

Overall, the arc ignition research indicates 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 powerlines are either turned off, or the fault current substantially reduced, faster than this ignition timeframe when a fault occurs. While this is an extremely challenging goal, some protection technologies appear to have the potential to achieve it in many circumstances that commonly occur on Victoria's rural powerlines.

The Taskforce identified two types of equipment which satisfy these requirements – remotely controlled automatic circuit reclosers (ACRs) and rapid earth fault current limiters (REFCLs).

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. The inputs to the model include fuels, weather, to-



Fire loss consequence by powerline section based on forced Ash Wednesday conditions with fires starting at 1pm. The areas of highest risk are mainly in the Dandenong Ranges extending north through to the foothills of the Great Dividing Range, the Otway Ranges and the Macedon Ranges.

pography, fire suppression levels, assets and their values, and scenario conditions. An analysis of the fire loss consequence data revealed that, based on forced Ash Wednesday (1983) conditions with fires starting at 1pm:

- fire risk from 10% of powerlines in rural areas that supply electricity to 18,000 customers (that is less than 2% of rural customers) represents 54% of the state's fire loss consequence
- fire risk from 16,450km of powerlines (21% of total rural powerline length) that supply electricity to 40,000 customers (4% of total rural customers) represents 80% of the state's fire loss consequence
- fire risk from the remaining 62,000km of rural powerlines (79% of total rural powerline length) that supply 900,000 customers (more than 90% of total rural customers) represents 20% of the state's fire loss consequence.

This indicates that a large proportion of the state's fire loss consequence can be mitigated by targeting actions to a relatively small proportion of rural powerlines supplying a small proportion of Victoria's rural customers. These powerlines are mainly located in the Dandenong Ranges (see map).

A precautionary risk analysis model was created to test the value of potential, practical precautions based on the threat-barrier diagram. This model describes all practicable options and tests a variety of precautionary measures 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. This return frequency was reduced to one in 20 years to take into account predicted weather pattern changes. This was used to normalise the relative risk estimation of the rest of the model.

Based on the analysis of consequences produced by Phoenix, the 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. Single wire earth return (SWER) and multiwire powerline options are identified.

The precautions that are considered are shown in the table 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

Potential fatality risk reduction achieved by taking a range of precautionary measures and the cost associated with their installation.

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

As recommended by the Taskforce, the government is requiring electricity distribution businesses to install both of these devices across the state over the next decade. Electricity distribution businesses will be required to specify, through their Bushfire Mitigation Plans, the location and timing of asset roll-out. Progress against these plans will then be reviewed by Energy Safe Victoria on an annual basis. This is estimated by the Taskforce to cost about $500 million over 10 years.

Further, the government will contribute up to $200 million over 10 years for a program of power line conductor replacement. The focus will be on locations with the highest fire loss consequences.

Richard Robinson is the chairman of R2A Due Diligence Engineers. He was the expert risk management member of the Powerline Bushfire Safety Taskforce.

Transmission line for southwest Queensland

John Holland has been awarded the contract for construction of the Columboola to Wandoan South Transmission Line project in southwest Queensland. The project is being developed on behalf of Queensland electricity company Powerlink.

The scope of work for Part A of the contract includes the construction of 70km of double circuit 275kV transmission line between Columboola and Wandoan South substations, and 5.5km of double circuit 132kV transmission lines between Wandoan South and Woleebee Creek substations.

Part B of the contract includes the provision of complete assembly and workshop drawings, structure prototype inspection and prototype testing of four S-Series transmission line towers. It also involves the construction of another 65km of line in the region, with routes being finalised.

Environmental consultant Parsons Brinckerhoff was engaged to conduct an environmental impact assessment and undertake community consultation in the lead-up to the project.

Site works on Part A have started and design on Part B will begin immediately with site works scheduled to commence in early 2013.